PROJECT

Sustainable Management of Tuna Fisheries and Biodiversity Conservation in the ABNJ

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REDUCING ECOSYSTEM IMPACTS OF TUNA FISHING

Workshop on WCPFC Bycatch Mitigation Problem-Solving

28 – 30 May 2018

NOUMÉA, NEW CALEDONIA

PROCEEDINGS

COMMON OCEANS

Seeking to generate a catalytic change, the *Global sustainable fisheries management and biodiversity conservation in the Areas Beyond National Jurisdiction Program* was approved by the Global Environment Facility (GEF) under the lead of the Food and Agriculture Organization of the United Nations (FAO) in close collaboration with two other GEF agencies, UN Environment (UNEP) and the World Bank, as well as other partners.

Focusing on tuna and deep-sea fisheries, in parallel with the conservation of biodiversity, the Common Oceans ABNJ Program aims to promote efficient and sustainable management of fisheries resources and biodiversity conservation in ABNJ to achieve the global targets agreed in international fora.

The five-year Common Oceans ABNJ Program is an innovative, unique and comprehensive initiative working with a variety of partners. It consists of four projects that bring together governments, regional management bodies, civil society, the private sector, academia and industry to work towards ensuring the sustainable use and conservation of ABNJ biodiversity and ecosystem services.

Food and Agriculture Organization of the United Nations

Table of Contents

1 Introduction

Bycatch can be defined as that portion of the catch returned to the sea as a result of economic, legal, or personal considerations (discarded catch) plus the retained catch of non-targeted species (incidental catch; Alverson et al. 1994). As such, bycatch may contain a variety of species, from marine mega-fauna to lower trophic-level species, critical for the maintenance of the structure and functioning of marine ecosystems, and the continued provision of marine ecosystem services. Bycatch in purse seine and pelagic longline tuna fisheries, the two major gear types for catching tunas, is a primary mortality source for some populations of seabirds, sea turtles, marine mammals and sharks. Bycatch can not only lead to unsustainable mortality, when catches are discarded bycatch represents waste of living resources. In addition, from an economic perspective bycatch represents an inefficiency which can and should be minimized in order to maximize the value of the fishery.

Several international instruments such as the 1995 Fish Stocks Agreement require States to address the issue of bycatch. The Western and Central Pacific Fisheries Commission (WCPFC) is one of five tuna Regional Fisheries Management Organizations (t-RFMOs) responsible for the sustainable use, conservation and management of highly migratory species taken by tuna fisheries. Although the WCPF Convention does not use the term "bycatch", it creates an explicit responsibility for assessing and managing not only tuna species, but also non-target and associated or dependent species under Articles 5, 6 and 10.1c.

The WCPFC has adopted a variety of measures to mitigate threats to bycatch species. These include prohibitions on shark finning (CMM 2010-07), no-retention and safe release provisions for several species of sharks and all cetaceans (CMMs 2011-04, 2012-04, 2013-08 and 2011-03), and bans on some types of gear designed to target sharks (CMM 2014-05). To reduce interactions with sea turtles, there are requirements to use circle hooks or finfish bait in shallow set longline fisheries for swordfish (CMM 2008-03) and to reduce interactions with seabirds, there are requirements to use techniques that will discourage seabirds from taking longline hooks in certain high risk areas (CMM 2017-06). Guidelines for safe handling and release have been adopted for several threatened species, and onboard observer programmes collect data on bycatch interactions and the use of mitigation measures.

When developing new measures to address bycatch, learning from previous experience is crucial for informed and effective decision-making. There is a vast body of literature on the interaction of non-target species with tuna fisheries, but it is often scattered and can be difficult to access in a structured way. With this in mind, the WCPFC in 2010 began developing a bycatch management information system (BMIS) to support the adoption and implementation of science-based management measures and ensure that bycatch is managed comprehensively and sustainably (Fitzsimmons et al. 2017).

Recent support for the WCPFC's BMIS has been provided under the Common Oceans Areas Beyond National Jurisdiction (ABNJ) Tuna Project. This project is a Global Environment Facility (GEF)-funded, FAO-implemented programme of work designed to encourage and reinforce sustainable tuna fisheries by:

- supporting a systematic application of a precautionary and ecosystem-based approach to fisheries management;
- reducing illegal fishing and improving compliance; and
- mitigating the adverse impacts of bycatch on biodiversity.

Under the third component, work on bycatch mitigation is implemented in collaboration with SPC and includes the development of a global BMIS (www.bmis-bycatch.org) which was re-launched in May 2017. This workshop is part of the effort to introduce the BMIS to potential users and demonstrate its utility in supporting science-based fisheries management. It was designed to work through various bycatch issues using the BMIS, SPC resources, and participants' national fisheries knowledge and experience. A call for nomination of workshop participants from WCPFC members, cooperating non-members, participating territories and approved observer organizations was released on 16 March 2018 under WCPFC Circular 2018/19.

SPC hosted the workshop at its headquarters in Nouméa, New Caledonia from 28-30 May 2018. A total of 27 participants representing eleven WCPFC CCMs and seven inter-governmental and non-governmental organizations with WCPFC observer status attended workshop (Annex 1). The workshop was facilitated by S. Clarke of the Common Oceans ABNJ Tuna Project/FAO and rapporteured by K. Hett of the Common Oceans ABNJ Tuna Project/FAO.

N. Smith (SPC) opened the meeting and welcomed participants on behalf of Moses Amos, Director of the SPC Fisheries, Aquaculture and Marine Ecosystems Division. He thanked the FAO Common Oceans ABNJ Tuna Project and the Global Environment Facility for supporting it. He underlined the importance of bycatch mitigation in the Western and Central Pacific Ocean and the world's largest tuna fishery. He noted that SPC is proud to be involved in the BMIS as a key tool to support decision-making related to one of the most complex problems the WCPFC is facing at this time.

2 Workshop Objectives

S. Clarke (ABNJ/FAO) introduced the workshop's objectives as follows:

- To introduce the Bycatch Management Information System (BMIS);
- To show how BMIS can help address some of the bycatch issues facing the WCPFC;
- To build capacity for understanding bycatch problems and demonstrate tools to facilitate solutions by using BMIS;
- To take suggestions on how to improve BMIS; and
- To discuss current practices and data requirements to identify potential improvements.

These objectives were addressed by activities and exercises in the areas of mitigation, safe release and monitoring. Mitigation refers to using special gear or techniques to reduce catches of unwanted species, particularly threatened species. The workshop examined a variety of techniques for mitigation through presentations and group exercises exploring the scientific literature, including the use of circle hooks and finfish bait to reduce sea turtle interactions (Section 6), and the use of hook shielding devices to reduce seabird interactions (Section 7), both of which will be considered by SC14 in August 2018.

Safe release refers to techniques for releasing species once they are caught to maximize their survival while maintaining the safety of the crew. The WCPFC has already adopted some safe release guidelines and has tasked SC14 with developing new guidelines for other species. Participants discussed potential content for safe release guidelines for both sharks (and rays) and seabirds (Section 5) based on existing references in BMIS.

Finally, monitoring refers to ongoing collection of data on the use of mitigation measures and their effectiveness. The workshop briefly discussed the current WCPFC Regional Observer Programme (ROP) minimum standard data fields (MSDF) and the data holdings available to describe bycatch mitigation use in the WCPFC (Section 3.2). This review is designed to support SC14's consideration of potential improvements to the collection of data relevant to sea turtle interactions, as tasked by WCPFC14. At the beginning of the workshop S. Clarke also provided a quick review of the status and issues for the main bycatch groups of sharks, sea turtles, seabirds and cetaceans, as well as a brief introduction to the WCPFC's existing conservation and management measures pertaining to these groups.

In response to the presentation participants inquired about the target audience for the output of this workshop. The facilitator clarified that the report will be submitted as a working or information paper to SC14 and potentially to TCC14, as appropriate, and asked for the participants further suggestions in this regard.

3 Bycatch Information in the WCPFC

There are several systems for information on bycatch management in the WCPFC. The first of these is the Bycatch Management Information System (BMIS), an initiative of the WCPFC and SPC to collect informational resources within a single reference system. The second is the WCPFC's Regional Observer Programme (ROP) comprised of national observer programmes collecting bycatch (and other) data at sea under a set of common standards. These two systems are described in further detail in the following sections. Further information on bycatch in WCPFC fisheries is available in members' annual reports and through logbooks, which are not further discussed here.

A recent development with potential to provide information on bycatch in the WCPFC is a number of ongoing trials of electronic monitoring. One example of such a system is presented in Section 3.3.

3.1 Bycatch Management Information System (BMIS)

3.1.1 Introduction to the Bycatch Management Information System (BMIS)

N. Smith (SPC) introduced the Bycatch Management Information System (BMIS), a global resource with funding provided by the Common Oceans ABNJ Tuna Project. BMIS has been in existence for seven years and now offers a broad range of curated material, with an emphasis on mitigation techniques and their efficacy. It includes information synthesis on a range of bycatch management topics including issues such as data harmonisation, bycatch interaction rates, population-level assessments and fisheries management performance. It also includes information on species identification, given its role in data quality and compliance, and on safe handling and release, which affects post-release survival rates. A key feature is that BMIS takes advantage of the large volume of information on mitigation – and other topics – from outside the WCPFC area, for the benefit of those within the WCPFC.

S. Caillot (SPC) presented an overview of the technology and the content logic driving the BMIS portal. Redeveloped in 2016 and released in 2017, the BMIS site is based on reliable and recognized software (Drupel, Zotero), which makes it very easy to extend and to maintain or update the different contents. Providing ergonomic and accessible interfaces has been an essential aspect of the redevelopment of this information system. On top of the navigation bar, the general information section provides diverse bycatch information (RFMO, gear, and species). The main menu is divided between searchable datasets (regulation, references), and topic-based syntheses (management, mitigation techniques, PLAs) are searchable using an advanced interface to provide the most up-to-date information available. Within the reference section, which is the central pillar of the BMIS, all the original bibliography is captured and stored in Zotero, the reference management system, and synced regularly with the BMIS. The mapping between the tags in Zotero and the different resources in BMIS brings flexibility in accessing and requesting reference information. References are provided either in PDF format or as a link in Google Scholar, if available, when there are copyrights are associated with the reference. The BMIS website re-launched about year ago has been already widely used by more than 4,300 users who have viewed more than 19,200 pages. The portal is very well-referenced and appears on top of search browsers.
In summary, BMIS is a living tool and is constantly being improved. It is based on up-to-date technology and designed to be readily portable onto future technology. BMIS includes searchable databases and topic syntheses, and utilises a powerful search tool. BMIS is increasingly utilised and increasingly recognised as a key source of bycatch management information.

