Twelfth Meeting of the Seabird Bycatch Working Group

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Seabird-Safe Fishing Toolkit

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SUMMARY

The Seabird-Safe Fishing Toolkit (the toolkit) supports tuna businesses in adapting to the expectations of consumers and in carrying out their work towards seabird-safe fishing. It was developed over the course of two years with social research processes to engage mitigation science experts and end users, and processes designed to use available evidence to develop and define simple categories for 1) seabird ocean zones 2) the effectiveness of mitigation options at reducing seabird captures, 3) the seabird-safeness of specific fisheries, and 4) the level of confidence that the measures are implemented. Toolkit categories for how seabird-safe a fishery is takes into account ocean zones and mitigation effectiveness.

RECOMMENDATIONS

We recommend that SBWG:

1. note the development of a Seabird-Safe Fishing Toolkit which is aimed to support tuna businesses adapt to the expectations of consumers and carry out their work towards seabird-safe longline fishing.
2. note the methodology developed to identify and define simple categories to describe the effectiveness of seabird bycatch mitigation options, how seabird-safe a fishery is, and how reliable verification tools are in confirming mitigation is used.
3. consider the role that ACAP could play in helping to maintain the currency of science and technical information in the toolkit and the promotion of the use of the toolkit.
4. consider the role that ACAP could play in further expanding the toolkit to encompass other fisheries beyond large vessel pelagic longline fisheries, including potential partnership and/or co-branding on the toolkit

Caja de herramientas de pesca segura para las aves marinas

RESUMEN

La caja de herramientas para la pesca segura para las aves marinas (la caja de herramientas) ayuda a las empresas atuneras a adaptarse a las expectativas de los consumidores y a hacer su trabajo para lograr una pesca segura para las aves marinas. Se desarrolló durante el transcurso de dos años mediante procesos de investigación social que contaron con la participación de científicos especialistas en mitigación y usuarios finales, y procesos diseñados para utilizar la evidencia disponible para desarrollar y definir categorías simples para 1) zonas oceánicas de aves marinas, 2) la efectividad de las opciones de mitigación para reducir la captura de aves marinas, 3) el nivel de seguridad que proporcionan ciertas pesquerías a las aves marinas, y 4) el nivel de confianza en que las medidas se implementan. La categoría de la caja de herramientas para considerar cuán segura es una pesquería para las aves marinas tiene en cuenta las zonas oceánicas y la eficacia de la mitigación.

RECOMENDACIONES

Se recomienda al GdTCS realizar las siguientes acciones:

1. Tomar nota de la elaboración de una caja de herramientas de pesca segura para las aves marinas, cuyo objetivo es ayudar a las empresas atuneras a adaptarse a las expectativas de los consumidores y llevar a cabo su trabajo en pos de la pesca con palangre segura para las aves marinas.
2. Tomar nota de la metodología desarrollada para identificar y definir categorías simples que describan la eficacia de las opciones de mitigación de la captura secundaría de aves marinas, cuán segura es una pesquería para las aves marinas y cuán confiables son las herramientas de verificación del uso de la mitigación.
3. Considerar el papel que podría desempeñar el ACAP para ayudar a mantener la vigencia de la información científica y técnica en la caja de herramientas y la promoción de su uso.
4. Considerar el papel que el ACAP podría desempeñar para seguir ampliando la caja de herramientas para abarcar otras pesquerías además de las pesquerías de grandes buques de palangre pelágico, como por ejemplo la posible asociación y/o el uso de una marca compartida en la caja de herramientas.

Boîte à outils pour une pêche sans danger pour les oiseaux de mer

RÉSUMÉ

La boîte à outils pour une pêche sans danger pour les oiseaux de mer (la boîte à outils) aide les entreprises thonières à s'adapter aux attentes des consommateurs et à mener à bien leur action en faveur d'une pêche plus sûre pour les oiseaux marins. Elle a été élaborée sur une période de deux ans, à l'aide de processus de recherche sociale visant à mobiliser des experts en sciences de l'atténuation ainsi que des utilisateurs finaux, et de processus conçus pour utiliser les données probantes disponibles afin d'élaborer et de définir des catégories simples concernant 1) les zones océaniques pour les oiseaux de mer ; 2) l'efficacité des options d'atténuation pour réduire les captures d'oiseaux de mer ; 3) le niveau de sécurité de chaque pêcherie spécifique pour les oiseaux marins ; et enfin 4) le niveau de confiance dans la mise en œuvre des mesures. Les catégories de la boîte à outils pour déterminer la sécurité d'une pêcherie pour les oiseaux de mer tiennent compte des zones océaniques et de l'efficacité de l'atténuation.

