Agreement on the Conservation of Albatrosses and Petrels

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Net Capture Programme: Investigating new tools to mitigate seabird net captures in demersal and pelagic trawl fisheries

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SUMMARY

Seabird net captures in the New Zealand squid trawl fishery remain a focus area for industry and government agencies. Despite the significant funds and resources invested into research, desk top studies, sea trials and other work, there remains no 'silver bullet' to significantly reduce the risk of seabirds getting entangled in trawl nets.

Established in 2019, the Net Capture Programme worked collaboratively to ensure all possible mitigation tools and approaches were considered and prioritised ideas for further work based on feasibility (i.e. the mitigation had to be practical within regulatory bounds and safe to use). A longlist of mitigation tools and approaches were initially considered, seven were trialled at sea, and two had shore-based trials. The level of investigation for the remainder depended on the feasibility (Appendix 1). All potential options were categorised into one of three themes:

1. **Attraction** – the mitigation minimises seabirds' attendance to the vessel by reducing cues such as sound and scent
2. **Deterrence –** the mitigation keeps attending seabirds away from the danger area (by distraction, scaring)
3. **Prevention** – the mitigation creates barriers to seabirds becoming caught (physical or visual barriers)

Few of the mitigation trials showed promise to reduce net captures in the context of New Zealand's southern squid fishery. It was concluded that attempts to minimise overall **attraction** of the vessels or using visual or sound **deterrents** are not feasible for the New Zealand squid trawl fishery. Deterrents were of little use at keeping birds away from the net when there was high bird abundance and competition (as well as weather effects). Reducing overall attraction to the vessel (in addition to measures already in place) was impractical given the multiple cues which attract birds.

The most plausible approach to reducing internal net captures (attributing to approximately 44% of captures) was **prevention,** by reducing the surface area encompassed by the headline to the end of the wings (referred to as the pooling area) in the last moments of

hauling (appendix 4, Fig. 2). However, some vessels have operational and engineering challenges with using this operation to close the headline of the net.

Despite challenges, seabird capture rates in the New Zealand southern squid fishery have appeared to be trending downwards in recent years. At this stage, it is impossible to determine all the driving factors of this reduction, but a part of this improved performance is likely attributed to a decade of incremental improvements across the fleet, facilitated by sound communication and feedback loops.

RECOMMENDATIONS

The Net Capture Programme recommends that the Seabird Bycatch Working Group:

1. Notes the range of mitigation options that have been identified, developed and tested to mitigate trawl net captures in New Zealand fisheries
2. Considers including the minimisation of the pooling area in front of the mouth of the net as one of the best practice options to minimise trawl net captures. Noting the ability to utilise vessel operational procedures rather than new engineering, whilst acknowledging limitations in applicability.
3. Notes the importance of communication and feedback loops between Government Observers, fisheries managers, vessel managers and skippers, as imperative for understanding the nature and characteristics of seabird risk with trawl nets.
4. Notes the importance of having experienced skippers and observers involved in mitigation idea development and implementation.
5. Acknowledges that the investigations and trials outlined in this paper were run within a New Zealand fishery context, regarding vessel, fishery, seabird characteristics and assemblages.

Programa Net Capture: investigación de nuevas herramientas para mitigar la captura de aves marinas en redes en pesquerías de arrastre demersal y pelágico

RESUMEN

La captura de aves marinas en redes de la pesquería de arrastre de calamar de Nueva Zelandia sigue siendo un área de interés para la industria y las agencias gubernamentales. A pesar de los cuantiosos fondos y recursos invertidos en investigación, estudios documentales, pruebas en el mar y otros trabajos, sigue sin haber una “fórmula mágica” para reducir significativamente el riesgo de que las aves marinas se enganchen en las redes de arrastre.

El programa Net Capture es un proyecto colaborativo establecido en 2019 con el objeto de garantizar que se consideraran todas las herramientas y los enfoques de mitigación posibles, y se priorizaran ideas para seguir trabajando en función de la viabilidad (es decir, la mitigación tenía que ser práctica dentro de los límites reglamentarios, así como segura).

Inicialmente se consideró una larga lista de herramientas y enfoques de mitigación, de los cuales siete se probaron en el mar y dos en tierra. El nivel de investigación del resto dependía de la viabilidad (Apéndice 1). Todas las posibles opciones se clasificaron en uno de estos tres temas:

1. **Atracción**: la mitigación minimiza la presencia de aves marinas en el buque reduciendo señales como el sonido y el olor.
2. **Disuasión**: la mitigación aleja a las aves marinas de la zona de peligro (por distracción o miedo).
3. **Prevención**: la mitigación crea barreras (físicas o visuales) que impiden la captura de aves marinas.

Pocos de los ensayos de mitigación resultaron prometedores para reducir las capturas en redes en el contexto de la pesquería de calamar austral de Nueva Zelandia. Se llegó a la conclusión de que los intentos de minimizar la **atracción** general de los buques o de utilizar **elementos de disuasión** visuales o sonoros no son viables para la pesquería de arrastre de calamar de Nueva Zelandia. Los elementos disuasorios fueron de poca utilidad para mantener a las aves alejadas de las redes cuando había gran abundancia de aves y competencia (así como fenómenos meteorológicos). Reducir la atracción general hacia el buque (además de las medidas ya aplicadas) no resultaba práctico dadas las múltiples señales que atraen a las aves.

El enfoque más plausible para reducir las capturas internas en las redes (a las que se atribuye aproximadamente el 44 % de las capturas) fue la **prevención,** mediante la reducción de la superficie que abarca la relinga hasta el final de las alas (denominada zona de agrupamiento) en los últimos momentos del virado (Apéndice 4, fig. 2). Sin embargo, algunos buques tienen dificultades operativas y de ingeniería con esta operación para cerrar la relinga de la red.

A pesar de las dificultades, las tasas de captura de aves marinas en la pesquería de calamar austral de Nueva Zelandia parecen haber tendido a la baja en los últimos años. En este momento es imposible determinar todos los factores que han impulsado esta reducción, pero es probable que una parte de este mejor desempeño se atribuya a una década de mejoras incrementales en toda la flota, facilitadas por una comunicación eficaz y circuitos de retroalimentación.

RECOMENDACIONES

El programa Net Capture recomienda que el Grupo de Trabajo sobre Captura Secundaria de Aves Marinas tome las siguientes medidas:

1. Tomar nota de la gama de opciones de mitigación que se han identificado, desarrollado y probado para mitigar la captura en redes de arrastre de las pesquerías neozelandesas.
2. Considerar la inclusión de la minimización de la zona de agrupamiento delante de la boca de la red como una de las opciones de mejores prácticas para minimizar la captura en redes de arrastre. Tomar nota de la capacidad de utilizar los procedimientos operativos de los buques en lugar de nueva ingeniería, reconociendo al mismo tiempo las limitaciones en la aplicabilidad.
3. Señalar la importancia de la comunicación y de los circuitos de retroalimentación entre los observadores gubernamentales, los administradores de pesquerías, los

administradores de buques y los capitanes como imperativos para comprender la naturaleza y las características del riesgo que corren las aves marinas con las redes de arrastre.

4. Señalar la importancia de contar con capitanes y observadores experimentados que participen en el desarrollo y la aplicación de las ideas de mitigación.
5. Reconocer que las investigaciones y los ensayos descritos en este documento se realizaron en el contexto de una pesquería neozelandesa, en relación con los buques, la pesquería, las características de las aves marinas y los ensamblajes.

Programme de capture au filet : Enquête sur de nouveaux outils permettant d'atténuer les captures d'oiseaux de mer dans les filets des pêcheries au chalut démersal et pélagique

RÉSUMÉ

Les captures d'oiseaux de mer dans les filets de la pêche au calmar au chalut en Nouvelle-Zélande restent un sujet d'intérêt pour les agences gouvernementales et du secteur. Malgré les fonds et les ressources considérables investis dans la recherche, les études documentaires, les essais en mer et dans d'autres travaux, il n'existe toujours pas de "solution miracle" permettant de réduire de manière significative le risque d'enchevêtrement des oiseaux de mer dans les chaluts.

Établi en 2019, le Programme de capture au filet a adopté une approche collaborative pour s'assurer que tous les outils et approches d'atténuation possibles étaient pris en compte ; il a également priorisé les idées pour des travaux ultérieurs basés sur la faisabilité (c'est-à-dire que l'atténuation devait être applicable dans les limites de la réglementation et sûre d'utilisation). Une liste préliminaire d'outils et d'approches d'atténuation a été initialement envisagée : sept d'entre eux ont été testés en mer et deux ont fait l'objet d'essais à terre. Pour le reste, le niveau d'investigation dépendait de la faisabilité (Annexe 1). Toutes les options ont été classées dans l'une des trois catégories suivantes :

1. **Attraction** – mesures d'atténuation diminuant la présence d'oiseaux de mer autour du navire en réduisant les signaux tels que les sons et les odeurs
2. **Dissuasion** – mesures d'atténuation éloignant les oiseaux de mer présents de la zone dangereuse (distraction, effarouchement)
3. **Prévention** – mesures d'atténuation créant des obstacles à l'enchevêtrement des oiseaux de mer (barrières physiques ou visuelles)

Peu d'essais d'atténuation se sont révélés prometteurs pour réduire les captures au filet dans le contexte de la pêcherie de calmar du sud de la Nouvelle-Zélande. Il a été conclu que les tentatives visant à minimiser l'**attraction** globale des navires ou à utiliser des **moyens de dissuasion** visuels ou sonores ne sont pas réalisables pour la pêche au calmar au chalut en Nouvelle-Zélande. Les dispositifs de dissuasion n'ont guère permis d'éloigner les oiseaux du filet lorsqu'une grande quantité d'oiseaux sont présents et se font concurrence (il faut également compter avec les effets météorologiques). La réduction de

l'attraction globale du navire (en plus des mesures déjà en place) n'était pas réalisable considérant la multiplicité de signaux attirant les oiseaux.

L'approche la plus plausible pour réduire les captures internes au filet (qui représentent environ 44 % des captures) est la **prévention,** en réduisant la surface entre la ralingue et l'extrémité des ailes (appelée zone de pooling) lors des derniers moments du virage (annexe 4, Fig. 2). Certains navires rencontrent toutefois des difficultés opérationnelles et techniques lorsqu'ils utilisent cette procédure pour fermer la ralingue du chalut.

En dépit de ces difficultés, les taux de capture d'oiseaux de mer dans la pêcherie de calmar austral de Nouvelle-Zélande semblent avoir entamé une tendance baissière ces dernières années. À ce stade, il est impossible de déterminer tous les facteurs à l'origine de cette réduction, mais cette amélioration des performances peut probablement être partiellement attribuée à une décennie d'améliorations progressives de l'ensemble de la flotte, facilitées par une bonne communication et de solides retours d'information.

RECOMMANDATIONS

Le Programme de capture au filet recommande que le Groupe de travail sur les captures accessoires :

1. Note la gamme d'options d'atténuation identifiées, développées et testées pour limiter les captures au chalut dans les pêcheries néo-zélandaises
2. Envisage d'inclure la minimisation de la zone de pooling devant l'embouchure du filet comme l'une des meilleures pratiques possibles pour réduire au minimum les captures au chalut. Note la possibilité d'utiliser les procédures opérationnelles des navires plutôt que de nouvelles techniques, tout en reconnaissant les limites de leur applicabilité.
3. Note l'importance de la communication et des retours d'information entre les observateurs gouvernementaux, les gestionnaires de pêcheries, les gestionnaires de navires et les capitaines, comme impératif pour comprendre la nature et les caractéristiques du risque que représentent les chaluts pour les oiseaux de mer.
4. Note l'importance de la participation de capitaines et d'observateurs expérimentés à l'élaboration et à la mise en œuvre des idées relatives à l'atténuation.
5. Reconnaisse que les recherches et les essais décrits dans le présent document ont été menés dans le contexte de la pêche en Nouvelle-Zélande, en ce qui concerne les caractéristiques et les assemblages des navires, des pêcheries et des oiseaux de mer.

1. INTRODUCTION

1.1. Background

New Zealand's southern squid trawl fishery operates in high latitudes (48ºS-51ºS), on the Stewart Snares Shelf (FMA 5) and off the Auckland Islands (SQU 6T) (Figure 1), during the austral summer and autumn months. The fleet uses both bottom and midwater trawls, on well-defined and relatively small grounds on the shelf edge. In 2022, 23 trawl vessels operated in the southern squid fishery. Over the years the number of vessels and the amount of effort in this fishery has decreased, due to a range of policy and economic factors. Since 2003, squid fishing effort has halved from around 8,000 trawl shots a year to around 4,000 trawls annually (Deepwater ARR 2020-21 and Figure 2).

Vessels that operate most frequently in this fishery range between 42 and 104 metres in length (Appendix 2). The fleet is currently made up of:

- Five foreign-owned charter vessels including one Japanese and four Korean-built vessels between 55 and 67 metres in lengths,
- Six[1] 104 metre long BATM[2] class vessels
- Twelve domestic (Spanish and Norwegian-built) vessels ranging from 42 metres to 70 metres.

