SIOFA | APSOI

Southern Indian Ocean Fisheries Agreement

Accord relatif aux Pêches dans le Sud de l'Océan Indien

SIOFA Ecosystem Summary 2023

Version 1.0 Date 29.03.2023 | Revised by SIOFA WS2022-SUM1 and SC8 | Endorsed by SC8 and MoP10

Next review date: 2024

Contributing authors: Marco Milardi, Stephen Brouwer, Alistair Dunn, Pierre Peries, Patrice Pruvost, Sebastian Rodriguez Alfaro, Ben Sharp, Trent Timmiss,

Please cite as: SIOFA Secretariat (2023). SIOFA Ecosystem Summary 2023. Southern Indian Ocean Fisheries Agreement (SIOFA), 54 pp.

Contents

1. Purpose of this document 4
2. Data sources 5
2.1 Data availability 5
2.2 Missing data for the purposes of this summary 6
2.3 Data used in this summary 6
3. Ecoregions of the Southern Indian Ocean 6
4. Main fisheries operating in the SIOFA Area 8
5. Observer coverage 10
6. Catch and bycatch 12
6.1 Catch of sharks 13
6.2 Discards and bycatch 17
7. Interactions with seabirds, marine mammals, turtles, and with sharks considered to be at high risk and/or of concern 19
7.1 Seabirds 21
7.1.1 Incidental captures 21
7.1.1 Abundance observed around fishing operations 21
7.2 Marine turtles 25
7.3 Marine mammals 25
7.3.1 Incidental captures 25
7.3.2 Abundance observed around fishing operations 25
7.4 Shark captures of species considered to be at high risk and/or of concern 26
8. Interactions with the seafloor and benthic organisms 27
8.1 Interim bottom fishing footprint 27
8.1.1 Revised bottom fishing footprint by gear 30
8.1.2 Bottom fishing footprint by Subarea 34
8.2 Bottom Fishing Impact Assessment 36
8.3 Bottom fisheries interaction with VME indicator taxa 38
8.4 Habitats of significance 40
8.5 Fishing in SIOFA protected areas 40
9. Interactions with larger ecosystem processes 43
9.1 Climate change and environmental variability 43
9.2 Trophic and ecosystem level effects 43
10. References 43
11. Appendix A – Target fish species reported in SIOFA fisheries and included among target species referred to in this summary 44

12. Appendix B – Common names, FAO species codes, and scientific names of sharks, referred to in this summary 45

13. Appendix C – Common names, FAO species codes, and scientific names of VME taxa reported as incidental captures in SIOFA fisheries 47

14. Appendix D – Data included in figures and additional figures 48

1. Purpose of this document

The SIOFA Ecosystem Summary describes the main known effects of SIOFA fisheries on ecosystems and species in the SIOFA Area (Figure 1) and summarizes the available data with an emphasis on the most recent five years. This document is targeted at the general public, institutions, and countries wanting to better understand SIOFA fisheries. It also describes SIOFA data available on SIOFA ecosystems and species that could be used by scientists and consultants for scientific research.

The SIOFA Fisheries Summaries provide more detailed information on target species of SIOFA fisheries, and their biology and ecology. The SIOFA Fisheries Overview further integrates this summary and illustrates broad temporal trends in the main fisheries in the SIOFA Area.

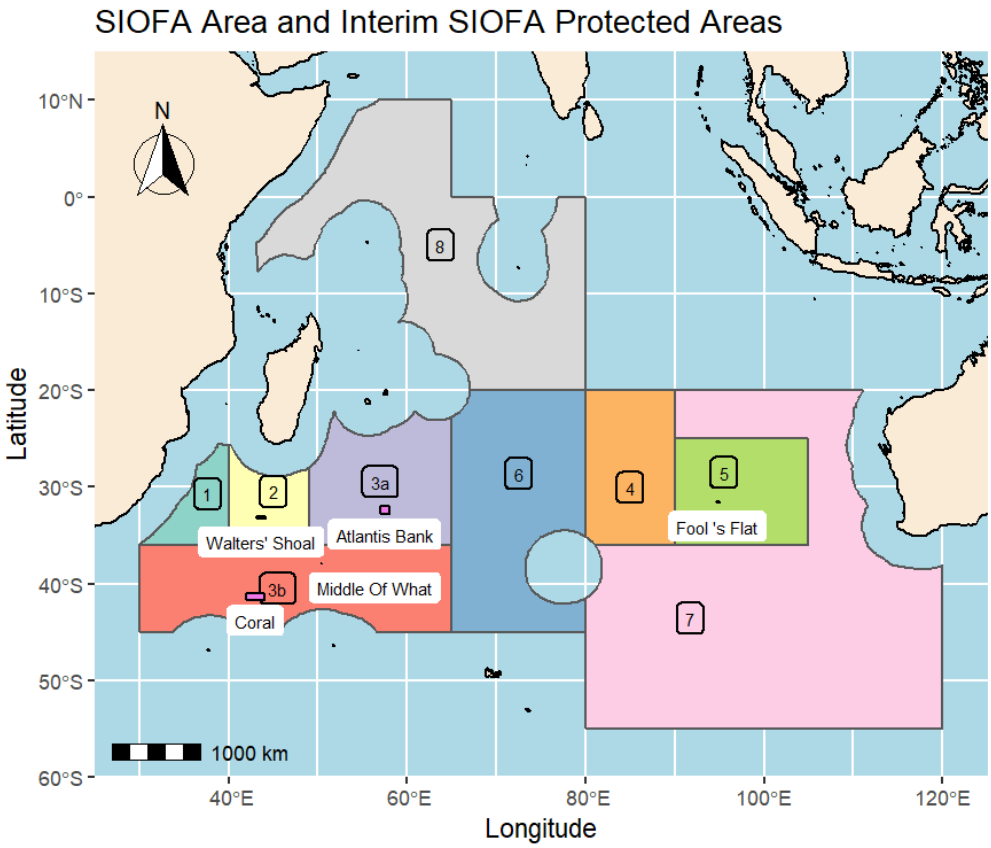


Figure 1 – The SIOFA Area and Subareas (source: SIOFA Spatial database). The Subarea numbers and colour codes are used consistently throughout this summary to identify Subareas. The map highlights SIOFA Interim Protection Areas (in magenta) as defined in CMM 01-2020 (Annex 3). All the interim protection areas have been labelled by name for easier recognition.

2. Data sources

2.1 Data availability

There are thirteen CCPs that are members of SIOFA. The SIOFA Secretariat receives data from CCPs pertaining to their fishing activities, biological sampling, and Scientific Observer reports as per CMM 02-2021 (Data Standards). The SIOFA Secretariat acts as custodian for these data on behalf of its members. Request to release or publish these data (e.g., for scientific purposes) are regulated under CMM 03-2016 (Data Confidentiality). Data requests can be made through the SIOFA Secretariat (secretariat@siofa.org).

The SIOFA databases are organized as follows:

- AggregatedCatchEffort: this database contains catch (and effort) aggregated at a range of spatial resolutions, varying from the whole SIOFA Area to 20' squares, from 2000 to 2019
- HBHCatchEffort: this database contains haul-by-haul catch and effort data at a range of spatial resolutions, varying from degrees to seconds, from 1998 to 2021
- SIOFA Observer Database: this database contains Scientific Observer-collected biological sampling and operational data, as well as retained/discarded species, from 2012 to 2021

The SIOFA databases are supported by other data assets such as:

- Spatial data layers (in various formats), including the GIS spatial layers available to the Secretariat (e.g., SIOFA Subareas, Management and Assessment units boundaries). These are stored at the SIOFA Secretariat.
- Codes, including countries, gears and FAO species codes etc. These are stored at FAO.

SIOFA databases and supporting data assets have been described in the reports of project SEC2021-05 (e.g. SC-07-08), where it was noted that some data are repeated (i.e., there are overlaps) across the AggregatedCatchEffort and HBHCatchEffort databases. It has been suggested to further develop the three databases as three 'subject areas' that form part of a single future SIOFA Fisheries Database.

Further data (e.g., on active vessels) are available from Annual National Reports (2015–2021) that SIOFA CCPs submit to the Scientific Committee every year, which are made publicly available on the SIOFA website (https://siofa.org/meetings/groups/Scientific%20Committee%20Meeting).

2.2 Missing data for the purposes of this summary

SIOFA fisheries data are summarised per calendar year (1 January – 31 December). In addition, the final 2022 catch, effort and Scientific Observer data to be submitted by each CCP are due 31 May 2023 and are thus only partly available here. Any data for 2022 displayed or referred in this summary should be considered as draft, potentially incomplete, and/or subject to further revisions.

A revision of this document during the 8th meeting of the SIOFA Scientific Committee has highlighted the possibility of data not included in the Secretariat database, in particular those of Scientific Observer-reported captures and recorded under other jurisdictions (e.g. other RFMOs).

2.3 Data used in this summary

The information presented in this summary has been extracted from different sources depending on the type of data required. To minimize the difficulty from having to interpret multiple data sources, explicit references have been made to data sources in each table/figure of the summary.

The summary covers the last five years of available data (at a minimum), but note that the data used covers the 2013–2021 period (9 years of data), and that the period covered varies across the different sections as detailed below. Data sources and the timespan of available data for the figures and tables included in this summary are:

i. Main fisheries operating in the SIOFA Area (2000–2019): National Reports submitted CCPs to the Scientific Committee
ii. Total catches per CCP (2013–2020): SIOFA AggregatedCatchEffort database, combined with SIOFA HBHCatchEffort database
iii. Catch, Effort (including per Subarea) and discards (2013–2020): SIOFA HBHCatchEffort, SIOFA AggregatedCatchEffort database and spatial layers (excluding non-fish catch; see Sections 6 and 6.2 for definitions of target catch)
iv. VMEs (2020): SIOFA Observer database
v. Fishing in Interim Protected Areas (2013–2020): SIOFA HBHCatchEffort and Spatial databases
vi. Biological sampling (2020): SIOFA Observer database

3. Ecoregions of the Southern Indian Ocean

The PAE2021-01 project (SIOFA Bioregionalization and VMEs) produced maps of biogeographical regions of the Southern Indian Ocean based on VME indicator taxa using two complementary predictive modelling approaches (“predict first, then group” and “group first, then predict”).

This work detected three biogeographical regions at the first hierarchical level, which broadly represented the upper and lower bathyal, the abyssal and the Southern Ocean (Figure 2). At the second hierarchical level, eight nested biogeographical regions were detected, displaying distinct geographical and bathymetric differences across the region (Figure 3).

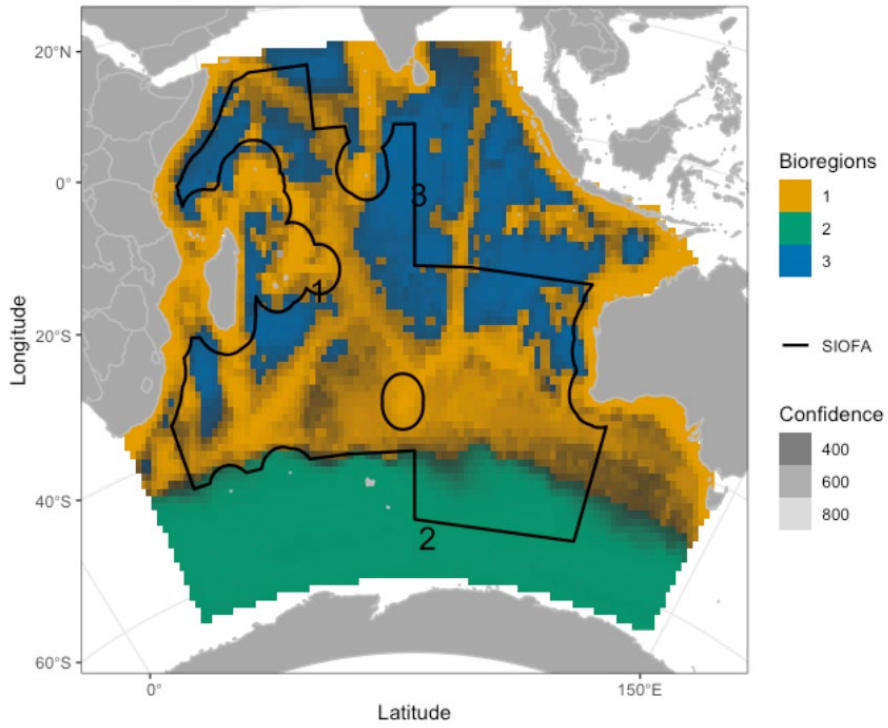


Figure 2 – Predicted biogeographical regions of VME indicator taxa in the Southern Indian Ocean at the first level of the hierarchy. Areas with low confidence in the prediction are shown in darker shades of grey.

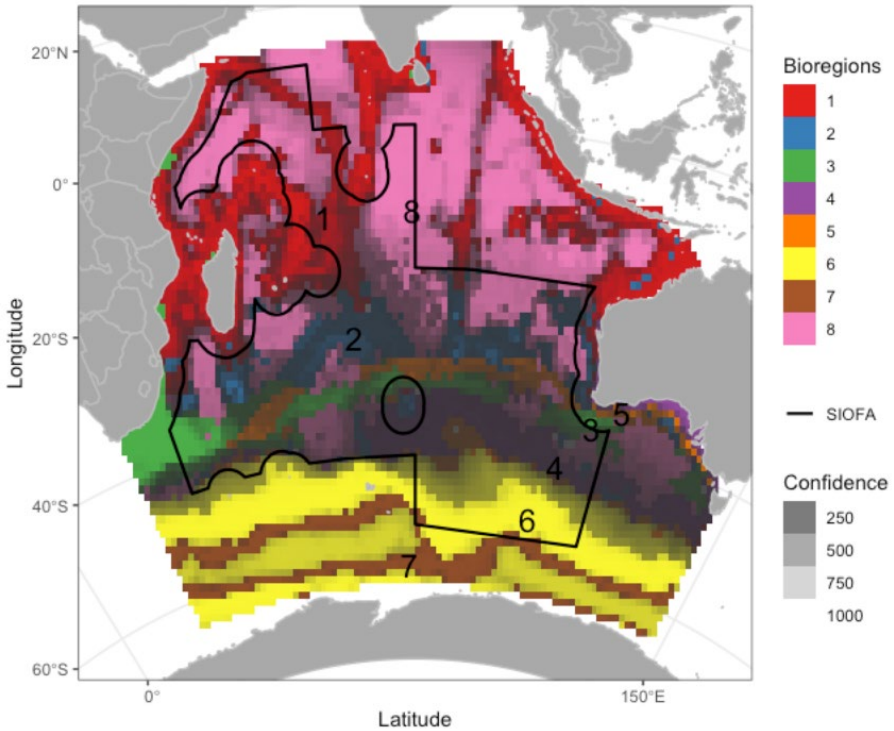


Figure 3 – Predicted biogeographical regions of VME indicator taxa in the Southern Indian Ocean at the second hierarchical level. Areas with low confidence in the prediction are shown in darker shades of grey. Note that, because of the low number of data points, we cannot reliably evaluate these predictions. Bioregion labels: 1: cluster 1.1; 2: cluster 1.2; 3: cluster 1.3; 4: cluster 1.5; 5: cluster 1.7; 6: cluster 2.1; 7: cluster 2.4; 8: cluster 3.1.