N. Smith provided an overview of why some references are not currently available through BMIS, and some options for accessing such papers. BMIS does have very comprehensive coverage. Accessing abstracts is generally easy, but often we need the full article. All journals have copyright on the material they publish. Some charge for access to the papers while some journals promote open access (although, even most open-access journals charge fees to publish). Where possible, BMIS provides an option to download the PDF corresponding to a reference using the URL of the website where the PDF can be accessed. However, in the case of 'pay-to-view' journal articles due to copyright restrictions, only a link to the journal page is provided. In such cases a Google Scholar link is also provided because that search engine can sometimes turn up free access, for example, authors often publish PDFs of journal articles on personal, academic (e.g. academia.edu or ResearchGate), or institutional websites. Beyond Google Scholar, personal and academic websites,

additional options to search for full articles include emailing the author directly, on open access search engines like unpaywall.org (although most of their content which is relevant is already available via BMIS). Generally options are greater for personal research than if you wish to share the papers, for instance in a workshop setting. One advantage of Zotero is that it provides a platform to securely share papers during workshops; an explicit exemption in Elsevier policy allows for this. In general the nature of access to science articles is undergoing rapid change. Open access journals and options to make articles open access in pay-to-view journals are increasing (although at the authors cost). At the same time pay-to-view journals are increasingly enforcing their sharing policies. In summary, although copyright is a real issue, increasingly many full access articles are available, or can be made available through the correct approaches.

Discussion

Some participants inquired about potential plans to make the BMIS available in different languages. The BMIS team explained that Drupal, the underlying system, could accommodate additional languages for the user interface and that this could be considered in the future. However, it was noted that most of the underlying scientific references, which are the main building block of the BMIS, would still be in English.

One participant asked about the selection criteria for the species included in the species section of BMIS and whether it would be possible to include additional background information on each species. The BMIS team informed participants that the species lists currently included are based on other databases and have not been tailored for BMIS per se; additional information could be added by cross-refererencing other sources, as appropriate.

One participant suggested inclusion of current management experiences, case studies and lessons learnt into the BMIS, through grey literature, but also through more active knowledge elicitation such as through providing a forum for exchange between fisheries managers in different countries. The BMIS team was open to discussing further ways of making the BMIS more interactive in addition to the current social media tools (BMIS Twitter account and 'bycatch bytes' blog feature).

One participant asked about the criteria for the inclusion of references into the BMIS and highlighted the importance of non-peer reviewed literature, in particular RFMO documents. The BMIS team clarified that the revised BMIS aims to be as comprehensive as possible in terms of references included (also reflected by the ~1,600 references currently in the system) and already covers grey literature, in particular related, but not limited to, the tuna RFMO Scientific Committees. The BMIS team added that this often leads to a large number of search results and might require some kind of prioritization to keep the results manageable for users. The BMIS team encouraged participants to provide their views on possible criteria for prioritization. Participants suggested that BMIS should prioritize rather than filter the results to make the available information as comprehensive as possible. One participant suggested applying a star rating system for references or showing the number of downloads or "reads" of a specific paper as a measure. Another participant suggested to prioritize studies identified as key supporting references when tuna RFMOs adopt a conservation and management measure (CMM).

3.1.2 Further development plans for the BMIS

N. Smith (SPC) provided an overview of current and future plans for BMIS. Bycatch mitigation is a very dynamic topic which is reflected in the evolving nature of BMIS. Current challenges include the ABNJ project-funding coming to an end in December 2018, access to copyright material, single RFMO focus, and constant maintenance requirements. With the end of current project funding, a key issue is to make BMIS sustainable. Ongoing funding is needed for curation, hosting and maintenance, noting ongoing support for hosting has been identified. There is a current work plan which is being addressed (Fitzsimmons et al. 2017). Ongoing work includes curating and adding new references, and information syntheses. BMIS is actively engaging with other RFMOs where it can, but this needs more attention. A peer review framework of subject matter experts, general commentary, users (e.g. this workshop) and RFMO-based experts is being implemented and will need ongoing resourcing. Searches are being developed to be more intuitive and focused. Promotion via Twitter is currently underutilised and options like getting others tweeting BMIS more are being explored. Review of monitoring information is regular to provide insights to development. End user input will be used to direct this work, including from this workshop.

Planned enhancements and developments include incorporating post-2011 shark PRM studies into SPC's Shark Tagging Information System (STAGIS) and better integrating STAGIS into BMIS, making BMIS available in other tRFMO languages (noting that most references are in English), tools to allow PDF export of fact sheets, incorporation of infographics and maps, and developing a shark app from the interactive shark browser. Development work under consideration includes developing summaries of public domain bycatch data (e.g. the Bycatch Data Exchange Protocol (BDEP); see Williams et al. 2016, 2017) at species of special interest (SSI) population scales, an image library, and getting user input from short, targeted surveys and an enhanced analytics-driven design approach. Feedback from before and during the workshop included making short video clips available on how to handle SSI; making management practitioner insights available, especially on hot topics; more guidance on screen; restructure of the search tool; a meta-ribbon approach to explaining landing page content; and exploring developing country status and institutional library access to address some copyright challenges.

In summary, SPC's role in BMIS is that of a custodian, especially beyond the end of the ABNJ project. There is considerable work to do before then, but BMIS remains more relevant now than ever in a dynamic environment. Developments occurring now, and more to come, retain a strong focus on user needs.

Discussion

Participants acknowledged the usefulness of BMIS for reviewing and collecting bycatch-related information and highlighted the importance of promoting the website at the national and regional levels. Also, dedicated training should be provided to ensure that target groups are aware of the tool and know how to use it. In this context, participants suggested including more interactive materials, in particular videos, for example of safe release techniques, which are becoming increasingly important as learning tools. The BMIS team encouraged participants to promote BMIS through their networks and highlighted the importance of champions for wider promotion across tuna RFMOs.

Participants suggested starting to look into a strategy for long-term sustainability of BMIS before the funding provided by the Common Oceans ABNJ Tuna project ends. They also encouraged the

BMIS team to position BMIS as a unique tool to share information across tuna RFMOs. This could require additional features within BMIS.

The BMIS team informed that the hosting of BMIS will be ensured through SPC in the medium-term. To facilitate ongoing curation of content, a more decentralized approach allowing external contributors to update and upload information, could be considered. This is already technically feasible with the current structure of the database through allowing access of users at different levels. Such an approach would also contribute to increased ownership. Longer term sustainability of BMIS as a common tuna RFMO initiative would be ideal, possibly also including other regional organizations. The BMIS team should explore the possibilities for SPC's library to support access to papers through special subscription rates for developing countries.

WWF informed participants about their ongoing, similar work within their global bycatch program and expressed interest in exploring ways to collaborate.

Participants welcomed the planned inclusion of a tool for global queries based on RFMO data available in the public domain such as BDEP. Synergies with ongoing initiatives in other tuna RFMOs should be explored with a view to avoiding duplication.

3.2 Data on Bycatch and its Mitigation collected by Observers

3.2.1 Observer Data Standards

Tim Park (SPC) introduced the Observer Programme Data Standards. The extent of data collected by observers in the region was initially driven by the needs of scientists and fisheries managers of SPC and FFA. However, since 2004 it has been WCPFC Conservation and Management Measures (CMMs) that are driving observers' data collection standards and as a result, impacting on the role of observers. The WCPFC ROP minimum standard data fields (MSDF, https://wcpfc.int/doc/table-rop-data-fields-including-instructions) were originally based on the data fields standardised across the observer programmes of Pacific Island Countries and Territories (PICT) by the SPC/FFA Data Collection Committee (DCC). The DCC assessed requests for new fields and stabilised any changes by meeting biennially since 1996. It was a conservative approach as any change required reprinting of observer workbooks, their regional distribution and compliance of all programmes to change. PICT observer programmes are the principal observer providers in the tropical WCPO. Observer training among PICTs has also been standardised to meet the WCPFC ROP minimum data standards under Pacific Island Regional Fisheries Observer (PIRFO) training and accreditation standards for observers.

The principal role of observers has been to verify the catch including bycatch and discards, and to collect biological data such as size and sex. However, with the advent of bycatch CMMs the role of observer has also included monitoring the use of mitigation measures and other data fields highlighted in CMMs. This has increased the role of the observer and where bycatch is a compliance issue also increased the level of risk to the observer. The types of bycatch data collected include: species identification; count of individuals (number), by size caught or in primary or non-primary interactions; size (length) related to a specific length code; fate (i.e. whether retained or discarded, why and how); condition (state of health at capture and release); mitigation gear use; and, mitigation of injury/safe handling (comments on treatment of SSI). Monitoring a vessels compliance with relevant bycatch CMMs also challenges observers: to identify species struck off on longlines; marine mammal identification at a distance in purse seine fisheries; loss of length data on silky and oceanic white tip sharks that cannot be landed; uncooperative crew behaviour; and the

long path of adoption from WCPFC decision to new data collection at-sea by all observers. These challenges are being met by the adoption of new tools such as electronic monitoring and a network of national trainers providing refresher training on new protocols to existing observers.

Discussion

One participant inquired about the differences between the WCPFC Regional Observer Program (ROP) and the SPC/FFA observer programme. The SPC Observer Programme Advisor clarified that the DCC is in charge of establishing SPC/FFA data standards, which are used by all PICTs' national and sub-regional observer programmes. These are the main observer providers in the tropical WCPO, whereas the WCPFC ROP incorporates distant water fishing nations as well and sets out minimum standards for reporting for all WCPFC CCMs. The WCPFC ROP MSDF represent a minimum standard, therefore the SPC/FFA DCC data standards go beyond the requirements of the WCPFC ROP in some cases. As an example, D. Golden (United States (US)) explained that the US national data for longliners is following the WCPFC minimum data standards, which are often exceeded as additional data is being collected, whereas for the US purse seiners the SPC/FFA requirements are being followed.

In relation to species identification guides for observers prepared by SPC, one participant asked about the frequency of updating of these guides and the availability of these guides in additional languages with a particular suggestion to provide translation to Bahasa. T. Park (SPC) informed participants that, with the addition of new species (e.g. the recent addition of mobulids), updating of the guides is required. Currently, testing of new identification guides is underway during observer trainings. The identification guides are being translated into as many relevant languages as possible, given the funds available.

Participants asked about the status of electronic reporting in the WCPO with respect to SSIs. T. Park stated that the Parties to the Nauru Agreement (PNA) countries are currently introducing enhancements to their electronic reporting, which allows verification of species identification and other information through addition of electronic photos taken with tablets. T. Park added that electronic monitoring (EM) is also gaining increasing attention within the region with EM systems currently being deployed on over 100 longliners and ongoing development of standards. The information generated by analysis of EM system records is mostly used to determine catch and effort, whereas collection of additional observer information via EM is in an initial stage of development. It was highlighted that EM and observers are considered complementary, with EM systems also providing the opportunity to independently verify some information.

