SCIENTIFIC COMMITTEE
NINETEENTH REGULAR SESSION

Koror, Palau
16 – 24 August 2023

An initial exploration of cetacean bycatch and interactions in the WCPFC

WCPFC-SC19-2023/EB-WP-08

Cara Masere (Miller) and Karen Baird

An initial exploration of cetacean bycatch and interactions in the WCPFC

Cara Masere (Miller) and Karen Baird

Abstract

A recent review of cetaceans in the Pacific Islands Region indicated there are at least 34 species that are resident, migrant or vagrant within this region and they face a variety of threats including incidental catch and fishing gear interactions; harvesting (direct take); pollution; vessel traffic; pathogens and introduced species; resource depletion; and ocean-physics alteration, including climate change. Of these threats, bycatch and interactions with commercial fishery vessels appears to be the most serious. An initial analysis from publicly accessible data covering 2013–2020 and also extracted from SPC summary reports suggests that in the purse seine fishery the species with the highest reported rates of interactions are false killer whales, short-finned pilot whales, rough-toothed dolphins, bottlenose dolphins and spinner dolphins – and in the longline fishery that the species most frequently interacting are false killer whales, bottlenose dolphins, and other toothed whales.

However, there are numerous caveats and limitations to this data including: uneven effort, coarse spatial and temporal resolution of the data, not all data is included (for longline there was an average of 2.5% observer coverage and 75% of effort available; for purse seine there was an average of 87% observer coverage and 55% of effort available), there are some issues with taxonomic classification and groupings, and changes in conservation management measures over time likely have had an impact on reporting rates and fishing activities. Some initial suggestions on how to progress this work in order to gain a better understanding on the scope and extent of the issue include more targeted training and resources for observers, review of historical data to guide future refinements and improvements in quality control and reporting by observers, introduction of single species and taxonomic-specific statistical modelling approaches, and a more substantive and finer-scale statistical analysis of relevant data.

Background

The Pacific Islands region provides year-round, annual and occasional habitat to at least 34 different species of cetaceans ranging from large, migratory baleen whales such as blue whales and fin whales – to small estuarine-associated dolphins such as the Australian snubfin dolphin (Table 1) (*see* Miller, 2023). For most of these species there is limited information available for important characteristics such as abundance, birth rates, potential biological removal, level of residency or site fidelity, genetic distinctiveness, or critical habitat. Further details on individual species along with cetacean diversity lists for each PICT EEZ (Economic Exclusive Zone) were also collated.

An overview of the threats faced by Pacific Island cetaceans (*also in* Miller, 2023) included categories described and linked to IUCN threat classes (following Avila et al. 2018) and concluded preliminary qualitative ratings as follows:

- High: Incidental catch and fishing gear interaction, Directed harvesting, and Pollution
- Moderate: Traffic and Ocean-physics alteration
- Low: Pathogens and introduced species, and Resources depletion

Table 1. Listing of all cetacean species (and associated IUCN Red List status) with at least one reliable record in any of the PICTs. Individual cetacean listings for each PICT (with associated references) are provided in Miller (2023).

Scientific name	Common Name	IUCN
Balaenoptera acutorostrata unnamed subsp.	Dwarf minke whale	LC
Balaenoptera bonaerensis	Antarctic minke whale	NT
Balaenoptera borealis	Sei whale	EN
Balaenoptera edeni	Bryde's whale	LC
Balaenoptera edeni edeni	Eden's whales	
Balaenoptera musculus	Blue whale	EN
Balaenoptera musculus brevicauda	Pygmy blue whale	
Balaenoptera omurai	Omura's whale	
Balaenoptera physalus	Fin whale	VU
Delphinus delphis	Short-beaked common dolphin	LC
Feresa attenuata	Pygmy killer whale	LC
Globicephala macrorhynchus	Short-finned pilot whale	LC
Grampus griseus	Risso's dolphin	LC
Indopacetus pacificus	Longman's beaked whale	
Kogia breviceps	Pygmy sperm whale	LC
Kogia sima	Dwarf sperm whale	LC
Lagenodelphis hosei	Fraser's dolphin	LC
Megaptera novaeangliae	Humpback whale	EN (Oceania)
Mesoplodon densirostris	Blainville's beaked whale	LC
Mesoplodon ginkgodens	Ginkgo-toothed beaked whale	DD
Orcaella heinsohni	Australian snubfin dolphin	VU
Orcinus orca	Orca	DD
Peponocephala electra	Melon-headed whale	LC
Physeter macrocephalus	Sperm whale	VU
Pseudorca crassidens	False killer whale	NT
Sousa sahulensis	Australian humpback dolphin	VU
Stenella attenuata	Pantropical spotted dolphin	LC
Stenella coeruleoalba	Striped dolphin	LC
Stenella longirostris	Spinner dolphin	LC
Steno bredanensis	Rough-toothed dolphin	LC
Tursiops aduncus	Indo-Pacific bottlenose dolphin	NT
Tursiops truncatus	Common bottlenose dolphin	LC
Ziphius cavirostris	Cuvier's beaked whale	LC

The remainder of this paper provides a summary of the findings and recommendations in relation to Incidental catch and fishing gear interactions. Further details on the other threats can be found in Miller (2023).