Bioregions at the first hierarchical level are the result of taxa distributions spatial clustering, while bioregions at the second hierarchical level reflect limits in dispersal likely driven by the circulation of the water masses in the area. The bioregions, in both predictive approaches, were entirely encompassed within the SIOFA Area. These maps suggest that the SIOFA has a great diversity of bioregions.

4. Main fisheries operating in the SIOFA Area

In the SIOFA Area, a few fisheries account for the majority of the total catch. Table 1 summarises the main SIOFA fisheries by target species and provides information about the fishing method and gear employed, which CCPs engaged in the fishery, and the main Subareas where these fisheries occured.

Table 1 – The main fisheries and target species in the SIOFA Area. The table also provides information on fishing methods and gear used, which CCPs engage in each fishery, and the main Subareas where each fishery operates.

Target species/fisheries	**Fishing method and gear type**	**Participants (from National Reports between 2000 and 2019)**	**Subareas and focal locations**
Patagonian toothfish	Set longline Traps	Australia, EU (Spain), France (Overseas Territories), Japan, Korea	SIOFA Subareas 3b, 7
Orange roughy	Bottom trawl	Australia, Cook Islands, China (2000-02), Namibia, Mauritius	Underwater topographic features in SIOFA Subareas 1, 2, 3a and 3b
Alfonsino	Midwater trawl	Australia, Cook Islands, Japan, Korea, Namibia	Underwater topographic features in SIOFA Subareas 1, 2, 3a and 3b
Saurida and scads	Trawl (nei), Single boat otter board trawl	Thailand	SIOFA Subarea 8 (mainly Saya de Malha Bank)
Shallow-water (<200m) snappers, emperors and groupers	Set longline, Hook and line (handlines) Bottom trawl Traps	EU (France), Mauritius, Thailand, Comoros	SIOFA Subarea 8 (mainly Saya de Malha Bank)
Deeper water snappers, lutjanids, Hapuka	Set longline Dropline	Australia China EU (Spain)	
Oilfish	Pelagic longline	Chinese Taipei	South-west Indian Ocean

5. Scientific Observer coverage

Scientific Observer coverage varies across years and fisheries, with highest observation rates in bottom fisheries, as prescribed by CMM 01-2020, and lower rates in pelagic fisheries (Table 2). Some gear codes (Demersal longlines, Mechanized lines and pole-and-lines, Traps (nei)) are recorded only in the CatchEffort database but not in the Scientific Observer database and are thus not reported in this section to avoid confusion.

Table 2: Total fishing events and Scientific Observer coverage ratio in SIOFA fisheries by gear types (source: Observer database 2018–2021). Events were recorded on a set level, except for handlines and hand operated pole-and-lines where they were recorded on a daily basis, and the Scientific Observer coverage is ratio between the number of events observed and the total events.

Year	Bottom trawls (nei)		Dropline		Midwater trawls (nei)		Set longlines		Trawls (nei)	
	Total events	Observed ratio	Total events	Observed ratio	Total events	Observed ratio	Total events	Observed ratio	Total events	Observed ratio
2018	575	0.619	46	1	1156	0.604	32	1	2	1
2019	161	0.894			545	0.928	405	0.968	1611	0.794
2020					199	1	595	0.79	1216	0.85
2021					287	1	446	0.74		

Year	Vertical lines		Handlines and hand-operated pole-and-lines		Longlines (nei)		Single boat bottom otter trawls		Drifting longlines		Pots	
	Total events	Observed ratio	Total events	Observed ratio	Total events	Observed ratio	Total events	Observed ratio	Total events	Observed ratio	Total events	Observed ratio
2018	9	0										
2019	12	0	103	0	40	1						
2020	8	1	134	1			464	1				
2021			52	1			1017	1	405	1	19	1

6. Catch and bycatch

A wide variety of fish species are targeted in the SIOFA Area (Appendix A). The list of target fish species was extracted from CCP-declared targets as per CMM 02-2021 , and as contained in the SIOFA HBHCatchEffort database. For the purposes of this summary, bycatch was defined as all fish species that were not declared as a target.

Target catch was taken mainly in SIOFA Subareas 1 and 3b (Figure 4a). Bycatch in 2020 was mostly taken in SIOFA Subareas 8 and 2 (Figure 4b). In absolute terms, bycatch is highly variable between years. Bycatch constituted >50% of the total fish catch by weight in 2015 and 2016 (Figure 4a) but has otherwise been around or below 25% of the total catch in other years (Figure 4a). In 2015-2016, when bycatch was highest, the majority of the bycatch came from Subarea 8 (Figure 4b).

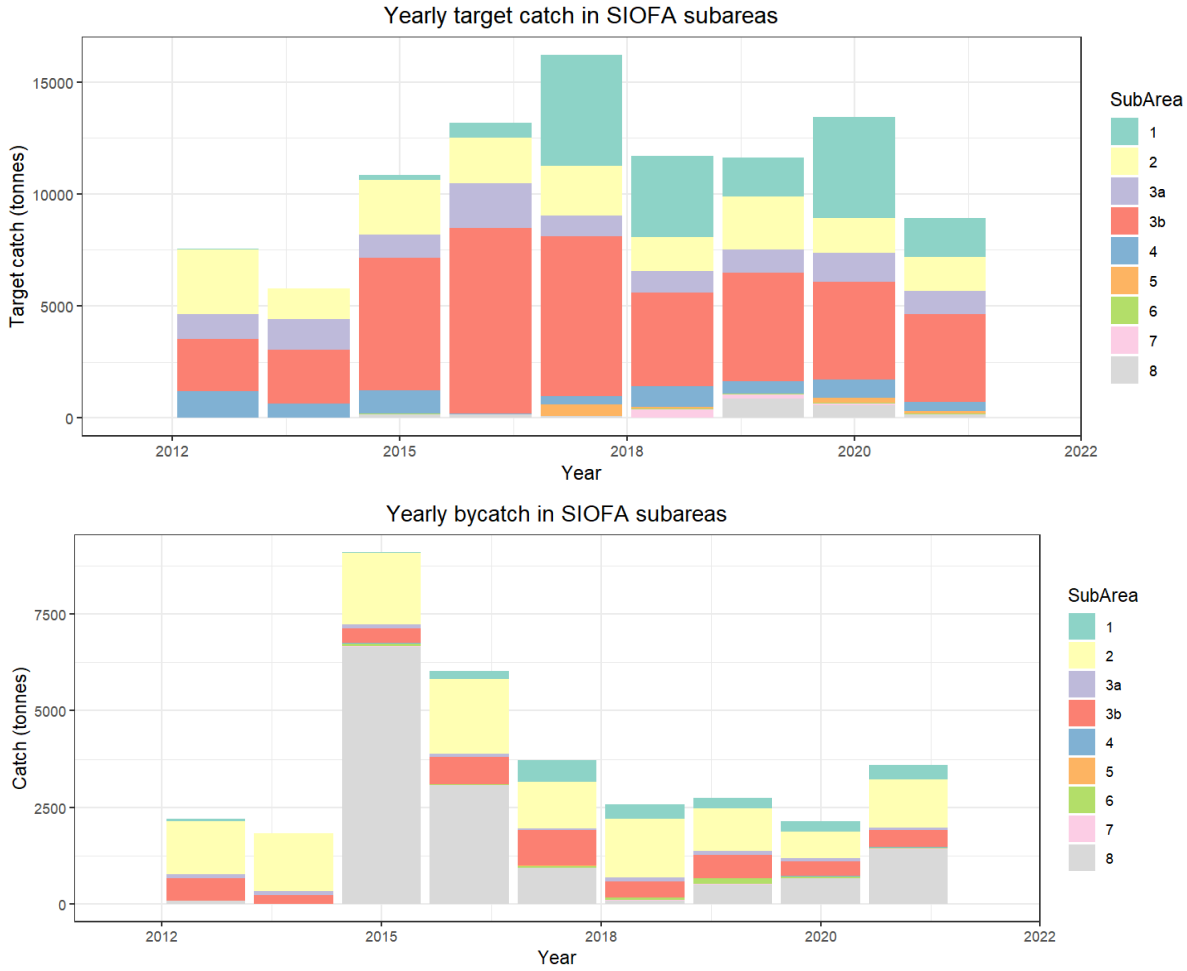


Figure 4a and b – Target catch (upper panel, a) and bycatch (lower panel, b) fish catch by weight in different SIOFA Subareas (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2021). Catches reported without spatial information are not included. See Table D.2 in Appendix D for the values associates with this figure.

The bycatch figures below (Figure 5) show the proportion of 'sharks' in the reported catch. The broad definition of 'sharks' used here includes Chondrichthyans in general (i.e., including rays and chimaeras). In this section, a list of all Chondrichthyan taxa captured in SIOFA fisheries and reported in the HBHCatchEffort database 2013–2021 was extracted and used to define 'sharks'. The full list of shark taxa reported as captured by SIOFA fisheries is shown in Appendix B.

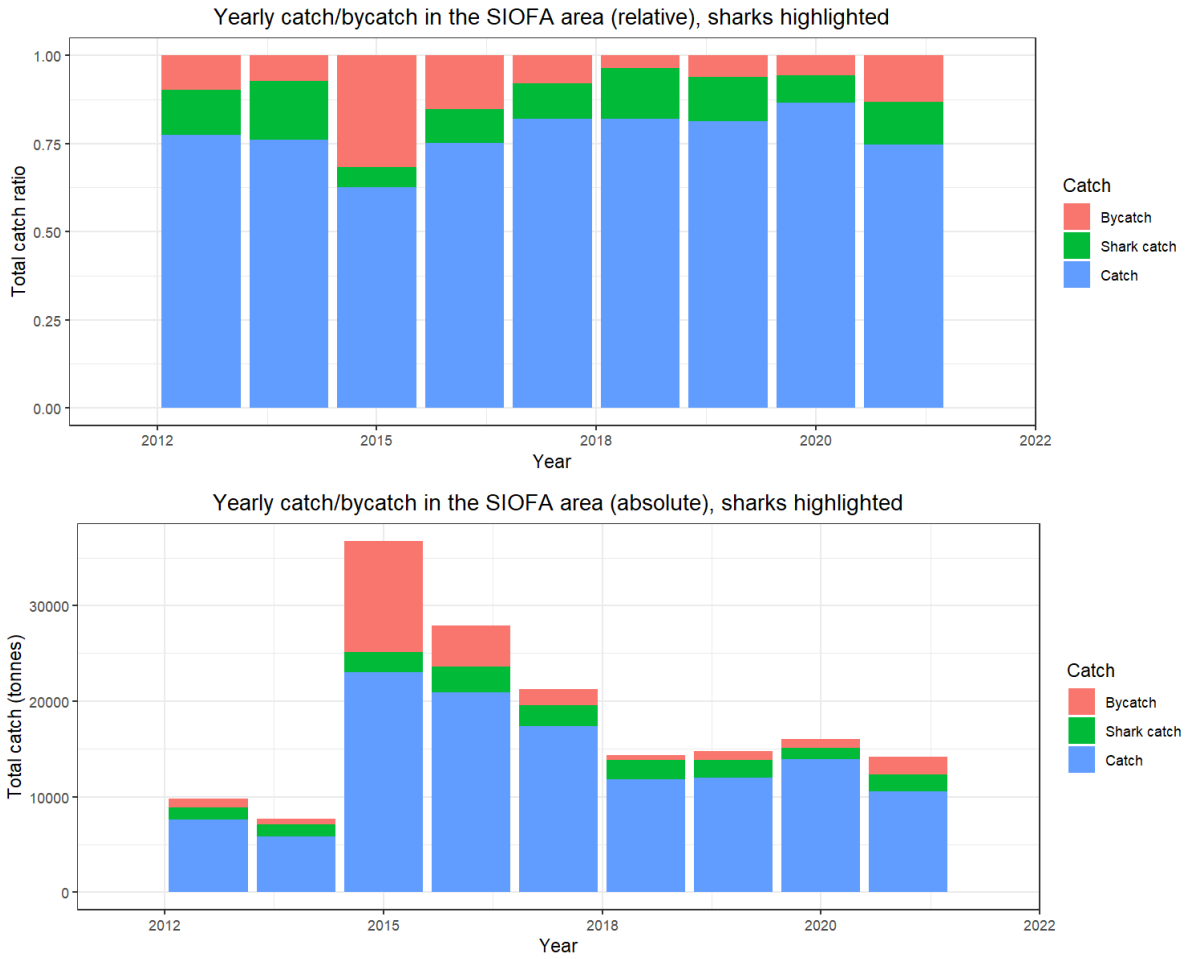


Figure 5a and b – Catch and bycatch in the SIOFA Area summarised as relative proportions (upper panel, a) and absolute weights (lower panel, b) (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2021). Catches reported without spatial information are not included. The portion of catch composed by sharks (as defined in Appendix B) is highlighted. Sharks were targeted in the SIOFA Area until the entry into force of CMM 12-2019(binding from October 10, 2019), which prohibited targeting any deep-sea shark species listed in its Annex 1. Following the entry into force of CMM 12-2019, all sharks are considered as bycatch for the purpose of this summary. See Table E.1 in Appendix E for the values associates with this figure.

6.1 Catch of sharks

Sharks were targeted in the SIOFA Area until the introduction of CMM 12-2019, which prohibited targeting the deep-sea shark species listed in its Annex 1 after October 10, 2019. Following the entry into force of CMM 12-2019, all deepwater sharks are considered as bycatch for the purpose of this summary.

Reported catch of sharks (as defined in Appendix B) increased between 2013 and 2016 but has decreased thereafter (Figure 6a). In most years shark catches were dominated by Portuguese dogfish (CYO) and a substantial proportion of unidentified 'other shark species' (including rays, skates, etc. coded SKX). Other prominent shark catch taxa include kitefin shark (SCK), birdbeak

dogfish (DCA) and gulper shark (GUP). The vast majority of shark catches in the SIOFA Area occurred in Subarea 2 (Figure 6b).