Operations vary between vessel classes, as well as fish waste management and mitigation deployment. All vessels are required by law to deploy at least one seabird scaring device (Seabird Scaring Devices Circular 2010) and additional non-regulatory measures are prescribed within the vessel-specific risk management plans (VMPs) and Operational Procedures. Deepwater Group (DWG) and Government Observers (hereafter called Observers) monitor adherence to these plans and instances of non-adherence are followed up as soon as practicable.

The ocean environment where the southern squid fishery operates is known for its hostile conditions (Roaring 40s and Furious 50s) due to its exposure and proximity to the Southern Ocean. Over two-thirds of the time, wind speeds exceed 38 km/h and frequently exceed 50 km/h (Meteoblue – Auckland Islands). Accordingly, large swells above three metres are also very common and the relatively shallow shelf makes for difficult seas even in summer.

There is significant overlap with foraging seabirds notably due to the proximity of adjacent breeding areas of sooty shearwaters (*Puffinus griseus* approx. 10 million pairs) white-chinned petrels (*Procellaria aequinoctialis* 200,000 pairs) and two albatross species, white-capped and southern Buller's (*Thalassarche cauta* and *T. bulleri* – approx. 95,000 pairs and 12,000 pairs respectively).

Since its development in the early 1980s, the fishery has been recognised for interactions with all of the above species – sooty shearwaters, white-chinned petrels, and white-capped albatross and southern Buller's albatross.

Between 2010 and 2018 there was considerable focus on reducing the risk of seabirds being caught on warps (cables) through warp mitigation and effective fish waste management.

[1] Some BATM vessels are domestically owned
[2] BATM-1288 vessels, a class of 104 m factory trawlers constructed in eastern Europe and designed for distant-water fisheries

However, interactions between seabirds and trawl nets in the New Zealand deepwater trawl are now responsible for a significant proportion of recorded seabird captures (Cleal, J. *et al* 2009).

Reduction of warp captures

The early focus was on the effects of net sonde cables (prohibited in 1992) and more recently (2000-2006) warp strikes on albatross. Both regulatory (Regulations Factsheet) and non-regulatory vessel risk management measures (DWG Seabirds OP) have significantly reduced the risks of warp captures with high certainty. Between 2003 and 2012, observer coverage in the squid fishery was between 15% and 39%, this increased to 74 - 89% in recent years (Figure 2). During this period of higher observer coverage capture rates of seabirds decreased from over 20 captures per 100 tows to around 10 (FNZ seabird Annual Report 2020-21, PSC Website).

Gross capture rates/trends

Gross capture rates and trends continue to both fluctuate and be significant enough to continue to cause concern. Whilst sooty shearwater and white-chinned petrels have always been observed captured in squid trawl nets and dominate the total interactions, it is now more common to also see albatross caught. A fraction (varying annually between approx. 30-50%) of these interactions are non-lethal as birds are reported as released alive; however, some are obviously compromised, and all are fate unknown. Assessment of risk to seabirds and seabird populations is reviewed annually by Fisheries New Zealand (AEBR 2021 pp211-316 here) and considers cryptic mortality and potential population-scale effects.

For the entire New Zealand deepwater trawl fleet, the squid fishery accounts for the majority of seabird captures annually due to its temporal and spatial overlap. The relatively high interaction rates, high observer coverage and species mix make it an obvious target to seek to both minimise impacts and trial tools and measures with some real ability to detect efficacy.

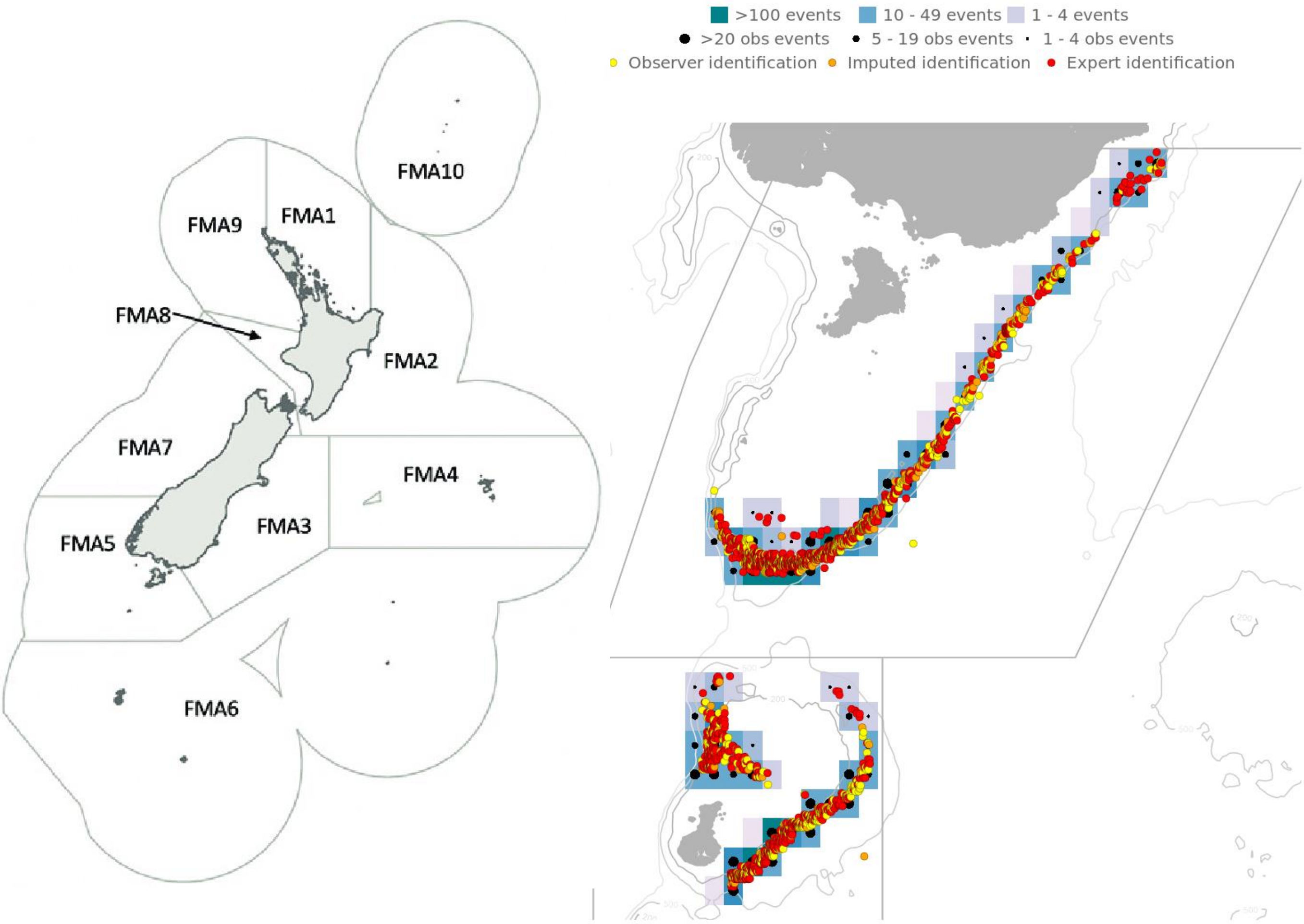

Figure 1: Left - New Zealand Fisheries Management Areas (FMAs). Right – Map of fishing effort and observed captures, 2012–13 to 2019–20 at the Stewart Snares Shelf and SQU 6T. Fishing effort is mapped into 0.2-degree cells, with the colour of each cell being related to the amount of effort. Observed fishing events are indicated by black dots (PSC website).

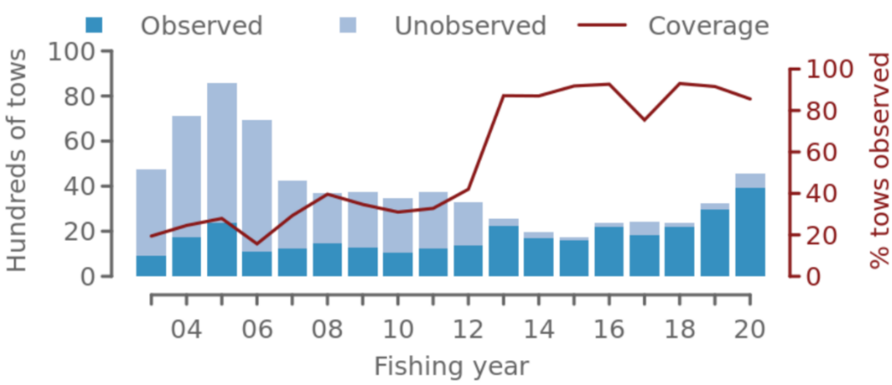

Figure 2: Fishing effort and observed effort in squid fishery in FMA 5 (Stewart Snares Shelf) and SQU 6T (Auckland Islands) between 2003 and 2020 (PSC Website).

1.2. Literature review

Since 2008, industry and government have been driving research and management to better understand the risks of trawl nets to seabirds and how to mitigate against captures. S.J. Baird (2008) used qualitative information from observer reports and observer data to characterise the risk factors related to net captures. The study concluded that potential causes of net captures were primarily related to the net being at the surface for long periods of time, poor fish waste management and not cleaning the net properly before shooting. This study illustrated some primary risk factors and was an important first step in better characterising the net capture issue. ACAP incorporated these findings into the pelagic and demersal trawl best practice and DWG ensured this was also reflected in the Operational Procedures for the deepwater fleet.

Eight years later, S.J. Baird and I. J. Doonan undertook further research based on observer data characterising seabird net captures in squid trawl fisheries. The paper was never published due to complications.

In 2013, Southern Seabirds Trust (SST) facilitated a workshop with fishing operators and representatives from Fisheries New Zealand (FNZ) to investigate mitigation measures that had the potential to minimise risk of net captures. This information fed into an Information paper submitted to ACAP SBWG in 2014 (SBWG6 Inf-04 here). Additionally, a Mitigation Stocktake paper (Parker, 2017) commissioned by SST was published in 2017 (Mitigation Stocktake).

More recently Edwards, C.T. and Dunn, A. (2021) assessed risk factors for seabirds in sub-Antarctic trawl fisheries. This study looked at vessel effects as well as environmental effects which contribute to risk. Conclusions suggested that there was evidence of a fishing effort effect in multiple instances, particularly concerning the time the net was at the surface, but the overall effect was small.

Results from these studies show the unpredictability of net capture events, especially with single capture events. The multitude of covariates that leads to this stochasticity and the many overlapping complexities are difficult to pull apart statistically.

There have been significant funding and resources invested into understanding the nature of net capture events. Despite the difficulties in understanding the more subtle risk exacerbators, the fishing industry, SST and government agencies continue to investigate new tools and approaches to mitigate net captures.

2. THE NET CAPTURE PROGRAMME

The Net Capture Programme (The Programme) was established in 2019 by SST and DWG to brainstorm, investigate, develop and trial new tools and operations to minimise net captures in New Zealand's deepwater trawl fleet. The Programme was initiated following industry acknowledgment of additional work needed. As with previous studies, the fishery of particular focus was the southern squid fishery due to its high observer coverage, spatial-temporal characteristics overlapping with the breeding range and season of many New Zealand seabird species, and the resulting relatively numerous net capture interactions.

To drive the workstreams of this programme, a core group was formed, consisting of representatives from the fishing industry[3], the Department of Conservation (DOC), FNZ, and SST. As the programme progressed, including the initial meetings, other technical expertise,

[3] Majority of vessel operators in squid fishery, led by DWG

including skippers, seabird experts, fishing gear technicians and Government Observers, were brought in to support the process. The wide involvement and expertise within the programme meant that investigations could cover a wide stretch of possible new tools and approaches. Advise and expertise was also sought from other nations such as the UK, South Africa, USA and Australia to understand whether there were similar issues elsewhere in the world and what work was being done to manage the risks. The collaborative nature of the programme also meant the process was transparent and well-documented.

Integration of fishers' knowledge and perspectives when developing mitigation has the potential to result in more practical and acceptable solutions that could lead to more successful outcomes for implementation (Suuronen, P. 2022). The group maintained that the process was kept operational and skippers' input was requested throughout the programme to advise on new tools and trial opportunities. Furthermore, fisher participation may help to incorporate valuable knowledge in the process which may foster a sense of ownership and increase credibility and acceptance of mitigation (Suuronen, P. 2022).

Between June 2019 and December 2023, the Programme members met at least twice per year with multiple subgroup intercessional meetings. Initial meetings consisted of the group reviewing the landscape of the problem at hand and included discussions contextualising:

- where seabird captures are occurring (e.g. geographical location, location on or in the trawl net, etc.)
- the timing of bird captures
- attractions to the vessels (e.g, mealplant odour, sound of hauling and shooting operations)
- seabird feeding behaviour and seasonal patterns.