Concerns were expressed regarding the need for a clear definition of the role of observer programmes with regard to scientific and compliance purposes. One participant cited the example of Japan, where the observer program is focusing strictly for the purpose of scientific data collection and would face opposition from industry if the information were used for compliance purposes. Participants also noted that monitoring the hauling of the entire set, as well as accomplishing the full range of tasks required, can sometimes be challenging and asked about prioritization of the information to be collected. The SPC Observer Programme Advisor clarified that the role of observers is guided by relevant WCPFC CMMs and that the information collected is largely driven by WCPFC requirements. T. Park further added that with respect to prioritisation of data, the primary duty is to verify catch and if catch cannot be measured the observer can identify the catch and use the code 'NM', 'not measured'. One participant indicated it is still possible to analyze a relationship between mitigation measures and their effect in reducing bycatch, even without knowing the extent of mitigation measure uptake by fleet. S. Clarke noted the scientific focus of this

meeting and gave her view that the scientific evalution of the effectiveness of a mitigation measure as implemented requires information about the level of uptake without using this information for compliance purposes.

3.2.2 Using Observer Data to Describe WCPFC Bycatch and Mitigation

T. Peatman (SPC) provided a descriptive analysis of SPC's observer data holdings relevant to bycatch mitigation measures in force through WCPFC CMMs, with a focus on longline mitigation for sea turtles, seabirds and sharks. First, maps of total longline effort and observed effort were presented to provide participants with a general overview of the levels of observer data, including areas with limited or no observer coverage. High-level summaries of data availability were then provided for data fields relevant to mitigation measures: bait types and hook shape and size for sea turtles; wire trace and shark-lines for sharks; and, data fields relevant to the full suite of seabird bycatch mitigation options. The majority of records had information recorded for bait species (82%) and hook shape (71%) and hook size (66%). Information on proportions of bait by species, hook numbers for each bait species, and hook offsets was more limited. Information on wire trace and shark-line usage was available for less than one-third of total records, though with increased recording from 2015 onwards. Availability of information for seabird bycatch mitigation varied. Information on blue dyed bait and tori line usage was available for 66% and 55% of records, respectively. Set time (in UTC), required to determine setting relative to nautical dawn and dusk, was available for 30% of records. Weighted branch line information was available for a small proportion of total sets. The use of side-setting, deep-setting line shooters and strategic management of offal discharge were not covered in SPC's data holdings. However there is likely to be available data from 'non-standard' observer programmes (i.e. observer programmes not using SPC/FFA observer forms) that have not been fully consolidated into SPC's observer holdings, and so the summaries of data availability likely underestimated coverage for some data fields. Summaries of condition information and species-specific code usage were also provided given their relevance to analyses of mitigation measure performance. Condition at vessel was available for 85% and 75% of sea turtles and seabirds, respectively. Species-specific codes were used for 95% and 80% of caught sea turtles and seabirds. The presentation concluded with some general considerations regarding the use of observer data to inform mitigation measures used in WCPFC longline fisheries, and analyses of their efficacy.

S. Clarke provided additional information on this topic including:

- that there are additional sources of bycatch information such as logsheets, and annual reports from Commission members (parts I and II);
- the process required to change WCPFC MSDF (which should be implemented by all observer programmes) involves agreement by the WCPFC Scientific Committee, the ROP Coordinator, the Technical and Compliance Committee and the Commission, and the most recent changes were adopted in 2015;
- the 2016 Joint Analysis of Sea Turtle Mitigation Effectiveness made several recommendations for changes to the WCPFC ROP MSDFs which will be considered by SC14 (Common Oceans (ABNJ) Tuna Project 2017); and
- some vessels cross between the WCPFC and the Inter-American Tropical Tuna Commission (IATTC) Convention Areas and reconciliation of the observer data required by both Commissions might be desirable.

Discussion

One participant inquired whether the information presented included Japan's observer data. T. Peatman clarified that the data summaries included all Japanese data that had been provided to SPC and consolidated with SPC's master observer database (including data from 2015 and 2016).

One participant asked about the low percentages of information available for certain data fields. T. Peatman clarified that some data fields have recently been added and that the percentages presented reflected the entire dataset, so annual percentages might be much higher since reporting on that specific information become mandatory.

Concerns were expressed about the low percentage of regional longline coverage (between 1.0-4.5%) with inconsistent coverage across fleets and gaps in terms of geographic and temporal coverage. Participants discussed to which extent higher observer coverage could help to address bycatch specific mitigation questions and referred to a general level of ~20% coverage as being necessary to cover interactions with common species. It was also noted that past reports by SPC (Lawson 2006) highlighted that to detect rare bycatch events coverage closer to 100% is required. S. Clarke encouraged participants to provide suggestions on how bycatch data from observers, logbooks and other data sources as well as sampling design in datasets could be improved with a view to answering bycatch mitigation related questions of the Commission. She added that this would not necessarily imply higher observer coverage and could focus instead on collection of the most useful information in the most efficient way.

One participant suggested that in relation to seabirds, species-specific bycatch rates for threatened species would be very important and would make a big difference to understanding impacts to vulnerable species.

3.2.3 Improvements to WCPFC Bycatch and Mitigation Data

Participants were invited to note any issues that have arisen during the week which relate to the MSDF for the WCPFC's ROP. S. Clarke reminded the workshop that WCPFC14 has tasked SC14 with reviewing MSDF recommendations arising from the sea turtle joint analysis work in 2016 (WCPFC14 Summary Report, para. 363). The US indicated that it would prepare for SC14 any necessary background information using the sea turtle workshop report and previous papers by Gilman and Clarke (2015, WCPFC-2015-SC11/EB-IP-05), etc.

With specific reference to those 2016 workshop recommendations, SPC noted that minimum hook width should be able to be calculated from other hook information already required to be reported and thus this change to the MSDF should not be necessary. Regarding sea turtle species identifications, SPC explained that debriefers already perform some verification on species records, but might not have the tools such as updated habitat maps which would be useful to flag potentially dubious records. SPC also inquired about the necessity of specifying bait type at a finer scale than the set level as currently required. It was noted that in some cases bait types may be alternated among branchlines between floats (basket) and so for analysis purposes it would be important to assess which bait types correspond to the hooks where sea turtle interactions occurred. These issues can be addressed in any background information provided to SC14.

With regard to seabird data collection, several participants noted weaknesses in the current seabird identification tools provided to observers. Improvements to these tools are expected imminently as

SPC is currently engaged in updating the guides to cover the range of seabird species encountered across the WCPF Convention Area. Other items to be considered included:

- Recording of which hooks were observed (acknowledging that an observer can often not be present for the entire haul) should be ensured;
- Recording of line weighting should be at the set level rather than at the trip level as currently required because weighting regimes may change;
- There should be sufficient information to determine whether the appropriate mitigation techniques are applied in situations where the set or haul spans a crepuscular period (dawn or dusk), i.e. recording a value once for a single set may not be sufficient.

SPC noted that the requirements for recording set and haul times are different for purse seine and longline fisheries under the WCPFC ROP MSDF. The more specific requirements (i.e. those for purse seine require the time to be reported in both ship time and UTC units) should be applied for the longline fishery as well.

Some participants noted that there are benefits from greater public visibility of bycatch data in WCPFC fisheries, including not only access to data but also basic analysis to allow general scale and trends of interactions to be considered by all members and the public.

FAO/ABNJ referred to the WCPFC's Bycatch Data Exchange Protocol (BDEP) produced by SPC which has been posted on the SC12 and SC13 websites and provides an aggregated summary of the Commission's bycatch data holdings (Williams et al. 2016, 2017). Although the BDEP represents a starting point, it is mainly limited to the public domain ROP data which are only a portion of the bycatch data available to SPC for analysis. As a result, SPC commented that its analyses of bycatch data (e.g. the purse seine bycatch estimates prepared for SC13 (Peatman et al. 2017) and the longline bycatch estimates to be presented at SC14) provide a better source of information on bycatch quantities and trends.

SPC noted that the use of the BDEP is not currently well understood though it could potentially be tracked through the download information from the WCPFC website. One participant noted that the Indian Ocean Tuna Commission's BDEP—which is similar to the WCPFC's—has been useful in a recent seabird analysis. Support from WCPFC CCMs and Observers for future production of BDEP templates by SPC will be necessary for it to continue.

Some participants noted that the issues being discussed are closely related to the WCPFC Data Rules[1]. While greater transparency and sharing of bycatch data for scientific purposes was widely supported, it was acknowledged that data confidentiality and access issues are sensitive and need careful discussion at the Commission level. It was noted that under the current WCPFC Data Rules some initiatives to analyze bycatch data at the regional or global scale are progressing, specifically the WCPFC/ABNJ Joint Analysis of Sea Turtle Mitigation Effectiveness and the Birdlife/ABNJ Global Seabird Analysis.

[1] WCPFC Rules and Procedures for the Protection, Access to, and Dissemination of Data Compiled by the Commission. Accessed online at https://www.wcpfc.int/system/files/Rules%20and%20Precedures%20%5BData%5D%20%5Bas%20revised%20at%20WCPFC4%20December%202007%5D.pdf

3.3 An example of using electronic monitoring and seabird mitigation in Southern Australia

D. Power (FFA) presented experiences with electronic monitoring in Australia. Bycatch including marine mammals, turtles and seabirds is often rare and is difficult to detect and quantify without very high levels of monitoring (Lawson 2006). In Australian pelagic longline fisheries e-monitoring was implemented as a mandatory monitoring requirement on all longline vessels from mid-2015. Demersal longline fisheries also have 100% monitoring coverage with observers in the Southern Ocean fisheries and e-monitoring around southern Australia. The higher levels of monitoring have enabled a more accurate quantification of seabird bycatch which supports scientific assessment of the impacts as well new management approaches that better incentivise fishers to take all reasonable steps to minimise their bycatch. Under the Seabird Threat Abatement Plan (TAP) in Australia, bycatch rate triggers were established that are monitored at the individual boat level across an 8-month summer season and 4-month winter season. All fishers are required to report their seabird bycatch in the daily fishing logsheets and the review of e-monitoring records is used to verify that fishers are reporting accurately. If a boat exceeds their bycatch rate trigger, it prompts pre-determined management responses that escalate if the bycatch continues over multiple seasons. Initial management response includes an assessment of mandatory mitigation measures (tori lines, line weighting and zero offal discharge during setting) to evaluate if they are being used effectively and if they are adequate. Fishers are then given the opportunity to improve their mitigation practices and continue fishing. However, if the bycatch problems continue at unacceptable levels (i.e. higher than the seabird TAP trigger), that boat can face temporary closures and restrictions on where they can fish. This approach is proving successful at minimising seabird bycatch to low levels as fishers are incentivised to invest in effective mitigation techniques and vessel practices. The emphasis of this approach is on working constructively with fishers and applying management responses to boats that have bycatch problems rather than applying stricter management across all vessels including those that don't have bycatch problems. Overall the use of e-monitoring as an audit tool with risk-based review of fisher's logbook reports, is a cost-effective approach to provide more reliable scientific information on the impacts of fishing on seabird populations and incentivises responsible fishing practices and effective use of mitigation techniques by fishers.