Incidental catch and fishing gear interactions

Data held by the Secretariat of the Pacific Community (SPC) on interactions with cetaceans has been collated from observers aboard commercial vessels fishing across the Western and Central Pacific Fisheries Commission (WCPFC) region. All observers undergo a training programme run by the

Pacific Islands Regional Fisheries Observer (PIRFO) programme (www.pirfo.org) which is a collaborative training programme supported by SPC and the Forum Fisheries Agency (FFA). The training programme is a competency-based system of training and assessment which has been periodically reviewed to ensure it is meeting core quality requirements and provides training in relation to any updates and changes in the Regional Observer Programme (ROP). The Certificate 3 in Observer Operations is a requirement for all observers in the WCPFC and "prepares candidates for emergencies that may occur at sea, to work safely and effectively, to perform basic navigation and communication and to undertake observation, monitoring and reporting duties required of an observer. The qualification will specify which fishing methodology or methodologies (pole & line, purse seine, long line) the holder of the qualification is trained in to undertake observer duties." Additional micro-qualifications can be gained by the observer in complementary skills such as port sampling operations, biological sampling of catch, electronic reporting, interpreting electronic monitoring operations, and monitoring and applying chain of custody processes and procedures. There are a relatively large number of observers involved in the PIRFO programme (> 800) with a turn-over of around 15 - 20% each year (T. Park, pers. comm.).

The two fishing gear types covered in this review are longline (LL) and purse seine (PS). The level of observer coverage on LL and PS vessels has varied throughout the years. Historically, PS has had higher priority for reporting and has achieved much higher levels of observer coverage; although while 100% coverage has been required since 2010 (CMM 2018-01 and CMM 2018-05, and see supporting/historical conservation measures that these have replaced), this has rarely been achieved, especially since the outbreak of the covid pandemic. The required coverage of all other fisheries operating in the region, especially LL, has been at 5% since 2014 (CMM 2007-01), this has rarely been achieved across the fleet although some individual countries may have significantly greater levels. Observer coverage targets not being met is an important factor to consider when summarising trends seen in the data collected by the PIRFO programme. In addition, there is variability in both LL and PS fishing activities across the region due to such factors as the distributions of target species along with logistics and preferences for fishing boats and fishing nations. Furthermore, there is likely some variability between the fishing footprint and the spatial (and temporal) observer coverage.

A number of forms are completed by observers while onboard vessels. Information on cetaceans is captured under the category of Species of Special Interest (SSI). For observers working on PS vessels, form PS 3 is used to document (i) the estimated total weight, status when landed and when discarded/released, and description of event for each cetacean, (ii) interaction and condition (i.e., alive, alive and healthy, alive injured, alive but dying, dead or unknown) of any cetaceans with primary gear that were not landed. The length and sex of landed individuals is also recorded on form PS 4. Further, open-ended questions regarding interactions with SSI are included in the PS trip report form. For observers working on LL vessels, form LL 4 is used to document (i) the nature of the interaction with primary gear (entangled; hooked externally; hooked internally; hooked in jaw (circle hook); hooked deeply (throat or stomach); hooked unknown; feeding on bait during set; interacted with primary gear only), (ii) condition when first caught and again when released (alive; alive, healthy; alive – injured; distressed; alive, but dying; dead; condition unknown), (iii) length, and (iv) sex. In addition, the LL report suggests writing a report on each SSI that was landed or interacted with the primary gear. Within this trip report there are also a set of questions which are linked to possible depredation events.

Key SPC reports of relatively recent assessments and overviews of the prevalence of cetacean by-catch provide a starting point for considering the number – and relative extent − of cetacean species that interact with and are caught as by-catch in these fisheries. In addition, a public domain by-catch database provides a readily accessible data source. An overview of key references is given below.

Cetacean interactions in the WCPFC longline and purse seine fisheries

Williams et al. (2020) provided an overview of interactions in both the LL and PS fisheries. Total numbers presented reflect totals reported by the 5% (target) coverage of the LL and 100% (target) coverage of the PS fisheries. In addition, the summaries reflect the temporal and spatial coverage of observer trips for each of these fisheries.

There was a total of 298 cetacean gear interactions reported in the long-line fishery between 2015 – 2019. This total comprised 27 cetacean species and species groups with the two groups/species with the highest percentage of individuals (both at ~23%) being reported for a general odontoceti/toothed whale group (*n* = 70) and false killer whales (*n* = 69). Species and species groups with more than 10 individuals reported during this time frame were bottlenose dolphin (*n* = 22), dolphins nei (dolphin - species unknown) (*n* = 8), Indo-Pacific bottlenose dolphins (n = 10), melon-headed whale (n = 10), pantropical spotted dolphin (*n* = 7), Risso's dolphin (*n* = 16), rough-toothed dolphin (*n* = 15), short-finned pilot whales (*n* = 22), spinner dolphin (*n* = 9), striped dolphin (*n* = 5) and unidentified whales (listed separately from toothed whales; *n* = 11). Species and species groups with fewer than 10 reported catches or entanglements were beaked whales, blue whale, common dolphin, dwarf sperm whale, fin whale, Fraser's dolphin, gingko-toothed beaked whale, humpback whale, killer whale, long-beaked common dolphin, Pacific white-sided dolphin, pygmy killer whale, pygmy sperm whale, and sperm whale. The very low observer coverage in the LL fishery makes it difficult to extrapolate these reports to the scale of the total fishery but nevertheless provides an indication of those species most at risk from LLs. The impact of these initial tallies at the species level is speculative yet potentially more serious for those species which are frequently bycaught and may have more structure, fragmentation, local residency or genetic differentiation within their populations or subpopulations across the region.