Much of this information was derived from anecdotal information provided by skippers, statistical evidence provided by FNZ and historical knowledge from experienced members of the group.

2.1 Net capture characteristics

Skipper and Crew Feedback

Skippers and crew were involved from the outset of the programme to provide first-hand knowledge and advice on the process. Given the long close association of DWG with the squid fleet (from 2005) in relation to seabird and marine mammal interactions, trust and credibility have built up over time to promote useful exchanges from the vessels. Skippers were present and contributed to both initial workshops. Further, a "deck crew information form" was created to get first-hand basic information from the crew working on deck during gear shooting and hauling operations, as they are closest to the action.

Over time, some skippers were re-engaged when in port or while at sea. Additionally, several vessels took part in full at-sea trials and provided their own support and feedback. Later in the programme, an information sheet was produced for both skippers and Government Observers to try and maximise the synergy between them in considering and collating information on causes and cures (Appendix 5).

Observer data

Both qualitative and quantitative information was used to identify drivers and characteristics of net captures. Seabird capture data were obtained from the FNZ Central Observer Database

(COD) and were analysed throughout the year, with the primary focus being on the squid fishery during the summer and autumn months when fishing effort and bird abundance are highest.

Between 2012 and 2022, on average >80% of squid trawl effort has been observed. This high observer coverage means we have high confidence in the protected species capture data from this fishery.

In 2020, additional ‘capture type’ fields were added to the observer Protected Species Interaction (PSI) form (Appendix 4). Observers are required to record details of the capture location (in terms of where in fishing gear), including whether the bird was captured inside the net or whether it was entangled externally in the wings, lengthener or codend (Figure 3). Other information recorded by Observers such as alive vs dead captures, condition of the bird, and other comments help improve understanding of risk. Comparing capture rates between vessels and vessel class also helped with contextualising the risk with different gear types and operations.

Below are some key learnings from Observer data collected during the Programme between 2019 and 2022:

- The majority (>75%) of observed seabird net captures in the deepwater trawl fisheries occurred in the Southern Ocean (FMAs 5 and 6) between December and May, primarily by vessels targeting squid.
- Most captures occur on “normal” tows (i.e. tows without gear breakdown or other unusual events).
- Of net captures, approximately 47% of birds are caught internally.
- Approximately 60% of birds captured are dead.
- Approximately 88% of birds caught inside the net are dead.
- If caught externally on the net the likelihood of them being dead is about 50%.
- Of externally caught birds, most are caught in the wings, less on the lengthener and the least are entangled with the codend.
- 80% of birds caught inside the net are petrels and shearwaters.
- Approximately twice as many albatrosses are caught externally in the net compared with internal captures.

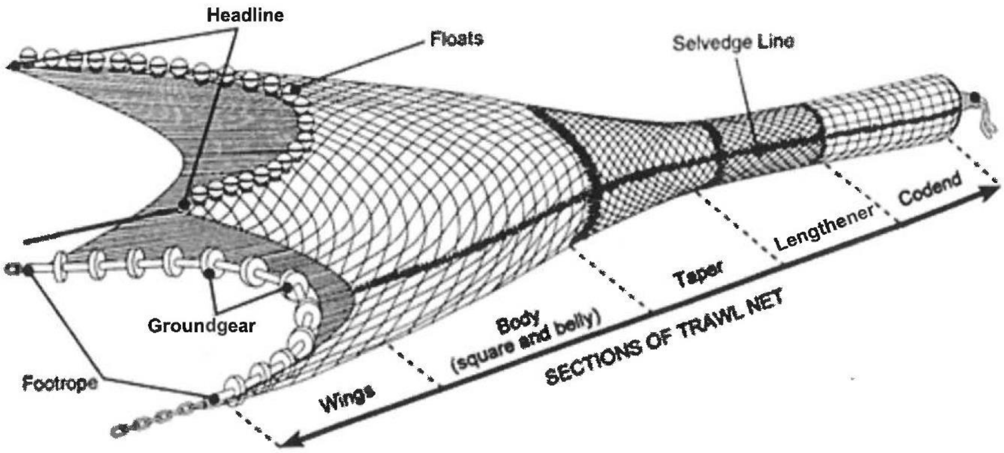

Figure 3: Diagram of midwater trawl net

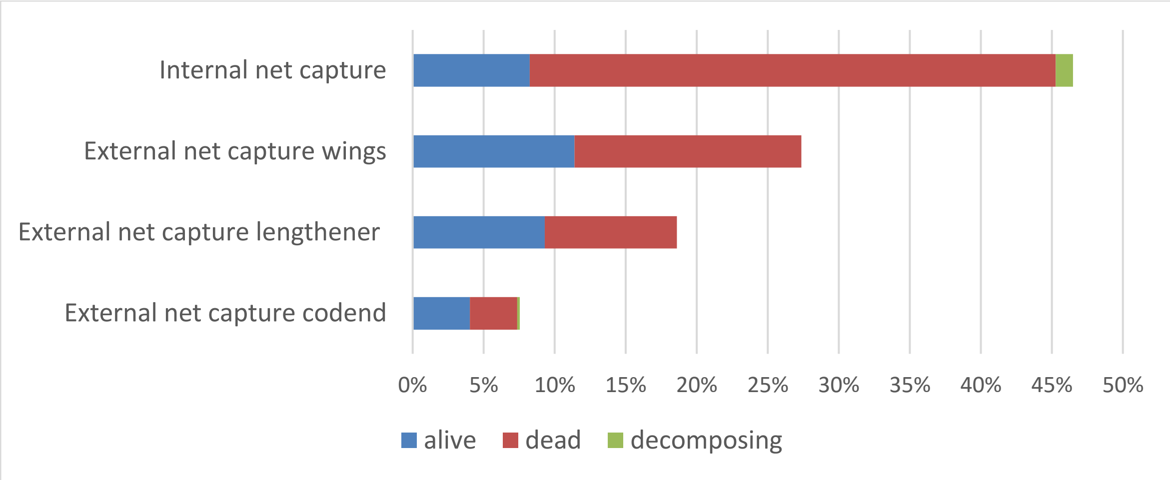

Figure 4: Observed seabird capture location and life status as a proportion of all seabird net captures in the southern squid trawl fishery (FMA 5 and FMA 6) across the 2019/20 and 2021/22 fishing years.

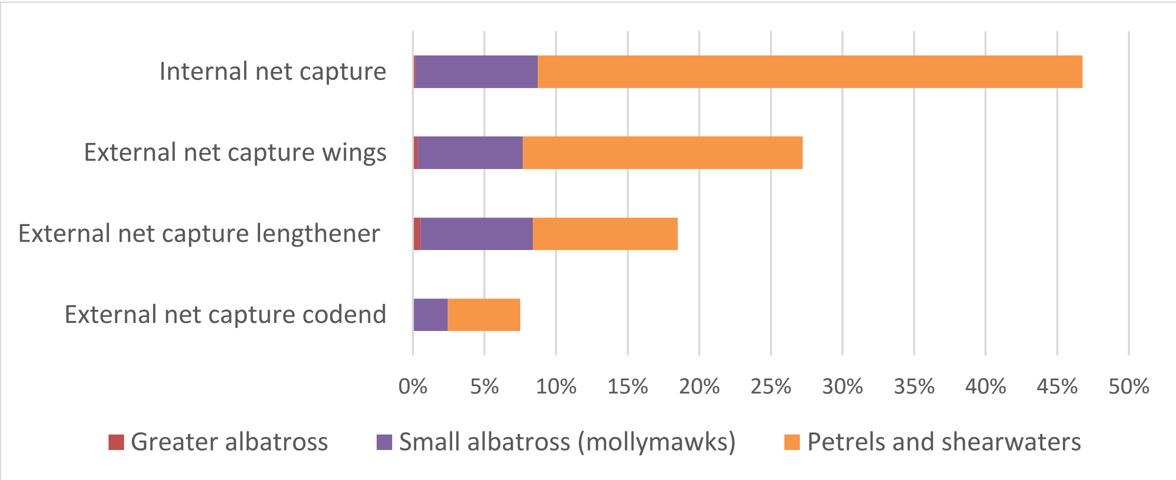

Figure 5: Observed seabird capture location and bird type caught as a proportion of all seabird net captures in the southern squid trawl fishery (FMA 5 and FMA 6) across the 2019/20 and 2021/22 fishing years.

Observer interviews

While the capture data were useful for the analysis, comments and feedback from Observers and skippers were also crucial to receive a qualitative view of risks and where improvements to mitigation might be useful.

Throughout the Programme, Observers were invited to share their knowledge and experiences with the wider group. Observers were formally interviewed on two occasions, once in April 2021 and a second time in June 2022. The Observers were chosen based on their experience in the squid fishery and across the different vessel types within it (Appendix 2). Experience as Observers ranged from 2 years to 25 years. Throughout the interview process, it was acknowledged that the opinions of the Observers were subjective.

Outside of the more formal interview process, DWG and FNZ members had email and phone conversations with other experienced Observers to improve understanding.

Key discussion points with Observers included:

- Observers' view of relative risk of parts of the net.

- Observers' view of shoot vs haul capture rates.
- Risk exacerbators.
- If any vessel was a standout with regard to better operational fishing "processes" that are thought to reduce risk.
- Any current mitigation devices which could be improved to minimise net capture events.
- What are gaps in our understanding of the interactions, and what additional data collection/investigations are suggested (i.e. what don't we know and what could be done to record and report this)?
- Ideas from Observers on how to stop seabirds getting caught in or on nets (whether gear design, new mitigation devices or fishing operations).

Feedback from Observers

Almost all Observers interviewed reported that bird behaviour and abundance were the main factors contributing towards net captures. Many Observers also noted that poor weather conditions contributed towards captures, by increasing the time it takes to haul the net (i.e. more net time at surface), or heavy seas increasing the movement of the net.

Some Observers noted the difference in net configuration between different fisheries. The headline of squid trawls tends to be much longer than that of hoki trawl, meaning there is more opportunity for diving birds to get inside the mouth of the net. It was also noted that squid tows are much cleaner (less bycatch) than hoki targets, resulting in less fish waste being discharged during the tow and birds becoming increasingly competitive when the net is hauled and food becomes available.

Tools and approaches suggested by Observers were largely similar to approaches already suggested by the net capture group, including strategic batch discarding (i.e distraction feeding), biodegradable dye bags, mesh alterations, water sprayers and lasers.

A concept that was discussed by one group of Observers was the "pooling area" astern of the vessel (Appendix 5, Fig 2). This area is formed between the headline and the stern when the net reaches the surface. They noted that any operations or tools to minimise the size of the pooling zone will reduce the risk of birds getting caught inside the net. This is particularly relevant for diving birds such as petrels and shearwaters which account for approximately 80% of internal net captures (FNZ COD and PSC Website).

It was noted that some of the views held by observers contradicted what was previously thought. One observer made the point that hauling as fast as possible is not always the best approach. They noted that managing the haul speed based on bird behaviour should be preferred. Hauling slower at times may enable birds time to escape the net if trapped. However, adjusting haul speeds will always need to be considered in the operational context.

Overall, discussions with observers helped contextualise the issues but solutions remained a challenge.

3. MANAGING RISK

As part of the first meetings, the group listed and discussed all possible options to manage risk of seabird captures, including operational changes and new tools. The thinking was purposefully not constrained in the initial stages of this process, as the group wanted to consider all conceivable options, although some of the options seemed unrealistic from the outset. A list of over 40 possible mitigation tools were put together after initial meetings in June 2019 (see Appendix 1 for full list). All potential ideas were categorised into one of three themes:

1. **Attraction** – the mitigation minimises seabirds' attendance to the vessel by reducing cues such as sound and scent
2. **Deterrence** – the mitigation keeps attending seabirds away from the danger area (by distraction, scaring)
3. **Prevention** – the mitigation creates barriers to seabirds becoming caught (physical or visual barriers)

These three themes are discussed below.

3.1. Attraction

ACAP recommends a number of measures to minimise general attractiveness of commercial trawl vessels. ACAP considers that in all cases, the discharge of offal and discards is the most important factor attracting seabirds to the stern of trawl vessels. The DWG Operational Procedures align with these recommendations and adherence is monitored by Government Observers.

However, there are many other cues that can attract seabirds to fishing vessels, meal plant smell, sound of winches and boat operations, and visual cues (e.g. other bird attendance and vessel signals). While improvements in fish waste management has been key in reducing seabird attendance at the stern of the vessel (Cleal, J, *et al* 2009), the meal plant odour and the noise of vessel hauling operations are still significant signals to birds further afield.