Discussion

Participants inquired about the level at which the values triggering specific actions were set and the additional costs of implementing the electronic monitoring component of the system. D. Power clarified that the values, as well as the restrictions resulting from exceeding them, were set at the level of the individual vessel. He further added that the initial costs during the trial phase were borne by the Government and, once the EM system was included in the licensing conditions, were shifted towards the vessel owners who need to deploy such a system on board when applying for a license.

T. Auger (New Caledonia) provided the example of the French Patagonian toothfish fishery with 100% observer coverage and strict application of mitigation measures and additional requirements to move into a different geographic area once the vessel catches a seabird. In this fishery, France and Australia, as CCMLAR member countries, are working closely together and managed to achieve a significant reduction of seabird mortality.

4 Critical Review Techniques for Bycatch Mitigation Papers

S. Clarke (ABNJ/FAO) introduced an exercise designed to illustrate potential issues and techniques to use when critically reviewing papers in the scientific literature. She noted that she generally starts by reading the abstract of the paper in order to assess whether the paper as a whole is worth reviewing in detail, and then proceeds to read the introduction and discussion, referring to the methods and results as necessary. She noted that relying on the abstract alone may provide an overly summarized perspective and thus omit some key information pertinent to the interests of the reviewer. It is also possible that the abstract may not accurately represent what was studied or what can validly be concluded. Therefore, the purpose of the exercise was to encourage reviewers to browse through the entire paper and to provide some tips on how to do this efficiently and effectively. (Some participants indicated that they never rely on the abstract to convey the content of scientific articles; instead they proceed straight to the methods and results sections.)

Two abstracts were presented to the workshop:

- *Afonso, A.S., F. H. V. Hazin, F. Carvalho et al. 2011. Fishing gear modifications to reduce elasmobranch mortality in pelagic and bottom longline fisheries off Northeast Brazil. Fisheries Research 108:336–343. doi: 10.1016/j.fishres.2011.01.007; and*
- *Rabearisoa N., P. Bach and F. Marsac. 2015. Assessing interactions between dolphins and small pelagic fish on branchline to design a depredation mitigation device in pelagic longline fisheries. ICES J Mar Sci 72:1682–1690. doi: 10.1093/icesjms/fsu252*

Participants were asked to read each of the abstracts and then summarize the topics and findings of each paper. They were also asked to indicate whether the abstracts raised any questions that should be verified by reading the paper in full. In the interest of time, S. Clarke then showed in each paper where the answers to those questions are found and participants discussed the relationships between the abstracts and the full papers. The merits of each paper were also discussed in a general sense to demonstrate the kinds of issues that a critical review of the mitigation literature could raise.

The following issues were identified as important in one or both of these studies, as well as when reviewing other scientific papers:

- Conclusions should only be drawn when there are adequate sample sizes and statistically significant differences. It may be necessary to critically scrutinize the methods and results sections to confirm this.
- If results vary by species, or if the species found in the study are different from the species of interest, this may have important implications for the overall effectiveness of the mitigation method being evaluated.
- If possible, the effects of the mitigation on catches of target species and other bycatch species should be evaluated alongside the effects on the bycatch species of interest.
- When evaluating shark mitigation measures, care should be taken to account for potential "missing" data points due to sharks biting through the leader (i.e. such bite-offs should be recorded).
- Since mortality is a function of haulback mortality, handling mortality (on deck) and post-release mortality, when referring to reductions in mortality it should be clear whether mortality is reduced at all stages or only some stages.

- The objective of the mitigation, and if possible, its potential cost should be clearly mentioned in the paper.
- It is important to verify whether the mitigation studies were carried out under commercial fishing conditions in order to evaluate the effectiveness and acceptability by fishers.

Participants also noted the following general considerations with regard to peer-reviewed scientific literature:

- Negative results, e.g. techniques that fail to mitigate or studies which do not show significant results, should also be reviewed as they add to the existing body of knowledge.
- A well-written abstract is an important entry point to the paper and may sometimes be the only source of information (e.g. when the full-text article is not available).
- The BMIS team should try to make as many papers as accessible as possible (i.e. they should not screen out papers) and promote open access as much as possible.
- Review of the scientific literature is an important precursor to informed decision-making and BMIS can help to facilitate this review.
- BMIS could benefit from an interactive interface in the form of an infographic with links to information on mitigation at different stages of the fishing operation.

5 Safe Release Techniques

K. Hett (ABNJ/FAO) provided an overview of the handling/safe release guidelines currently in place in WCPFC. A variety of factors have been considered when developing practices for releasing bycatch, which generally aim at avoiding mortality to incidentally, caught species. This includes maintaining safe conditions of the crew, and recovering gear to allow recycling/re-use. In some cases the development of such guidelines is required in order to comply with WCPFC requirements. Safe release guidelines usually include handling options as well as release options. WCPFC currently has three different guidelines for handling and safe release of bycatch species, which are listed in Table 1 below.

These guidelines are not mandatory and WCPFC can take no action for not adhering to the guidelines. Recent developments during WCPFC14 included:

- Agreement to task SC14 to develop proposed guidelines for safe release of rays and sharks and taking into account existing standards or guidelines adopted on other fora. The Commission agreed that priority should be given to the development of guidelines for safe release of silky shark and oceanic whitetip sharks (WCPFC Summary Report, para. 331).
- Adoption of CMM 2017-06, which "encourages CCMs to adopt measures aimed at ensuring that seabirds captured alive during longlining are released alive and in as good condition as possible and that wherever possible hooks are removed without jeopardizing the life of the seabird concerned" (WCPFC Summary Report, Attachment R, para. 7).

The group exercise aimed at reviewing the existing guidelines for these two taxonomic groups, available through BMIS, in terms of readability, format, target audience, clarity, completeness and consistency of advice with a view to developing ideas for the format and content of future WCPFC guidelines.

Participants formed two groups addressing sharks and rays, and seabirds, respectively.

Table 1. WCPFC guidelines for handling/safe release of bycatch species

Title of guideline	Content	Year of adoption/Year of implementation start	Fisheries covered	Development mandate	Format	Reporting required?
WCPFC Guidelines for the Handling of Sea Turtles	Recommended practices	2009/ 2010	Longline and purse seine	WCPFC CMM for sea turtles (CMM 2008-03) calls for "proper mitigation and handling techniques to be developed and provided to all CCMs".	Text and graphics	No
WCPFC Guidelines for the safe release of encircled whale sharks	Non recommended practices	2015/ 2016	Purse seine	WCPFC CMM for whale sharks (CMM 2012-04) requires that "in the case of incidental encirclement by purse seine that whale sharks be safely released following any guidelines adopted by the WCPFC for this purpose"	Text only	Yes WCPFC CMM 2012-04 requires flag states to report the number of whale sharks encircled, the number released, the techniques used and the condition on release.
WCPFC Best handling practices for the safe release of mantas and mobulids	Recommended and non recommended practices	2017/ 2018	Longline and purse seine	Based on concern for these species (including recent WCPFC key species, CITES and CMS listings)	Text only	No

5.1 Safe Release Techniques for Sharks and Rays

The subgroup considering the development of shark and ray safe release guidelines reviewed the seven guides readily accessible in BMIS by searching on the References page for species group "sharks and rays" and collection "safe handling and release guides" (AFMA (2016a), Anon (2012), ISSF (2016), NOAA (2017), Poisson et al. (2012), Poisson et al. (2016) and AFMA (2016b)). This review of safe release information in various formats suggested that ideally a fully-documented policy statement (e.g. AFMA 2016a) on safe release would be agreed by the Commission from which a simple one-page poster or leaflet aimed at outreach to fishers would be produced. Graphics were considered necessary for the outreach product and desirable for the policy statement as well, although it was noted that such graphics are not included in the WCPFC's current whale shark and manta/mobulid safe release guidelines.

Most of the guides focused on longline fisheries. The group acknowledged that short of fishing sharks out of the purse seine net (or removing a FAD that may have attracted sharks) it is difficult to avoid causing mortality to sharks encircled in purse seine fisheries. If a shark did survive to the point of being brought onto the purse seine deck, many of the same safe release guidelines would apply as when a shark is brought onboard a longliner. Some participants suggested that sharks that are slated for release will almost never be brought onboard alive, therefore, detailed guidelines for such cases (e.g. methods for calming the shark) are probably unnecessary. One representative from industry remarked that only small sharks (approximately less than 100 cm) are brought onboard where hook retrieval is quickly attempted if possible.

Participants identified that one of the guidelines achieved a kind of balance between the policy statement and the poster formats by showing graphics with a small amount of text (Anon. 2012). This guide provided both dos and don'ts for longline fisheries, which was considered an advantage, but participants noted that the guide covered more situations than necessary and could be slimmed down (i.e. retain Sections 1, 2 and part of 6). The group noted the trend toward producing separate guidelines for different species when actually many of the recommended handling methods are the same across species. It was suggested that it might even be possible to develop one safe release guideline for all animals to be released.

For the moment, given WCPFC14's tasking, it was considered most practical to focus on building new guidelines for all sharks and rays into the recently adopted "Best Handling Practices for the Safe Release of Mantas and Mobulids". The following points were suggested to be considered when preparing such a combined draft:

- Use the existing manta and mobulid guidelines as the starting text
- Add graphics/drawings for the do's and don'ts contained in the existing guideline
- Consider constructing the format to facilitate conversion to a poster format
- Modify language as necessary to suit sharks (e.g. weight limits may need to be adjusted for sharks, special language may be needed for thresher sharks)
- Ensure there is appropriate language regarding the maintenance of crew safety.

S. Clarke (FAO/ABNJ) agreed to follow these suggestions to prepare a draft document for submission as an information paper to SC14. Consultation with industry on the guidelines was considered important, as was the eventual production of a poster or flyer version that can be distributed for onboard use.

5.2 Safe Release Techniques for Seabirds

The subgroup on seabirds reviewed the four guidelines readily accessible in BMIS by searching on the References page for species group "seabirds" and collection "safe handling and release guides" (NOAA (2010), BirdLife (undated), ACAP (2014) and Southern Seabird Solutions (2018).

The seabird group discussed that there might be different target groups for safe release guidelines depending on the context. Generally, the Commission provides guidance at the higher level, such as guiding principles and clear guidance on when the intervention is necessary. Based on these principles, more detailed technical guidelines with additional supporting information and graphic "quick and easy" guidelines could be developed for practical use on vessels by crew.

The subgroup also discussed the potential usefulness of training videos based on case studies, which could be used in observer and crew trainings (EM system footage could be a starting point). The group highlighted strong and weak elements in all four guidelines analysed including some conflicting advice between guidelines. Key areas of agreement on the guidelines were:

- Handling birds of all sizes requires two people: one to restrain the bird while a second removes the fishing gear.
- Style for the detailed graphics should not be cartoon style as it may be inaccurate, rather guides should make use of detailed illustrations or photos.
- Further technical advice is needed on whether or not to recommend an intervention when the hook is stuck in the throat and when hook removal would be recommended.
- Advice on risks to crew of handling birds, e.g. boobies have an especially dangerous bill.
- Advice on good bird handling to maximize survival (e.g. not holding birds by the end of the wings).