A total of 2131 individuals from 20 species and species groups were reported to have engaged in "non-gear" interactions with long-line fishing vessels (i.e., sightings alongside the vessel without interacting with gear). A majority of these interactions (>95%) were classified as interactions occurring alongside the boat. The main species involved in non-gear interactions were false killer whales (61.8%), followed by pantropical spotted dolphins (10.4%), rough-toothed dolphins (9.9%), Risso's dolphins (5.5%) and spinner dolphins (4.1%).

Rates of interaction within the PS fisheries were also presented. While raw numbers seem to show a peak in the central reporting period these changes must be considered against the change in required observer coverage which was 5 – 10% from 1995 to 2009 and which has risen to a target of 100% after this time – although there is some variability in meeting this target, due to delayed reporting in some instances, as well as noted difficulties in coverage recently due to the pandemic (Panizza et al. 2021). Furthermore, the influence of other factors such as the introduction of mitigation measures related to setting on cetaceans as well as variable environmental conditions should also be considered.

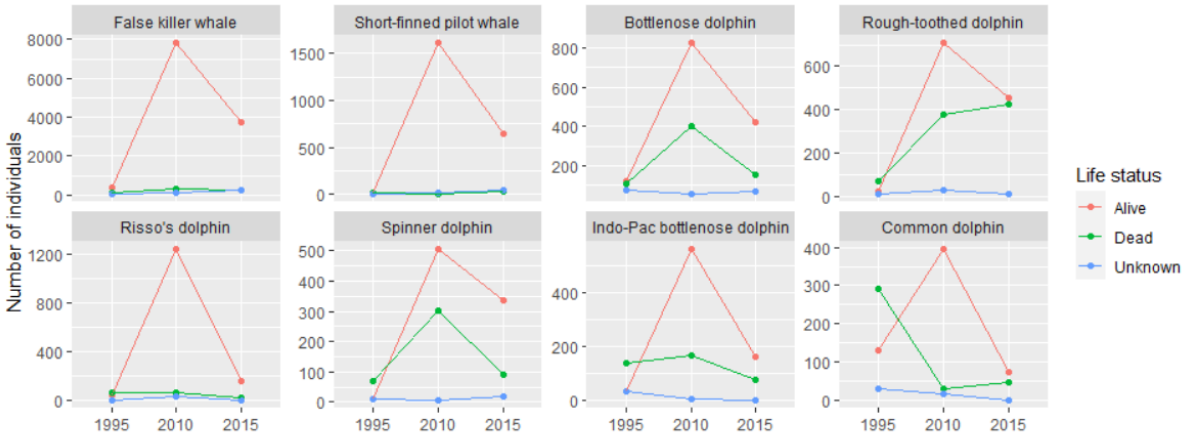

Figure 1. Summary of the number of interactions reported in the purse seine fishery in 1995, 2010 and 2015 for the eight highest ranked overall counts. (Data extracted from Table 9 – Williams et al. 2020). Note that there are different scales on the y-axis – i.e., they range from a maximum of 8000 for false killer whales (top left) to 400 for common dolphins (bottom right). The life status is colour-coded as alive (red), dead (green) or unknown (blue). However, there were also different levels of observer coverage in the first time period (~5%) as compared to the second two time periods (target of 100%).

An updated report by Williams et al. (2021) included limited updates (and partial records) for the most recent, additional year. Due to Covid the expected coverage for the PS fishery in 2020 is expected to be much decreased (~ 45 - 50%) as compared with the required 100% for this fishery. False killer whales were the cetacean species with the highest number of interactions with both unassociated (i.e., set on free swimming schools of target species only) and associated sets (i.e., set on floating objects that are either natural, such as logs or palm fronds, or man-made, such as FADs) – with interactions with the latter being 3 – 5 times higher than the former. Review into the post-release survival of released or discarded false killer whale individuals requires some further investigation. Furthermore, reasons as to why fate is listed as "unknown" in some cases is critical. For example, of the 219 individuals involved in interactions between 2020 to present, 23.7% had a life status listed as "unknown". Of the 2831 individuals involved in interactions between 2015 – 2019, 383 (17.6%) were reported as having "unknown" life status. Bryde's and Sei whales were both reported in interactions at relatively high rates in both set types. In 2014 – 2020 there were 55 Bryde's whales (54 - alive and 1 - dead) and 87 Sei whales (79 - alive, 1 - dead, and 7 - unknown). Species with relatively higher interaction rates with unassociated sets were short-finned pilot whales and Risso's dolphins – whereas rough-toothed dolphins and bottlenose dolphins had higher interactions with associated sets. Of particular concern are the proportion of mortalities overall for rough-toothed dolphins since 2020 (alive – 120, dead – 145, and unknown – 3) yet other time periods were of note also.