RECOMMANDATIONS

Nous recommandons que le GTCA :

1. Note l'élaboration d'une boîte à outils pour une pêche sans danger pour les oiseaux de mer, qui vise à aider les entreprises thonières à s'adapter aux attentes des consommateurs et à mener à bien leur action en faveur d'une pêche à la palangre plus sûre pour les oiseaux marins.
2. Note la méthodologie élaborée pour identifier et définir des catégories simples permettant de décrire l'efficacité des options d'atténuation des captures accessoires d'oiseaux de mer, le niveau de sécurité d'une pêcherie pour les oiseaux de mer qui en résulte, et la fiabilité des outils de vérifications utilisés pour confirmer l'atténuation.
3. Examine le rôle que l'ACAP pourrait jouer pour contribuer à maintenir à jour l'information scientifique et technique contenue par la boîte à outils, ainsi qu'à promouvoir l'utilisation de cette dernière.
4. Examine le rôle que l'ACAP pourrait jouer dans l'élargissement de la boîte à outils à d'autres pêcheries que les pêcheries à la palangre pélagiques sur les navires de grande taille, y compris un partenariat potentiel et/ou un co-branding de la boîte à outils.

1. BACKGROUND

The world's albatrosses and petrels are facing an urgent and continuing conservation crisis. The international expert body on albatross and petrel conservation (ACAP) reports that thousands of albatrosses and petrels are continuing to die every year as a result of fisheries operations (ACAP 2024).

Several albatrosses are facing a high risk of extinction. Most notably the Antipodean albatross which breeds in the New Zealand sub-Antarctic, the Tristan Albatross which breeds on Gough Island in the South Atlantic, and the Waved albatross from the Galapagos Islands (ACAP 2021) Recovery of these populations requires fishing companies to rapidly adopt fishing practices that are safe for albatrosses and other seabirds.

There is growing pressure on the tuna fishing industry to improve their sustainability credentials, and this includes marine wildlife conservation issues. Markets are increasingly responding by setting sustainability procurement policies. In many instances, large retailers will only sell tuna with sustainability credentials such as Marine Stewardship Council certification (MSC).

The Seabird-Safe Fishing Toolkit (hereafter "the toolkit") was developed by the Southern Seabirds Trust in partnership with the New Zealand Department of Conservation. It was developed in recognition that there are solutions available to reduce captures of seabirds, but that these solutions are not being widely adopted on the water. Initial research revealed that a key challenge is that the best available information about how to reduce bycatch and verify good practices is fairly inaccessible for tuna businesses. The objective of the toolkit was therefore to make evidence-based information available to assist tuna companies and those supporting them to:

- make informed decisions that support reductions in seabird captures and
- transparently demonstrate the use of seabird bycatch mitigation measures.

The toolkit contains four main elements:

1) zoning of the world's oceans according to the ACAP species present, their status, and vulnerability to longline fishing.
2) categories describing the effectiveness of mitigation measures at reducing seabird captures
3) categories describing the seabird-safeness of different mitigation options in the different ocean zones.
4) categories describing the level of confidence different verification tools can provide, in terms of ensuring measures are in use, and meeting specifications.

Fishing companies using the toolkit can assess their current seabird-safeness, based on what zone they are fishing in, and what mitigation measures they currently employ. They can also learn how to improve their seabird-safeness. In terms of verification, a fishing company can learn how to transparently demonstrate measures are being used on board.

2. TOOLKIT DEVELOPMENT

The toolkit development was divided into two projects. The first involved developing an ocean mapping tool to identifying ocean zones where there would be high, medium and low risk for ACAP-listed seabirds. The methodology to develop individual seabird species distributions is described by Fischer et al in PaCSWG8 Doc 03, and the methods used to identify ocean zones is described in a supplementary information paper to the Joint Meeting of SBWG12 and PaCSWG8.

The second project involved developing categories to assess the effectiveness and verification of seabird bycatch mitigation measures. The methodology for this process is described in detail in Appendix 1. This project included both literature reviews and social research processes to engage expert panel of leading mitigation researchers and seabird scientists to collect and review the information presented in the toolkit. We also took advice from people with first-hand knowledge of tuna fishing and the tuna industry, to ensure the toolkit included the most sought-after information and that it is provided in an accessible format. The categories and other information in the toolkit are based on the best available scientific and technical data, and over time this will be updated as new science and mitigation technology develops.

