Ecological risk assessment for the effects of fishing on seabird and mammal species in the SIOFA area.

Report prepared in accordance with Project PAE2021-02. ToR1: Document the seabird and mammal species that commonly interact with fishing activity in the SIOFA area and undertake Ecological Risk Assessments for the Effects of Fishing (ERAEF) on those species.

> Here we have taken the term 'commonly' to mean 'have the potential to' in order that the extent of the assessment is not unduly restricted by relying on the data available from SIOFA fisheries, noting that the data reporting requirements and observer data collection protocols have limitations. This interpretation was agreed with the SIOFA executive Secretary and the Chair of the Scientific Committee.

Introduction

Undertaking an ecological risk assessment provides a formal mechanism to determine:

(i) which taxa are at risk from interactions with fisheries,
(ii) the particular fisheries, areas, and times of year when interactions occur,
(iii) the actions, including research, that can be taken to better quantify and to mitigate any impacts.

Methods for conducting ecological risk assessments for seabirds are well developed and have been applied in several fisheries management bodies that are relevant to SIOFA (CCAMLR, WCPFC, IOTC). Although the details of the methods and implementation of ecological risk assessments differ between different organisations the overarching principles are generally consistent with the tiered approach developed by CSIRO (Hobday et al. 2011). While there are fewer examples of ecological risk assessment for the effects of fishing on marine mammals and other non-target taxa the same principles can be applied and hence the same underpinning data are required (see for example Baje et al 2021). The principle elements of the tiered approach to ecological risk assessment approach are:

> Level 1 - which provides a comprehensive process that examines the distribution of species and activities of interest to establish qualitative measures of the ''Scale, Intensity, Consequence'' of any interactions,
>
> Level 2 is a semi-quantitative ''Productivity-Susceptibility'' analysis that further develops the potential consequences of any interactions on species of interest, and
>
> Level 3 is a highly quantitative, model-based analysis, involving the taxa identified as being at high risk in the Level 1 and 2 analyses

In developing an ecological risk assessment, it is essential that interpretation of the outputs are guided by data availability and the assumptions made where data are scarce and/or missing. As Small et al. (2013) noted, developing quantitative estimates of the species-specific consequences of bycatch are 'problematic and often impossible'. Small et al. (2013) also noted that the definition of risk has proved sufficiently problematic that it can become an impediment

to implementation of the outcomes of ecological risk assessments. Fortunately, the tiered approach provides a mechanism to progress an ecological risk assessment that takes account of, but is not curtailed by, these concerns; as they do not impact the process of assembling the comprehensive information needed to categorise the scale and intensity elements of a Level 1 assessment. This is a particularly important consideration where there are large difference in the data available across different taxa, e.g available data on the distribution of seabirds compared to cetaceans. Furthermore, because they are land-breeding species there is much greater knowledge of population demographics for seabirds compared to many marine mammals. In this project the aim is to assemble the information required to undertake a Level 1 ERA for seabirds and marine mammals and to undertake an initial Level 2 ERA.

Collating all available data to determine which species of seabirds and marine mammals should be included in an ERA across the entire SIOFA area, that extends from the tropics to the subantarctic, is challenging. However, the aim here is to ensure that while such list of species may not be absolutely comprehensive, it should be representative of the biology and ecology of all species that are likely to be involved. This means that any species that occur in the area, but are not explicitly included, would be likely to share the ecological and behavioural traits that guide the development of mitigation strategies and would therefore benefit from the introduction of such measures. Moreover, as the overall aim is to progress multi-species ERA according to the data available and the assessed risk, the need for increased data collection can be considered as an important part of the risk mitigation strategy.

Methods

Fishing Effort

Table 1. Haul level effort records (number of individual fishing events) by gear type made available with CCP permission from SIOFA Secretariat (12 Jan 2022).

	Trap	Hand operated	Demersal Longline	Trawl
Australia			358	26
Spain (EU)			1841	
France	6		161	
Japan				557
Thailand		237		625

Haul level fishing data were made available from the SIOFA Secretariat for the period 2016 to 2020 (Table 1).These data were aggregated into 5º x5º cells for each fishery type (e.g. trawl, demersal longline and hand operated line) in the SIOFA Area (droplines and vertical longlines were both included as demersal longline). Given the small number of sets the trap data were not used in the analysis. Pelagic longline data from Chinese Taipei were provided

by the SIOFA Secretariat as 5° x5° cell and monthly aggregated data for the period 2016 – 2020. Data provided up to 12 Jan 2022 were included in the analysis.