<u>Summary of regional purse seine by-catch (2003 – 2017 and 2003 – 2020)</u>

Peatman et al. (2018) found strong variability in yearly by-catch estimates with lower values occurring most recently (2010 – 2017) and higher values recorded from 2003 – 2009 (average ~ 1,200 individuals). Median estimated values range from 334 (273 – 421 95% CI) in 2016 to 1,631 (1,114 - 2,369 95% CI) in 2009. There appeared to be a correlation with set choice; the highest proportion of cetacean by-catch was associated with hauls that were set on floating logs from 2003 to 2008, whereas drifting FAD sets were linked to increased counts from 2009 to the end of the data reporting period. The use of FADs has grown rapidly and one of the stock management measures is a closed season on fishing on FADs. PS vessels then switch to fishing on other large floating objects such as logs, whale sharks or cetaceans. Peatman and Nicol (2021) updated this work and used a slightly different approach for estimating by-catch of whales as they considered the previous

approach may have underestimated total counts. More specifically, they used a combined definition of category of association (i.e., combining whale and whale-shark associated sets with free school sets) to extrapolate observed by-catch up to estimated numbers of by-catch under the assumption that all events had been observed. This adjustment resulted in an increase of 150% relative to Peatman et al. (2018). These revised estimates proposed that annual rates of by-catch in the purse seine fishery for marine mammals have ranged from 1623 (1378 – 1939 95% CI) in 2003 to 3861 (3789 – 3945 95% CI) in 2013. The average for the five most recent years with full data (2015 – 2019) is 1941.8 individuals. Peatman et al. (2021) suggested that future iterations of this work should consider estimating by-catch rates for individual species or species groups in order to gain more meaningful insights into species-specific by-catch rates. In addition, inspection of these estimates in the context of both the introduction of relevant WCPFC Conservation Management Measures as well as review of compliance would provide additional perspective into these estimated trends.

Summary of regional longline by-catch (2003 – 2017)

Estimated annual median longline by-catch for all marine mammals (estimated collectively as a group) varied between approximately 1,700 in 2006 to 5,000 in 2017. Percentage of sets with recorded marine mammals for different depths and regions range from 0.2 (deep, northern temperate) – 3.0% (shallow, southern temperate). The coefficient of variation is relatively large (37.6%) which suggests large uncertainty around these estimates because of the low level of observer coverage. The highest estimated catches were in deeper sets in more recent years (2012 – 2017) with maximum numbers in 2017. In general, higher values were reported in the northern temperate (>10°) areas. Estimated by-catch of marine mammals in this report was aggregated across species and species groups. Hence, the signal coming from this analysis (Peatman et al. 2018) inherently includes bias which may be associated with observer coverage, fishing effort, and the inclusion of other marine mammal groups. Furthermore, while the use of hooks between floats has been used as a general proxy for relative fishing depth in fisheries models there is not an immediate connection of these two depth categories with numerical depth ranges that could then be linked to habitat preferences of different cetacean species in the region.

BDEP database

A summarised database of by-catch data (BDEP data) is accessible in the public domain and was last updated in July 2020 (https://www.wcpfc.int/doc/by-catch-data-file-bdep). These excel datasheets are inclusive of longline data from 2013 – 2019 and purse seine data from 2013 – 2019. Due to regulations regarding release of some observer records (such as minimum number of observations within a given latitude-longitude block), this public database represents a subset of the full database. For the longline fishery, there is approximately 2.6% observer coverage of the 75.2% of total effort included in the BDEP. For the PS fishery, there is approximately 54.5% observer coverage for the 86.9% of total effort included in the BDEP. The BDEP data for both the longline and the purse seine fisheries is collated in two ways, (i) by year, and (ii) by year and 5°latitude-longitude cell. Within the summaries for the longline data the following data is available: species category (bird, mammal, shark or turtle), species group (individual species name or a broader grouping when species identification is uncertain (for e.g., “toothed whale”, “baleen whale”, “dolphins nei”, “beaked whale” – see BDEP database Species Listing for full list), number of vessels with observer data, reported number of captures (count and rate), reported number of mortalities (count and rate), and observed live releases. Within the summaries for the purse seine data the following data is available: species category, species group, number of vessels with observer data, number of sets observed, reported number of interactions (count and rate), reported number of mortalities (count and rate), and

observed live releases. Highest reported catches in the BDEP database for LL vessels were of false killer whale, bottlenose dolphin and toothed whales nei, whereas false killer whales, short-finned pilot whales, rough-toothed dolphins, bottlenose dolphins, and spinner dolphins were the most frequently caught species in the purse seine fishery. Overall, the number of individuals involved in the PS fishery is more than 10 times greater than the LL fishery, yet this of course may reflect the uneven observer coverage of the two fisheries also. Nevertheless, the number of false killer whales being caught in both LL and PS is greater than all other species.

Other reports

More generally, in the north Pacific there have been a number of anecdotal reports of potential fisheries interactions and associations. For example, pantropical spotted dolphins were often encountered near FADs off the west side of Guam. In the Mariana Archipelago this same species – along with short-finned pilot whales, false killer whales and rough-toothed dolphins have been noted to exhibit scars suggesting fisheries interactions (Hill et al. 2020).

Additional, primarily undocumented, risk from fishing gear is also possible through abandoned, lost and discarded fishing gear – and is not only related to direct mortality/injury (ghost fishing) but also the transfer of microplastics and toxins into foodwebs, spread of invasive alien species and harmful microalgae, habitat degradation, obstruction of navigation and in-use fishing gear, and coastal socioeconomic impacts (Gilman et al. 2021). The global risk analysis undertaken by Gilman et al. (2021) listed derelict tuna purse seine gear (including drifting and floating FADs) as one of the key targets for mitigation in order to achieve maximum conservation gains. In general, the use of FADs across the region continues to be of significant concern as both a source of direct and indirect harm to cetaceans and other marine species. For example, the reporting of drifting FADs (dFADs) that are lost or abandoned by fishing companies in coastal areas potentially creates both a risk for marine species while in transit to such locations and also in such areas. Projects to enumerate both active and inactive dFADs and work towards guidelines to reduce impact have been initiated in the Pacific region with initial estimates suggesting that between 20,000 – 40,000 dFADs are deployed annually in the Western and Central Pacific Ocean (WCPO) (Escalle et al. 2021a,b,c). In some locations worldwide, competition and at times conflict between cetacean species and fisheries for the same resources has been noted. Reports of cetacean depredation on tuna appear to be relatively widely spread across the region and occur throughout the year (Williams et al. 2021).