3. TOOLKIT LAYOUT

We have summarised and presented the data so that a user can easily and quickly get the information they need. If they wish, they can dig deeper and see all the source information and underlying logic applied to the categorisations.

The toolkit is being devel oped in a webpage format and we plan to complete an initial version by August 2024.

4. CONCLUSIONS AND NEXT STEPS

The toolkit was developed over the course of two years and with extensive stakeholder engagement, including direct engagement with the tuna industry and organisations supporting them with transitioning to more sustainable practices. Taking the time to build effective relationships has been an important part of the development process and has led to greater understanding about the needs of end user and how the toolkit can meet them.

Maintaining the currency of information provided in the toolkit will be vital to achieve ongoing seabird conservation benefits. Ongoing review and potential adaptation of the toolkit structure to ensure it meets the needs of key target audiences will also be important. We believe the toolkit complements existing ACAP products and leverages the information ACAP has produced to improve uptake and use of seabird-safe fishing practices.

We are currently investigating a range of extension work to facilitate the use and uptake of information provided in the toolkit in large vessel pelagic longline fleets, and we are seeking to partner with others also active in promoting seabird-safe fishing methods.

We believe the approach developed in this initial toolkit can be applied to other vessel classes and fishing methods, although further resourcing would be required.

REFERENCES

Agreement on the Conservation of Albatrosses and Petrels. 2021. Report of the Population and Conservation Status Working Group. Twelfth Meeting of the Advisory Committee, Virtual meeting, 31 August – 2 September 2021.

Agreement on the Conservation of Albatrosses and Petrels. 2024. https://acap.aq/about-acap. Accessed 6 June 2024.

APPENDIX 1. Methods to assess the effectiveness and verification of seabird bycatch mitigation measures and overall seabird-safe level

This document outlines the methodology for developing the mitigation and verification sections of the Seabird-Safe Fishing Toolkit ("the toolkit"). The scope of the toolkit is for threatened seabird species (listed on Appendix I of ACAP) in all ocean basins and for large pelagic longline fishing vessels greater than 24m.

Background information collection

At the start of the process, three reports were commissioned. The first contained a literature review for information on five seabird bycatch mitigation measures (as well as combinations of measures) for pelagic longline fisheries, specifically: bird-scaring lines, branchline weighting, night setting, hookpods and underwater bait setting devices. For each, the key design elements and specifications are provided, along with information on the efficacy in reducing seabird captures, the effects on target and other non-target catches, strengths and limitations and operational considerations (Pierre 2023a).

The second report compiled information on five main tools available to verify the implementation of seabird bycatch mitigation measures: vessel position monitoring, dockside monitoring, at-sea inspections, at-sea fishery observers and electronic monitoring. Tools were characterised in terms of how they work, which measures they can be used to verify, limitations and constraints (Pierre 2023b).

The third report included a review of frameworks, tools and organisations that support the fishing industry in improvements to better understand the wider landscape that the toolkit would exist in, and to ensure that it was aligned or could be easily integrated into existing frameworks (Good 2023).

All three reports were used throughout the development of the toolkit. The first two were predominately used as resources for the development of toolkit categories and content. The latter was used as a starting point for targeted engagement with specific organisations and frameworks.

Stakeholder engagement

To ensure that the toolkit reflected best available evidence and expertise and that it will provide useful information in an accessible format to end users, two advisory groups were set up. The expert panel included individuals with experience conducting pelagic longline mitigation studies, experience with mitigation use on high seas vessels, or practical knowledge of fisheries management and verification tools in relation to mitigation measures. This group therefore had collective expertise on the practicalities of implementing mitigation and verification on high seas vessels. They were tasked with using an evidence-based approach to inform toolkit decisions, relying on scientific and technical information (to the extent it exists), and using the panel's own knowledge and direct experience.

The ground-truthing group included members from tuna fishing companies, tuna suppliers, fisheries managers, environmental NGOs who work directly with fisheries and fisheries ecolabels. This group was tasked with ensuring that the different needs of end users are reflected in the design and content of the toolkit.

Both groups were engaged through a variety of methods, including: online meetings, in-person sub-group meetings, surveys and requests for feedback on specific documents.

In addition to these two groups, the toolkit project team consulted with the tuna industry more widely as part of the Asia-Pacific Economic Cooperation Ocean and Fisheries Working Group. A Roundtable event was held on 29 November 2023 attended by 73 people from ten APEC economies, representing around 30 different fishing companies or industry bodies (APEC 2024). This event provided information on the market drivers mobilising the industry to improve bycatch management and on how the toolkit can assist seafood companies working to address bycatch of seabird species. Participants actively engaged in discussion at the meeting and provided input on toolkit development, such as content and the need for capacity building (APEC 2024). In addition, information was collected prior to the event via a web-based survey, completed by 34 participants, which explored levels of pre-existing knowledge and reasons for interest in seabirds and seabird bycatch (APEC 2024). Results indicated that there was a high interest in the seabird bycatch issue from participants, but that knowledge of the threats to seabirds is low to medium, suggesting an area for future engagement (APEC 2024).