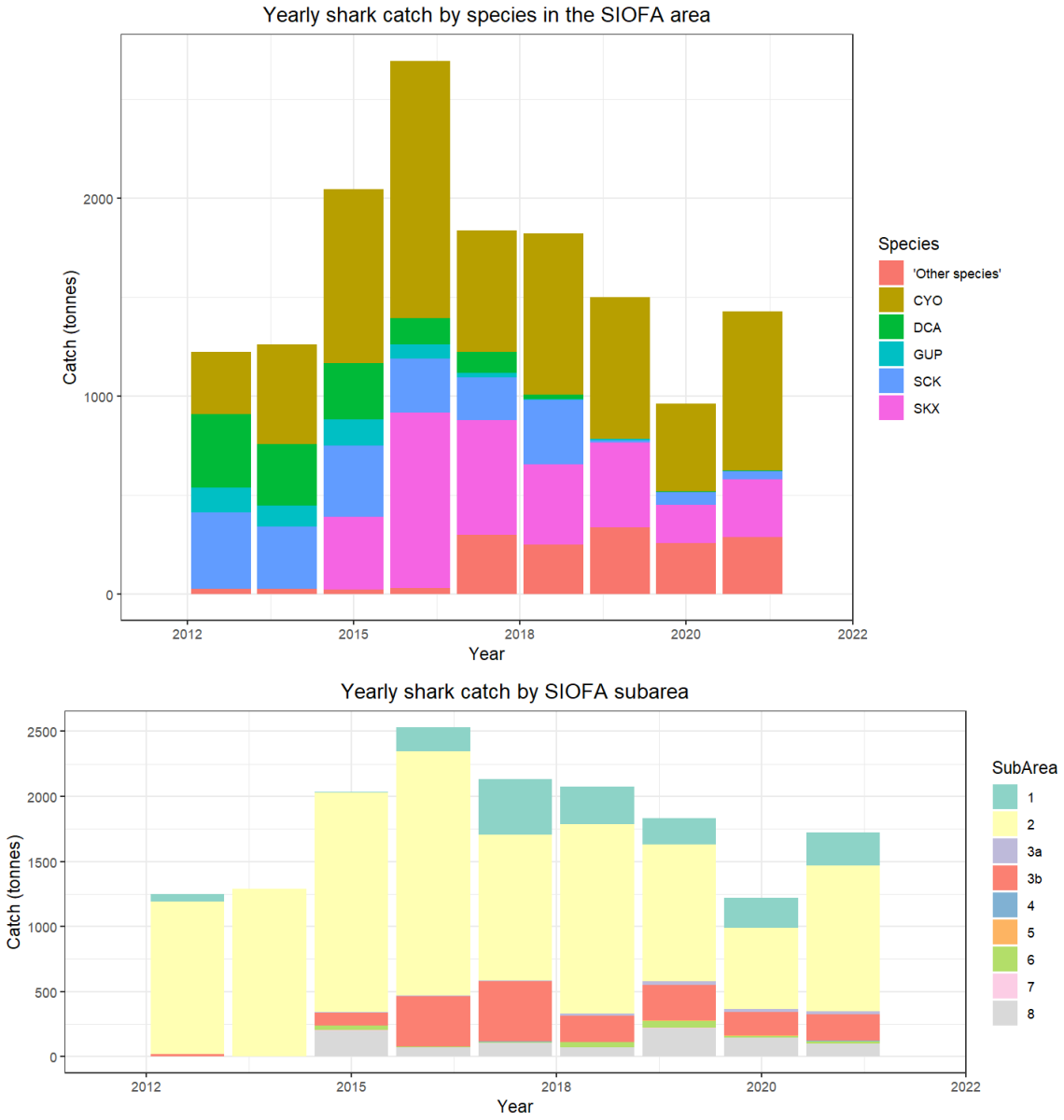


Figure 6a and b – Yearly catch of sharks in the SIOFA Area by taxon (upper panel, a) and by SIOFA Subarea (lower panel, b) (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2021). Only the top 5 species by weight (cumulatively in the full database) are shown individually (identified by their FAO species code, see Appendix B). All other species are grouped under 'other species. Figure D.1 in Appendix D provides a full list of species caught. See Table D.3 in Appendix D for the values associated with the lower panel figure.

Sharks are caught using several different fishing methods and gears. Historically, a larger proportion of sharks reported captured in SIOFA were caught using gillnets, but in recent years sharks have been mainly caught with longlines (Figure 7).

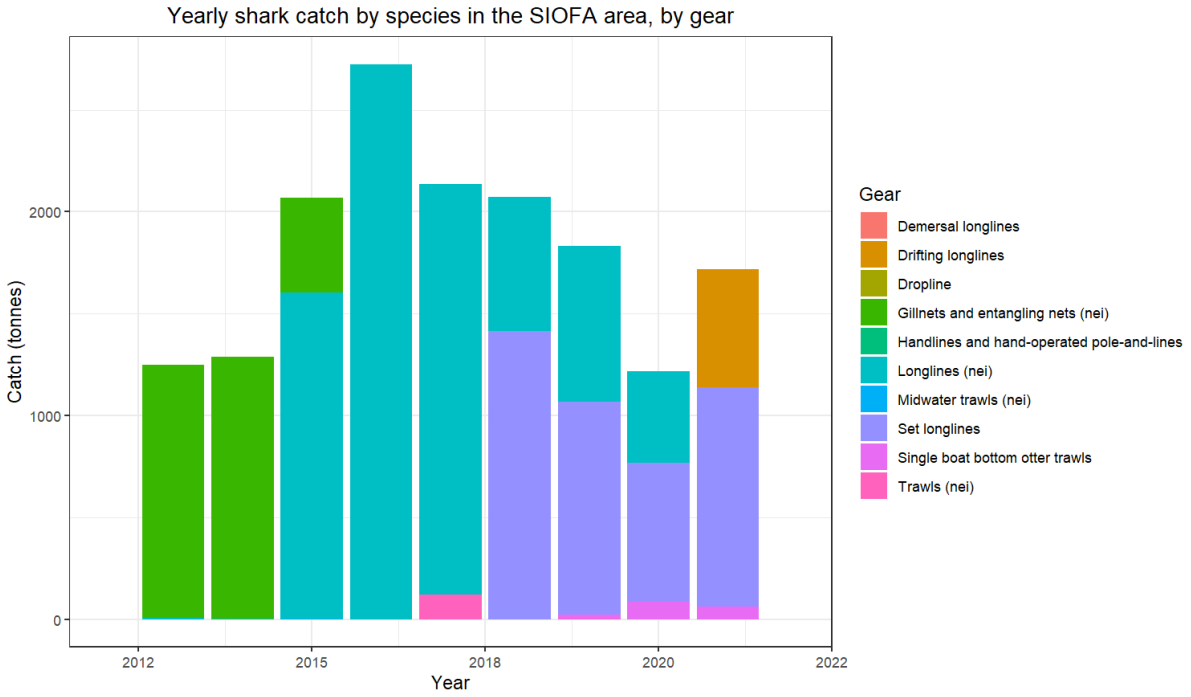


Figure 7 – Yearly catch of sharks in the SIOFA Area by gear type (lower panel, b) (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2021).

A list of deep sea sharks considered to be at "high risk" and/or "of concern" is included in Annex 1 of SIOFA CMM 12-2019 (Conservation and Management Measure for Sharks) and was derived from Georgeson et al. (2020). The following figures refer to the sharks listed in CMM 12-2019. This list is reproduced below in Table 3.

Table 3– Deep-sea shark taxa considered to be at "high risk" and/or "of concern" , as listed in Annex 1 of SIOFA CMM 12-2019(Conservation and Management Measure for Sharks) and derived from Georgeson et al. (2020). Species considered to be at "high risk" are highlighted in bold.

FAO code	English common name	French common name	Scientific name
APD	Smallbelly catshark	Holbiche artouca	*Apristurus indicus*
BZL	Narrowhead catshark		*Bythaelurus tenuicephalus*
BZO	Bach's catshark		*Bythaelurus bachi*
CYO	Portuguese dogfish	Pailona commun	*Centroscymnus coelolepis*
CYP	**Longnose velvet dogfish**	**Pailona à long nez**	***Centroscymnus crepidater***
CYU	**Plunket shark**	**Pailona austral**	***Centroscymnus plunketi***
DCA	**Birdbeak dogfish**	**Squale savate**	***Deania calcea***
ETP	Smooth lanternshark	Sagre nain	*Etmopterus pusillus*
EZU	Whitecheek lanternshark		*Etmopterus alphus*
GUP	Gulper shark	Squale-chagrin commun	*Centrophorus granulosus*
HCR	Pacific longnose chimaera	Chimère à nez rigide	*Harriotta raleighana*
HXC	Frilled shark	Requin lézard	*Chlamydoselachus anguineus*
HXN	Bigeyed sixgill shark	Requin-vache	*Hexanchus nakamurai*
LMO	Goblin shark	Requin lutin	*Mitsukurina owstoni*

FAO code	English common name	French common name	Scientific name
SCK	**Kitefin shark**	**Squale liche**	***Dalatias licha***
SON	Pacific sleeper shark	Laimargue dormeur	*Somniosus pacificus*
SSQ	**Velvet dogfish**		***Zameus squamulosus***
ZZC	Dark-mouth chimaera		*Chimaera buccanigella*
ZZD	Falkor chimaera		*Chimaera didierae*
ZZE	Seafarer's ghost shark		*Chimaera willwatchi*

Note that the CMM 12-2019 listed the scientific name of *Somniosus antarcticus* (FAO species code SHX) under the FAO species code for *Somniosus pacificus* (SON), but only SON was recorded in the data, and likely represents a nomenclature discrepancy in CMM 12-2019.

Catch of shark species considered to be at "high risk" and/or "of concern" (as defined in CMM 12-2019) increased between 2013 and 2016 but has been decreasing thereafter (Figure 7a). In most years the Portuguese dogfish (CYO) was the most commonly caught species on this list, with a significant presence of Kitefin shark (SCK) until 2019 (Figure 8a). The vast majority of catches of shark at "high risk" and/or "of concern" in the SIOFA Area came from Subarea 2 (Figure 8b).

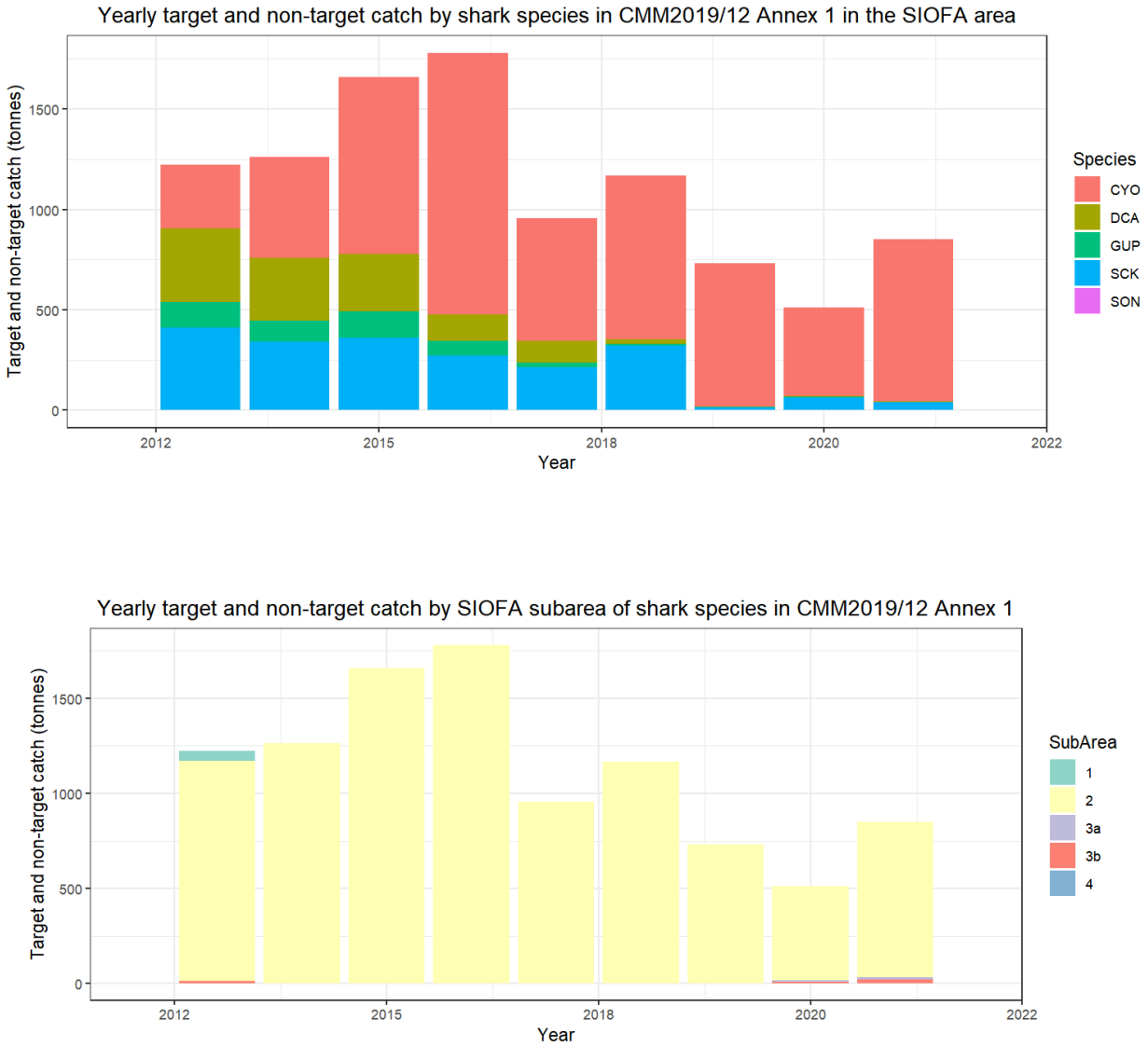


Figure 8a and b – Yearly catch in the SIOFA Area of sharks considered to be at "high risk" and/or "of concern" as included in Annex 1 of SIOFA CMM 12-2019(Conservation and Management Measure for Sharks). Catches are summarised by species (upper panel, a) and by SIOFA Subarea (lower panel, b) (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2021). Species are identified by their FAO species code (see Table 3 for disambiguation).

6.2 Discards and bycatch

In SIOFA fisheries most of the catch (both target and bycatch) is retained and landed, with small proportion being discarded at sea. The SIOFA CatchEffort database records the fate of catch per species, aggregated at different levels, which enables an analysis of the proportion discarded.

Discards typically involve non-commercial species in the bycatch and undersized or damaged fish in the target catch.

Discards have historically been a very minor proportion of the total bycatch (Figure 9a), and consequently an even smaller proportion of total catch. In absolute terms, only up to around 100 t of catch is discarded per year, but discards were much higher in 2015, when they were more than 1500 t (Figure 9b). Note that, in this figure, discards also include sharks.