Seabirds

A list of seabird species that occur, or are likely to occur, in the SIOFA Area, was compiled from published sources and data repositories along with their conservation status and relevant biological parameters.

The following information was compiled for each species:

1. Conservation Status (IUCN) including current status and threats
2. Key biological parameters including reproductive biology,
3. Susceptibility to fisheries interaction

Where this information is not available the closest analogous species was used as a proxy.

Based on the approach of Baker et al. (2002) all species of flying seabirds exceeding c500 g in weight that occur in the Indian Ocean were included,(ie. all albatross, both species of giant petrel, all *Procellaria* petrels, all shearwaters and some *Pterodroma* petrels). Other species that have been observed interacting with fishing vessels, including those operating in the Indian Ocean, were also included. Data on seabird distribution, conservation status, population status, overlap and likelihood of interacting with fisheries and vital rates were obtained from species assessments developed by ACAP (http://www.acap.au), IUCN (2021), Carneiro et al 2020 and the BirdLife International Seabird Tracking Database (http://www.seabirdtracking.org/).

For those species included in Carneiro et al (2020) the extent of overlap was quantified based on the proportion of 5x5 cells occupied by both the species of interest and each fishery type based on the 5x5 utilisation maps downloaded from https://datadryad.org/stash/dataset/doi:10.5061/dryad.z612jm685. For other species the extent of overlap was based on visual comparison of the available distribution and/or tracking data.

> Note that Carneiro et al (2020) included "all ACAP species that breed in the Southern Ocean, except for the pink-footed shearwater (*Ardenna creatopus*), southern royal (*Diomedea epomophora*), Campbell (*Thalassarche impavida*) and shy (*T. cauta*) albatrosses for which insufficient tracking data were available in the Seabird Tracking Database to confidently map their distributions" (Carneiro et al 2020 supporting information. Appendix S1).

The data on each species and the spatial overlap with fishing activity was used to produce a risk score for that species-fishing activity combination according to the following scoring procedure:

(a) IUCN status: Critically endangered = 3, Endangered = 2, Vulnerable = 1, Near Threatened = 0.5 and Least Concern = 0;

(b) Breeding population status: rapid decline (>2% per year) = 3, decline = 2, stable = 1, increase =0;

(c) Degree of overlap with SIOFA fishery: proportion of 5x5 cells in which a fishery type occurred in which the species of interest also occurred: high (≥ 0.6) = 3, medium (.25-.59) = 2, low (≤ .25) = 1. Where there were different scores for an individual species (eg by season) the overlap was categorised according to the higher value.

(d) Behavioural exposure to capture high =3, medium=2, low = 1, based on the tendency to follow fishing vessels and relative incidence in bycatch other fisheries;

(e) Susceptibility measure - the mean of scores for (a) to (d)

(e) Life-history strategy: biennial breeder, single egg clutch = 3, annual breeder, single egg clutch = 2, annual breeder, multiple egg clutch = 1.

(f) Median age at first breeding: (≤ 5 years = 1, 5-7.5 years = 2, (≥ 7.5 years =3. Used in the calculation of Characteristic (g) below.

(g) Productivity measure - the mean of the scores for (e) life history strategy and (f) median age of first breeding.

The measures of relative risk (R) for each species was then estimated following the method of Williams et al. (2011) as the Euclidean distance from the species to the origin for a two-dimensional plot of P on S such that $R = ((P - X_0)^2 + (S - Y_0)^2)^{1/2}$ where X_0 and Y_0 are the x, y origin coordinates.

Marine Mammals

A list of marine mammal species that occur, or are likely to occur, in the SIOFA Area, was compiled from published sources and relevant data repositories along with their conservation status (Table 1.2).

As the distribution of marine mammal species in the SIOFA area is not well quantified an the extent of likely overlap between fishing activities and those areas in the region that have been designated as Important Marine Mammal Areas (IMMAs) (see IUCN-MMPATF (2021), Hoyt & Notarbartolo di Sciara 2021) was also used to examine the extent of spatial overlap.