From the initial workshops, the group put forward a selection of ideas to be considered as ways to minimise seabird attraction to vessels, including:

- Masking/reducing winch noise.
- Reducing meal plant smell
- Use venturi system to transport fish waste under water
- Mechanised sticker removal

3.2. Deterrence

Once seabirds are in the vicinity of the vessel, deterring or keeping them from the net and shooting/hauling zone is a key mitigation approach. Visual deterrents such as tori lines, warp scarers and bird bafflers have been recommended as best practice mitigation by ACAP in many fisheries including demersal and pelagic trawl and have been proven to reduce capture risk on baited hooks and trawl warps. Given these are already mandatory, the Net Capture Programme was interested in other ways to deter or distract birds from the area of the trawl net specifically.

From the initial workshops, the group put forward a selection of ideas to be considered as ways to deter or distract seabirds from the trawl net, including:

- Acoustic deterrents (e.g. net mounted acoustic devices, ultrasonic sound and underwater acoustic devices)
- Visual deterrents: (e.g. above and below water lasers, coloured meshes on the wings of the net, drones, dye release, water sprayer, additional tori lines and pop-up whippy poles)

- Distraction feeding: (e.g. strategic batch discarding, discarding frozen blocks of fish waste or catapulting fish waste away from vessel.

3.3. Prevention

Physically preventing seabirds from entering or becoming tangled externally on the net is the third key mitigation category. Seabird entanglement in trawl nets generally occurs as birds attempt to access food through the mesh of the net (Edwards, C.T.T, *et al* 2021). Diving birds such as white-chinned petrels and sooty shearwaters are also often caught inside the net, as they become trapped under the headline when foraging for fish or other small edibles during hauling.

ACAP recommends two options as best practice, which were considered as 'prevention' tools, these are net weighting and net binding. ACAP does not currently recommend any mesh alterations as best practice due to insufficient information (acap.aq).

Several ideas were put forward by the group to be considered as ways to prevent seabirds from becoming entangled or caught inside the net. These included:

- Net binding (and alterations of current best practice)
- Sinking the net quickly by adjusting operations and/or shooting the net into the weather.
- Net mesh alterations
- Retractable net covers
- Reducing vertical movement of the net
- Closing the mouth of the net on hauling

4. PRIORITISATION PROCESS

Once a wide suite of options had been collated from the meetings with the Programme group, a subgroup was mandated to crystallise options for further consideration, investigation and possible trial.

Whilst the earlier meetings were held on an "all ideas on the table" basis in order not to constrain thinking, the discussion regarding candidate tools and ideas needed to be filtered, due to the constraints of reality. The group considered three components to keep in mind during the prioritisation part of the process:

- **Regulatory environment** – Are there any regulations that would inhibit the use of such tools or operations? E.g. animal welfare issues, fisheries legislation, maritime rules, food production and health and safety requirements,
- **Practicality** – Is the proposed mitigation practically feasible in the real world? i.e. the mitigation had to be commercially viable, cost-effective and usable in the operating environment.
- **Risk** – The mitigation must not increase the risk to seabirds (e.g. deter birds to an area of the vessel of greater risk or directly harm birds) or other protected species. It must not create a risk to the vessel or crew or to fish quality.

Each member of the group was assigned mitigation tools to investigate further and to assess against the three considerations above.

In November 2019, the group established a priority list of mitigation to progress. The tools which did not meet the components above continued to be investigated but were not prioritised.

Further meetings of specialist groups were held to further develop the candidate projects with gear and engineering specialists involved as appropriate. Meetings were documented and notes circulated to the wider group to maintain inclusion, knowledge and consensus.

The arrival of Covid-19 impinged on the programme due to lockdowns preventing vessel visits, face-to-face group meetings and the importation of some materials.

4.1. Summary of prioritised projects

Fishmeal Plant Steam Condenser (odour scrubber)

Theme: Attraction

Objective: Remove particles from meal plant exhaust to minimise smell

Trialled: Partial

Summary:

The Net Capture Programme investigated the plausibility of using a condenser (or scrubber) to remove the meal plant odour as it passed through the smoke stack. Meal plant engineers and technicians were heavily involved in designing a possible system that could be effective. After an in-depth investigation into the feasibility, it was concluded that costs were too significant (upward of $350,000 per vessel) to be trialled and the overall effectiveness of the concept was limited as there are other cues to which seabirds are attracted, such as sight and sound.

While this investigation was underway, one operator was trialling a shore-based chemical odour scrubber. This trial was also discontinued due to health and safety concerns with the use of chemicals.

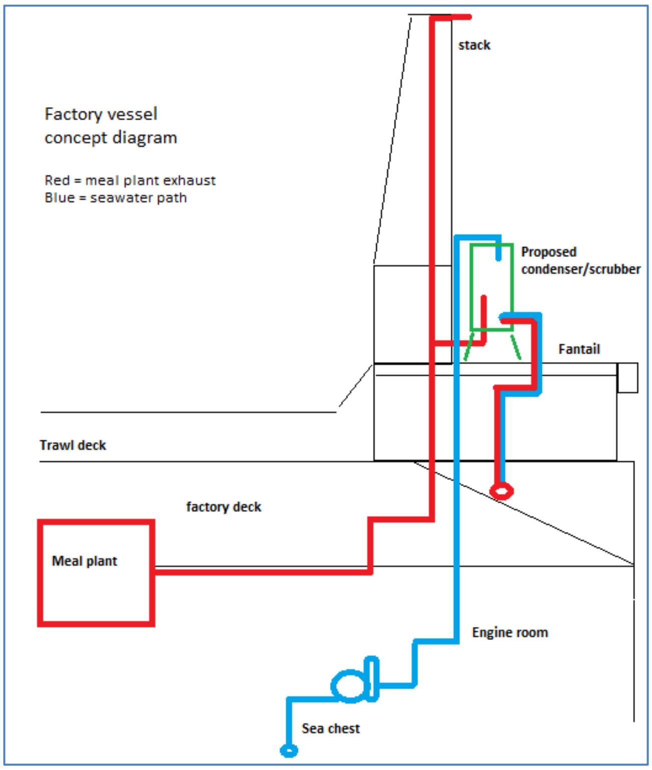

Figure 5: Concept for meal plant condenser

Strobe on net

Theme: Deterrence

Objective: Attach strobe lights to the nets

Trialled: Yes

Summary:

After a shore-based trial with black-backed gulls (*Larus dominicanus)* and red-bill gulls (*Chroicocephalus. n. scopulinus)*, it was concluded that the strobe lights were ineffective at deterring the birds during daylight. Trials were not completed during the night.

There is a chance that a stronger more intense light may be more effective for deterring seabirds however there were concerns over animal welfare, crew safety and navigation with using strong lights.

Until there is better information about the effect of strong lights (lasers and strobes) on birds' eyesight, strobe trials as mitigation will not continue.

Water sprayer from vessel
Theme: Deterrence **Objective:** Water spray/curtain to cover the net during hauling **Trialled:** Yes
Summary: The group investigated the concept of using a high-pressure water sprayer mounted at the stern of the vessel to deter/ block seabirds from the hauling zone and net. It was determined that the spray must reach a considerable distance behind the vessel to be effective, and therefore significant water pressure was required. A single vessel in the fleet had sufficient pressure and capacity to operate the water sprayer without drawing water away from the factory. This vessel was chosen to complete the trial, however, it became immediately evident that this would not be a viable mitigation option across the fleet. A high-pressure irrigator water sprayer (Nelson Irrigation) was mounted to the vessel and an initial trial was completed at the wharf under calm conditions and was filmed for future reference. The spray was able to reach back approx. 40 metres depending on the arch of the spray. The sprayer was then trialled at sea on the same vessel under fishing conditions. An Observer was deployed onboard and was tasked with recording performance of the sprayer, seabird behaviour and overall effectiveness as a bird deterrent. The Observer also filmed the trial for future reference. Results from the trials concluded that, while the water sprayer was able to reach a moderate distance behind the vessel during the shore trials, the sprayer was ineffective at sea when wind speeds reached above 15 knots (wind speeds are typically greater than this in the area). The vessel adjusted the nozzle angles in different ways to get more direct pressure at the hauling zone but the birds continued to forage as usual and were undeterred. The Observer reported similar conclusions. The water sprayer trial was discontinued. However, it should be noted that this may still be a viable option in other fisheries, depending on the vessel configuration and environmental conditions. The typical high wind speeds of the sub-Antarctic and the required water pressure make the water sprayer an unfeasible mitigation option for the New Zealand squid fishery.  Figure 6: High-pressure water sprayer installed on vessel

Strategic batch dumping
Theme: Deterrence **Objective:** Dumping fish waste prior to shooting and during haul to distract birds **Trialled:** Yes
Summary: The concept of this mitigation approach was that seabirds in attendance of a vessel would be attracted to deliberately discharged fish waste in a safe area during time of risk of net captures. The vessel would store enough fish waste from the previous tow and discharge immediately before hauling so that the batch of food is behind the net when it surfaces. While ACAP recommends batch discarding as best practice when unable to hold fish waste for warp mitigation, it has not before been proposed as a distraction tool. The first trial took place on a 66m trawler in FMA 5. An observer was deployed on board to record how the birds responded to the batch and to assess overall effectiveness of the trial. During normal trips, the vessel would meal fish waste but for the purpose of the trial, the vessel stored fish waste in batching tanks to be strategically discharged. After initial trials, the skipper noted that there is a possible effect of distracting birds when there are small numbers and when there was enough offal to discharge. The composition of fish waste also made a difference - When using hoki, javelinfish and rattails, the birds were more attracted compared with using barracouta offal and shark. When there were large numbers of birds the batch discarding was less effective, especially when there wasn't much fish waste available to dump. The skipper noted that it could be a measure when bird captures are getting high but it is not a practical solution. There was also concern that the vessel would be losing product stream to the meal plant which would an economic effect. A second trial was conducted on a trawl vessel with a much larger batching tank (approximately 5-5 tonnes of fish waste). The Observer on board recorded three scenarios to assist with comparability – hauling without batch discard, batch discard without the net in the water and strategic batch discard during hauling. The Observer noted that there was a variation in birds and behaviour between the different scenarios but this could have been due to many factors, (e.g. other vessels in the vicinity, fish waste volume and composition, and bird species composition). During the strategic batch discharge while hauling, the trial was cut short due to the number of birds gathering in the hauling zone. It was believed that the batch discharge was timed poorly and with the current direction, the offal was transported to the stern of the vessel into the propellor wash, immediately before the net reached the surface. The offal release was immediately ceased as the risk of capture was deemed to have been elevated. The group analysed the videos and read the notes recorded by the Observer. The group concluded that strategic batch discharging was not a practical solution and was dependent on many variables for it to be effective, e.g. current direction during hauling, volume and composition of fish waste available, other vessels in the vicinity and seabird assemblages. If conditions weren't ideal, then the risk could increase significantly.

Coloured mesh
Theme: Deterrence **Objective:** Make the netting more visible to seabirds while hauling and shooting the trawl. **Trial:** No
Summary: The initial concept was to change the wing netting and upper panels of the trawl net to a brighter colour to deter the birds. The ordering of materials was disrupted by COVID-19, and cost were more expensive than expected (approximately $6,000). After additional discussion and review of previous work done (Cleal, J. *et al.* 2009) about the feasibility of the idea, the group re-considered its overall effectiveness. It was noted that many codends are brightly coloured and do not deter birds. Likewise with the brightly coloured (orange, yellow and blue) buoys on the headline (Figure 7). Seabirds do not appear to be deterred from these bright colours, especially during competitive feeding behaviour. It was considered that different coloured netting panels would provide little benefit to deter birds. The Net Capture Programme did not continue the investigation into coloured mesh as a mitigation tool for these reasons.

Coloured streamers from headline
Theme: Deterrence **Objective:** Attach red streamers to the headline of the net **Trial:** Yes
Summary: The concept was that brightly coloured streamer attached to the headline would move in erratic ways from the water and would deter sections of the net. The red streamers were installed on the headline of a trawl net of a 66-metre trawl vessel and trialled in FMA 5. The streamers were trialled in a range of sea conditions, moon phases and bird activity. An Observer was deployed on this trip and was tasked with taking notes on the effectiveness of the streamers, along with the skipper. The skipper and Observer noted no change in bird behaviour between conditions. There was no visible effect on bird behaviour with the presence of streamers. The birds would continue to forage as usual, as if the streamers were not there. Two seabird captures occurred while the streamers were being used but the events were considered unrelated.

After discussions with the skipper and the wider net capture group, it was decided that the streamers were ineffective, and the trial was discontinued.