The subgroup considered that the most practical approach would be to focus on developing draft guidelines for seabirds specific to WCPFC bringing together elements from all four available guidelines. The following points were suggested to be considered when preparing such a draft:

- Sequential structure of the guidelines for seabirds including a decision tree to be followed.
- Taking a comprehensive approach addressing different situations that might occur such as:
    - handling birds of different sizes;
    - different positions of the hook (on the beak, in the neck or in the stomach); and
    - how to handle the different situations.
- Including do's and don'ts.
- Using schematic drawings supported by pictures, as needed.
- Including information on the risks of handling injured birds.
- Ensuring clarity and removing ambiguity in pictures and drawings (testing with different user groups).
- Listing required equipment.

The group agreed that advice specifically for the WCPFC on seabird safe handling would be useful, and suggested that a draft guideline be developed for consideration by the SC.

5.3 Estimates of post-release mortality for whale sharks

S. Clarke (ABNJ/FAO) made a presentation on one aspect of an ongoing assessment of interactions between whale sharks and Pacific purse seine fisheries involving the estimates of post-release mortality. WCPFC CMM 2002-04 requires the safe release of whale sharks if they are unintentionally encircled in purse seine nets. While observers record the condition of whale shark upon release, the post-release mortality rates are currently not well understood. There have been post-release mortality studies of whale sharks in other oceans but the results are very likely to be dependent on the release practices of the fleet which are expected to differ from one ocean to another. Since the probability of mortality to a whale shark from an encounter with purse seine net involves both the immediate mortality (recorded by the observer) and post-release mortality (currently not known), a Delphi (expert elicitation) survey has been developed in an attempt to parameterize post-release mortality. S. Clarke invited participants to test the survey by accessing it online and answering the questions posed. Participants were then asked to provide feedback on the scope and wording of the questions, the format and interface of the survey and the target audience for the survey.

Participants found the wording of the questions with regard to the minimum and maximum estimates to be cumbersome and difficult to understand. It was recommended that these questions be posed in more straightforward language which can be more easily understood by non-scientists and non-native English speakers. One participant who had used a Delphi approach in a previous study found it useful, but noted that the wording of the questions is critical to a successful outcome.

Participants also noted the importance of targeting the survey to the appropriate respondents as this could easily bias the outcome. S. Clarke explained that the responses from this workshop are just for illustration and that the formal survey responses will be those received in response to a separate survey URL which will be sent out by ISSF. It was noted that the questions don't refer specifically to the Pacific and ISSF's mailing list might be global, therefore it may need to be tailored to the Pacific.

The group discussed the possibility of providing survey respondents with a summary of observer data on whale shark condition prior to them filling out the survey for the first time. It was noted that initial sea turtle habitat maps were provided to inform first round survey participants when the Delphi technique was used in the sea turtle joint analysis workshops. However, there may be concerns about the statistical use of the observer data for the estimate of immediate mortality as well as an input to the estimate of post-release mortality of whale sharks. This point will be discussed with the statistical consultant.

6 Review of Sea Turtle Mitigation Issues

6.1 Introduction

S. Clarke (ABNJ/FAO) noted that six sea turtle species are currently listed in threatened categories by the IUCN Red List. All sea turtle species have been listed by the Convention on International Trade in Endangered Species (CITES) on Appendix I (i.e. a trade ban) for several decades, and all except the flatback (*Natator depressus*) are listed by the Convention on Conservation of Migratory Species (CMS) Appendices I & II. Bycatch in fishing activities is considered the most important threat to sea turtles worldwide and in the Pacific the greatest threat is to hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*) sea turtles. When

threats from fishing are considered by gear type, longlines are considered to pose less of a threat than trawls or set nets, but more of a threat than purse seines (though entanglement in fish aggregated devices (FAD) is a recognized concern).

Options to mitigate threats to sea turtles from longline fisheries for tuna vary by species and life-stage but generally involve avoiding preferred habitat, altering the attraction to bait and gear, and reducing the sea turtles' propensity to ingest or entangle in gear. There have been many experiments investigating one or more of these aspects and results from different fisheries and conditions are sometimes contradictory (Clarke et al. 2014). The evidence for some of the most common mitigation techniques, including use of circle hooks, finfish bait, avoiding shallowing setting, minimizing soak time and the use of deterrents, will be explored in the group exercises.

WCPFC adopted a sea turtle conservation and management measure (CMM) in 2008 (CMM 2008-03). This CMM requires that shallow set longline fisheries (provisionally defined as those for which the majority of the hooks are set shallower than 100 m) fishing for swordfish use one of the following three mitigation measures: (i) large circle hooks with an offset of no more than 10 degrees; (ii) whole finfish bait; or (iii) another measure, mitigation plan or activity approved by the WCPFC Scientific Committee. WCPFC convened two joint analysis workshops in 2016 designed to estimate current interaction and mortality rates in Pacific longline fisheries and to examine how these estimates could be reduced through improved mitigation (Common Oceans ABNJ Tuna Project 2017). The analysis was conducted jointly by the Pacific Community (SPC), WCPFC members (CCMs), IGOs and NGOs involving 38 participants from 16 countries and utilized observer data from 1989-2015 covering 34 fleets with >2,300 observed turtles of four species. A variety of scenarios involving the use of large circle hooks, finfish bait and the removal of the first and second shallowest hooks adjacent to each float, were applied to shallow set fisheries for swordfish, shallow set fisheries for other target species, and deep set fisheries. Several conclusions were drawn including a finding that if all longline fisheries are required to use circle hooks and finfish bait, interactions and mortalities would be reduced by approximately 50%. One of the tasks for WCPFC's Scientific Committee meeting in August 2018 (SC14) will be to evaluate several potential sea turtle management scenarios, including, but not limited to, ones in which vessels in all longline fisheries in the Convention Area are required to: (1) use either large circle hooks or whole finfish for bait; (2) use large circle hooks and whole finfish for bait; or (3) use any other combination of mitigation methods identified by the SC as being potentially effective. SC14 was asked specifically to evaluate the effects of such mitigation measures on target and bycatch species catch rates.

6.2 Group Exercise on Sea Turtle Mitigation Techniques

S. Clarke (ABNJ/FAO) led a discussion of the outputs of the group exercises exploring BMIS resources on four sea turtle mitigation options: operational changes (including setting hooks deeper and changing soak times); circle hooks; use of finfish rather than squid bait; and visual, auditory and chemical deterrents. Participants were asked to summarize primarily using BMIS, *inter alia*, the extent to which the technique had been tested, its effectiveness for the bycatch species of interest, impacts on target species, impacts on other bycatch, any identified crew safety issues, costs, and any areas of uncertainty.

It was acknowledged that for simplicity each technique was being reviewed as a stand-alone option even though in reality some methods might be used in combination. Groups were encouraged to discuss multi-method mitigation options when they identified them in the literature. Participants were also asked to provide feedback on the ease of use of BMIS and any other issues that arose when accessing the references.

Worksheets used by the sea turtle groups are provided in **Annex B.**

6.2.1 Circle hooks

The group examining circle hooks as a mitigation option for sea turtles reviewed seven papers covering various hooks types and sizes, two of which were meta-analyses. The group noted that large circle hooks are useful in reducing sea turtle interactions with longline gear because their minimum width often inhibits the sea turtle from swallowing the hook thereby preventing deep hooking. This technique has been tested throughout the world and is widely accepted as an effective sea turtle mitigation measure. Large circle hooks have no known effect on the catch rates of seabirds and marine mammals, have no particular crew safety concerns and are known to be similar in cost to other commercial hook types. In some cases circle hooks have been shown to have higher retention rates for some sharks likely due to less bite-offs compared to J hooks. The group noted that circle hooks are required for US shallow set fisheries in the Atlantic and Hawaii longline fisheries, and are also used in Australia and New Zealand.

The effect of circle hooks on target species catch rate varies by hook size (i.e. studies tested sizes ranging from 13/0 to 18/0), and is not well understood. While acknowledging the potential power of meta-analyses on this topic, the group recognized the concern that studies included in the meta-analysis are by definition conducted under very different circumstances, not all of which can be accounted for in a statistical analysis. The group acknowledged that in a review of this kind it can be difficult to isolate the effect of large circle hooks from the effects of different bait types in a particular fishery, especially when these two measures are often applied as a package and there are insufficient data on the effects of each measure on its own. It was noted, however that the WCPFC/ABNJ sea turtle joint analysis did address this point and found that the use of large circle hooks resulted in greater reductions in sea turtle interactions and mortalities than did the use of finfish bait. It is also likely that sea turtles caught on circle hooks will be hooked in the jaw rather than deeply hooked; this suggests they are less likely to suffer major trauma that can lead to post-release mortality.

6.2.2 Operational changes

The group reviewing operational changes involving setting hooks deeper and changing soak times noted that the references for soak time were relatively fewer and somewhat more difficult to access through BMIS. The group also noted concerns about the practical implementation of limiting soak time as mitigation measure given that soak time is a function of haul time which is in turn a function of catch (and thus variable). As a result, most of the review focused on the option of setting hooks deeper. Most of the reviewed studies pertained to the deeper placement of hooks in deep set tuna fisheries as there was little information on the application of this option in fisheries which are targeting species in waters shallower than 25m (i.e. most swordfish fisheries). One participant noted that there had been a swordfish fishery in the Mediterranean that targeted that species in deeper waters but that this had resulted in the catch of large, mature individuals whose removal from the population adversely affected its productivity.

In deep set tuna fisheries, the group identified a study in Hawaiian waters which proposed using weights to lower the entire basket (branchlines between floats) to fish at a deeper level. This was effective in reducing interactions for most bycatch species and indicated a slight increase in bigeye tuna (target species) catch. In another study based on observer data for American Samoa, analysis showed that green turtles mainly interacted with the three hooks closest to the floats and thus removing those shallowest hooks could substantially reduce interactions with most sea turtle

species and sharks. If such a removal reduced the number of hooks fished, a decrease in target species (albacore tuna) catch would also be expected, but this decrease could be avoided by redistributing the hooks to other (deeper) parts of the basket. The group did not identify any safety concerns and, assuming reduced catch of target species is avoided, the only cost would be the purchase of additional weights for the first option. In response to a question it was clarified that both the Hawaiian and American Samoa fisheries use circle hooks and finfish bait.

If implementing this mitigation option, it may be more difficult to monitor that the hooks were effectively placed deeper than 100 meters. The group noted that there appeared to be little opportunity with this method to mitigate interactions with leatherback turtles due to their preference (relative to other sea turtles) for deeper habitat. Also, there will be a strong interaction between fishing efficiency (and mitigation efficiency) and oceanography, therefore the suitability of this mitigation measure will vary by area.