Assigning seabird-safe categories for mitigation

The toolkit was designed to allow fishing companies to determine how seabird-safe their current fishing is or investigate how seabird-safe a measure or suite of measures is. The seabird-safe categories were assigned based on two things: 1) where the fishery is taking place relative to the seabird ocean zones identified on the toolkit maps and 2) how effective the measure(s) selected are at reducing captures of seabirds (Figure 1). The process for determining the underlying seabird distributions and ocean zones is described elsewhere. The mitigation effectiveness for a measure or combination of measures was based on the magnitude of the effect and the strength of evidence associated with it.

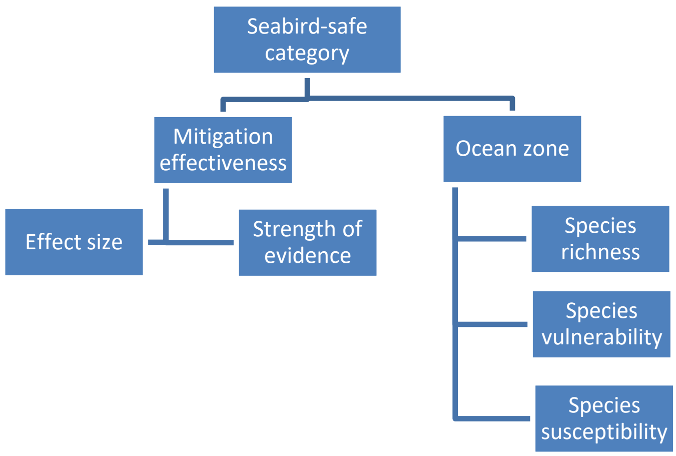

Figure 1 Process for determining the overall seabird-safe category based on ocean zone and mitigation effectiveness.

The mitigation measures selected are those that have been demonstrated to be effective and are commercially available. This means that practices such as blue-dyed bait and lasers, for which there is no evidence of effectiveness, are not included in the toolkit. However, a note will be included in the toolkit explaining this.

To determine the effect size, information from Pierre 2023a (see section 2.1) was compiled in an Excel spreadsheet. Information recorded included measure/combination of measures, region where study took place, bycatch or interaction rate when measure applied (treatment), bycatch or interaction rate when measure is not applied (control) and the source. Where quantitative information was available, e.g. a bycatch rate or interaction rate, this information was used to calculate a % reduction in seabird interactions for each study. Only those studies that had a clear treatment using the measure and a control not using the measure were included. This information is provided in Annex 1.

This information, along with inputs from the Expert Panel, was used to assign mitigation effect categories as follows:

- Very high (interactions with threatened seabirds is minimised): >95% reduction in bycatch AND overall bycatch of threatened is seabirds ≤0.05birds/1000 hooks.
- High (a few threatened seabirds may still be caught): 80-95% reduction in bycatch.
- Medium (threatened seabirds can still be caught): 40-80% reduction in bycatch.
- Low (threatened seabirds can still be caught): <40% reduction in bycatch.

In cases where there were multiple studies and the results varied, the category where there was most evidence was assigned. For example, if the majority of studies showed that the reduction in seabird captures was 40-80%, the Medium category was assigned. Where there was an even split in the number of studies between two categories, the more precautionary (lower) category was assigned.

A decision tree was developed in consultation with the Expert Panel to determine the strength of evidence (high, medium or low) associated with the bycatch effectiveness (Figure 2). The decision tree was applied to the whole body of evidence for each measure or combination of measures. It was used to evaluate whether there was more than one peer reviewed paper in the studies reviewed, whether any individual study used more than 30,000 hooks in the trial or statistical significance was indicated in the results. A threshold minimum sample size was used to remove any short-term trials or ad-hoc observations that may not have collected enough evidence to robustly determine an effect. The threshold of 30,000 hooks was based on reviewing the number of hooks used in each study and selecting a natural cut-off point indicative of a minimum value used in peer-reviewed quality research outputs. Where no studies on the effect of a mitigation measure exists, it was automatically assigned as low strength of evidence.