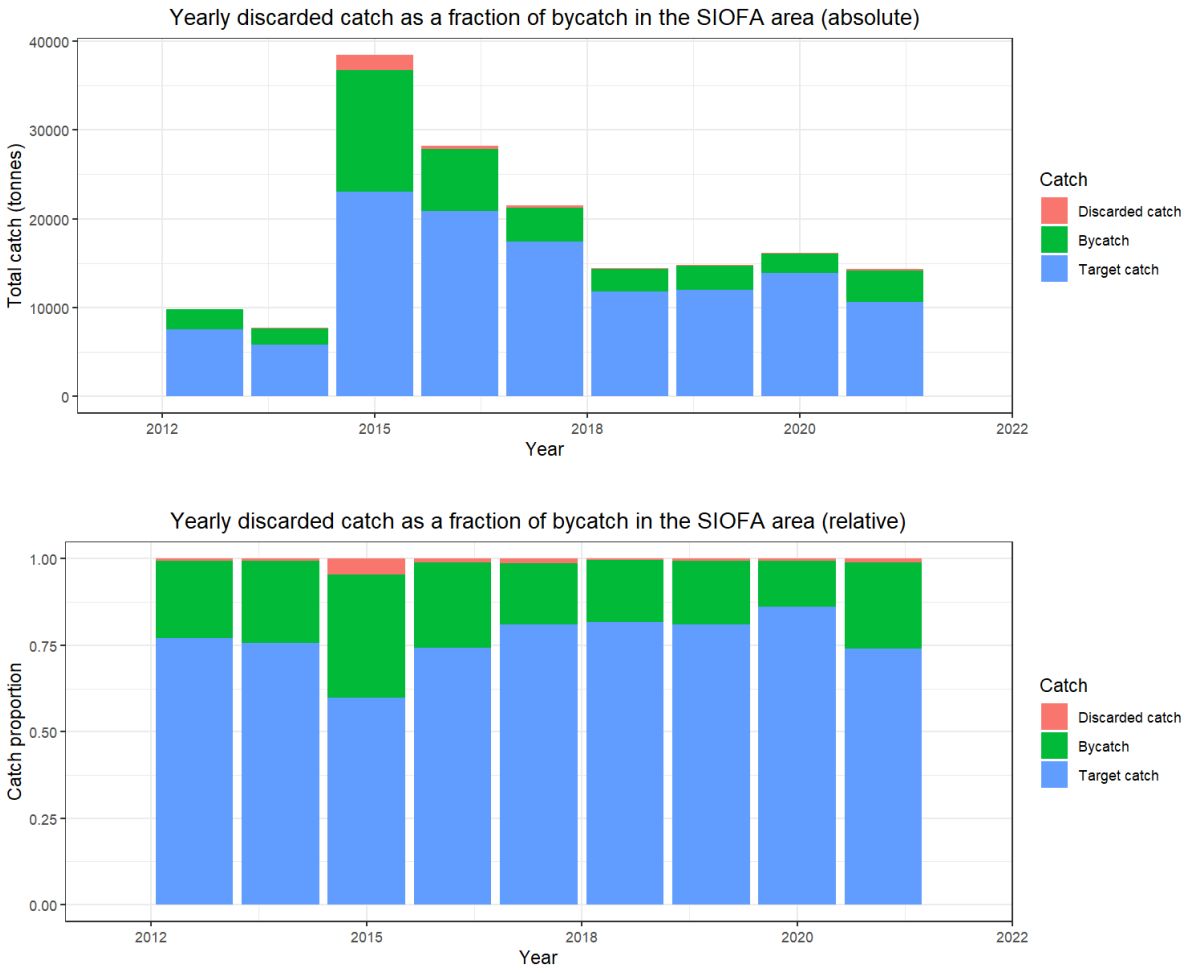


Figure 9a and b – Catch, bycatch and discards (including of sharks) as absolute weights (upper panel, a) and relative proportions (lower panel, b) (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2021). Catches reported without spatial information are not included.

Given the high number of species, and imperfect taxonomic reporting, estimates of discards by species was not easy to determine. The high discards recorded in 2015 were recorded as an 'unspecified marine species' (MZZ) which was also reported in 2016 and 2017 (Figure 9). The most heavily discarded species that was identified to species level (in 2017) was little sleeper shark (SOR) (Figure 10).

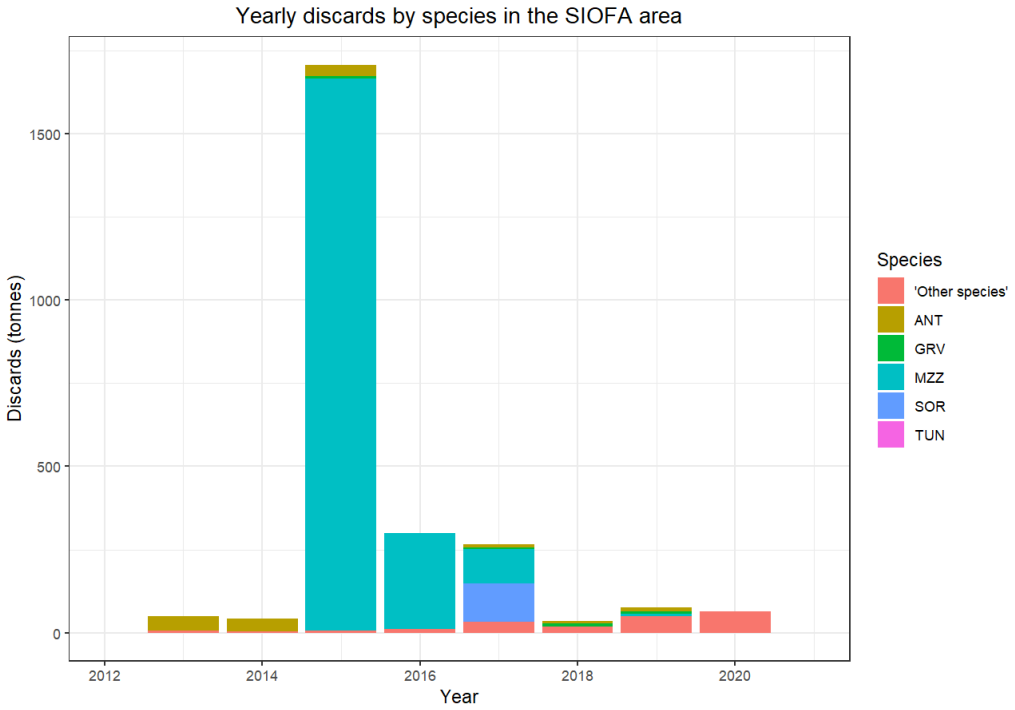


Figure 10 – Yearly discards in the SIOFA Area by species (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2020) Only the top 5 species by weight (cumulatively in the full database) are recorded (indicated by their FAO species code, see Appendix B). All other species are grouped and recorded as 'other species'. See Figure D.2 in Appendix D for a full account of all discarded species.

7. Interactions with seabirds, marine mammals, turtles, and with sharks considered to be at high risk and/or of concern

Only incidental captures of seabirds, marine mammals, turtles, and sharks considered to be at high risk and/or concern are reported in the Observer database, and the following sections have drawn from this database to explore the number and locations of these interactions. Bycatch of other species (e.g. of sharks) are recorded in the CatchEffort database and are not reported here.

Figure 11 shows the reported locations of incidental captures of seabirds, mammals, turtles and sharks considered to be at high risk and/or concern in the SIOFA Area as recorded by fisheries Scientific Observers.

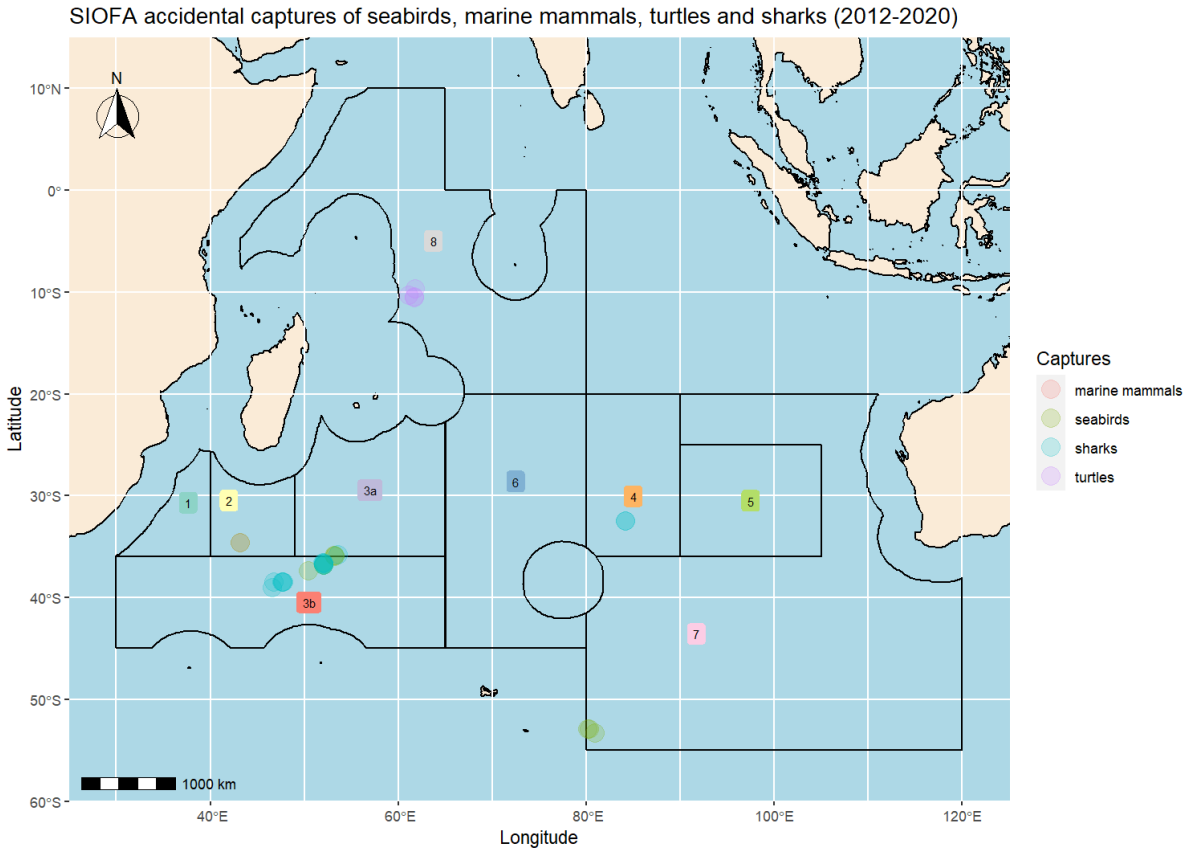


Figure 11 – Reported locations of incidental captures of seabirds, mammals, turtles and sharks in the SIOFA Area as recorded by fisheries Scientific Observers (source: SIOFA Observer database 2012–2021).

7.1 Seabirds

7.1.1 Incidental captures

Only a small number of seabird captures have been reported in SIOFA fisheries. From 2007-2020 there have been ten seabird captures reported in the SIOFA Area as summarised in Table 4, below.

Table 4: Incidental captures of seabirds for which interactions have been reported (source: SIOFA Observer database).

Year	Common name	Scientific name	Captures	Status at release	Gear
2009	Wedge-tailed shearwater	*Puffinus pacificus*	1	Dead	Single boat midwater otter trawls
2012	Hall's giant petrel	*Macronectes halli*	1	Dead	Single boat bottom otter trawls
2013	White-chinned petrel	*Procellaria aequinoctialis*	1	Unknown	Single boat midwater otter trawls
2014	White-faced storm petrel	*Pelagodroma marina*	1	Alive	Single boat midwater otter trawls
2016	White-chinned petrel	*Procellaria aequinoctialis*	1	Unknown	Set longlines
2019	Antarctic giant petrel	*Macronectes giganteus*	2	Unknown	Set longlines
2020	Black-browed albatross	*Thalassarche melanophrys*	1	Dead	Set longlines
2020	White-chinned petrel	*Procellaria aequinoctialis*	2	Dead	Set longlines

7.1.1 Abundance observed around fishing operations

The abundance and species of seabirds around fishing operations has been recorded on individual fishing events by onboard Scientific Observers starting from 2007. Table 5 shows the total numbers of seabirds recorded by Scientific Observers, per species, across all fishing events of each year.

Table 5: Numbers of seabirds observed around fishing operations per species and year (source: SIOFA Observer database).

Year	Common name	Scientific name	Total	Fishing Method and Gear
2007	Wandering albatross	*Diomedea exulans*	26	Single boat bottom otter trawls
2007	White-chinned petrel	*Procellaria aequinoctialis*	536	Single boat bottom otter trawls
2007	Atlantic yellow-nosed albatross	*Thalassarche chlororhynchos*	50	Single boat bottom otter trawls
2007	Black-browed albatross	*Thalassarche melanophrys*	6	Single boat bottom otter trawls
2008	Cape petrel	*Daption capense*	35	Single boat bottom otter trawls
2008	Wandering albatross	*Diomedea exulans*	3	Single boat bottom otter trawls
2008	Albatrosses nei	*Diomedeidae*	31	Single boat bottom otter trawls
2008	B/W bellied storm petrels nei	*Fregetta spp*	1	Single boat bottom otter trawls
2008	Giant petrels nei	*Macronectes spp*	22	Single boat bottom otter trawls
2008	Sooty albatross	*Phoebetria fusca*	1	Single boat bottom otter trawls
2008	Light-mantled sooty albatross	*Phoebetria palpebrata*	2	Single boat bottom otter trawls
2008	White-chinned petrel	*Procellaria aequinoctialis*	8	Single boat bottom otter trawls
2008	Grey petrel	*Procellaria cinerea*	4	Single boat bottom otter trawls
2008	Shy albatross	*Thalassarche cauta*	21	Single boat bottom otter trawls
2008	Atlantic yellow-nosed albatross	*Thalassarche chlororhynchos*	5	Single boat bottom otter trawls
2008	Black-browed albatross	*Thalassarche melanophrys*	21	Single boat bottom otter trawls
2010	Wandering albatross	*Diomedea exulans*	113	Single boat bottom otter trawls
2010	Albatrosses nei	*Diomedeidae*	104	Single boat bottom otter trawls
2010	Hall's giant petrel	*Macronectes halli*	8	Single boat bottom otter trawls
2010	White-chinned petrel	*Procellaria aequinoctialis*	1	Single boat bottom otter trawls
2010	Petrels nei	*Procellaria spp*	6223	Single boat bottom otter trawls
2010	Atlantic yellow-nosed albatross	*Thalassarche chlororhynchos*	322	Single boat bottom otter trawls
2011	Cape petrel	*Daption capense*	184	Single boat bottom otter trawls
2011	Wandering albatross	*Diomedea exulans*	166	Single boat bottom otter trawls
2011	Albatrosses nei	*Diomedeidae*	18	Single boat bottom otter trawls
2011	Antarctic giant petrel	*Macronectes giganteus*	12	Single boat bottom otter trawls
2011	Giant petrels nei	*Macronectes spp*	82	Single boat bottom otter trawls
2011	Wilson's storm petrel	*Oceanites oceanicus*	2	Single boat bottom otter trawls
2011	White-chinned petrel	*Procellaria aequinoctialis*	306	Single boat bottom otter trawls