Summary

At present, there is disparate yet leading data available in regard to cetacean interactions within the WCPFC that could be summed up as follows:

(i) Data availability: Observer reports from regional fisheries is the primary source of information on by-catch across the region. Primary fisheries of concern are LL and PS. Observer coverage is highly variable in space and time compared to the commercial fishing footprint itself, particularly for LL. Publicly available databases (such as BDEP) represent proportions of the overall observer data as some aspects of the data have been removed for reasons such as confidentiality and commercial sensitivity. In some cases, the resolution and detail of the data is not available, i.e., data may be collated over a given spatial scale or temporal scale, or, a given code status may simply be designated as unknown. There is much less data and coverage of local and domestic fishing activities.

(ii) Confidence: Observer coverage in the LL and PS are mandated to be 5% and 100% respectively, however these targets have not always been met. There is more confidence in PS data due to higher coverage. There are some issues with reliability and accuracy of species identification for some species of cetaceans. There is a lack of data on cetacean entanglements in ALDFG.

(iii) Impact: Both direct (fatalities) and indirect (interactions or release with unknown longer-term impacts) are plausible. The impacts for species with population substructure (i.e., smaller, discrete populations, high residency in some areas, or low genetic diversity) may be more serious. Likewise, those species with higher levels of conservation concern or in which key groups or activities constitute the take (such as calves, breeding mothers) may have particularly adverse impacts.

(iv) Species of concern: False killer whale, short-finned pilot whale, Bryde's whale (but also "Bryde's-like" whales which may be misidentified as Bryde's whales such as Omura's whale, Sei whale, and Eden's whale), Risso's dolphin, rough-toothed dolphin, and bottlenose dolphin (both common and Indo-Pacific species)

Next steps

This initial review identified a suite of recommendations which would be useful in providing a more detailed and comprehensive review of cetacean bycatch and interactions in the WCPFC which broadly relate to increasing the quality and quantity of data collected in the ROP and focal cetacean species' for statistical modelling. A summary is given below yet more details are also available in Miller (2023).

Regional observer programme (ROP)

Training and resources

Some suggestions for improvements and additions to training materials and resources (including ID manual, ID cards and training presentations) for observers include:

- Include all species that are known to inhabit the region (see Table 1)
- Provide distribution / geographic range of each species with some indication of relative likelihood of presence within this range (if known)
- Show images of relative size of the given species in relation to other species as well as humans, vessel etc.
- Highlight the most significant / identifying / unique features. It is recognised that key features have been indicated yet some of these are very distinctive and provide certainty to identification whereas others are at times variable and not as distinct.
- Add information on common surface behavior
- Add images of species' surface profiles, diving sequence, blow shape etc.
- The two images of each species appear to be relatively similar. Could these images represent different sexes, ages, colouration patterns etc. to assist with identification?
- Provide some additional detail to assist with separation of commonly confused species
- Fish damage section – as it is difficult to directly observe this occurring it may be more objective to categorise different "types" of damage and then ask observers to identify which is the most similar. Including questions about whether animals (including cetaceans) were seen in the vicinity of the given damage would also be helpful.
- Change the scientific name of dwarf sperm whale from *Kogia simus* to *Kogia sima*
- Delete the inclusion of the gray whale in presentation materials

- Provide additional video footage or develop an app to assist with species ID training

Table 2. Notes to assist in correct and consistent observations of cetaceans within WCPFC observer reports and also to avoid "false precision" when species differentiation is difficult.

Species (as listed in observer records)	**Notes and suggestions**
Blue whale	Pygmy blue whales have been noted to occur in the Pacific Islands Region also. Suggestion: List all blue whales as *Balaenoptera musculus* sp. unless additional identification or size records, and/or data (such as images, genetics etc.) is available or expertise is sufficient.
Bottlenose dolphin (*Tursiops truncatus*) and Indo-Pacific bottlenose dolphin (*Tursiops aduncus*)	Relatively similar in at-sea appearance. *T. truncatus* are generally larger (> 2m) and more robust animals. *T. aduncus* are more coastally located and often have reasonable site-fidelity for given bays or coastline. *T. tursiops* have varying life-history characteristics including both wider ranging patterns as well as demonstration of residency to smaller regions and bays. Suggestion: List all bottlenose dolphins as *Tursiops* sp. unless additional identification records (images, genetics etc.) available or expertise is sufficient.
Short-beaked common dolphin (*Delphinus delphis*) and long-beaked common dolphin (*Delphinus capensis*)	Relatively similar in at-sea appearance. Key differences in features include slightly elongated beak in the latter case as well as more robust body type for the short-beaked common dolphin. Geographic range differences occur also with *D. capensis* having a more southerly distribution. Suggestion: List all common dolphins as *Delphinis* sp. unless additional identification records (images, genetics etc.) is available or expertise is sufficient.
Dwarf sperm whale (*Kogia sima*) and pygmy sperm whale (*Kogia breviceps*)	Relatively similar in at-sea appearance. Key differences in features are slight differences in physical size as well as relative location and shape of dorsal fin. Suggestion: List all diminutive sperm whales as *Kogia* sp. unless additional identification records (images, genetics etc.) is available or expertise is sufficient.
Pacific white-sided dolphin	Distribution is generally north of the tropics (and only in the northern hemisphere) and so unlikely to occur in a majority of fisheries operating in the WCPO
Spinner dolphin	Species most likely to occur in the region is *Stenella longirostris* however it is possible that a dwarf subspecies may occur in some parts of the region. Hence, any morphometrics, size referenced images or samples from this species would be very useful.
Bryde's whale, Omura's whale, and sei whales	The difficulty of distinguishing Bryde's whales from Omura's whales and sei whales has confounded much of the historical literature, and even some modern survey data. The animals traditionally called Bryde's whales fall into two species (*B. edeni* and B. *omurai*, with large ('ordinary') and small forms of the former. Suggestion: In cases where insufficient genetic and/or morphological evidence was provided, the *B. edeni/ brydei* records are not distinguished from one another.