Figure 7: Red streamers attached to the headline

White strips from headline
Theme: Prevention **Objective:** Attach wide white synthetic strips from the headline and upper panels of the trawl net **Trial:** Yes
Summary: The concept for the wide white strips was to attach five strips of light but very strong synthetic sheet material to the headline and upper panels of the trawl net, similar to the coloured streamer trial. It was envisaged that the water flow would make the strips move erratically, deterring birds from the top of the net and also acting as a block to prevent the birds from getting entangled or through the meshes. Two trial trips were conducted on two separate trawl vessels of similar size (66 m and 65 m). As with the installation of the coloured streamer, the white strips were relatively cheap and easy to install. There were minimal modifications to the net and all regulatory specifications were adhered to. The first trip took place between 1 September and 3 November 2020 (approx. 2 months) in FMA 5 and 6 while targeting ling. Trials of the white strips were completed daily, during a variety of weather conditions and bird activity. During setting the skipper noted that the birds were undeterred by the strips and foraged as normal. It was also noted that the strips would tangle because of the lack of linear water flow. During hauling the strips did not tangle due to the water flow keeping them spread out. However, the birds' behaviour was not affected by their presence, the skipper noted that the birds used the strips as a platform as they fed on the fish in the net. While the seabirds were not deterred by the strips, the skipper noted that they were more effective at blocking the birds, although the effect was not significant as the strips only covered a small section of the net.

The second trial was completed between October and November 2021 on the Chatham Rise (FMA 3 and 4) targeting hoki. The skipper during this trial noted similar results – seabirds were not deterred by the presence of the white strips during setting or hauling. Additionally, the skipper noted that the strips made removing stickers and checking the net for damage more difficult.

Figure 8: Wide white strips attached to upper panels

After the completion of the trials, the Net Capture Group reviewed footage of the trials being done and derived a similar conclusion as the skippers. Due to the operational challenges, risks of not being able to remove stickers and the apparent ineffectiveness of the strips, the group discontinued trials.

Dye trials

Theme: Deterrent

Objective: Release environmentally friendly dye from the stern of the vessel immediately prior to hauling

Trial: Yes

Summary:

Green dye bags are often used in tuna purse seine fisheries to herd the fish. It was considered that using the same dye bags could deter seabirds from the hauling zone of the trawl if timed correctly.

Two dye trials were undertaken on a large trawl vessel while fishing in FMA 5 targeting squid. There was no Observer onboard, however crew filmed the trials for review by the Net Capture Programme. At the time of both trials, there was a large abundance of birds, including white-chinned petrels, mollymawks and great albatross. A designated crew member was tasked with throwing the dye bag astern of the vessel seconds before the headline reached the surface. On both occasions the deployment objective was achieved, however there was no evidence of the birds being deterred. From the footage, it even appeared that some birds were attracted to the dye.

This proposed mitigation was deemed ineffective.

Operations to sink gear quickly
Theme: Prevention **Objective:** Shooting net into weather or adjusting shooting technique to sink gear more rapidly **Trial**:Yes
Summary: To reduce risk of seabird entanglement, ACAP recommends minimising the time the net is at surface during hauling. It may also be important to sink the gear more rapidly during shooting. Feedback was requested from skippers on the ability to sink trawl nets more rapidly. It was noted that extreme caution is needed to ensure any change in the shooting operation does not increase the risk of having gear entanglement or the need to re-shoot which would increase the risk to birds and potentially marine mammals also. It was noted that some vessels in the deepwater fleet already use operations to sink the gear as quickly as possible. One skipper explained how they use the weight of the ground gear to “bulldoze” the codend over the stern ramp to ensure the net is out of diving depth from birds as quickly as practical. The skipper notes that this operation is effective at reducing risk, if executed correctly but requires great seamanship and an acute awareness of the operating and sea, conditions. While minimising net time at the surface during shooting should be incorporated into the mitigation toolbox, analysis of the capture location in trawl nets and life status suggests the majority of captures occur during hauling.

Closing the net during hauling
Theme: Prevention **Objective**: Close the mouth of the net during hauling by turning the vessel or by other method **Trial:** Trial conducted in the past
Summary: Operations to close the trawl net during hauling ere recommended by Cleal, J. *et al.* (2009). It was considered that any method that minimises the spatial volume of netting available on the surface and the net mouth opening itself was a logical first step to reduce risk. Closing the mouth of the net would prevent diving birds from entering the net and close up the meshes to minimise chances of birds being entangled externally. Trials undertaken in 2006 indicate the merits of turning the vessel to close the net (by bunching it against a stern quarter of the trawl ramp) as a mitigation approach. However, it was noted that there were practical issues associated with this method; on congested fishing grounds or in bad weather it may be difficult or unsafe to execute the procedure properly. Additionally, for some vessels this may be operationally difficult under normal conditions, due to the hauling set up of the vessel i.e. vessels that haul directly onto a netdrum (Cleal, J. *et al* 2009), or vessels that use arenas to store the net (in New Zealand, these are Sterkoder class and other Norwegian designed vessels). Since 2006, many vessels in the New Zealand deepwater trawl fleet have adopted this method of hauling. In particular, the foreign-owned fleet have indicated that they use the technique frequently. These vessels do not haul directly onto a drum, instead they fleet the net onto the deck during hauling, meaning they can turn the vessel while hauling with relative ease. The vessels which have indicated they execute turns frequently when hauling have also been some of the vessels which have markedly reduced their capture rates over time. There is insufficient data available to directly relate this approach to the reduced capture rates but it is likely to be a contributing factor. Additionally, this approach does not rely on extensive engineering costs and does not impede fishing performance, operation or crew safety.

5. INTERNATIONAL ENGAGEMENT

DWG met by video link as well as email exchanges, on multiple occasions with various members from BirdLife International, the Albatross Task Force (ATF), and Cape Marine from South Africa to identify whether the net capture issue faced in New Zealand was also an issue in other nations with similar fisheries and bird assemblages.

Discussions initially focussed on a recently published paper by members of the ATF (N. Da Rocha *et al* 2021), highlighting the reductions in seabird captures across the Namibian hake trawl and bottom longline fishery. The trawl component of the paper focused on the observed reductions of warp captures on smaller inshore vessels after the implementation of regulations to enforce the use of seabird scaring devices. The offshore factory vessels were not part of the study, instead the results from the inshore fleet were extrapolated out to the factory fleet assuming that both fleets are operationally similar (N. Da Rocha *et al* 2021).

The ATF noted in conversation that net captures were not a known issue across the factory trawl fishery in Namibia or South Africa. However, it must be acknowledged that the bird species most frequently interacted with in the New Zealand squid fishery (white-chinned petrels, sooty shearwaters and mollymawk species) are breeding and rearing chicks in high numbers on islands close to the fishing grounds. The breeding characteristics of seabirds observed in the South African hake fishery may invoke different foraging behaviours and potentially lower levels risk. Additionally, observed fishing effort in similar fisheries overseas may be significantly less than the 80+% observer coverage in the New Zealand squid fishery.

In 2013, BirdLife International conducted a study on the effectiveness of seabird scaring lines for reducing cable-related seabird mortality in the Chilean hake trawl fishery. A total of 198 trawl shots were observed during the trials, where a total of 54 birds were observed being caught dead, with a further 51 being injured. While the focus was on interactions with trawl cables, the study showed 20 (37%) of the birds captured dead were killed in net entanglements (SBWG5 Doc 39). The study did not trial any measure to mitigate net captures but suggested the use of net binding and cleaning stickers during shooting.

DWG also spoke to researchers from the south Atlantic fisheries (e.g. A. Kuepfer and V. Iriarte), to provide international context to net captures.

Further feedback was sought via ACAP members and participants.

Conclusions from international discussions reiterate the challenges in understanding the nature and extent of net captures on a global level, especially for nations that have poor observer coverage and unstandardised or minimal mitigation measures.

New Zealand continues to have the most comprehensive understanding of net captures, largely due to its known occurrence, and supported by high observer coverage and efficient feedback loops. However, the development of effective and operationally viable mitigation tools is still limited.

6. DISCUSSION

6.1 Attraction

The concept of reducing seabird attendance around fishing vessels by reducing the overall attractiveness is impractical and infeasible in the real world. Seabirds are attracted to fishing vessels from up to 10 km away (Torres et al 2013), suggesting that there are multiple cues that draw them near. Possible cues include sight, sound, smell and instinctual responses to other seabird activities. Other drivers of seabird attendance may also include the number of vessels in the vicinity, temporal and spatial variability, and local bird assemblages. Without reducing multiple cues, it is unlikely that bird attendance will reduce considerably.

It is well documented that seabirds are attracted to fish waste and can be from significant distances, but observations have shown that vessels that have meal plants still attract large numbers of birds, especially in the New Zealand sub-Antarctic squid fishery. The Net Capture Programme considered ways to minimise the odour from meal plants but concluded that the costs of engineering such a mechanism or using a chemical scrubber significantly outweighed any perceived benefits. Seabirds will likely still be in attendance due to the sounds of hauling operations, the sight of vessels and the actions of other birds.

Therefore, the Net Capture Programme does not consider there to be any other viable methods of reducing overall attraction to fishing vessels, other than what is currently recommended by ACAP for managing fish waste.

6.2 Deterrents

The Programme investigated a number of visual deterrents to keep birds away from nets, many of which were similar to that of the traditional deterrents (e.g. the use of brightly coloured moving objects), but others attempted more novel approaches, such as water sprayers, and strobes.

The use of seabird scaring devices has been mandatory for >28 m trawl vessels since 2006. Paired streamer lines (tori lines), bird bafflers and warp deflectors are all approved seabird scaring devices[4] in New Zealand. All three of these devices are considered visual deterrents for mitigating warp captures but have not been reported as being effective at reducing net captures. The Net Capture Programme used capture data to investigate the effectiveness of different bird baffler configurations including standard port and starboard bafflers, brady bafflers, bafflers with stern droppers and super bafflers. Results showed no differences in the capture rate for the different set ups.

Findings from the trials have shown that devices used to deter birds from the net may have some immediate effect when bird abundance and competition are low. However, with high bird attendance, visual, audio or light deterrents had minimal effect on bird behaviour. It was also noted that by increasing the intensity and duration of some deterrents such as sound, light/ laser (Melvin, E. *et al* 2016) or water sprayer, the birds could end up being harmed or crew safety could be at risk.

It was also noted that birds can become habituated to many deterrents. The open water environment will allow seabirds unlimited options to temporarily move away from any disturbing noise source or light but if the attraction of food is strong enough the seabirds will learn to tolerate it and will continue to forage in and around the net.

Distraction feeding such as strategic batch discarding may increase the risk of bird capture rather than reduce the risk if it is timed poorly or ocean currents move the discharge to an area of higher risk. Additionally, in the context of the New Zealand squid trawl fishery, there is often not enough bycatch or offal to make strategic batch discarding a viable option on a daily basis. Since 2007 the volume of discards has approximately halved, with a greater proportion of

[4] Seabird Scaring Devices Circular 2010 (No. F517) - 2010-go1762 - New Zealand Gazette

vessels using meal plants (AEBAR - Non-target fish and invertebrate catch) and overall improved fish waste management systems.

6.3 Prevention

Throughout the Net Capture Programme, the group investigated and trialled tools and operations to restrict birds from accessing the trawl or to prevent them from becoming entangled. The members of the Programme concluded that operations to restrict or prevent birds from being physically entangled in the trawl was the most plausible approach to reducing net captures.

Risk factors attributed to net mesh shapes have been analysed in previous work such as Edwards, C.T. and Dunn, A. (2021) and have been reviewed by ACAP for demersal and pelagic trawl best practice mitigation. However, there continues to be a lack of supporting evidence. Additional work was undertaken by FNZ as part of the Net Capture Programme, to analyse net mesh differences at different locations on the net and associated risk but results were inconclusive (Appendix 3) due to heavy data bias for captures attributed to diamond mesh trawls (which predominate in the gear). The group decided to discontinue investigating mesh alterations due to the lack of supporting evidence for alternatives.

Other tools such as retractable net covers or the use of synthetic sheet material to cover the top panels of the net, had operational and engineering challenges. The volatile conditions of the southern squid fishery make the deployment of devices difficult and potentially unsafe during shooting and hauling. The wide white strips trialled in this programme did not show any effectiveness and also made it more difficult to remove stickers once the net was on deck – something which is a priority and recommended by ACAP. Additionally, mitigation to restrict birds from getting entangled externally in the meshes will only have a potential effect on the number of birds getting caught in the wings, lengthener or codend (depending on the mitigation). None of the feasible ideas investigated would be effective for the whole external area of the net, attributing to approximately 56% of net captures.

It also needs to be acknowledged that modifying trawl gear may have a significant effect on the water flow of the net and therefore fishing performance. Fish bycatch rates may increase as a result, possible gear failure, and/or potential for loss of economic revenue.

Minimising pooling area

The interrogation into observer data has shown that for net-captured birds, approximately 44% of birds are caught on the inside of the net with most of these being recovered dead. Therefore, any approach to minimise the surface area between the headline and the stern of the vessel will theoretically reduce the risk of internal net captures. This was investigated by Cleal, J. *et al* (2009), where turning of the vessel was used to close the headline of the net. This was also supported by conversations with Observers as they explained the key risk area being the ‘pooling area’ immediately astern of the vessel during the haul. Furthermore, discussions with skippers from some of the most improved vessels (in terms of reducing seabird capture rates), noted that they turn the vessel while they haul if space allows. While there is insufficient data to directly relate the reduction in capture rates from these vessels to the approach of minimising the pooling area, it is logical that any attempts to minimise the surface area of the headline and close off the meshes in the wings of the net will reduce risk. However, it must be acknowledged that some vessels may be unable to turn the vessel while hauling for operational reasons, such as vessels that haul directly onto a net drum.