Year	Common name	Scientific name	Total	Fishing Method and Gear
2011	Grey petrel	*Procellaria cinerea*	2	Single boat bottom otter trawls
2011	Shy albatross	*Thalassarche cauta*	82	Single boat bottom otter trawls
2011	Atlantic yellow-nosed albatross	*Thalassarche chlororhynchos*	44	Single boat bottom otter trawls
2019	Cape petrel	*Daption capense*	15298	Set longlines
2019	Southern royal albatross	*Diomedea epomophora*	1	Set longlines
2019	Wandering albatross	*Diomedea exulans*	4992	Set longlines
2019	Antarctic giant petrel	*Macronectes giganteus*	18570	Set longlines
2019	Hall's giant petrel	*Macronectes halli*	1155	Set longlines
2019	Wilson's storm petrel	*Oceanites oceanicus*	8	Set longlines
2019	Prions nei	*Pachyptila spp*	3	Set longlines
2019	White-chinned petrel	*Procellaria aequinoctialis*	2050	Set longlines
2019	Indian yellow-nosed albatross	*Thalassarche carteri*	34	Set longlines
2019	Shy albatross	*Thalassarche cauta*	1956	Set longlines
2019	Black-browed albatross	*Thalassarche melanophrys*	1140	Set longlines
2020	Brown skua	*Catharacta lonnbergi*	2	Set longlines
2020	Great skua	*Catharacta skua*	2	Set longlines
2020	Cape petrel	*Daption capense*	5686	Set longlines
2020	Wandering albatross	*Diomedea exulans*	10987	Set longlines
2020	Wandering albatross	*Diomedea exulans*	9	Vertical lines
2020	Albatrosses nei	*Diomedeidae*	11	Set longlines
2020	Black-bellied storm petrel	*Fregetta tropica*	568	Set longlines
2020	Southern fulmar	*Fulmarus glacialoides*	5	Set longlines
2020	Antarctic giant petrel	*Macronectes giganteus*	3953	Set longlines
2020	Hall's giant petrel	*Macronectes halli*	10295	Set longlines
2020	Giant petrels nei	*Macronectes spp*	365	Set longlines
2020	Wilson's storm petrel	*Oceanites oceanicus*	100	Set longlines
2020	Prions nei	*Pachyptila spp*	151	Set longlines
2020	Sooty albatross	*Phoebetria fusca*	16	Set longlines
2020	Light-mantled sooty albatross	*Phoebetria palpebrata*	29	Set longlines

Year	Common name	Scientific name	Total	Fishing Method and Gear
2020	White-chinned petrel	*Procellaria aequinoctialis*	21429	Set longlines
2020	White-chinned petrel	*Procellaria aequinoctialis*	19	Vertical lines
2020	Grey petrel	*Procellaria cinerea*	156	Set longlines
2020	Great shearwater	*Puffinus gravis*	1	Set longlines
2020	Buller's albatross	*Thalassarche bulleri*	4	Vertical lines
2020	Indian yellow-nosed albatross	*Thalassarche carteri*	231	Set longlines
2020	Shy albatross	*Thalassarche cauta*	1893	Set longlines
2020	Atlantic yellow-nosed albatross	*Thalassarche chlororhynchos*	2	Set longlines
2020	Grey-headed albatross	*Thalassarche chrysostoma*	1	Set longlines
2020	Black-browed albatross	*Thalassarche melanophrys*	4633	Set longlines
2020	Antarctic petrel	*Thalassoica antarctica*	3	Set longlines
2021	Cape petrel	*Daption capense*	96	Set longlines
2021	Amsterdam Island albatross	*Diomedea amsterdamensis*	20	Set longlines
2021	Southern royal albatross	*Diomedea epomophora*	1848	Set longlines
2021	Wandering albatross	*Diomedea exulans*	16080	Set longlines
2021	Antarctic giant petrel	*Macronectes giganteus*	5655	Set longlines
2021	Hall's giant petrel	*Macronectes halli*	2370	Set longlines
2021	Giant petrels nei	*Macronectes spp*	20	Set longlines
2021	White-chinned petrel	*Procellaria aequinoctialis*	24033	Set longlines
2021	Parkinson's petrel	*Procellaria parkinsoni*	380	Set longlines
2021	Indian yellow-nosed albatross	*Thalassarche carteri*	3321	Set longlines
2021	Shy albatross	*Thalassarche cauta*	35	Set longlines
2021	Black-browed albatross	*Thalassarche melanophrys*	5561	Set longlines

7.2 Marine turtles

Four incidental captures of marine turtles have been reported in SIOFA fisheries, in 2019 and 2020 (Table 6).

Table 6: Reported Incidental captures of marine turtles (source: SIOFA Observer database).

Year	Common Name	Scientific Name	Captures	Status at release	Fishing Gear
2019	Hawksbill turtle	*Eretmochelys imbricata*	1	Unknown	Handlines and hand-operated pole-and-lines
2020	Leatherback turtle	*Dermochelys coriacea*	3	Alive	Single boat bottom otter trawls

7.3 Marine mammals

7.3.1 Incidental captures

Only a single incidental capture of a marine mammal has been reported in SIOFA fisheries, in 2012 (Table 7).

Table 7: Reported Incidental captures of marine mammals (source: SIOFA Observer database).

Year	Common Name	Scientific Name	Captures	Status at release	Fishing Gear
2012	Sperm whale	*Physeter macrocephalus*	1	Alive	Single boat bottom otter trawls

7.3.2 Abundance observed around fishing operations

A single incident of Antarctic minke whale presence around fishing operation has been recorded, of three individuals, in 2021 (Table 8).

Table 8: Observations of marine mammals around fishing operations (source: SIOFA Observer database).

Year	Common name	Scientific name	Abundance	Gear
2021	Antarctic minke whale	*Balaenoptera bonaerensis*	3	Set longlines

7.4 Shark captures of species considered to be at high risk and/or of concern

This summary reports captures of sharks considered to be "at high risk" and/or "of concern", as defined in Annex 1 of CMM 12-2019. However, these shark captures have only been occasionally recorded in the SIOFA Observer database, as shark captures were able to be targeted before 10 October 2019 and were reported in the CatchEffort database (summarised in Section 5.2 and Figure 7 above) instead of in the Observer database. For completeness, shark captures recorded in the Observer database are shown in Table 9, but these data cannot be considered a reliable indicator of actual numbers of captures (e.g. see Figure 7).

Note that discussions during the 8th meeting of the SIOFA Scientific Committee suggested the possibility of data from the Secretariat records being incomplete, in particular those of Scientific Observer-reported captures of sharks included in Annex 1 of CMM 12-2019.

Table 9: Incidental captures of sharks for which interactions have been reported via the Observer database (source: SIOFA Observer database).

Year	Common Name	Scientific Name	Captures	Status at release	Fishing Gear
2019	Kitefin shark	*Dalatias licha*	8	Unknown	Midwater trawls (nei)
2019	Leafscale gulper shark	*Centrophorus squamosus*	1	Dead	Midwater trawls (nei)
2019	Southern sleeper shark	*Somniosus antarcticus*	1	Dead	Midwater trawls (nei)
2020	Kitefin shark	*Dalatias licha*	3	Unknown	Midwater trawls (nei)
2021	Kitefin shark	*Dalatias licha*	2	Unknown	Midwater trawls (nei)
2021	Leafscale gulper shark	*Centrophorus squamosus*	1	Dead	Midwater trawls (nei)

8. Interactions with the seafloor and benthic organisms

A particular focus in the work of the SIOFA Scientific Committee has been the interaction of fisheries with the seafloor and its benthic organisms. This followed a specific mandate included in CMM 01-2020, which required the Scientific Committee to develop and provide advice and recommendations to the Meeting of the Parties to define the maximum extent of an appropriate SIOFA bottom fishing footprint (i.e. a map of the spatial extent of historical bottom fishing in the Agreement Area, for all vessels flagged to all CCPs). Furthermore, VME presence in the SIOFA Area is being investigated, and the SIOFA Scientific Committee is planning to elaborate its scientific advice on management of VMEs for the Meeting of the Parties to consider.

8.1 Interim bottom fishing footprint

The 7th meeting of the SIOFA Scientific Committee endorsed a map of the spatial extent of historical bottom fishing in the SIOFA Area, as presented at PAEWG4 (Figure 11, para 180 of the SC7 Report). The footprint shown in this figure includes midwater trawling fishing activities. The Scientific Committee also recommended that further work was needed to clarify whether national data was properly accounted for in the PAEWG4 footprint shown here and that heatmaps of fishing activity be developed.

The 9th Meeting of the Parties of SIOFA (MoP9) noted that there was still outstanding work on the footprint recommended by the 7th meeting of the Scientific Committee but recommended that this estimate of the footprint be adopted on an interim basis until the Scientific Committee can update it (para 113 of the MoP9 Report). However, MoP9 also decided that midwater trawling was not to be considered bottom fishing for the purposes of defining the footprint (Annex I of the MoP9 Report).

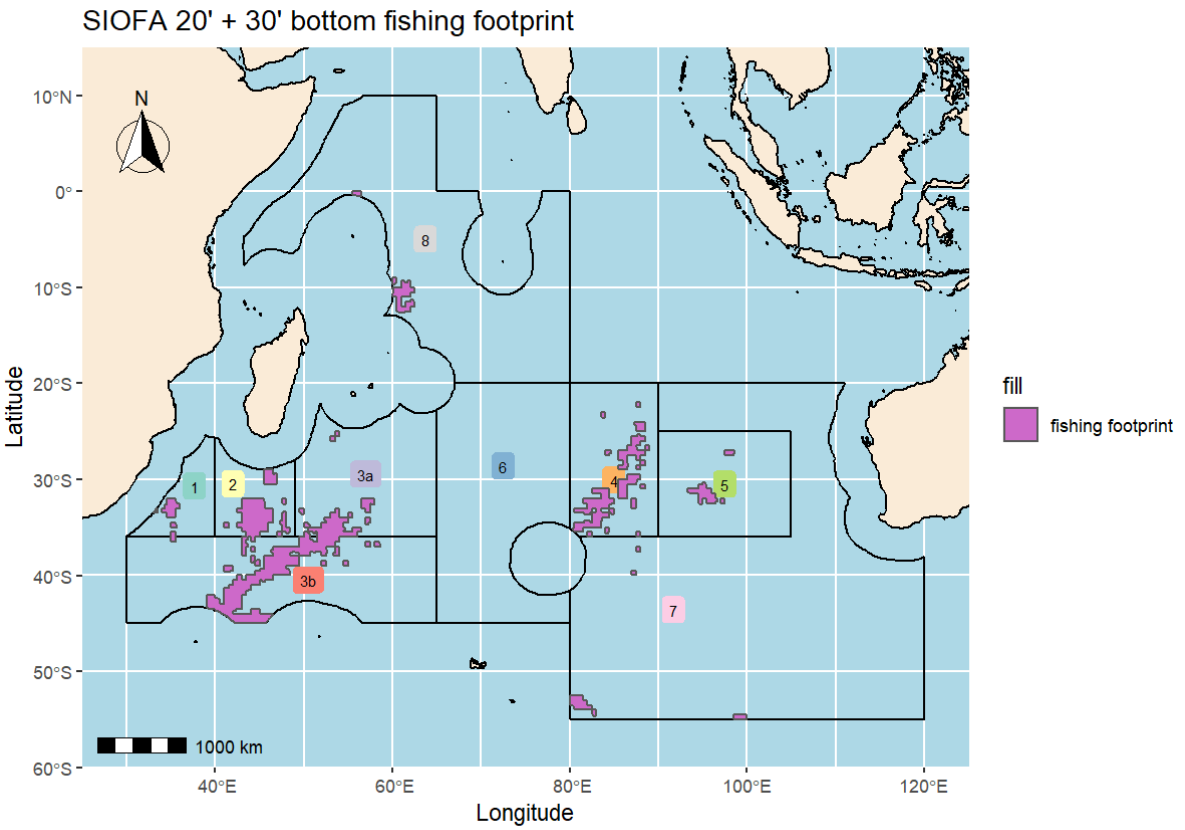


Figure 12 – SIOFA bottom fishing interim footprint map derived from recent (2016–2020) set level and aggregated historical (1998–2015) fishing data, at a hybrid 20' x 30' square resolution (sources: SIOFA HBHCatchEffort 1998–2020, and SIOFA spatial layers, edited from the SC7 final report and PAEWG-04-12 versions for clarity). Note that because actual fishing events are narrower than the spatial resolution at which the data are summarised, the combined area of the cells will exceed the area of the actual fishery footprint.

After removing midwater trawls, and accounting for the national data provided by SIOFA CCPs for the purpose of updating the mapped footprint, the Interim Footprint map endorsed at MoP9 was revised (Figure 13) and the overall footprint area increased marginally (6%) and shifted in its relative position.

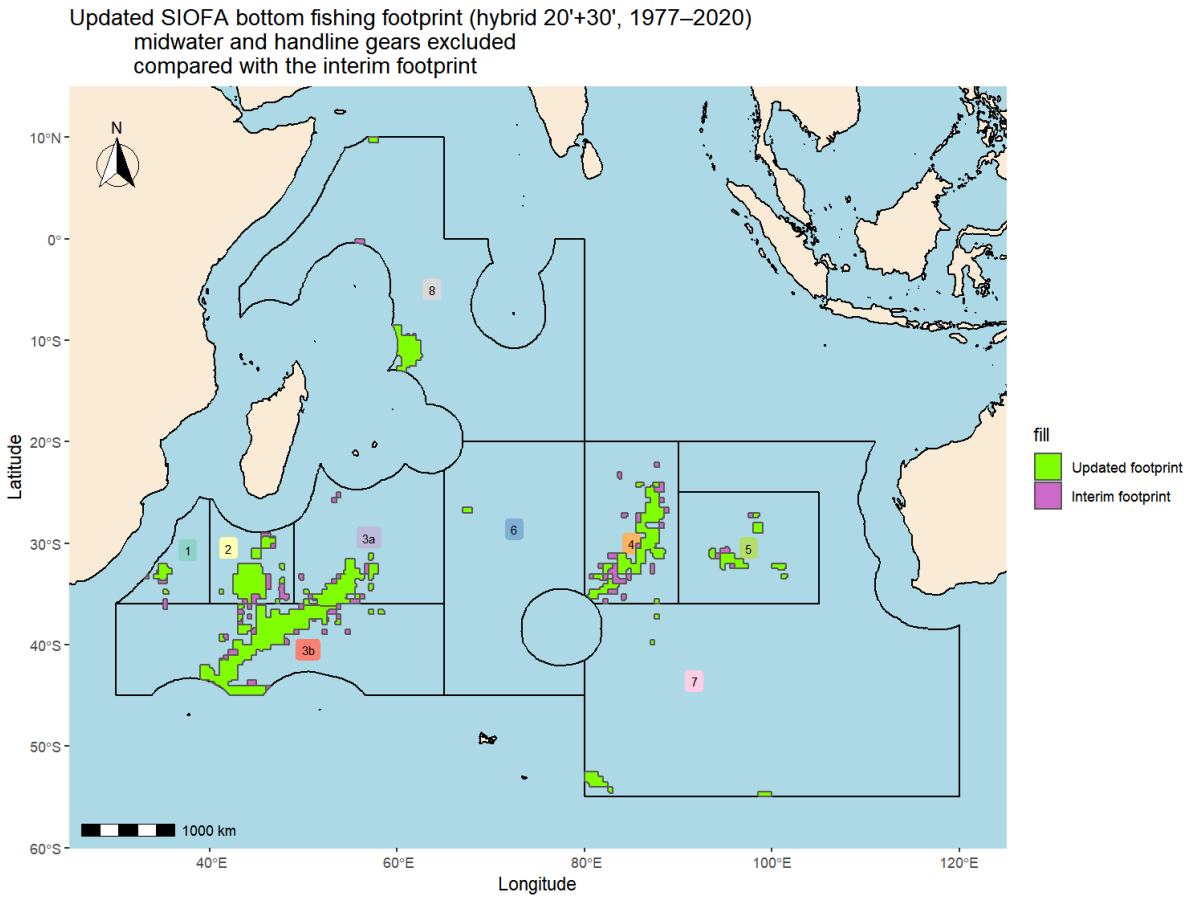


Figure 13 – Revised SIOFA bottom fishing footprint map derived from recent set level and historical fishing data from 1977–2020, at a hybrid 20' x 30' square resolution (sources: SIOFA HBHCatchEffort 1998–2020, national data, and SIOFA spatial layers). The footprint shown in this map does not include midwater trawling or handlining, and includes additional data provided by SIOFA CCPs for the purpose of updating the footprint map. Note that because actual fishing events are narrower than the spatial resolution at which the data are summarised, the combined area of the cells will exceed the area of the actual fishery footprint.