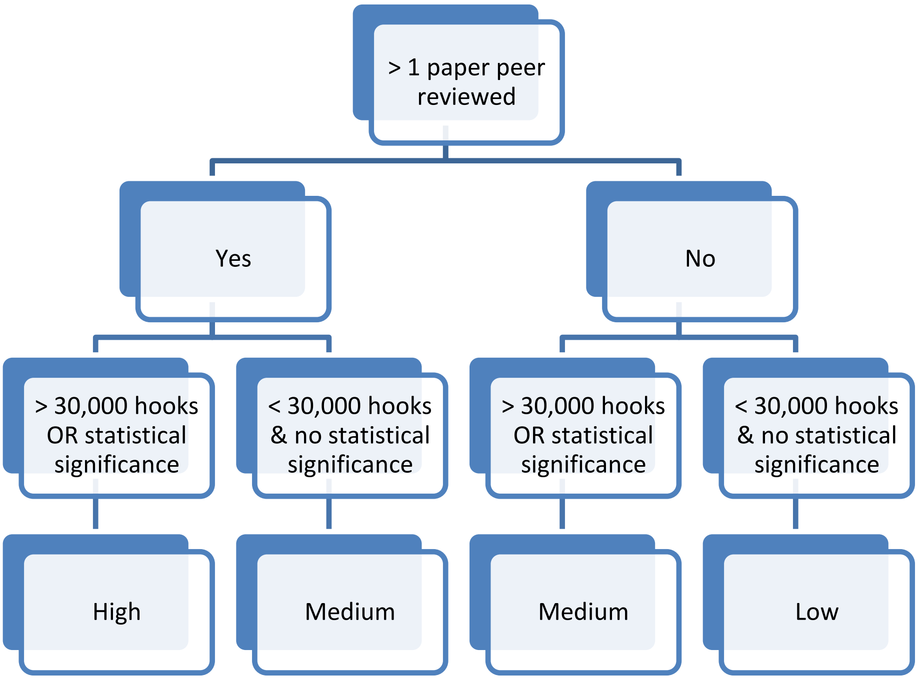

Figure 2 Decision tree used to determine strength of evidence of mitigation effectiveness

Once the effect size and strength of evidence was determined for each measure or combination of measures, an overall category was assigned to the mitigation effectiveness by applying Table 1. More detail on how this was determined for each mitigation measure and combination is provided in Annex 1.

Table 1 Categorisation of mitigation effectiveness based on effect size and strength of evidence

Effect size	**Strength of evidence**	**Mitigation effectiveness (overall)**
Very high (Minimised)	High	Very high (Minimised)
Very high (Minimised)	Medium	High
Very High (Minimised)	Low	Medium
High	High	High
High	Medium	Medium
High	Low	Low
Medium	High	Medium
Medium	Medium	Low
Medium	Low	Low
Low	High	Low
Low	Medium	Low
Low	Low	Low

Finally, an overall seabird-safe category was applied considering the ocean zone and the mitigation effectiveness by applying Table 2.

Table 2 Categorisation of seabird-safe level based on risk zone and mitigation effectiveness

Seabird-safe category	Ocean zone (risk)	Mitigation effectiveness
3 – very safe	High	Very high (Minimised)
	Medium	High or Very high (Minimised)
	Low	Medium, High or Very high (Minimised)
2 – somewhat safe	High	High
	Medium	Medium
	Low	Low
1 – not very safe	High	Medium
	Medium	Low
	Low	Nil
0– not safe	High	Low or Nil
	Medium	Nil

Based on the available information, the seabird safe risk categories for each ocean zone are provided in Table 3.

Table 3 Seabird safe risk categories for each mitigation measure in the high, medium and low risk zones.

Ocean zone (risk)	Mitigation measure(s)	Combined mitigation effectiveness + Strength of evidence	Seabird-safe category
High	BSL + Night setting + Line weighting	Very high (Minimised)	3 – very safe
	Hookpods	Very high (Minimised)	3 – very safe
	Underwater bait setter	High	2 – somewhat safe
	Night setting + Line weighting	High	2 – somewhat safe
	BSL + Night setting	High	2 – somewhat safe
	BSL + Line weighting	High	2 – somewhat safe
	BSL	Medium	1 – not very safe