6.2.3 Finfish bait

The third group reviewed the scientific literature on whole finfish bait (as opposed to squid bait). The conclusion was that all studies reviewed, including those in Hawaii, the Atlantic and west of Japan, were fairly similar in showing that interactions with sea turtles are more likely when squid bait is used. This group also noted the potential for large circle hooks and whole finfish bait to be applied together and thus also found it difficult to assess bait type effects in isolation. Studies did not indicate any significant difference between shark interaction rates and bait type.

Although finfish bait is typically used for tuna fisheries, squid bait is typically used for swordfish fisheries targeting the shallow zone where sea turtle interaction rates per set are highest for most species. Practical experience from participants suggests though that most fisheries are already using circle hooks and whole finfish bait, and that even those fisheries which have preferred squid bait in the past (i.e. the Japanese shallow set longline fishery for swordfish) have recently switched to whole finfish bait due to the high price of squid bait. The group noted no particular issues for crew safety from the change in bait type, as well as a potential preference for finfish bait if prices remain lower than for squid bait.

Some participants noted that the dyeing of bait to be blue in color is used in some fisheries as a mitigation measure for seabirds. This dyeing presumably works better for squid bait than for whole finfish. Blue-dyed bait was not found to have a significant effect on sea turtle interaction rates in an experimental study conducted with commercial fishing vessels off Japan.

6.2.4 Deterrents

The group reviewing the literature on deterrent-based mitigation measures for sea turtles found that chemical methods have not proved effective and that animals tend to quickly habituate to auditory methods. This leaves visual methods as the most promising of the three types. While potential exists for visual deterrents, most of the studies reviewed simply identified this potential without actually testing it in the field (with exception of gill net fisheries). The group speculated that this situation may reflect negative results from studies which are then not published.

Important distinctions in the visual sensory systems of different species of sea turtles were noted, in particular for leatherback turtles, which are usually found in deeper water and thus better adapted to low light conditions. This species is likely to be attracted to lightsticks that are used to lure swordfish, however, flicker sensitivity differences between leatherbacks and swordfish might

provide potential for designing lightsticks that would attract swordfish but not leatherbacks. There might also be the potential to exploit differences in the color spectrum perceived by billfishes (more blue) and turtles (more green) when designing lightsticks. Finally, since turtles may descend toward baited hooks from above while swordfish ascend from below it might be possible to shade lightsticks so that they shine only in one direction. Light Emitting Diodes (LEDs) may be effective but are potentially cost-prohibitive.

An interesting analysis estimating a mitigation cost of $34 to prevent one turtle mortality was mentioned in the context of gillnet fisheries. Participants noted that it can be helpful to estimate costs, but it is often not clear how much is a reasonable price to pay to avoid bycatch impacts.

6.2.5 Comments on the use of BMIS in the exercise

Participants raised the following comments with regard to the use of BMIS in these exercises:

- Although some reference searches identify large numbers of papers, it is possible to sort longer lists by date to move the most recent references to the top of the list. This was considered a very useful feature.
- A number of weblinks appeared to be broken and this hampered access to the paper being sought.
- It is generally better not to enter too many search terms as the results may be too constrained and not applicable. This may be due to missing or imprecise "tags" on bibliographic references.
- For specific searches it is often better to use the key word search option. Further development might consider making this search option more prominent on the main search page, or highlighting this as a search "hint" somewhere on the site.
- Some participants noted that the time available for the exercises was very limited. This constrained the number of papers that could be reviewed and also the detail of those reviews. This was noted to be particularly challenging for non-native English speakers.

7 Review of Seabird Mitigation Issues

7.1 Introduction

An introduction to important issues to consider was presented by K. Baird of Birdlife International, a partner organization in the Common Oceans ABNJ Tuna Project. The incidental mortality of seabirds, mostly albatrosses and petrels, in longline fisheries continues to be a serious global concern including in the Western Central Pacific Ocean. Seabirds become hooked when baited hooks are deployed or when hauling. The Agreement for the Conservation of Albatrosses and Petrels (ACAP, https://acap.aq/) is a multilateral agreement which seeks to conserve albatrosses and petrels by coordinating international activity to mitigate known threats to their populations. ACAP regularly reviews the most up to date research available on seabird bycatch mitigation techniques and provides updated best practice advice to the Agreement. This presentation reviews some of that key research for pelagic longline fisheries. The most recent update occurred in May 2016. ACAP advice is the simultaneous use of three measures: bird scaring lines (BSLs) also known as tori lines, night setting and branchline weighting. Alternatively ACAP recommends the use of one of two hook-shielding devices as a "one-stop" mitigation solution. These devices encase the point and barb of the baited hook until a prescribed depth or time immersed is reached. BSLs use brightly coloured streamers hanging from the aerial extent of the line to deter seabirds from flying to and under the line so preventing them from accessing baited hooks before they sink. Weighted

branchlines should ensure baited hooks sink out of range of diving birds while protected by tori lines. Updated best practice advice for branchlines is a) 40g or greater attached within 0.5 m of the hook; or b) 60g or greater attached within 1 m of the hook; or c) 80g or greater attached within 2 m of the hook. Night setting works for albatrosses as they tend to forage during the day. For hook shielding devices ACAP has developed performance standards to assess their efficiency in reducing seabird bycatch: a) the device shields the hook until a prescribed depth of 10 m or immersion time of 10 minutes is reached; b) the device meets current recommended minimum standards for branchline weighting; and c) experimental research has been undertaken to allow assessment of the effectiveness, efficiency and practicality of the technology against ACAP best practice seabird bycatch mitigation criteria.

Discussion

Participants raised several questions related to the hook shielding device, which is a recently developed mitigation measure. They inquired about the universal applicability in terms of fitting on all types of hooks and the cost of the hookpod.

One participant informed the group that the hookpod has been tested successfully with various types of hooks, but others suggested they might not work for very small hooks. The current cost for the production of small numbers is around seven USD/per hookpod, and is expected to go down if production increases. One participant suggested that given the high cost, and therefore the cost of losses, application might be restricted to areas and seasons of high risk for seabird interactions.

7.2 Group Exercise on Seabird Mitigation Techniques

S. Clarke (ABNJ/FAO) led a discussion of the outputs of the group exercises exploring BMIS resources on four seabird mitigation options: bird scaring lines, branch line weighting, night setting and hook shielding devices.

Participants were asked to summarize primarily using BMIS, *inter alia*, the extent to which the technique had been tested, its effectiveness for the bycatch species of interest, impacts on target species, impacts on other bycatch, any identified crew safety issues, costs, and any areas of uncertainty. Participants were also asked for feedback on the ease of use of BMIS for this topic and any other issues that arose when accessing the references.

This exercise was slightly different in focus than the one described in Section 6.2 and discussed in more detail than just general effectiveness of the bycatch mitigation measures for seabirds as principles are already well established including through ACAP best practice guidelines.

The worksheets used by the seabird groups are provided in Annex C.

7.2.1 Bird scaring or tori lines

The group reviewing the literature on bird scaring lines noted that the general principle of bird scaring lines (BSL) is based on a line attached to a pole at the back of the boat with streamers of varying lengths and a towed device at the end of the line to maintain aerial extent. The streamers keep birds away from the main line by scaring birds away from the main line and from diving while the baited hooks are still within diving range under the BSL. Maximal aerial coverage described for tori lines is approximately 100 m. Tori lines have been tested in South Africa and the North Western Pacific and New Zealand.

The group noted that the studies reviewed showed a good effectiveness of tori lines in terms of reduction of seabird bycatch, in particular in combination with line weighting. Effects of tori lines on target species or effects on non-target species have not been reported. No safety issues related to the use of tori lines have been reported. The cost of tori lines have not been specified in the studies reviewed, but based on the materials described, the group expected it to be low.

The group noted a recent Japanese study that looked into the use of tori lines for small longliner vessels. On 35 sets with tori lines albatross interactions could be decreased by the use of tori lines, but achieving sufficient aerial coverage is a key challenge on smaller vessels. The group also noted new guidelines for tori line construction based on studies for small vessels in New Zealand, which would reduce entanglement of birds and provided costs of between NZ$240-340). This study informed the latest ACAP best practice guidelines which have now been incorporated into the WCPFC seabird measure (CMM 2017-06). The group noted that better materials are often more costly, but have better longevity.

The group noted that tori lines are being widely used throughout all oceans and noted that they are already included in CMM 2017-06. The group further noted that the availability of materials for tori lines might be an issue in certain areas. BSL require appropriate deployment on a set by set basis and changing wind patterns during tori line settings and consequent changes in vessel direction might be also problematic.

7.2.2 Night setting

The group reviewing night setting noted that the underlying principle is to set the line at night when most sea birds are not active. This mitigation technique has been tested in, *inter alia*, Australia, the Mediterranean and South Africa.

The group noted that all reviewed papers consistently found that night setting in combination with tori lines or weighted branchlines is an effective technique except for nocturnal seabirds such as the white-chinned petrel. The group further noted that the effectiveness of this technique depends on the lunar light intensity. Night settings have no additional cost.

The group noted that the setting time depends on the particular target species; whereas night settings are routinely done in many fisheries (e.g. the US and EU swordfish fisheries and the New Zealand surface longline fishery), they are not appropriate for others due to the target species (such as tropical tunas). It was suggested that day versus night setting is often a characteristic of the fishery and so is not easy to change. The group also discussed the need to complete the set during the night, although often this does not happen and it continues through the dawn period when albatrosses are actively foraging. It was noted that additional mitigation would need to be used if this occurs in areas which are likely to have interactions with seabirds. Some fisheries (e.g. Hawaii longline fishery) are mainly catching birds during the day on the haul.

The group noted that night setting is already included in CMM 2017-06. Monitoring of implementation can be done via logbooks and possibly VMS. Uncertainties associated with night setting as a mitigation measure include the applicability to a specific fishery and a possible transfer of pressure to other vulnerable species.

7.2.3 Line weighting and bait sink

The group reviewing line weighting noted that the basic underlying principle consists of adding weight to the branchlines which leads to increased sink rate of hooks out of the diving range of most feeding seabirds. This mitigation technique has been studied in Japan, South Africa, Brazil, Australia and Uruguay.

The reviewed references widely showed that line weighting is effective at reducing seabird bycatch when used in combination with tori lines and can provide mitigation for hauling as well as setting. Impacts on target species catch rates are limited, but have been described for bigeye tuna, yellowfin and albacore if the weight is placed close to the hook. No changes in shark catch rates have been described, and effects on sea turtles and marine mammals are not identified in the references reviewed.

Crew safety has been described as an issue in terms of 'flybacks' caused by shark bite-offs, which might strike the crew. Technical solutions to safety issues have been developed in the form of sliding leads, which can significantly reduce the risk of 'flybacks'. Weighted swivels of 40-60g currently cost around 0.2 USD if ordered in bulk.