For the draft heatmap of bottom fishing activities, the number of bottom fishing events (all gears combined) was calculated for each of the 30' cells in the SIOFA Area (Figure 14). WS2022-SUM1 suggested that further developments of this heatmap could consider representing different metrics of fishing effort (e.g., number of hooks or length of trawls), but doing so would require the production of separate maps for different gears, as these measures are not directly comparable.

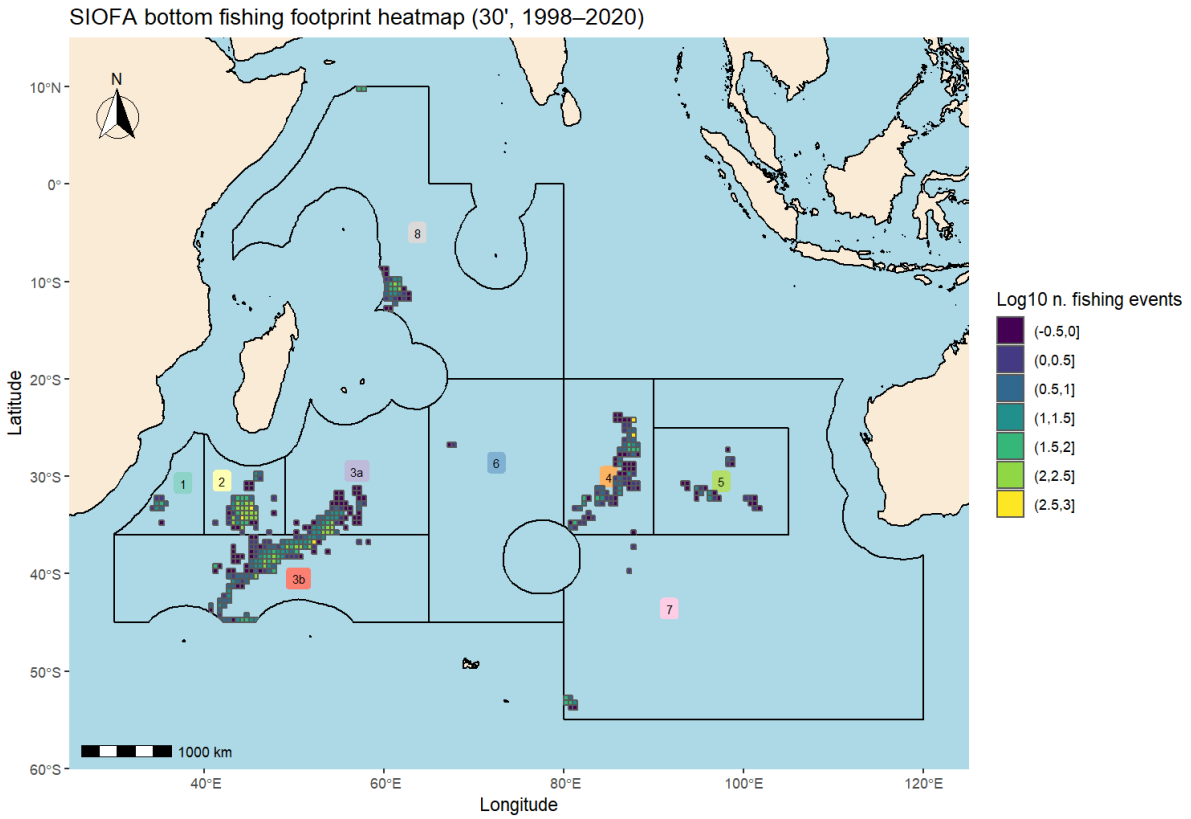


Figure 14 – Heatmap of bottom fishing effort levels in the SIOFA Area, derived from recent set level and historical fishing data from 1998–2020, at 30' square resolution (sources: SIOFA HBHCatchEffort 1998–2020, and SIOFA spatial layers). The footprint shown in this map does not include midwater trawling or handlining, and includes additional data provided by SIOFA CCPs for the purpose of updating the footprint map. Note that because actual fishing events are narrower than the spatial resolution at which the data are summarised, the combined area of the cells will exceed the area of the actual fishery footprint.

8.1.1 Revised bottom fishing footprint by gear

The revised bottom fishing footprint was disaggregated to produce gear-specific maps of bottom fishing effort distribution. Gear-specific maps of bottom fishing effort distribution included longlines (including Demersal longlines, Dropline, Set longlines, and Vertical lines), trawls (including Bottom trawls (nei), Trawls (nei), and Single boat bottom otter trawls), gillnets and entangling nets (nei), and traps (nei).

These maps are summarised in Figures 15-18, shown at a coarser spatial resolution (5 x 5 degree squares) as recommended by WS2022-SUM1.

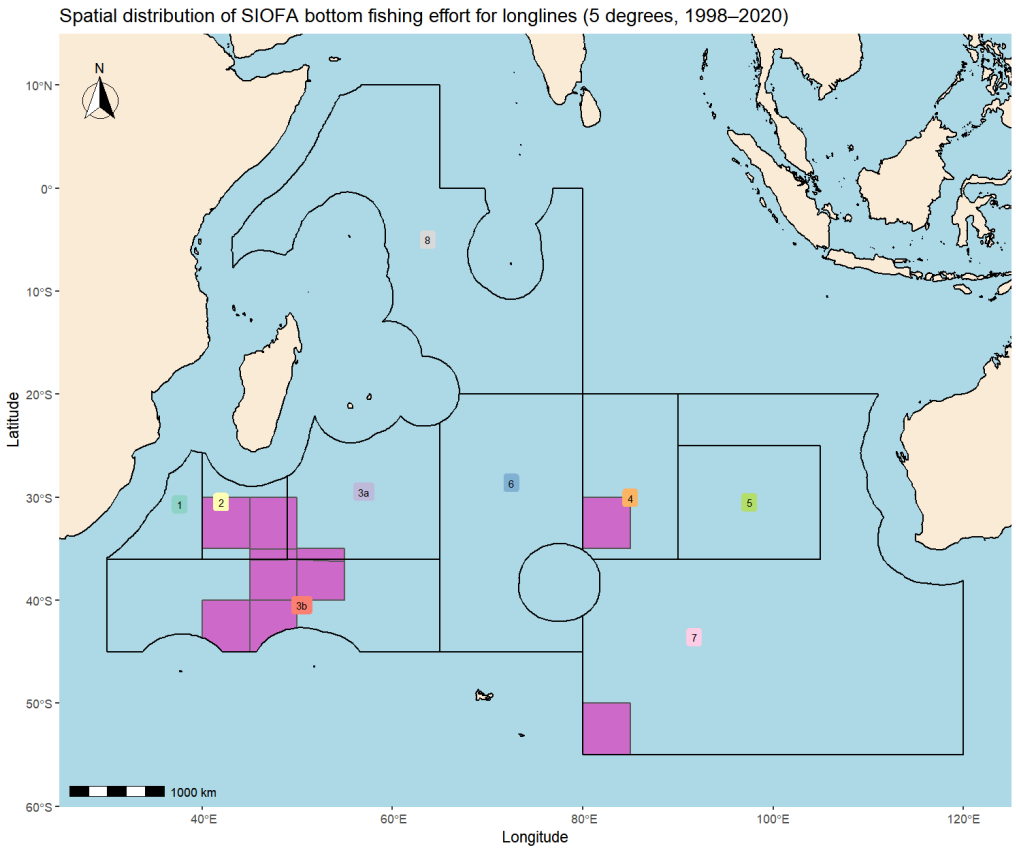


Figure 15 – Spatial distribution of SIOFA bottom fishing effort for longlines (including Demersal longlines, Dropline, Set longlines, and Vertical lines) derived from recent set level and historical fishing data from 1998–2020, at a 5 degrees square resolution (sources: SIOFA HBHCatchEffort 1998–2020, and SIOFA spatial layers). Note that due to the coarse spatial resolution of these data, the area of the non-zero-effort cells will greatly exceed the actual area of the fishing footprint.

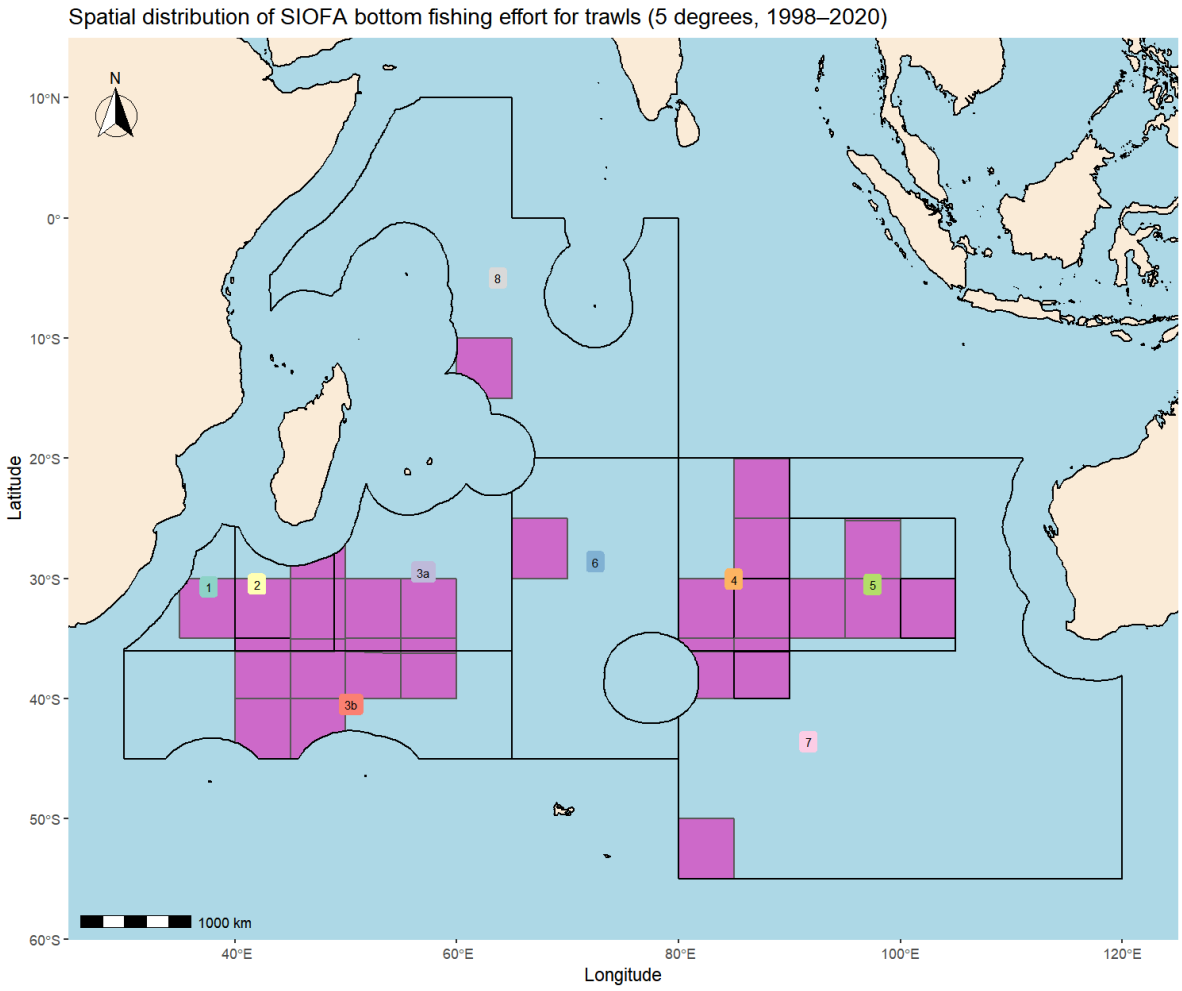


Figure 16 – Spatial distribution of SIOFA bottom fishing effort for trawls (including Bottom trawls (nei), Trawls (nei), and Single boat bottom otter trawls) derived from recent set level and historical fishing data from 1998–2020, at a 5 degrees square resolution (sources: SIOFA HBHCatchEffort 1998–2020, and SIOFA spatial layers). Note that due to the coarse spatial resolution of these data, the area of the non-zero-effort cells will greatly exceed the actual area of the fishing footprint.