	Night setting	Medium	1 – not very safe
	Line weighting	Low	0 – not safe
Medium	BSL + Night setting + Line weighting	Very high (Minimised)	3 – very safe
	Hookpods	Very high (Minimised)	3 – very safe
	Underwater bait setter	High	3 – very safe
	Night setting + Line weighting	High	3 – very safe
	BSL + Night setting	High	3 – very safe
	BSL + Line weighting	High	3 – very safe
	BSL	Medium	2 – somewhat safe
	Night setting	Medium	2 – somewhat safe
	Line weighting	Low	1 – not very safe
Low	BSL + Night setting + Line weighting	Very high (Minimised)	3 – very safe
	Hookpods	Very high (Minimised)	3 – very safe
	Underwater bait setter	High	3 – very safe
	Night setting + Line weighting	High	3 – very safe
	BSL + Night setting	High	3 – very safe
	BSL + Line weighting	High	3 – very safe
	BSL	Medium	3 – very safe
	Night setting	Medium	3 – very safe
	Line weighting	Low	2 – somewhat safe

Assigning reliability categories for verification

The toolkit also provides information on the reliability of independent verification tools for specific mitigation measures when applied at the vessel level. The reliability category (High, Medium, Low, None) was assigned based on whether it was possible to verify that a specific mitigation measure is being used and whether the specifications are adhered to. The categories are:

- High = Can verify whether mitigation is used, as well as whether all specifications are adhered to

- Medium = Can verify whether mitigation is used, as well as some but not all of the specifications are adhered to
- Low = Cannot verify whether mitigation is used or is uncertain but can verify whether some specifications are adhered to if the mitigation is in fact used.
- None = Cannot verify whether mitigation is used or whether specifications are adhered to.

A sub-group of the Expert Panel met to review whether independent verification tools would be able to verify if specific mitigation measures are used and whether they followed specifications (Tables 4-8). Verification tools were selected based on whether they were effective for one or more mitigation measure and whether they were commercially available. This information was used to determine the reliability category. Only independent verification tools were considered, as fisheries reporting provides lower confidence due to a perceived conflict of interest. In addition, tools for at-sea inspections (aerial or vessel-based) were not considered as these are typically used by Government to detect non-compliance across a fleet or fishery, so the vessel-level sample would be too small to verify measures are being used.

Using a combination of independent verification tools, a higher level of reliability can be gained than by using verification process in isolation. For example, when used together a combination dockside inspection and electronic monitoring can provide a high level of reliability for verifying the presence and correct use of hook shielding devices. This would suggest that to achieve a high level of reliability in all ACAP best practice options that a tool for verifying aerial extent and line weighting regimes should be a top priority to ensure that fleets opting for electronic monitoring can be effectively monitored.

Table 4 Reliability of verification methods for bird-scaring lines

Verification method	Can verify if used (BSL deployed)	Specifications					Comments	Reliability
		Attachment height	Adjustable attachment point	Aerial extent	Streamer config	In water section (post swivel)		
VMS	N	N	N	N	N	N		None
AIS	N	N	N	N	N	N		None
Dockside inspection (independent)	N	Y	Y	N	Y	Y	Assumes no change at-sea Presence on board: pre-departure can tell whether they are on the vessel; post-trip not helpful as could have lost gear at sea	Low
Human observers (independent)	Y	Y	Y	Y	Y	Y	Aerial extent monitoring - day only Measuring aerial extent is inherently difficult but observers are the best placed to do so	High
Electronic monitoring (independent)	Y	N	Y	N	Y (low confidence)	N	Could be improved if put markers on the line	Medium

Verification method	Can verify if used (BSL deployed)	Specifications					Comments	Reliability
		Attachment height	Adjustable attachment point	Aerial extent	Streamer config	In water section (post swivel)		
							There is potential to develop methods to confirm attachment height and aerial extent	
Dockside monitoring + EM	Y	Y	Y	N	Y	Y	Note potential to develop EM methods to confirm aerial extent	Medium
BSL tension devise	Y	N	N	N	N	N	Can only tell if it was used during setting, but not for which part of the set Only a reliable tool when integrated into other systems to detect setting (i.e., EM)	Medium
Underwater bait setter counter	N	N	N	N	N	N		None

Table 5 Reliability of verification methods for line weighting

Verification method	**Can verify if used (presence on branch line)**	**Specifications**		**Comments**	**Reliability**
		Distance from hook on set	**Weight in water**		
VMS	N	N	N		None
AIS	N	N	N		None
Dockside inspection (independent)	Y	N	Y	Relies on no change when at sea; replacement of lost gear Underlying uncertainty if unweighted gear on board Feasible, but to get accurate weight in water requires work to be done	Medium
Human observers (independent)	Y	Y	Y	Feasible, but to get accurate weight in water requires work to be done	High
Electronic monitoring (independent)	Y	N	N	Same for night setting Capturing presence becomes difficult if water on lens and/or at night	Medium