Group participants considered the technique is already one of the options in the WCPFC seabird mitigation measure. If it were to be made mandatory, crew safety issues would need to be properly addressed.

Line weighting is currently mandatory in Australia and Hawaii. The Hawaii deep set longline fishery uses wire leaders meaning that bite-offs are less likely and there is a reduced risk of 'flybacks'.

The group noted that uncertainties with regard to this technique exist in terms of the risk posed to crew and the lack of information on the effects on sea turtles and marine mammals. The group did not review the latest ACAP best practice line weighting recommendations, which reduce the leader length to allow for a greater initial sink rate.

7.2.4 Hook shielding devices

The group reviewing hook shielding devices noted that the basic underlying principle consists of shielding the point and the barb of the hook during the line setting by devices which release the bait once a certain depth outside the diving range of seabirds is reached or after 10 minutes soak time. This mitigation technique has been studied in Brazil, South Africa, New Zealand and Australia.

The group introduced a study carried out in Brazil where two different types of hookpods with and without LED lights were tested. The interactions with seabirds were significantly reduced, although one seabird was hooked during the soak. The hookpods with LED showed an increased catch of target species for swordfish and blue shark.

The group considered another study carried out in New Zealand, which studied the effectiveness of mini-hookpods and found a reduction in seabird bycatch; however, due to entanglement during the soak, some seabirds were still caught.

No crew safety issues were raised during the reviewed studies. The group noted that the cost of hookpods (currently 7 USD) is high and that the failure rate of the device (around 0.4%) plus a combined loss and damage rate in the New Zealand study (around 0.6%) might be considered high

if thousands of hooks need to be deployed. These costs do not reflect commercial production, so cost could be expected to decrease significantly. The inclusion of LEDS in the device could also represent a cost saving in fisheries where light sticks are used.

A second shielding device the group looked at was the smart tuna hook, which consists of a metal cap covering the hook point, which is released after a soak time of 10 minutes. The group looked at trials of the smart tuna hook in South Africa where a significant reduction of seabird catches was described. No variation in target species catches was observed and no crew safety issues were identified. Uncertainties exist in relation to the cost implications especially as the caps are lost each time and need to be replaced. Participants expressed concerns regarding the amount of metal that would be intentionally released into the environment through large scale application of the tuna hook and suggested that this might have implications for countries signed up to MARPOL. The metal cap dissolves after about 12 months in the sea.

7.2.5 Comments on the use of BMIS in the exercise

With regard to their user experience with BMIS, participants made increased use of the keyword search, which they considered very useful. The group also suggested inclusion of cost information for different mitigation techniques in BMIS as this aspect is rarely addressed in scientific publications, or becomes quickly outdated.

8 Close of the Workshop

Participants requested that the Common Oceans (ABNJ) Tuna Project prepare the workshop report based on cleared text and submit the report as an information paper to SC14. Opportunities to present the workshop report as working paper will be investigated through consultation with the EB theme convenors.

Participants thanked the Common Oceans (ABNJ) Tuna Project, WCPFC and SPC for the workshop and the effort invested in developing the BMIS (results of a participant survey are attached as Annex D). The facilitator expressed appreciation for the multi-year commitment of L. Fitzsimmons to making the BMIS what it is today. She also thanked all attendees for their active engagement and enthusiastic participation in the workshop. The workshop closed at 17:30 on 30 May 2018.

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Annex A. Workshop Participants List

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Annex B. Blank Sheets for Exercise on Sea Turtle Mitigation Techniques

CIRCLE HOOKS	
SUGGESTED KEY REFERENCES: Andraka S, Mug M, Hall M, et al (2013) Circle hooks: Developing better fishing practices in the artisanal longline fisheries of the Eastern Pacific Ocean. Biological Conservation 160:214–224 Curran D, Bigelow K (2011) Effects of circle hooks on pelagic catches in the Hawaii-based tuna longline fishery. Fisheries Research 109:265–275. doi: 10.1016/j.fishres.2011.02.013 Reinhardt JF, Weaver J, Latham PJ, et al (2017) Catch rate and at-vessel mortality of circle hooks versus J-hooks in pelagic longline fisheries: A global meta-analysis. Fish Fish 2017:1-18. Gilman E, Chaloupka M, Swimmer Y, Piovano S (2016) A cross-taxa assessment of pelagic longline by-catch mitigation measures: conflicts and mutual benefits to elasmobranchs. DOI: 10.1111/faf.12143 Huang H-W, Swimmer Y, Bigelow K, et al (2016) Influence of hook type on catch of commercial and bycatch species in an Atlantic tuna fishery. Marine Policy 65:68–75. Swimmer Y, Gutierrez A, Bigelow K, et al (2017) Sea Turtle Bycatch Mitigation in U.S. Longline Fisheries. Front Mar Sci 4:. doi: 10.3389/fmars.2017.00260 Piovano S, Gilman E (2017) Elasmobranch captures in the Fijian pelagic longline fishery. Aquatic Conserv: Mar Freshw Ecosyst 27:381–393.	
How or why does it work?	
Where has it been tested?	
Effectiveness for bycatch species of interest?	
Impacts on target species?	
Impacts on other bycatch?	
Crew Safety Issues?	
Cost?	
Currently being used where?	
Any Issues for WCPFC??	
Areas of Uncertainty?	
Overall Summary?	

FINFISH BAIT

SUGGESTED KEY REFERENCES:

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How or why does it work?	
Where has it been tested?	
Effectiveness for bycatch species of interest?	
Impacts on target species?	
Impacts on other bycatch?	
Crew Safety Issues?	
Cost?	
Currently being used where?	
Any Issues for WCPFC??	
Areas of Uncertainty?	
Overall Summary?	

DEEP/SHALLOW SETTING

SUGGESTED KEY REFERENCES:

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How or why does it work?	
Where has it been tested?	
Effectiveness for bycatch species of interest?	
Impacts on target species?	
Impacts on other bycatch?	
Crew Safety Issues?	
Cost?	
Currently being used where?	
Any Issues for WCPFC??	
Areas of Uncertainty?	
Overall Summary?	

SOAK TIME

SUGGESTED KEY REFERENCES:

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How or why does it work?	
Where has it been tested?	
Effectiveness for bycatch species of interest?	
Impacts on target species?	
Impacts on other bycatch?	
Crew Safety Issues?	
Cost?	
Currently being used where?	
Any Issues for WCPFC??	
Areas of Uncertainty?	
Overall Summary?	

DETERRENTS (AUDITORY, CHEMICAL AND VISUAL)	
SUGGESTED KEY REFERENCES: Southwood A, Fritsches K, Brill R, Swimmer Y (2008) Sound, chemical, and light detection in sea turtles and pelagic fishes: sensory-based approaches to bycatch reduction in longline fisheries. Endangered Species Research 5:225–238. doi: 10.3354/esr00097 Wang JH, Fisler S, Swimmer Y (2010) Developing visual deterrents to reduce sea turtle bycatch in gill net fisheries. Marine Ecology Progress Series 408:241–250. doi: 10.3354/meps08577 Werner T, Kraus S, Read A, Zollett E (2006) Fishing Techniques to Reduce the Bycatch of Threatened Marine Animals. Marine Technology Society Journal 40:50–68. doi: 10.4031/002533206787353204 Jordan LK, Mandelman JW, McComb DM, et al (2013) Linking sensory biology and fisheries bycatch reduction in elasmobranch fishes: a review with new directions for research. Conservation Physiology 1:20. doi: 10.1093/conphys/cot002 Crognale M, Eckert S, Levenson D, Harms C (2008) Leatherback sea turtle *Dermochelys coriacea* visual capacities and potential reduction of bycatch by pelagic longline fisheries. Endangered Species Research 5:249–256. doi: 10.3354/esr00112 Clarke SC, Sato M, Small C, et al (2014) Bycatch in longline fisheries for tuna and tuna-like species: A global review of status and mitigation measures. FAO, Rome	
How or why does it work?	
Where has it been tested?	
Effectiveness for bycatch species of interest?	
Impacts on target species?	
Impacts on other bycatch?	
Crew Safety Issues?	
Cost?	
Currently being used where?	
Any Issues for WCPFC??	
Areas of Uncertainty?	
Overall Summary?	

Annex C. Blank Sheets for Exercise on Seabird Mitigation Techniques

STREAMER (TORI) LINES (bird scaring lines (BSL))[1]	
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How or why does it work?	
Where has it been tested?	
Effectiveness for bycatch species of interest?	
Impacts on target species?	
Impacts on other bycatch?	
Crew Safety Issues?	
Cost?	
Currently being used where?	
Appropriate for WCPFC?	
Areas of Uncertainty?	
Overall Summary?	

NIGHT/DAY SETTING	
SUGGESTED KEY REFERENCES[1]: ACAP (2017) ACAP Review and Best Practice Advice for Reducing the Impact of Pelagic Longline Fisheries on Seabirds. In: ACAP - Tenth Meeting of the Advisory Committee. ACAP, Wellington, New Zealand Melvin, E.F., Guy, T.J. and Reid, L.B., 2013. Reducing seabird bycatch in the South African joint venture tuna fishery using bird-scaring lines, branch line weighting and nighttime setting of hooks. Fisheries Research 147: 72-82. Klaer, N. and Polacheck, T. 1998. The influence of environmental factors and mitigation measures on bycatch rates of seabirds by Japanese longline fishing vessels in the Australian region. Emu 98: 305-316 Baker, G.B. and Wise, B.S., 2005. The impact of pelagic longline fishing on the flesh-footed shearwater *Puffinus carneipes* in Eastern Australia. Biological Conservation 126: 306–316. Weimerskirch, H. and Wilson, R.P. 1992. When do wandering albatrosses forage? Marine Ecology Progress Series 86: 297-300 Melvin, E.F., Guy, T.J. and Reid, L.B., 2014. Best practice seabird bycatch mitigation for pelagic longline fisheries targeting tuna and related species. Fisheries Research 149: 5-18. ATF, 2011. Developments in experimental mitigation research – Pelagic longline fisheries in Brazil, South Africa and Uruguay. Agreement on the Conservation of Albatrosses and Petrels, Fourth Meeting of the Seabird Bycatch Working Group, Guayaquil, Ecuador, 22 - 24 August 2011. Løkkeborg S (2011) Best practices to mitigate seabird bycatch in longline, trawl and gillnet fisheries—efficiency and practical applicability. Marine Ecology Progress Series 435:285–303. doi: 10.3354/meps09227	
How or why does it work?	
Where has it been tested?	
Effectiveness for bycatch species of interest?	
Impacts on target species?	
Impacts on other bycatch?	
Crew Safety Issues?	
Cost?	
Currently being used where?	
Any Issues for WCPFC??	
Areas of Uncertainty?	
Overall Summary?	