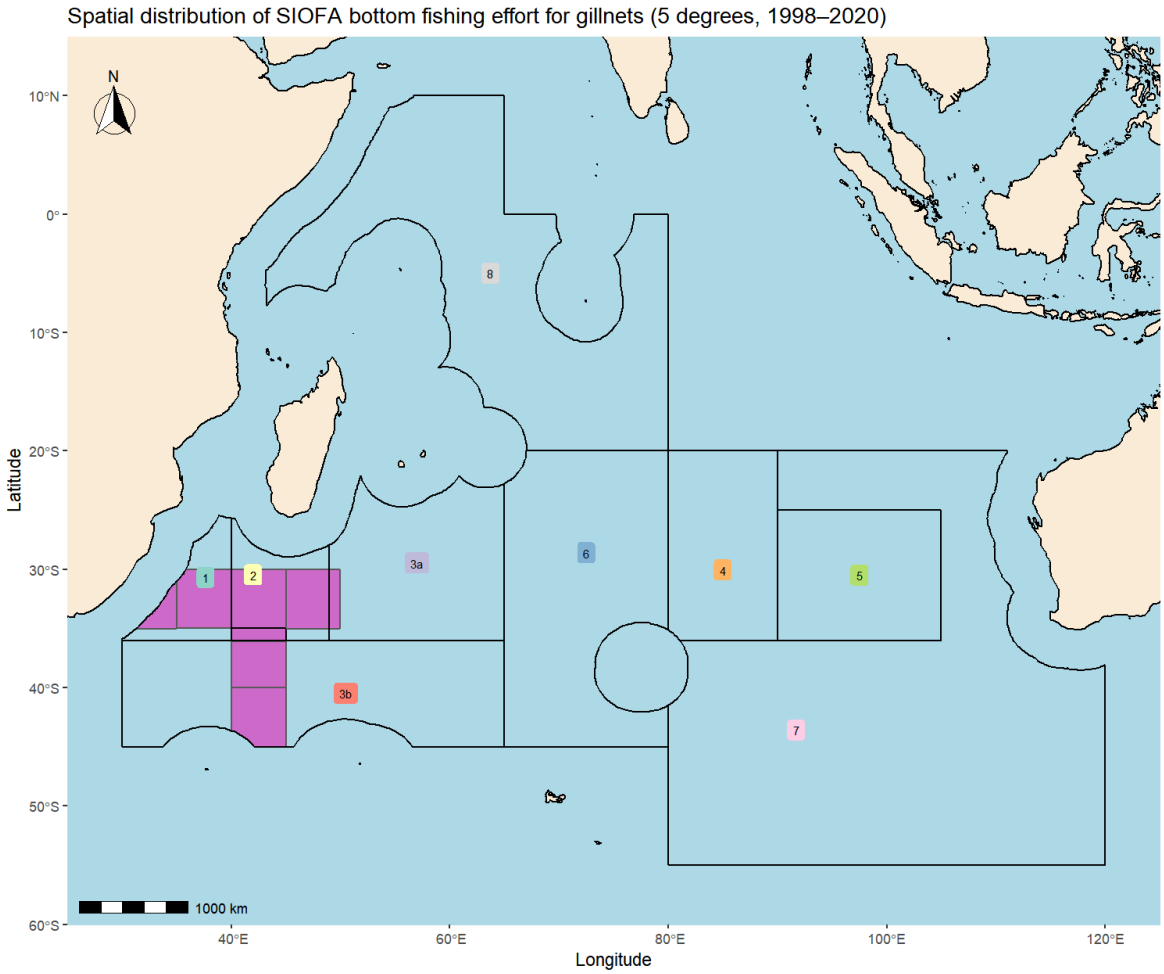


Figure 17 – Spatial distribution of SIOFA bottom fishing effort for gillnets and entangling nets (nei) derived from recent set level and historical fishing data from 1998–2020, at a 5 degrees square resolution (sources: SIOFA HBHCatchEffort 1998–2020, and SIOFA spatial layers). Note that due to the coarse spatial resolution of these data, the area of the non-zero-effort cells will greatly exceed the actual area of the fishing footprint.

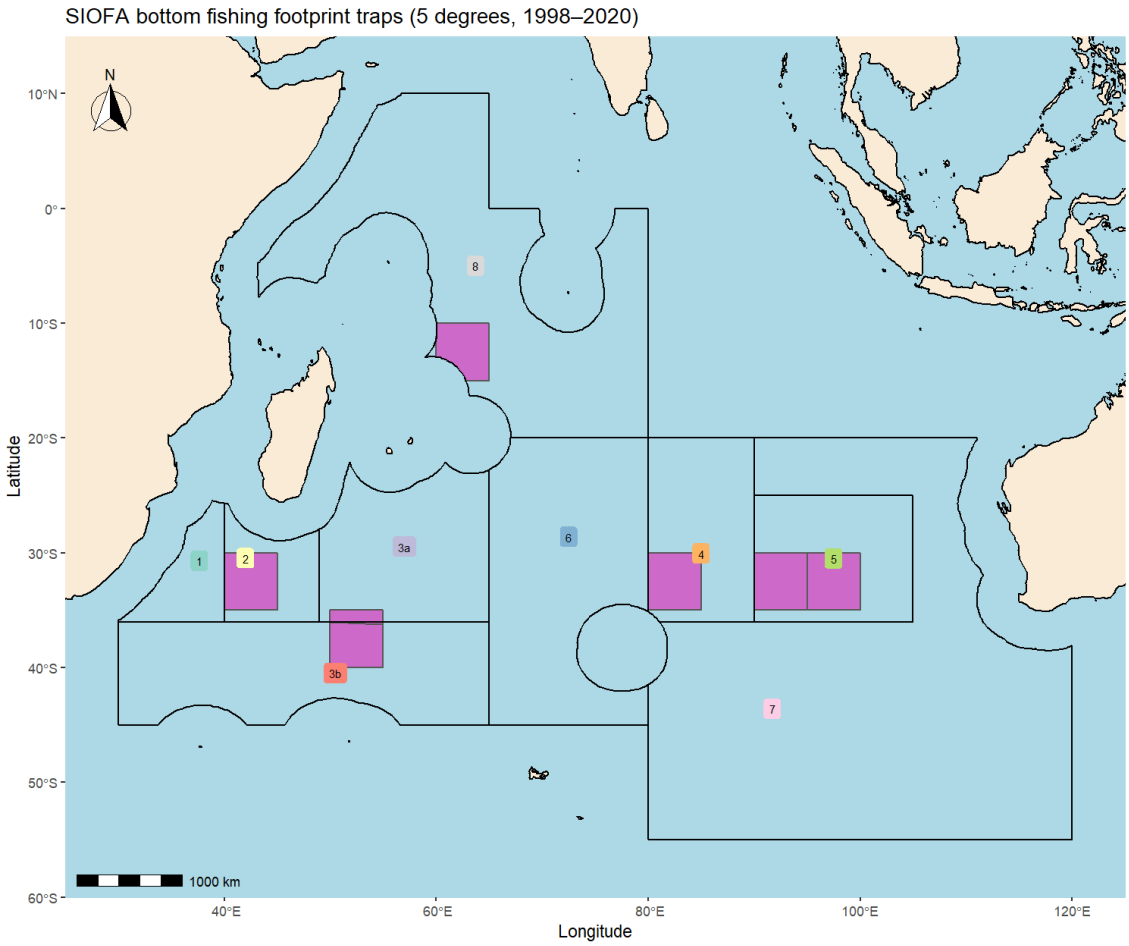
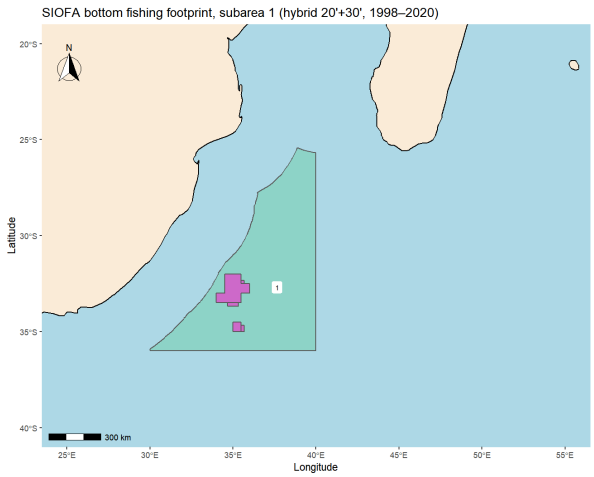
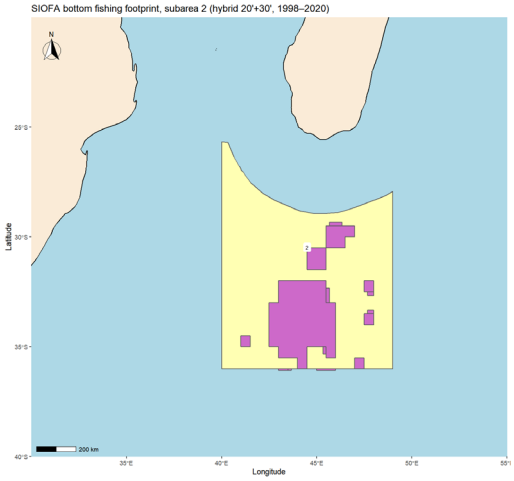


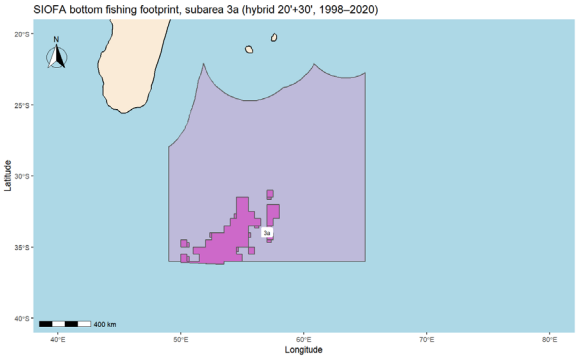
Figure 18 – Spatial distribution of SIOFA bottom fishing effort for traps (nei) derived from recent set level and historical fishing data from 1998–2020, at a 5 degrees square resolution (sources: SIOFA HBHCatchEffort 1998–2020, and SIOFA spatial layers). Note that due to the coarse spatial resolution of these data, the area of the non-zero-effort cells will greatly exceed the actual area of the fishing footprint.

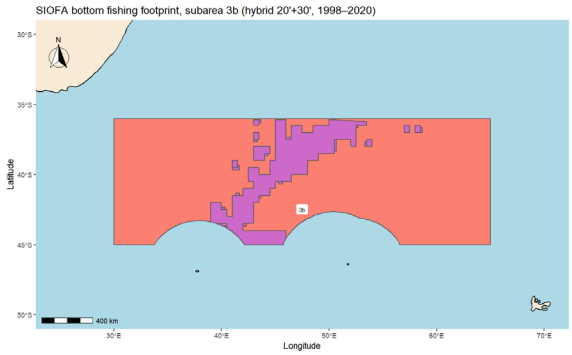
8.1.2 Bottom fishing footprint by Subarea

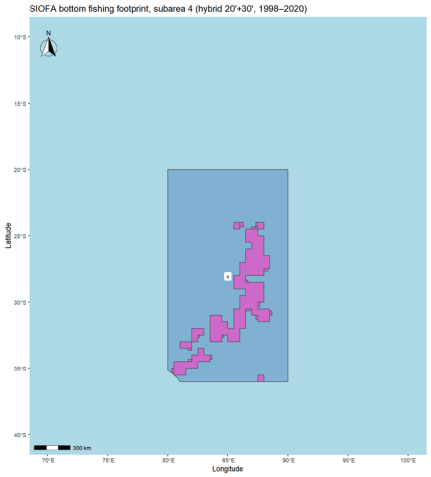
The revised bottom fishing footprint was disaggregated to produce Subarea-specific maps of bottom fishing. Figure 19 details the revised combined-method fisheries footprint (at a 20'+30' resolution), for each of the SIOFA Subareas.

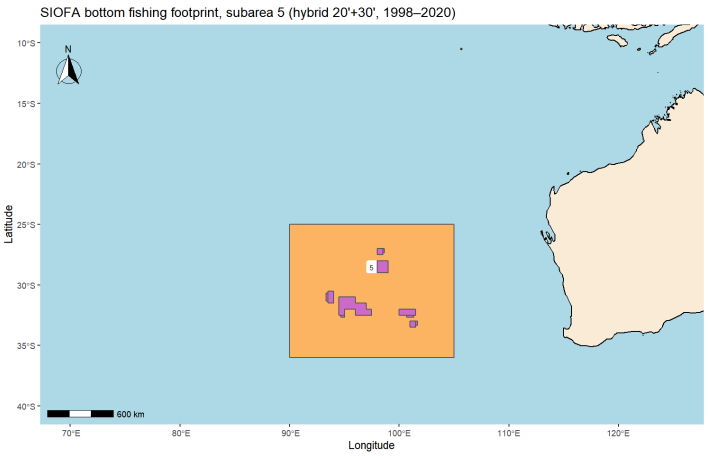

SIOFA bottom fishing footprint, subarea 1 (hybrid 20'+30', 1998–2020)
Latitude
Longitude
300 km


SIOFA bottom fishing footprint, subarea 2 (hybrid 20'+30', 1998–2020)
Latitude
Longitude
200 km


SIOFA bottom fishing footprint, subarea 3a (hybrid 20'+30', 1998–2020)
Latitude
Longitude
400 km


SIOFA bottom fishing footprint, subarea 3b (hybrid 20'+30', 1998–2020)
Latitude
Longitude
400 km


SIOFA bottom fishing footprint, subarea 4 (hybrid 20'+30', 1998–2020)
Latitude
Longitude


SIOFA bottom fishing footprint, subarea 5 (hybrid 20'+30', 1998–2020)
Latitude
Longitude
600 km

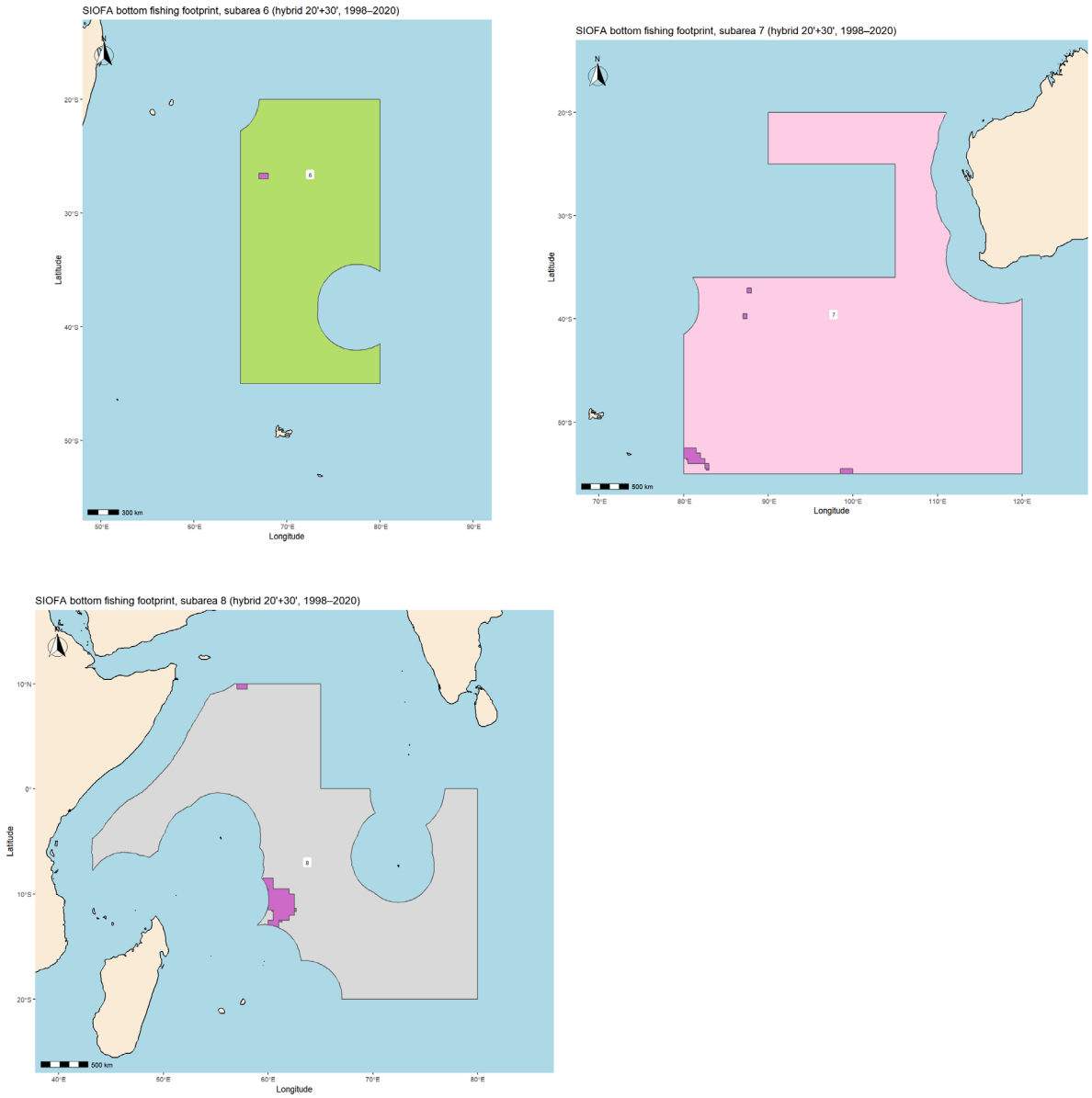


Figure 19 – Bottom fishing footprint by each SIOFA Subarea. These are the same as Figure 12 above (i.e. not including midwater trawling or handlining, and using updated data since adoption of the interim footprint in Figure 12) but represented at the scale of individual SIOFA Subareas. Cell sizes are at a hybrid 20' x 30' square resolution. As for other figures, because actual fishing events are narrower than the spatial resolution at which the data are summarised, the combined area of the cells will exceed the area of the actual fishery footprint.