Dusky dolphin	Geographic range is generally restricted to coastal waters around New Zealand and South America and hence is unlikely to occur in any other regions across the WCPFC.
Long-finned pilot whale	In the southern hemisphere the geographic range of this species is generally restricted to waters south of the tropics.
Minke whale	There is much similarity between the appearance of the different species of minke whales. Furthermore, it is unclear in some publications as to whether they consistently and accurately differentiate between the common minke whale and the dwarf form. Furthermore, some difficulty has been noted in distinguishing the *B. acutorostrata* species from Antarctic minke whale – as well as Bryde's whales in some cases. The present convention is to regard this species as consisting of two, and possibly three subspecies; the North Atlantic population *B. a. acutorostrata*, the North Pacific population *B. a. scammoni*, and the 'dwarf' minke whale, *B. a.* unnamed subsp., which is found in parts of the Southern Ocean (Rice 1998). Suggestion: In cases where insufficient genetic and/or morphological evidence was provided, minke whales and/or Bryde's whales should not necessarily be distinguished from one another and may be classified as minke-like whales or Bryde's-like whales.
Northern right whale	Geographic range is restricted to coastal areas in the northern hemisphere and is very unlikely to occur in any of the regions of the WCPFC

An observer undertaking the initial training programme will cover whale and dolphin identification in an approximate 2-hour window on the 4th day of a relatively information dense two-week schedule. Refresher training for observers is conducted annually which provides some reinforcement of learning, however overall there is a relatively limited time available for observers to build their knowledge on cetacean identification.

Recommendations:

(i) Explore methods which may innovatively increase exposure to understanding cetacean identification and ecology (for example an app which would allow a way for observers to test or reinforce their knowledge over time) or expand the array of resources available to observers on cetacean identification and ecology would be helpful.

(ii) Ensure knowledge sharing of best practice for safe handling and release of cetaceans to observers (USA 2021).

Reporting/recording of observations

Observer coverage in the PS fishery is targeted to be 100% whereas in the LL fishery it is 5%. Increasing data collection and ensuring even coverage would greatly benefit understanding of by-catch and fisheries interactions in the region.

Recommendations:

(i) Increase observer coverage in the LL fishery. A recommended percentage of coverage could be informed by a power analysis that considered current rates and variability in interactions rates for species of highest concern.

(ii) Explore approaches to increase the spatial and temporal overlap of observer coverage with commercial fishing activity.

Increase photographic capture of cetaceans that are landed or interact with fishing vessels.
Recommendation:

(iii) Provide observers with suitable devices to capture photographic images and/or video footage of cetaceans landed or interacting with fishing vessels (see below also regarding data collection for landed cetaceans).

In observer reports there are a number of places in which a given category (such as interaction type, code, status) can be coded as "unknown". In overall summaries of observer data it is evident that this code is sometimes used relatively frequently.

Recommendation:

(iv) Explore the frequency of different categorical responses to identify which observer responses are often listed as "unknown". This review will provide a platform to then explore whether additional resources, training or information is needed for observers to understand how to assess and categorise their observations accurately. Alternatively, it may reveal that other issues such as task prioritization, time available etc. are impacting the collection of such data.

There are general sections in both the PS and LL trip reports to provide additional detail on cetacean interactions. It is noted that the space available to provide this information is relatively small, and there are many questions in these cetacean-related queries.

Recommendation:

(v) Conduct an analysis of the responses to cetacean related questions in observer trip reports to gain a more detailed understanding of whether (i) there is information which may assist with the development of new resources, and (ii) there are any consistent gaps in responses in this section which may need to be strengthened.

Some species are relatively difficult to tell apart at sea, even to an experienced observer. Other species may be able to be differentiated at close range (i.e., possibly if landed on the deck) or with verification from photographs, measurements, DNA samples etc. A summary of useful species category combinations and when they might be most useful is listed in Table 3. Additional notes on geographic range of some species are also given.

Recommendations:

(vi) Include descriptions of – and create codes – for the species groupings listed in Table 3, and
(vii) Update relevant geographic range information as has been noted in Table 3.

There should be priority placed on recording the condition of a landed cetacean – and also in collecting as much additional information as possible within welfare considerations and the need to release the given animal.

Recommendations;

(viii) Condition of landed animals when they first appear on the vessel and when they are released should always be directly assessed (rather than listed as "unknown"),
(ix) When possible, length, morphometric measurements, and description of each individual should be reported, including any injuries or marks which may be present,

(x) Identification of species or species group categories should be used in line with the taxonomic level at which the observer feels most confident in reporting to,
(xi) Photographic images or video footage should be taken, and
(xii) Genetic samples should be extracted appropriately and stored to verify species identification.