LINE WEIGHTING & BAIT SINK RATE

SUGGESTED KEY REFERENCES[2,3]:

ACAP (2017) ACAP Review and Best Practice Advice for Reducing the Impact of Pelagic Longline Fisheries on Seabirds. In: ACAP - Tenth Meeting of the Advisory Committee. ACAP, Wellington, New Zealand

Melvin, E.F., Guy, T.J. and Reid, L.B., 2013. Reducing seabird bycatch in the South African joint venture tuna fishery using bird-scaring lines, branch line weighting and nighttime setting of hooks. Fisheries Research 147: 72-82. Also in WCPFC-SC6-2010/EB-IP-09

Robertson G, Candy SG, Hay S (2012) New branch line weighting regimes reduce risk of seabird mortality in the Australian pelagic longline fishery without affecting fish catch. WCPFC-SC8-2012/EB-WP-10, Busan, Republic of Korea

Barrington, J.H.S., Robertson, G. and Candy S.G., 2016. Categorising branch line weighting for pelagic longline fishing according to sink rates. Agreement on the Conservation of Albatrosses and Petrels, Seventh Meeting of the Seabird Bycatch Working Group, 2 - 4 May 2016, La Serena, Chile, SBWG7 Doc 07.

Rollinson, D.P., Lee, S.I., Kim, Y., An, D.H., Wanless, R. M. 2016 Lumo leads: a new, safe line weighting technique to reduce seabird bycatch for pelagic longline fisheries. IOTC-2016-WPEB12-33 Rev_1

Pierre, J.P., Goad, D.W., and Abraham, E.R. (2015). Novel approaches to line-weighting in New Zealand's inshore surface-longline fishery, 41 pages. Final Report prepared for the Department of Conservation: Conservation Services Programme project MIT2012-04

*Sullivan BJ, Kibel P, Robertson G, et al (2012) Safe Leads for safe heads: safer line weights for pelagic longline fisheries. Fisheries Research 134–136:125–132. doi: 10.1016/j.fishres.2012.07.024

Domingo A, Jiménez S, Abreu M, et al (2017) Effectiveness of tori line use to reduce seabird bycatch in pelagic longline fishing. PLOS ONE 12:e0184465. doi: 10.1371/journal.pone.0184465

Melvin, E.F., Guy, T.J. and Reid, L.B., 2014. Best practice seabird bycatch mitigation for pelagic longline fisheries targeting tuna and related species. Fisheries Research 149: 5-18.

*Jiménez, S., Forselledo, R. and Domingo, A., 2017. Effect of reduced distance between the hook and weight in pelagic longline branch-lines on seabird attack and bycatch rates and on the catch of target species. Agreement on the Conservation of Albatrosses and Petrels, Eighth Meeting of the Seabird Bycatch Working Group, 4 - 6 September 2017, Wellington, New Zealand, SBWG8 Inf 27 Rev 1.

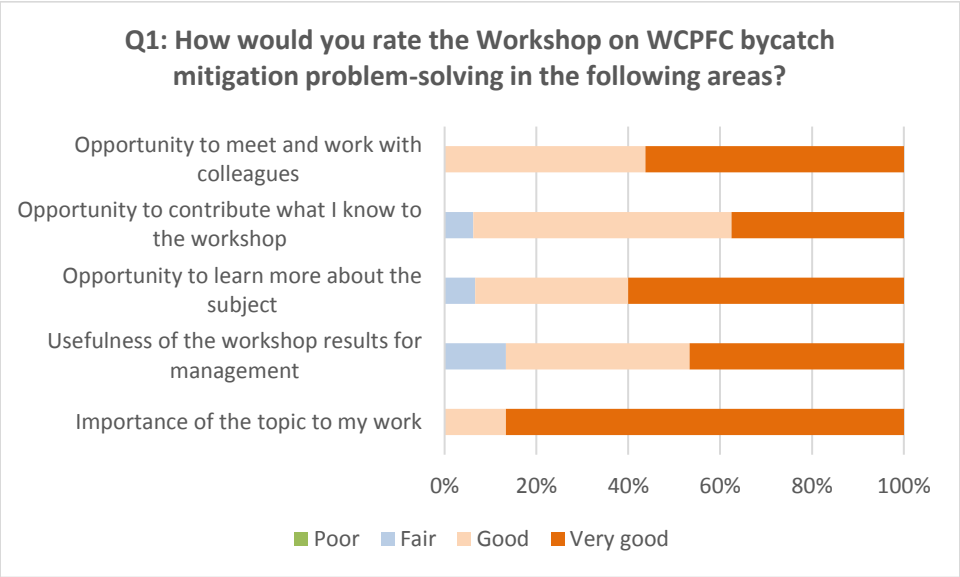
How or why does it work?	
Where has it been tested?	
Effectiveness for bycatch species of interest?	
Impacts on target species?	
Impacts on other bycatch?	
Crew Safety Issues?	
Cost?	
Currently being used where?	
Any Issues for WCPFC??	
Areas of Uncertainty?	
Overall Summary?	

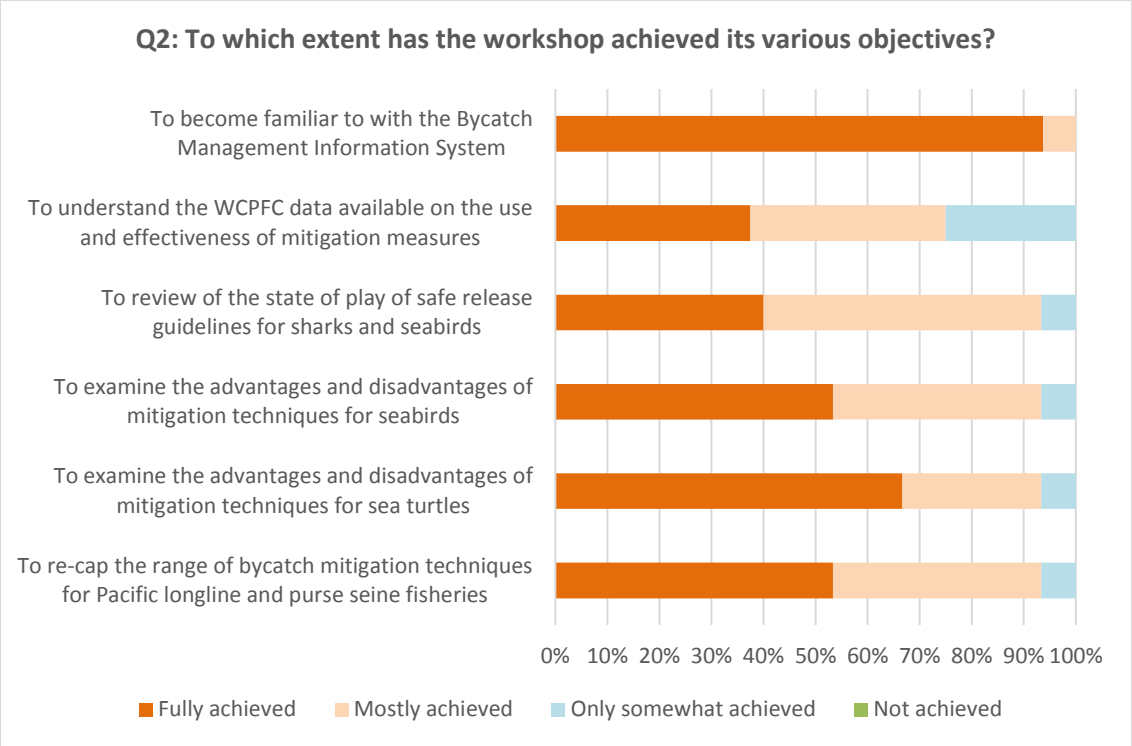
[2] yellow highlighted text – referred to in seabird mitigation presentation

[3] * full reference may not be available on BMIS but may be available for workshop on request

HOOK SHIELDING DEVICES	
SUGGESTED KEY REFERENCES[1]: ACAP (2017) ACAP Review and Best Practice Advice for Reducing the Impact of Pelagic Longline Fisheries on Seabirds. In: ACAP - Tenth Meeting of the Advisory Committee. ACAP, Wellington, New Zealand Baker GB, Candy SG (2014) Proof of concept experiment to demonstrate the efficacy of the "Smart Tuna Hook." Sullivan B. J., Kibel B., Kibel P., et al (2018) At-sea trialling of the Hookpod: a 'one-stop' mitigation solution for seabird bycatch in pelagic longline fisheries. Animal Conservation 21:159–167. doi: 10.1111/acv.12388 Walker N, Sullivan B, Debski I, Knowles K (2016) Development and testing of a novel seabird mitigation option, the Hook Pod, in New Zealand pelagic longline fisheries. WCPFC, Bali, Indonesia Barrington J (2016) "Smart Tuna Hook" as best practice seabird bycatch mitigation in pelagic longline fisheries. In: ACAP - Seventh Meeting of the Seabird Bycatch Working Group. ACAP, Serena, Chile, p ACAP-SBWG7-Doc9 Jusseit H (2010) Testing seabird & turtle mitigation efficacy of the Smart Hook system. AFMA Silva-Costa A, Neves T, Marques C, et al (2017) The performance of Hookpods under commercial fishing conditions in the Brazilian pelagic longline fleet. In: ACAP - Eighth Meeting of the Seabird Bycatch Working Group. SBWG8-Doc-INF08, Wellington, New Zealand	
How or why does it work?	
Where has it been tested?	
Effectiveness for bycatch species of interest?	
Impacts on target species?	
Impacts on other bycatch?	
Crew Safety Issues?	
Cost?	
Currently being used where?	
Any Issues for WCPFC??	
Areas of Uncertainty?	
Overall Summary?	

Annex D. Summary of Results of the Participant Feedback Survey





Q3: In order to achieve the workshop objectives, was the overall length of the workshop?
13% of respondents said the workshop was too short, 87% of respondents said that the workshop was about the right length, no respondent said that it was too long.

Q4: What participants liked most about the workshop:

- Interactive group work and the opportunity to review bycatch mitigation
- Learning about BMIS, challenges and ways to improve it

- Discussing in an informal setting with colleagues from different countries and organizations

Q5: What participants liked least about the workshop:

- Not enough time to discuss bycatch mitigation measures in detail
- Objectives of the workshop could have been more clear
- Some of the discussions went out of context

Q6: Quality of the WIFI: Feedback was positive, some participants experienced some issues at the beginning.

Q7: Additional comments (selected):

- Great job overall and need to have this type of workshop in country for those interested national fisheries offices to expand the wealth of knowledge on BMIS
- BIMS is very useful, but would need sometime for new users to familiarize with it
- Thoroughly enjoyed the workshop and meeting everyone, and what a stunning venue!
- The workshop provided an opportunity to learn about the bycatch issues and challenges with implementing the measures as well as the effectiveness of the measures in place for turtles and seabirds. It would be good to explore more opportunities to work with countries to trial these measures as well as assist with collection of data and analysis to ensure the minimal bycatch for these species.