Appendix 6 provides an example of the assessment of this mitigation option for inclusion in ACAP's Review of Mitigation Measures and Best Practice Advice for Reducing the Impact of Pelagic and Demersal Fisheries on Seabirds.

Other operations such as sinking the gear quickly, and net binding help to minimise the time and area that birds can have access to the trawl net during setting. However, as with other mitigation measures trialled in this programme, the ability of vessels to execute operations effectively and safely, without increasing the risk to seabirds, varies from vessel to vessel.

6.4 Communication and feedback loops

The importance of good communication and developing feedback loops were imperative to ensure the process was transparent and efficient. Skippers, shore staff, fisheries and conservation management and observers all played an important function in the process, but the information needed to be communicated effectively between groups.

Since 2006, DWG has been an information conduit between government officials and the deepwater fishing fleet, providing protected species risk management advice and support, and facilitating conversations between groups. The constructive and trusting relationship between DWG and the government has enabled significant progress in managing risks to protected species and was particularly valuable for the Net Capture Programme.

The Programme was implemented in 2019, however it has taken over a decade to develop effective reporting systems between skippers, managers and DWG. The Programme facilitated the discussion but improving awareness about the issue has required significant effort over the years.

Supporting Observers to think more analytically about capture events (e.g. where the risk is, what contributed to the risk etc.) encourages more comprehensive information to be reported back to the managers and then to the industry. The poster developed by FNZ and DWG for Observers and skippers, helps them think more about net interactions and risk factors (Appendix 5). The poster also encourages Observers and skippers to discuss these risk factors with one another, think about solutions and report back to shore staff.

7. CONCLUSIONS

Seabird net captures in the squid trawl fishery remain a focus area for industry and government agencies. Despite the significant funds and resources invested into research, desktop studies, sea trials and other work, there remains no 'silver bullet' to significantly reduce the risk of seabirds getting entangled in trawl nets.

Throughout the programme, the group investigated every possible mitigation tool or approach that came to mind. It was concluded that attempts to minimise the overall attraction of the vessels or using visual or sound deterrents are not feasible for the New Zealand squid trawl fishery.

Tools and operations to prevent birds from getting caught in the net are the most plausible approach to reducing captures (technical and operational challenges aside), specifically internal net captures.

Furthermore, the outcomes of the programme support the full involvement of skippers and Observers to ensure tools and operations are practical and can be implemented broadly.

Despite challenges, seabird capture rates in the New Zealand squid fishery have been trending downwards from above 20 captures per 100 tows in 2014 to around 10 captures per 100 tows in 2020 (PSC website). At this stage, it is impossible to determine all the driving factors of this reduction, but a part of this improved performance is likely attributed to a decade of incremental improvements across the fleet. These improvements are unquantifiable but sum to a better outcome, not least driven by awareness amongst vessel crew for the need for improvement.

8. REFERENCES

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APPENDIX 1: MITIGATION IDEAS LONGLIST

Mitigation	Type of mitigation	Trial	Trialled/ researched
Mask winch noise (e.g. by playing continuous music)	attraction	N	Adding another sound will likely continue to attract birds as they begin to associate it with food
Minimise meal plant smell with filter etc; pump underwater	attraction	N	Engineering solution involved to pass odour through a simple condenser/scrubber has been investigated by operator. Operator’s initial cost estimates to engineer this are very high. Likely to be ineffective given the other attractants to the vessel.
Minimise winch noise	attraction	N	Winch noise cannot be reduced
Venturi system to suck fish waste underwater	attraction	N	Costs too large and vessels with mealing plants also get captures
Fake cues (i.e. vessels playing ‘hauling’ sounds whilst a second vessel hauls)	attraction	N	Not practical
Mask meal plant smell by adding extra product	attraction	N	Costly and likely ineffective. Company may be trialling one at their land-based meal plant.
Mechanised sticker removal	attraction	N	Technically challenging. Not worth the investment
Sticker proof nets	attraction	N	No known nets available
Strategic batch discarding	attraction	Y	Trial on vessel resulted in increased risk of capture. Possibly a tool to use in ideal conditions but risks may increase if not performed correctly.
Bells, whistles that use wind/sea movement	Deterrent	N	Acoustic deterrent devices used in the open water fishing environment are unlikely to have a significant lasting effect on removing seabirds from the hazardous net area. Any devices fitted will also present a potential hazard to the vessel crew.
Long-range directional acoustic device	Deterrent	N	Acoustic deterrent devices used in the open water fishing environment are unlikely to have a significant lasting effect on removing seabirds from the hazardous net area. Any devices fitted will also present a potential hazard to the vessel crew.
Net-mounted acoustic device	Deterrent	N	
Sonic boom	Deterrent	N	
Underwater hull-mounted acoustic deterrent	Deterrent	N	
Underwater net-mounted acoustic deterrent	Deterrent	N	
Lift top of net above waterline so less scissoring	Deterrent	N	Operationally not feasible
Above water laser	Deterrent	N	

Mitigation	Type of mitigation	Trial	Trialled/ researched
Lasers hull mounted underwater	Deterrent	N	Lasers are not an option at this stage. Research has identified possible animal welfare issues with using lasers.
Catapult fish waste away from vessel	Deterrent	N	Discard analysis by FNZ suggest availability of fish waste in southern squid fishery not enough to make it a viable option. Potential for increased risk as suggested by the batch discard trial
Frozen blocks of fish waste during to shooting and hauling	Deterrent	N	Inadequate fish waste (discard analysis by FNZ) and handling issues
Coloured mesh in body of net and wings	Deterrent	N	Investigated – costs are high and predicted effectiveness is low. Noting that currently there are highly visible/ brightly coloured buoys attached to the headline
Drones	Deterrent	N	higher risk to birds, won't work in all conditions, likely to lose
Release dye/foam/bubbles when setting/hauling	Deterrent	Y	Dye trials completed by hoki fillet vessel. Minimal to no effect on bird behaviour
Net-mounted water sprayer	Deterrent	Y	Trialled – Initial feedback from vessel is set out below from Skipper and Observer and is showing limited/nil efficacy. Not viable across the fleet. High cost
Net-mounted strobe/light	Deterrent	Y (shore based)	Trialled – Initial wharf trials showed not significant deterring effect. Possible animal welfare issues and other negative impacts. Group spoke with researched about strobe proposal with light wavelength designed to get birds to alter focus and thus not be able to perceive well in the dark. Research ceased through lack of funding.
Underwater stern-mounted strobe light	Deterrent	N	
UV/black light directed onto fluorescent net objects	Deterrent	N	could likely increase risk. Birds maybe attracted to bioluminescence which the black light could resemble
Floating deterrent behind net	Deterrent	Y	Trialled – Red streamers attached to headline of the net. Purpose to deter birds. Trialled showed no change in bird behaviour. Second trial used 5m white PVC strips from the headline. Purpose to block birds from getting caught on the outside of the net. Trial showed limited effectiveness.
Pop-up visual deterrent on whippy poles on net	Deterrent	N	To be effective, the pop-up poles would need to be installed across the whole headline and upper body of net. This would likely affect the hydrodynamics of net and pose challenges when removing stickers.
Tori line on a stick on gantry	Deterrent	N	Operationally challenging during hauling. Tangling would be biggest issue
Wide white strips	Deterrent	Y	Was deemed ineffective at deterring birds but did have some effect of blocking birds access to the upper panels of the net. However, it made it challenging to remove stickers.
Square mesh in parts of net where birds get pinched	prevention	N	C. Edwards and A. Dunn (2021) concluded that square mesh in lengthener was associated with the highest risk
Net mouth collapsar (foils on wing ends)	prevention	N	Effect on hydrodynamics of net. Significant investment required to trial and implement if feasible

Mitigation	Type of mitigation	Trial	Trialled/ researched
Haul as fast as possible	prevention	N	Haul speeds need to be managed. Hauling too fast may cause increased risk if birds don't get out of the way fast enough.
Extended baffler	prevention	N	Engineering issues around extending the bird baffler further back. Strengthening comes at a very high cost. Analysis conducted on capture effect of different baffler set ups. Benefits of different baffler set ups were inconclusive.
Light chaffing in parts of net where birds get pinched	prevention	N	Challenges with removing stickers from net
Selected Mesh shape alterations to minimize 'entanglement'	prevention	N	Mesh alterations Have been investigated multiple times but studies have all been inconclusive (C. Edwards and A. Dunn, 2021). Altering mesh shape and size also influences target catch, fish bycatch and hydrodynamics of the net (Broadhurst et al 2014). There are also regulatory considerations.
Smaller mesh in parts of net where birds get pinched	prevention	N	
T90 mesh in parts of net where birds get pinched	prevention	N	
Net cinch – pennant rope from doors	prevention		Possible with midwater trawl gear but not possible with bottom trawl gear because of weight
Operations to sink the gear quickly – Almost stop the vessel so net sinks faster without tension on bridles/sweeps. Shoot into weather	prevention	Y	Different operations to sink the net faster but same objective. Stack codend and bellies aft and then pull the ground rope up to the codends. Use the ground rope to "bulldoze" the codends over the ramp. Shoot at a speed to be able to use the resistance of the codends in the water to be able to pull the ground rope over the side together with the bridles and sweeps off the sweep drums.
Dampener to reduce vertical movement of the net	prevention	N	There was insufficient information to suggest reducing the vertical movement of the net during hauling would reduce capture events in the wings
turning vessel to close mouth of net	prevention	Y	Appears to be an effective tool for some vessels which currently execute turns while hauling the net.
Retractable net cover that covers top of net on shot/haul	prevention	N	Needs to be considered in an operational context. Engineering challenges and possibility of increasing risk

APPENDIX 2: SOUTHERN SQUID FLEET CHARACTERISTICS AS OF 2021-22 FISHING YEAR

Country of Build	No. of Vessels	Length	HP	Gear type	Headline height/ Length (SQU target)	Max mesh size	Number of vessels with meal plants	Number of vessels with mincers	Hauling process (i.e. directly onto net drum, fleeting onto deck
Eastern Europe	6	104m	7500HP	Mid-water	70m/ 116m	12m	all	Nil	- Fleet to deck - 2 trawls on deck at once. Shoot one soon as other is tipped into pound
Japan	1	60-65m	4300HP	Bottom	4.5m/ 120m	240mm	0	All	- Fleet to deck
Korean	4	50 to 60m	2750 to 4000hp	Bottom	3.0-3.5m/ 100-120m		0	all	
Spain	2	45m & 60m	2000HP	Bottom and mid-water	4m/ 74m	230mm	0	Mincers only in factory sumps but not for main fish waste discharge	- Fleet to deck, takes 5 fleets-pulls to get codends onboard. - stow in arenas; sometimes difficult to turn the vessel during haul because of vessel layout.
Norway – fillet	8	55m-68m	3300-5500HP	Bottom and mid-water	3.4m/ 100m	230mm	all	Most have mincers, mince waste prior to fishmeal or prior to pumping from factory-floor sumps	- Fleet to deck and stow in arenas sometimes difficult to turn the vessel during haul because of vessel layout.
Norway - H&G	2	45m & 70m	3000hp &7000hp	Bottom and mid-water	4.2m/ 100-120m	230mm	all		

APPENDIX 3: ANALYSIS OF BIRD CAPTURES ON BATM VESSELS IN SQU TARGET

Trawl from 2017-2022 Background

It has been noted that the percentage of bird captures in the wings and lengthener of trawl nets (compared with other capture locations) have been higher in the BATM fleet than on domestic and other foreign-operated vessels (shown in Figure 1). It was hypothesised that the higher number of captures in these areas was due to more vertical movement of BATM vessels relative to the net during rougher sea conditions, leading to more stretching and relaxing of the lengthener in the water. The relaxing of the net creates opportunities for birds to access the fish, and the stretching of the net constricts the mesh openings, resulting in birds getting stuck.