Additional research areas of interest to consider in relation to cetaceans and the ROP include:

(xiii) Exploration of electronic monitoring as means of collecting complementary and/or useful data on cetaceans documented by observers. At present, the focus of EM is to enhance accurate detection and counts of target species and fish by-catch (Brown et al. 2021) however future work is focusing on (among other things) how to incorporate length measurements, assess status of given species, and potentially document species that are not landed on deck. As this area of work develops in the WCPFC it will be useful to monitor if the processes are able to include work into species of special interest as well.
(xiv) More detailed review of the condition of cetaceans that are landed on board on long-term health and survival would be useful. Targeted research efforts to address these questions would be required.

<u>Focal cetacean species' for statistical modelling</u>

Some suggestions related to progressing statistical modelling approaches for cetaceans in the Pacific Islands are provided below.

Recommendations:

(i) Bycatch estimates by species or group. Extrapolations of purse seine by-catch (see Peatman et al. 2018 and 2021) have been collectively grouped as "marine mammals". Consideration of individual cetacean species and species groups analyses is needed to better understand the risk of by-catch to cetaceans. Ideally all species should be assessed, however as a starting point the following species are suggested: false killer whale, short-finned pilot whale, Bryde's whale (but also "Bryde's-like" whales which may be misidentified as Bryde's whales such as Omura's whale, Sei whale, Fin whale, and Eden's whale), Risso's dolphin, rough-toothed dolphin, and bottlenose dolphin (both common and Indo-Pacific species).

(ii) Species distribution models. Undertake species distribution models (SDMs) for cetacean species. It is likely that many species will have insufficient data available to populate some varieties of SDMs and/or have only a limited number of known, strong environmental correlates to be useful in a habitat modelling approach. Hence, one approach would be to attempt to locate and extract not only presence but also absence data from relevant research surveys and databases. Suggested species are false killer whales, "Brydes-like" whale species, Risso's dolphin, rough-toothed dolphin and bottlenose dolphins.

(iii) Species abundance indices. Examine methods to robustly calculate an index of abundance or density across the region for individual species. Direct assessment may be one approach yet interpolation using appropriate predictors such as environmental variables (SDMs) or other approaches could be undertaken. An understanding of any population, social or demographic structure within an estimation of abundance is also required. For example, resident populations, geographically or genetically distinct populations, subspecies, critical habitats, or vulnerable groups (calves, pregnant females). Without knowing both the

population size and having a clear understanding of suitable management unit to use for a given cetacean species it is very difficult to model long-term impacts or possible conservation risks.

(iv) Species risk assessments. Investigate whether any rapid risk assessment methods that have been used within the WCPFC or other Regional Fisheries Management organisations to evaluate the vulnerability of data-poor stocks and species of species interest to fishing activities may be applicable to cetacean species. One approach that is currently being investigated by the WCPFC in this setting is the EASI-Fish (i.e., Ecological Assessment of the Sustainable Impacts of Fisheries) method (Griffiths et al. 2019, Phillips et al. 2021). It is recommended that at least a few candidate cetacean species are used as species of investigation within this programme of work. Given that EASI-Fish requires length measurements it is suggested that dolphin species or small whale species for which this information is routinely (and more likely accurately) measured such as false killer whales, rough-toothed dolphins and bottlenose dolphins might be utilised.

Literature

Avila I.C., Kaschner K. and Dormann C.F. 2018. Current global risks to marine mammals: Taking stock of the threats. Biological Conservation 221: 44-58.

BDEP database. Public domain by-catch data for llongline and purse seine: 2013 – 2019. Available at https://www.wcpfc.int/doc/by-catch-data-file-bdep

Brown, C.J., A. Desbiens, M.D. Campbell, E.T. Game, E. Gilman, R.J. Hamilton, C. Heberer, D. Itano, and K. Pollock. 2021. Electronic monitoring for improved accountability in western Pacific tuna longline fisheries. Marine Policy 132: 104664.

Castro C., Van Waerebeek K., Cárdenas D. and Alava J.J. 2020. Marine mammals used as bait for improvised fish aggregating devices in marine waters of Ecuador, eastern tropical Pacific. Endang. Spec. Res. 41: 289–302, http://www.int-res.com/articles/esr2020/41/n041p289.pdf

Dalebout M.L., Robertson K.M., Chivers S.J. and Samuels A. 2008. DNA identification and the impact of illegal, unregulated, and unreported (IUU) fishing on rare whales in Micronesian waters. Micronesica 40(1/2): 139–147.

Escalle, L., S. Hare, G. Moreno and P. Hamer. 2021a. Overview of ongoing work on FADs. WCPFC-SC17-2021/EB-IP-01. WCPFC scientific committee meeting.

Escalle, L., S. Hare, P. Hamer, and G. Pilling. 2021b. Pacific dFAD retrieval feasibility study. WCPFC-SC17-2021/EB-IP-17.

Escalle, L., S.R. Hare, T. Vidal, M. Brownjohn, P. Hamer and G. Pilling. 2021c. Quantifying drifting Fish Aggregating Device use by the world's largest tuna fishery. ICES J. Mar. Sci. https://doi.org/10.1093/icesjms/fsab116.