Verification method	Can verify if used (presence on branch line)	Specifications		Comments	Reliability
		Distance from hook on set	Weight in water		
				Issue with swivels - wont be able to tell whether there's enhanced weighting in place	
Dockside inspection + EM	Y	N	Y	Note priority to confirm distance from hook	Medium
BSL tension devise	N	N	N		None
Underwater bait setter counter	N	N	N		None

Table 6 Reliability of verification methods for night setting

Verification method	Can verify if used (time setting occurs)	Location	Comments	Reliability
VMS	Y - Indirect	Y - Indirect	tamper proof but low resolution	High
AIS	Y - Indirect	Y - Indirect	not tamper proof but better resolution	High
Dockside inspection (independent)	N	N		None
Human observers (independent)	Y - direct	Y - direct	Issues - only 1 obs for 24hr, accuracy of reporting	High
Electronic monitoring (independent)	Y - direct	Y - direct	Requires minimum specs, on-board system standards, data processing standards Note winch sensors may be used as part of the system	High
Dockside inspection + EM	Y	Y		High
BSL tension devise	N	N	Only if data integrity can be confirmed and maintained Same issue as company &	None

Verification method	Can verify if used (time setting occurs)	Location	Comments	Reliability
			independent monitoring/observers Only records when BSL in use	
Underwater bait setter	N	N		None

Table 7 Reliability of verification methods for Hookpods

Verification method	**Can verify if used**		**Specifications**	**Comments**	**Reliability**
	Verification whether attached to branch line	**Verification whether hook inserted in pod before setting**	**ACAP-approved Hook Shielding Device**		
VMS	N	N	N		None
AIS	N	N	N		None
Dockside inspection (independent)	Y	N	Y	Assumes no change at sea	Low
Human observers (independent)	Y	Y	Y	Would be 100%. What proportion of hooks need to be observed?	High
Electronic monitoring (independent)	Y	Y	N		Medium
Dockside inspection + EM	Y	Y	Y		High

Verification method	**Can verify if used**		**Specifications**	**Comments**	**Reliability**
	Verification whether attached to branch line	**Verification whether hook inserted in pod before setting**	**ACAP-approved Hook Shielding Device**		
BSL tension devise	N	N	N		None
Underwater bait setter	N	N	N		None

Table 8 Reliability of verification methods for underwater bait setter

Verification method	**Can verify if used**		**Specifications**	**Comments**	**Reliability**
	Verification whether installed	**Verification if baited hooks inserted in capsule**	**Set at ACAP-prescribed depth and sink rate**		
VMS	N	N	N		None
AIS	N	N	N		None
Dockside inspection (independent)	Y	N	N		Low
Human observers (independent)	Y	Y	Y		High
Electronic monitoring (independent)	Y	Y	N		Medium
Dockside inspection + EM	Y	Y	N		Medium
BSL tension devise	N	N	N		None

Verification method	Can verify if used		Specifications	Comments	Reliability
	Verification whether installed	**Verification if baited hooks inserted in capsule**	**Set at ACAP-prescribed depth and sink rate**		
Underwater bait setter sensor	Y	Y	Y		High

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Annex 1 Seabird interaction information used to determine measure effectiveness

Table A1. Seabird interaction information provided (sourced from Pierre 2023a) and how measure effectiveness was determined Note: in Reduction column * indicates reduction presented is from BSL-only, not no mitigation; **indicates study used attempts, not mortalities.

Measure	Region	With measure (birds/1000 hooks)	Without measure (birds/1000 hooks)	Source	Reduction in interactions (%)	Effect size	Strength of Evidence	Mitigation effectiveness
BSL + night setting + line weighting	Southern oceans	0	5.49	Jimenez et al 2019	100.00%	Minimized (100% reduction)	High (PR, statistical significance, >30K hooks)	Minimized
	Southern oceans	0	0.63	Melvin et al 2014	100.00%*			
Hookpod	Southern oceans	0	0.13	Gianuca et al 2021	100.00%	Minimized (95-100% reduction, rate <0.05 birds/1000 hooks)	High (PR, >30K hooks, 2 studies)	Minimized
	Southern oceans	0.04	0.8	Sullivan et al 2018	95.00%			
Underwater bait setter (10m)	Southern oceans	0	11.6	Robertson et al 2018	100%	Minimized (100% reduction)	Medium (PR, >30K hooks, 1 study)	High
Night setting + line weighting	Southern oceans	0	5.49	Jimenez et al 2019a	100.00%	Minimized (100% reduction)	Medium (PR, >30K hooks, 1 study)	High
BSL + night setting	Southern oceans	0.1	0.28	Duckworth 1995	64.29%	High (majority between 80-95%)	High (PR, >30K hooks, statistical	High