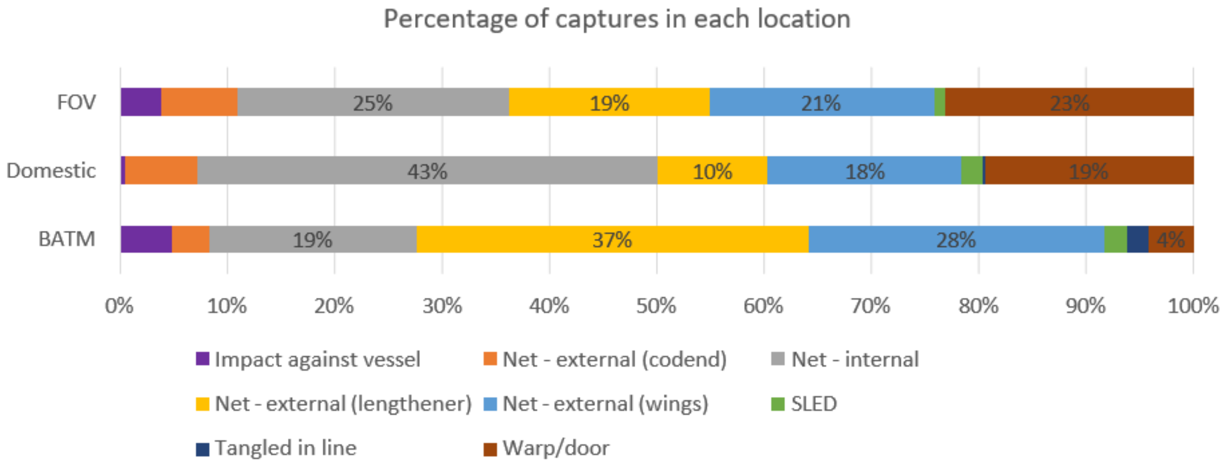

Figure 1. Number of captures by vessel type in each capture location

Purpose of this analysis

To explore whether more vertical movement of BATM vessels is associated with higher numbers of lengthener and wings captures, the relationship between sea state, mesh types, and reported captures was investigated. The data was extracted from the centralised observer database (COD). It represents all seabird capture events from the 2016/17 fishing year to the 2021/22 fishing year on trawl vessels over 28 metres in length targeting squid (SQU). Sea state is represented as a number on the Beaufort wind scale.

Looking at the percentage of captures at each Beaufort level suggests there are fewer lengthener and wings captures during calmer sea states than in rougher sea states (Figure 2). At the highest reported Beaufort levels (the scale goes from 0 to 12), 100% of the captures are in the wings or lengthener. This would support the hypothesis that captures in the wings and lengthener are more frequent in rougher seas when there is more vertical movement of the vessel relative to the net. The actual number of captures, however, is much higher at Beaufort levels 3 and 4 than the surrounding sea states, with very few reported captures at the very calm (uncommon when targeting SQU) and very rough sea conditions (when vessels tend to seek shelter rather than fish). These numbers could simply show that capture rates increase as a result of higher fishing effort in the most favourable conditions at squid grounds.

It is interesting to note that deck strikes are most abundant on BATM vessels at a low Beaufort level. Deck strikes comprise almost half of reported captures on BATM vessels at Beaufort level 2 with very low representation in rougher sea states.

Note: Observers previously recorded all net captures as 'caught in net.' This has now been separated into the three external net capture codes (wings, lengthener, and codend) and one internal net capture code. All 'caught in net' records have been omitted from this analysis for clarity, as well as codes with insufficient information for analysis ('not applicable', 'other', or 'unknown').

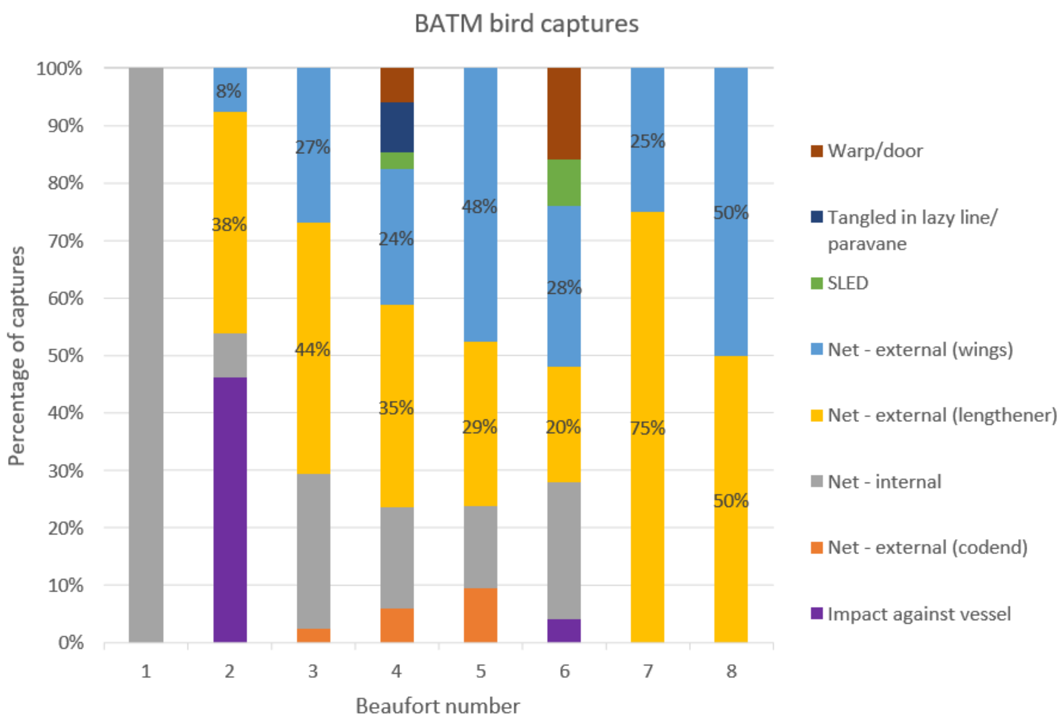

Figure 2. The percentage of BATM captures in each location at each level of the Beaufort scale, as reported by observers.

It was suggested that lengthener mesh type may play a role in the higher proportion of wings and lengthener captures on BATM vessels. Mesh types for these capture locations are shown in the below figure

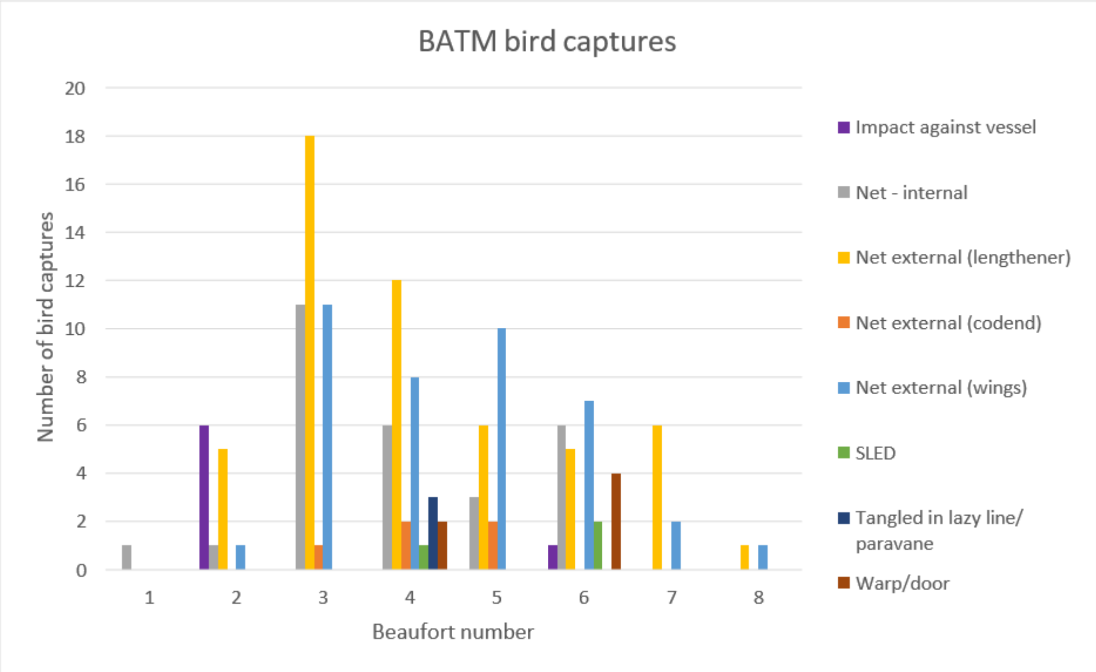

Figure 3. The number of BATM captures in each location at each level of the Beaufort scale, as reported by observers.

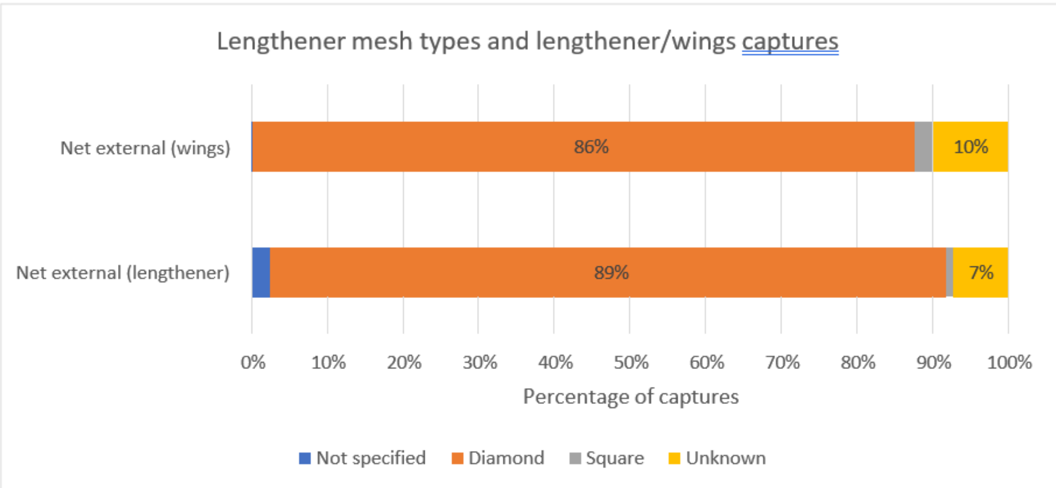

Figure 4. The percentage of wings and lengthener captures according to the type of lengthener mesh used

Figure 4 shows the types of mesh used by the vessel when wings and lengthener captures were recorded by observers. Diamond mesh is the most common mesh type recorded for both wings and lengthener captures. This is possibly due to diamond mesh being the preferred mesh configuration when targeting SQU, leading to this mesh type being over-represented in this data set.

Observers are not taught in detail how to identify various mesh configurations. This information is usually obtained from the skipper directly, or from a trawl gear details form completed by a previous observer and/or on a previous trip that may not always be applicable. This information may not always be confirmed with the skipper of a vessel by the observer due to language barriers.

APPENDIX 4: OBSERVER PROTECTED SPECIES INTERACTION FORM (PSI)

Observer Protected Species Interaction Form

Fisheries New Zealand
Tini a Tangaroa

(20 May 2020)

Page__ of__

Write the trip number ______ Were there protected species interaction(s) for this trip (Y/N) ___

1. Protected species includes seabird, marine mammals, marine reptiles and protected fish/sharks (for a full list of species to be included, consult the observer manual). Protected corals are still to be recorded on the Benthic materials form.
2. Protected species interactions are deemed to have occurred when animal(s) have become fixed, entangled or trapped so that is prevented from moving freely or freeing itself. A bird which lands on the vessel, and leaves the vessel **without assistance** from yourself/crew should not be recorded on this form.
3. Complete a **separate entry** for each individual interaction.
4. If the protected species interaction is an impact /landing interaction type, record negative one (-1) for tow/set numbers not associated with fishing events and 'L' for the interaction type.
5. Tick the appropriate box to indicate whether any protected species interactions occurred during this trip.

Interaction number	On duty (Y/N)	Witnessed interaction (Y/N)	Animal seen (Y/N)	Tow/set number	Observation date	Observation time	Species code	Life status when first sighted*	Interaction type*	Only complete these sections if interaction type is "F" or "M": Location of capture*	Part of body*	Injury/ bodily status*	Length (cm)	Measurement method A or E	Sex	CSP tag number you attached	Codes for samples taken*	End status*
					/ /	:												
Tag number or marking on animal at time of capture					Image file name			Observer code		.		Operating in accordance with PSRMP/VM (Y/N/U)		Comments				

Interaction number	On duty (Y/N)	Witnessed interaction (Y/N)	Animal seen (Y/N)	Tow/set number	Observation date	Observation time	Species code	Life status when first sighted*	Interaction type*	Only complete these sections if interaction type is "F" or "M": Location of capture*	Part of body*	Injury/ bodily status*	Length (cm)	Measurement method A or E	Sex	CSP tag number you attached	Codes for samples taken*	End status*
					/ /	:												
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Interaction number	On duty (Y/N)	Witnessed interaction (Y/N)	Animal seen (Y/N)	Tow/set number	Observation date	Observation time	Species code	Life status when first sighted*	Interaction type*	Only complete these sections if interaction type is "F" or "M": Location of capture*	Part of body*	Injury/ bodily status*	Length (cm)	Measurement method A or E	Sex	CSP tag number you attached	Codes for samples taken*	End status*
					/ /	:												
Tag number or marking on animal at time of capture					Image file name			Observer code		.		Operating in accordance with PSRMP/VM (Y/N/U)		Comments				

***Refer to instructions overleaf**

Life status when first sighted
Use one of the codes below to indicate the life status of the animal when it was first observed.