Fader, J. E., B. W. Elliott and A. J. Read. 2021. The Challenges of Managing Depredation and Bycatch of Toothed Whales in Pelagic Longline Fisheries: Two U.S. Case Studies. Frontiers in Marine Science 8: doi 10.3389/fmars.2021.618031.

Gomez, G., S. Farquhar, H. Bell, E. Laschever and S. Hall. 2020. The IUU nature of FADs: Implications for tuna management and markets. Coastal Management 48(6): 534-558.

Griffiths, S.P., K. Kesner-Reyes, C. Garilao, L.M. Duffy and M.H. Román. 2019. Ecological assessment of the sustainable impacts of fisheries (EASI-Fish): a flexible vulnerability assessment approach to quantify the cumulative impacts of fishing in data-limited settings. Marine Ecology Progress Series 625: 89–113.

Hamer, D.J., S.J. Childerhouse and N.J. Gales. 2012. Odontocete by-catch and depredation in longline fisheries: a review of available literature and of potential solutions. Marine Mammal Science, 28: 345–374.

Hamer, D.J., S.J. Childerhouse, J.P. McKinlay, M.C. Double and N.J. Gales. 2015. Two devices for mitigating odontocete by-catch and depredation at the hook in tropical pelagic longline fisheries. – ICES Journal of Marine Science 72: 1691–1705.

IUCN. 2021. IUCN Red List of Threatened Species. www.iucnredlist.org. Downloaded on 14 June 2021.

Miller, C. 2023. Review of cetacean diversity, status and threats in the Pacific Islands region 2021. Secretariat of the Pacific Regional Environment Programme, Apia, Samoa. 87 pp.

Panizza, A., P.G. Williams, C. Falasi, E. Loganimoce. 2021. Status of observer data management. WCPFC-SC17-2021/ST-IP-02. WCPFC scientific committee meeting.
Peatman, T., V. Allain, S. Caillot, P. Williams and N. Smith. 2017. Summary of purse seine by-catch at a regional scale, 2003 – 2016. WCPFC-SC13-2017/ST-WP-05. WCPFC Scientific Committee meeting.

Peatman et al. 2018a.: Summary of purse seine fishery by-catch at a regional scale, 2003 – 2017. WCPFC-SC14-2018/ST-IP-04 rev. 1. WCPFC Scientific Committee meeting.

Peatman, T., L. Bell, V. Allain, S. Caillot, P. Williams, I. Tuiloma, A. Panizza, L. Tremblay-Boyer, S. Fukofuka, and N. Smith. 2018b. Summary of longline fishery by-catch at a regional scale, 2003 – 2017. WCPFC-SC14-2018/ST-WP-03 rev. 3. WCPFC Scientific Committee meeting.

Peatman, T. and S. Nicol. 2020. Estimates of by-catch for marine mammals based on longline fishing from 2003 to 2018 in the WCPFC Convention Area, including the region overlapping the IATTC Convention Area. WCPFC-SC16-2020/ST-IP-11. WCPFC Scientific Committee meeting.

Peatman, T. and S. Nicol. 2020. Updated longline by-catch estimates in the WCPO. WCPFC-SC16-2020/ST-IP-12.WCPFC Scientific Committee meeting.

Peatman, T. and S. Nicol. 2021. Updated purse seine by-catch in the WCPO. WCPFC-SC17-2021/ST-IP-06. WCPFC Scientific Committee meeting.

Phillips, B., J. Potts, C. Rigby, V. Allain, S. Nicol, and S. Griffiths. 2021. Applying rapid risk assessment methods to by-catch in the WCPO. WCPFC-SC17-2021/SC17-EB-IP-10. WCPFC Scientific Committee meeting.

Secretariat of the International Whaling Commission. 2021. Assessing and addressing cetacean by-catch in tuna fisheries – a collaborative project proposed to Common Oceans ABNJ Tuna Phase II. WCPFC-SC17-2021/EB-IP-18. WCPFC Scientific Committee meeting.

SPREP (South Pacific Regional Environment Programme). 2020. State of Environment and Conservation in the Pacific Islands: 2020 Regional Report. Straza TRA (author). Wheatley A, Anderson P, Callebaut J, Reupena L (eds). Apia, Samoa: Secretariat of the Pacific Regional Environment Programmeme.

Temple, A. J., E. Westmerland, and P. Berggren. 2021. By-catch risk for toothed whales in global small-scale fisheries. Fish and fisheries 22(6): 1155-1159.

USA. 2021. Draft best handling practices for the safe handling and release of cetaceans. WCPFC-SC17-2021/EB-WP-02 (Rev. 01). WCPFC scientific committee meeting.

Williams, P.G., G. Pilling and S. Nicol. 2021. An update on available data on cetacean interactions in the WCPFC purse seine and longline fisheries. WCPFC-SC17-2021/ST IP-10. WCPFC Scientific Committee meeting.

Williams, P.G., G. Pilling and S. Nicol. 2020. Available data on Cetacean interactions in the WCPFC longline and purse seine fisheries. WCPFC-SC16-2020/ST IP-12 rev. 1. WCPFC Scientific Committee meeting.

Wilson C. 1994. Kiribati: State of the Environment Report. SPREP, Apia, Western Samoa.

Yahn, S., R. Baird, S. Mahaffy, D. Webster. 2017. How to tell them apart? Blackfish species discrimination using fin and body morphometrics obtainable from photos at sea. Abstract (Proceedings) 22nd Biennial on the Biology of Marine Mammals, Halifax, Nova Scotia, October 22-27, 2017.