Measure	Region	With measure (birds/1000 hooks)	Without measure (birds/1000 hooks)	Source	Reduction in interactions (%)	Effect size	Strength of Evidence	Mitigation effectiveness
	Southern oceans	0.28	5.49	Jimenez et al 2019b	94.90%		significance, multiple)	
	Southern oceans	Lower	Higher	Jimenez et al 2020	Qualititative			
	Southern oceans	0.02	0.25	Klaer and Polacheck 1998	92.00%*			
	Southern oceans	0.44	2	Melvin et al 2013	78.00%*			
	Southern oceans	0.06	0.63	Melvin et al 2014	90.48%*			
BSL + line weighting	North Pacific	0.1	7.7	Ochi et al 2013	98.70%	High (3 >95% but 3 <95%, precuationary)	High (PR, >30K hooks, multiple)	High
	North Pacific	0	1.6	Ochi et al 2013	100.00%			
	Southern oceans	0.17	0.45	Gianuca et al 2011	62.22%			
	Southern oceans	0	5.49	Jimenez et al 2019a	100.00%			
	Southern oceans	0.06	1.07	Melvin et al 2013	94.39%*			

Measure	Region	With measure (birds/1000 hooks)	Without measure (birds/1000 hooks)	Source	Reduction in interactions (%)	Effect size	Strength of Evidence	Mitigation effectiveness
	Southern oceans	0.12	0.63	Melvin et al 2014	80.95%*			
Bird-scaring lines	Southern oceans	0.47	0.74	Brothers 1991	36.49%	Medium (majority between 40-80%)	High (PR, >30K hooks, multiple)	Medium
	Southern oceans	Not stated	Not stated	Meyer and MacKenzie 2022	51%			
	Southern oceans	2.35	5.49	Jimenez et al 2019a	57.19%			
	Southern oceans	0.31	0.85	Mancini et al 2009	63.53%			
	Southern oceans	0.11	0.33	Rollinson et al 2016a	66.67%			
	Southern oceans	0.1	0.64	Petersen et al 2008	84.38%			
	Southern oceans	0.13	0.85	Domingo et al 2017	84.71%			
	Southern oceans	0.28	0.2	Duckworth 1995	N/A – increased (but noted issues with BSL design)			

Measure	Region	With measure (birds/1000 hooks)	Without measure (birds/1000 hooks)	Source	Reduction in interactions (%)	Effect size	Strength of Evidence	Mitigation effectiveness
	North Pacific	0.02	0.07	Boggs et al 2001	71.43%			
	North Pacific	0.02	0.08	Boggs et al 2001	75.00%			
	North Pacific	0.47	2.23	McNamara et al 1999	78.92%			
	North Pacific	0.8	10.7	McNamara et al 1999	92.52%**			
	North Pacific	Albatross capture 1.1x less likely		Gilman et al 2021	Qualititative			
Night setting	Southern oceans	0.38	0.95	Baker & Wise 2005	60.00%	Medium (majority between 40-80%)	High (PR, significance, multiple)	Medium
	Southern oceans	0.09	0.28	Duckworth 1995	67.86%			
	Southern oceans	Lower	Higher	Jimenez et al 2009	Qualititative			
	Southern oceans	1.21	5.49	Jimenez et al 2019	77.96%			
	Southern oceans	Lower	Higher	Jimenez et al 2020	Qualititative			

Measure	Region	With measure (birds/1000 hooks)	Without measure (birds/1000 hooks)	Source	Reduction in interactions (%)	Effect size	Strength of Evidence	Mitigation effectiveness
	Southern oceans	0.09	N/A	Petersen et al 2008	Qualititative			
	North Pacific	0.6	2.23	McNamara et al 1999	73.09%			
	Southern Oceans, North Pacific	0	0.01	Gilman et al 2023	100.00%			
Line weighting	North Pacific	2.4	7.7	Ochi et al 2013	68.83%	Medium (2 <80%, 2 >80%, precautionary)	Medium (not PR, >30K hooks, multiple)	Low
	North Pacific	0.5	1.6	Ochi et al 2013	68.75%			
	Southern oceans	Too few birds caught to determine	Too few birds caught to determine	Rollinson et al 2016b	N/A			
	North Pacific	0.06	0.69	Boggs et al 2001	91.30%**			
	North Pacific	0.06	0.83	Boggs et al 2001	92.77%**			

References: Full references are available in Pierre 2023a