1	Alive
2	Dead (showing no sign of life)
4	Decomposing

Interaction type
Use one of the codes below to indicate the interaction type. Note that for the purposes of interaction type, SLEDs can be considered a part of the net. Therefore any SLED captures should be coded under "F".

F	Caught in the fishing gear (this includes warps, paravanes or any other equipment directly involved in fishing).
M	Caught in seabird mitigation device (i.e. tori line or bird baffler)
L	Deck impact/deck landing (use this code for birds that impact against the superstructure of the vessel or land on the deck and are assisted off the vessel)
B	Brought on board (use this code for when an animal is brought on board the vessel and released by crew but was not tangled in commercial fishing gear (e.g. animals "riding" the cod-end)
R	Caught in recreational gear (for interations used on board this vessel)
O	Other (any other capture type that does not meet any definition above; describe in comments)
U	Unknown (you do not know how the interaction occurred, describe circumstances in comments)

Part of body
Use one of the codes below to indicate which part of the body was caught.

E	Entire body caught (i.e. net/warp capture, tangled in line or foul hooked)
W	Caught by wing (seabirds and protected rays)
F	Caught by flipper/feet
H	Caught by head (e.g. in net mesh)
M	Caught by mouth (i.e. hook in mouth)
U	Unknown (you do not know which part of the body was caught)

End status
Use one of the codes to indicate what happened to the animal at the end of the incident.

R	Whole body retained	U	Returned alive but injury status unknown
A	Returned alive and uninjured	D	Returned dead and unmarked
I	Returned alive and injured	M	Marked or tagged and then discarded dead
F	Returned alive but unlikely to survive	L	Not recovered
T	Tagged/banded and released alive uninjured	V	Tagged/banded and released alive injured
W	Tagged/banded and released unlikely to survive		

Code for samples taken
Use as many codes as applicable to indicate the samples taken from the animal.

B	Head	L	Feather
C	Leg	M	Tissue
E	Stomach	O	Other (detail in comments)
F	Teeth	V	Video
G	Skin sample	Y	More than 4 samples
J	Image (photograph)	Z	No samples collected
K	Ovary		

Location of capture
Use one of the codes below to indicate where the capture occurred (note that some codes are method specific). Complete this column if the interaction type is "F" or "M".

Trawl/danish seine vessels	
S	Caught on warp or door
NI	Internal net capture (the animal was caught inside the trawl net/codend/pounds)
NC	External net capture (the animal was caught/tangled in mesh of the cod-end)
NL	External net capture (the animal was caught/tangled in the mesh of the lengthener/taper)
NW	External net capture (the animal was caught in the mesh of the net wings/body)
SC	Animal was caught in the centre net of a triple-rig (SCI only)
SH	Animal was caught/tangled in the hood of the SLED
SG	Animal was caught on the grid of the SLED
L	Animal was caught/tangled in the net lazy line or paravane
OT	Other capture location on a trawl vessel (describe in comments)
Longline vessels	
TM	Tangled in mainline
TF	Tangled in float line
TS	Tangled in snood/branch line
TU	The line the animal was tangled in was unable to be determined
H	Caught on hook
TH	Animal was both caught on the hook and tangled in line
LL	Other type of gear capture on longline vessel (describe in comments)
Mitigation device – all vessels	
TO	Tangled in tori line
BB	Caught in bird baffler
WS	Caught in warp scarer
ML	Caught in longline hauling mitigation device
MO	Caught in other mitigation device (describe in comments)
Other	
NO	Net capture (purse seine or set net vessels only)
P	Caught in fishing pot
R	Caught in gear retrieval rope (i.e. potting/set netting)
O	Other location (only use this code if no others apply; describe in comments)
W	Caught on troll lure
X	Unknown

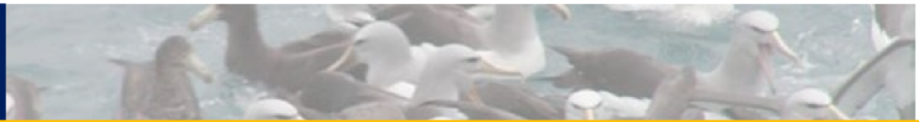
Injury/bodily status
Use as many of the codes as applicable to indicate the injury status of the animal.

A	Broken or drooping wing	P	Disorientated or unco-ordinated
B	Broken beak	Q	Froth or foam present in mouth/nostrils
C	Broken leg	R	Body in rigour
D	Broken flipper, fin or tail	S	Predated upon (e.g. by shark)
E	Broken shell	T	Liced
F	Open wound	V	Decaying
1	Killed by crew	W	Waterlogged
2	Injured by crew	X	Greased/oiled
K	Swallowed hook	O	Other describe in comments
L	Severed body part	U	Unknown (not able to assess)
M	Bleeding from orifices	Y	More than three visible injuries
N	Breathing but unconscious	Z	No visible injuries

APPENDIX 5: SEABIRD NET CAPTURE POSTER

Seabird Net Captures in the Squid Fishery

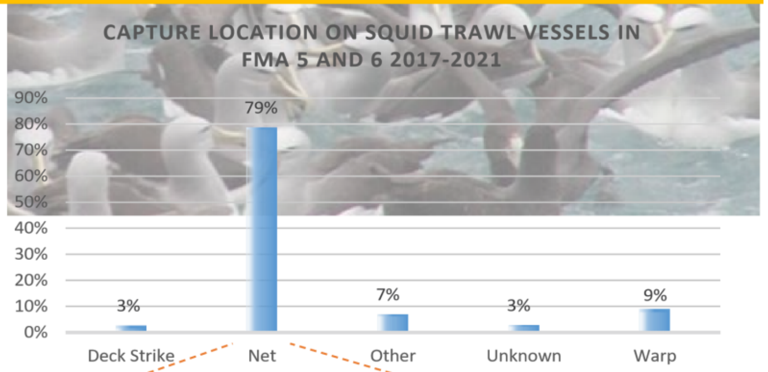
Better awareness… more information…



The New Zealand arrow squid trawl fishery is the second largest fishery by volume in New Zealand. Most of the targeted fishing effort occurs in the southern squid fishery: SOU - Stewart Snares Shelf (SQU1T) (around 40%) and SOI Auckland Islands (SQU6T) (around 30%). The rest of the fishing effort occurs off the Otago coast and on the Chatham Rise. The fishery generally starts in December and finishes around June, but this varies slightly from year to year.

The timing and spatial distribution of the southern squid fishery coincides with the breeding season and foraging range of many New Zealand seabirds including white chin petrels and albatross species. Due to the increased concentration and aggressive feeding behaviour of seabirds, along with increased fishing effort, birds frequently get caught by fishing vessels around the Auckland Islands and on the Stewart Snares Shelf.

Seabird captures in this fishery occur most frequently inside and on top of the trawl net. We are beginning to understand which parts of the trawl net are higher risk to seabirds but there is still a lack of understanding of what factors (or the interplay between factors) that increase the risk to seabirds and what we can do to manage these risks better.



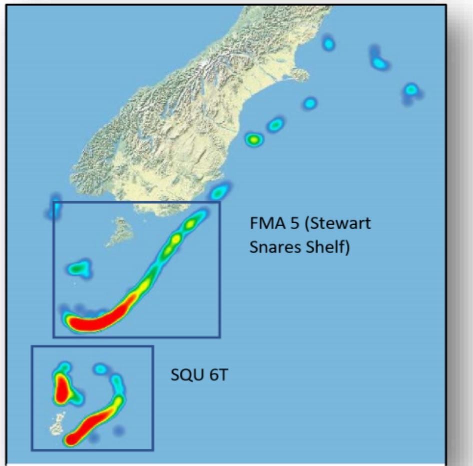
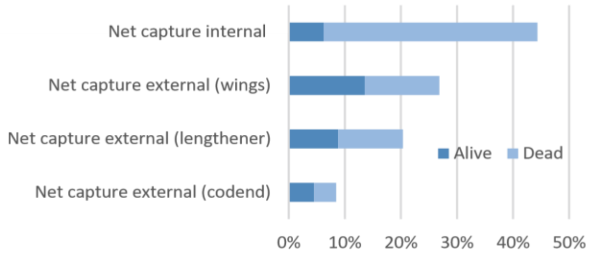


Figure 1: Spatial distribution of seabird captures by vessels targeting squid.



Capture location	Greater Albatross	Small albatross	Petrels
Internal net capture	1%	17%	82%
External wings net capture	2%	29%	68%
External lengthener net capture	4%	44%	52%
External codend net capture	0%	30%	70%
all net captures	**2%**	**27%**	**71%**

What we know:

- Approximately 71% of all net captures in SQU1T and SQU6T are petrels (predominantly white chin petrels - XWC)
- The highest rate of internal net captures of seabirds is in SQU6T
- About 50% of seabirds caught on the outside of the net are alive
- About 86% of birds caught inside the net are recovered dead

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Gathering Information on Net Captures – How, When, Why and Which?

Differences between vessels…be aware

There are many physical and operational differences between trawl vessels in the arrow squid fishery. Domestic, BATM and Korean vessels all have unique operational characteristics which may increase the risk to seabirds. Even within each group of vessels there are subtle differences which may contribute to the risk. Over the course of the trip, you need to be aware of all the operational and physical hazards to seabirds. Some examples include:

- Headline pooling area during haul (Figure 2)
- Haul speed, trawl type
- Net haul speed (after doors are up)
- Mesh size
- Reduced mitigation effectiveness
- Increasing bird numbers and aggressive feeding behaviour
- Crew and captain awareness

Although there is no strong evidence suggesting one group of vessels is higher risk than others, if observers and crew can identify particular or subtle risks, we may be able to manage them more effectively. We're interested in understanding the processes which lead to capture events; what was different on *that* day compared with others and how did the vessel respond to the capture event.

Figure 2: Headline creating pooling area at the stern of the vessel

Best Practice, Risk Management Procedures:

- Haul as quickly as practicable to minimise the time the trawl is near to or on the surface
- When completing turns keep the trawl at fishing depth and/or bring trawl door's to the surface to close up wing-ends
- When practicable close-up wings/mouth of trawl by turning vessel to run sweeps then trawl across stern quarter to reduce volume of mesh and surface area of net
- No discharge of fish-waste immediately before/during hauling & shooting

In the event of a multiple capture or 'Trigger-Point' event; access, discuss with the skipper, & record all known factors which may have increased risk to that tow:

- Weather, environmental conditions
- Time trawl took to haul
- Which part of the net birds were caught in; internal? (drowned or alive) or tangled externally? or in fish pound? (figure 3)
- Did bird numbers & species change? or number of other vessels nearby
- Number of birds around vessel
- Fish waste discharge issues, from main offal discharge or floor wash.
- Watch more closely next few tows to see if the same issues reoccur.

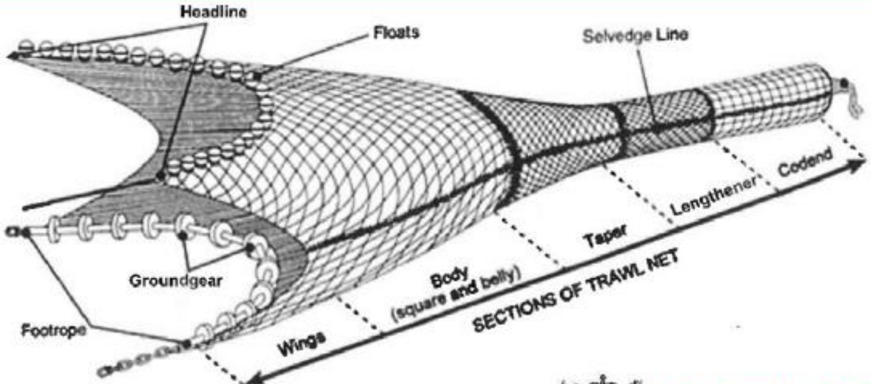

Figure 3: Trawl net diagram

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APPENDIX 6: EXAMPLE OF BEST PRACTICE REVIEW

3.7 Minimise pooling area

ACAP advice

Recommended for reducing bycatch during hauling of trawl gear in both pelagic and demersal trawl fisheries.

Scientific evidence for effectiveness in trawl fisheries

Trials undertaken in 2006 (Cleal, J. *et al* 2009) indicate the merits of turning the vessel to close the net (by bunching it against a stern quarter of the trawl ramp) as a mitigation approach. While there is no empirical evidence that operations to close the headline of the net will reduce net entanglements, it is logical that minimising the surface area of the exposed risk will reduce risk.

Notes and Caveats

Some vessels may be unable to turn the vessel while hauling for operational reasons (i.e. the structure of the vessel doesn’t allow for it, limited sea space, or vessel which directly haul nets onto a net drum.

Minimum standards

None established.

Need for combination

Should be used in combination with good net cleaning and other applicable best practice measures.

Implementation monitoring

None established.

Research needs

None established.