8.2 Bottom Fishing Impact Assessment

In 2022, SIOFA adopted its first Bottom Fishing Impact Assessment (BFIA) (Mormede 2022), as required by CMM 01-2020 (Conservation and Management Measure for the Interim Management of Bottom Fishing in the Agreement Area).

A bottom fishing impact assessment method was developed and applied for trawl and longline gears including all reported effort in 1998–2020 in the SIOFA Area. Summary statistics show the proportion of cells that were fished by at least one fishing event at the designated spatial scale.

To quantify impact and status, a relative benthic status (RBS) method was used, which considered both the actual width of the fished footprint (i.e., the area contacted by fishing gear, independent of cell size), and the fragility to damage of benthic organisms inside the footprint, and their potential for recovery.

When considering only cells within the fishable area (i.e., to 2000 m depth) at the 0.1° cell resolution, 48% of cells in Subarea 3b and 45% of cells in Subarea 2 have had at least one fishing event (including both trawl and/or longline gears) since 1998). At fishable depths in the 1° cell resolution, 88% of cells in Subarea 8 have been fished at least once. At both scales, the number of fished cells has expanded between 1998 and 2020.

Because the size of cells used in the analysis were larger than the actual width of the fishing events, these 'proportional area fished' summary statistics overestimated the size of the actual fished footprint and were sensitive to the size of the cell used in the calculation. In contrast, impact assessment methods such as RBS estimate proportional impact per cell as a function of actual footprint width and the fragility of the benthic taxa contacted by fishing gear inside the footprint. Because the total area of the footprint and the area of the assessed domain did not depend on cell size, estimates of cumulative impact and VME taxon status under the RBS method were relatively insensitive to the use of different cell sizes.

The final BFIA calculation in Mormede (2022) was carried out at a 0.1° resolution south of 20° S (SIOFA Subareas 1 to 7) and 1° resolution north (SIOFA Subarea 8) for both trawl and bottom longline gears. The analysis estimated that the cumulative bottom fishing impact of trawl and longline gears on stony corals, *Demospongiae* and *Hexactinellida,* and on *Anthiparia* in the assessed area ranged from 0.4% to 1% in different Subareas (i.e., the intact status of each taxon per Subarea ranged 99%-99.6%) in 2020.

The distribution of this impact was not uniform within each Subarea. Summarised per Subarea, mean impact varied from 0.4–1%, but impact in the most heavily impacted cell in each Subarea ranged from 0.7–12.7%. When considering only fishable depths (< 2000 m), mean impact ranged from 0.5–3.5% in the different Subareas, and impact in the most heavily impacted cell per Subarea ranged 1.4–100%.

The Subareas most impacted was Subarea 2 followed by Subareas 3a, 3b and 4 (Figure 20).

Sensitivity analyses showed that in the estimation of relative benthic status (which combined both impact and recovery), biological characteristics of the VME taxa were the most influential parameters (i.e., steepness of the stock-recruit curve and recovery parameters), followed by factors affecting uncertainty about impact (i.e., VME fragility and the width of the bottom impact associated with individual fishing events).

In 2022, SIOFA adopted its first Bottom Fishing Impact Assessment (BFIA) (Mormede 2022), as provided for in its Conservation and Management Measure for the Interim Management of Bottom Fishing in the Agreement Area (CMM 01-2020).

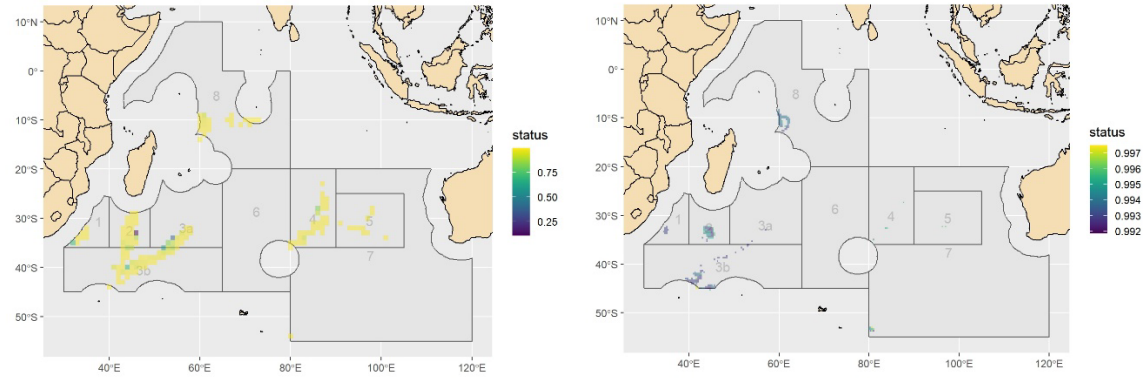


Figure 20 – Relative benthic status as affected by cumulative bottom trawl (left panel) and bottom longline (right panel) impacts within the SIOFA Area. Note unimpacted cells are at 100% status by definition, but these values are not shown. Reproduced from Mormede (2022).

8.3 Bottom fisheries interaction with VME indicator taxa

The incidental capture of VME indicator taxa during fishing operations were recorded by Scientific Observers on board of vessels and reported by SIOFA CCPs in their annual data submissions. Additionally, the Observer database also includes VME taxa captures that have been recorded occasionally in the Catch and Effort database.

While fishing operations and effort have not significantly changed, reporting of incidental captures of VME indicator taxa has been inconsistent over this period, with reports being supplied at the beginning and at the end of the time series but missing from several years in the middle (Figure 21). The species that were most reported (by weight) include precious corals nei (COR), hard corals, madrepores nei (CSS), Animalia (OTH), Porifera (PFR) and Spongiidae (SPO).

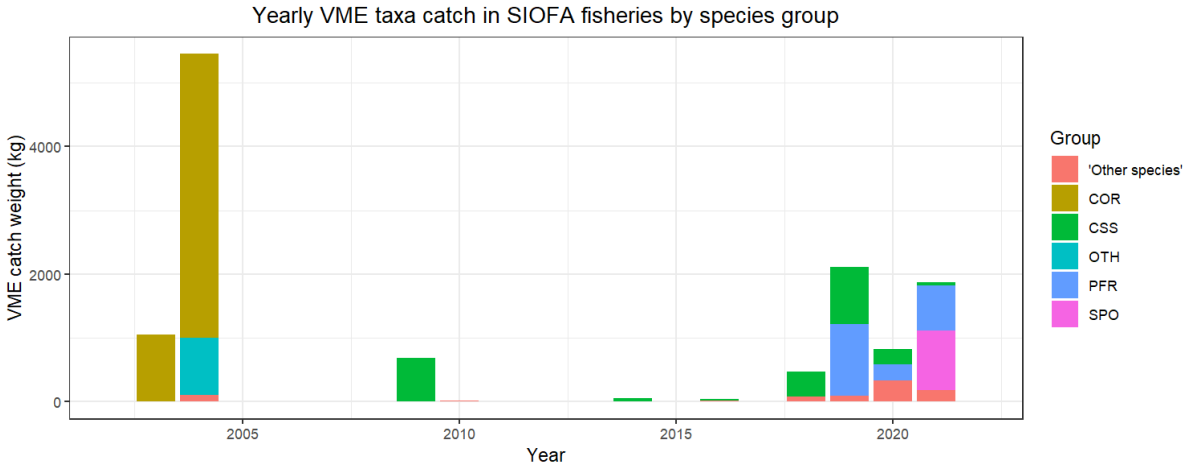


Figure 21 – Yearly incidental catch of VME indicator taxa in the SIOFA Area by taxa group (source: SIOFA Observer and HBHCatchEffort databases 2003–2020). Only the top 5 taxa by weight (cumulatively in the full database) are represented, indicated by their FAO species code (see Appendix C) and all other taxa are grouped in a separate category. Figure D.3 in Appendix D provides a full account of taxa caught.

Incidental captures of VME indicator taxa were reported predominantly in trawls (Figure 22) and especially in bottom trawls, with occasional records being reported for midwater trawls.

Occurrences of captures are reported for line fishing gear, but usually these had small weights compared to those reported in trawls. Table D.4 in Appendix D gives the results by taxon, weight and gear.

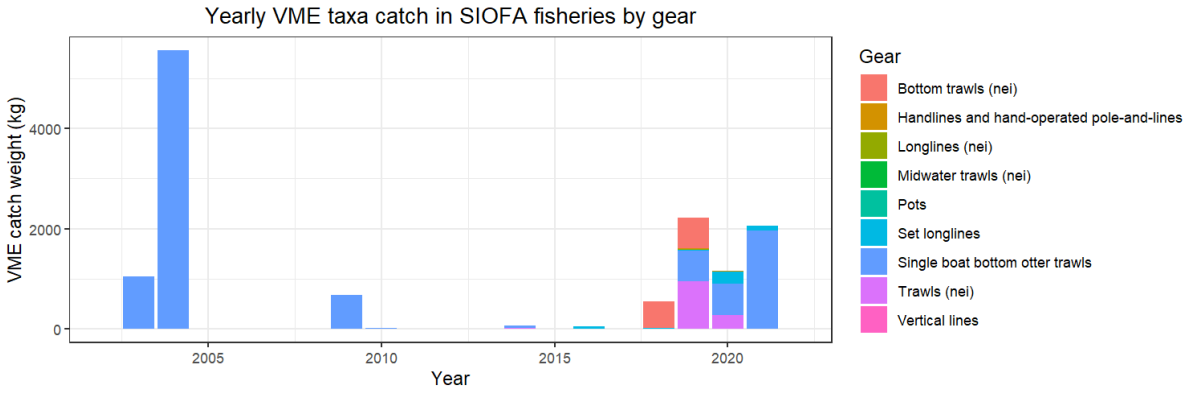


Figure 22 – Yearly incidental catch of VME indicator taxa in the SIOFA Area by fishing method and gear (source: SIOFA Observer and HBHCatchEffort databases 2013–2021).

Hard corals (*Scleractinia*) were commonly caught by fisheries operating at higher latitudes, while sponges *(Porifera*) were caught by fisheries operating throughout the SIOFA Area (Figure 23).

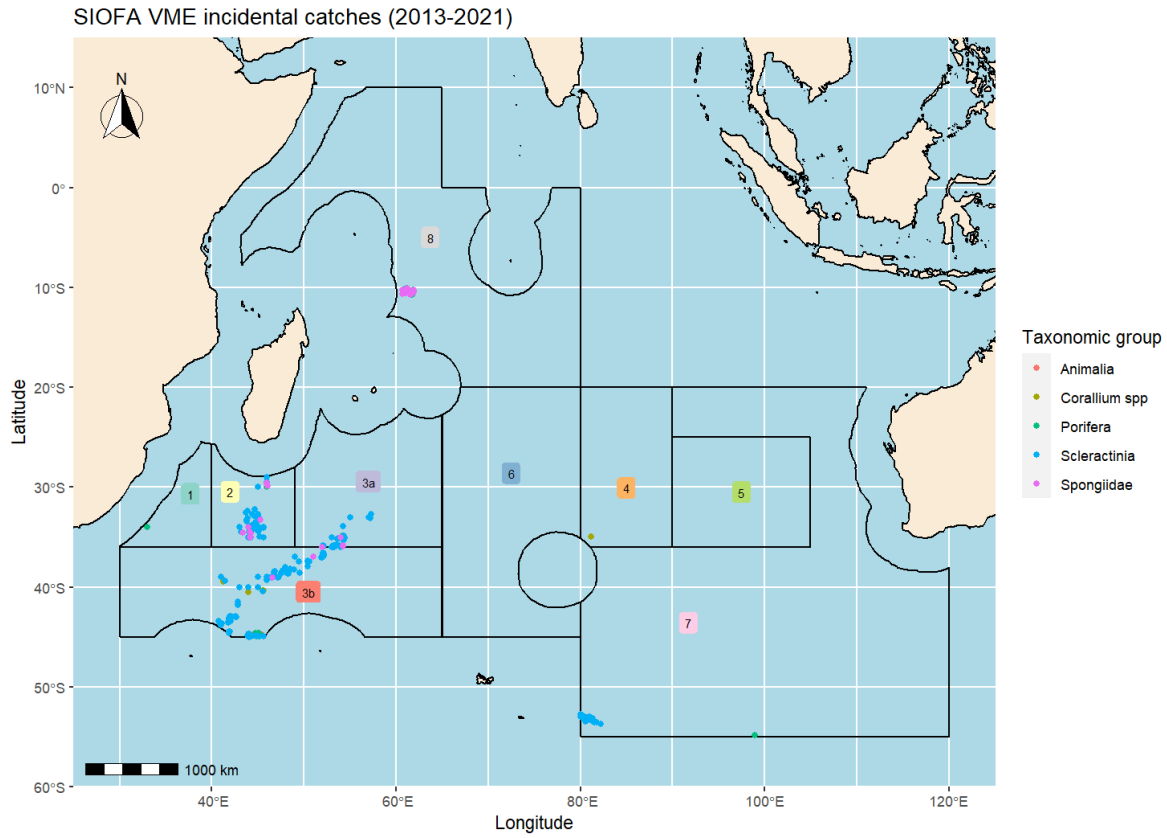


Figure 23 – Reported incidental catch of VME taxa in the SIOFA Area, mapped by taxonomic group (source: SIOFA Observer and HBHCatchEffort databases 2013–2021). Only the top 5 taxa by weight (cumulatively in the full database) are represented in this map. Figure D.4 in Appendix D provides a more detailed map at the highest taxonomic resolution.

8.4 Habitats of significance

This section has been left empty, pending discussions by the SIOFA Scientific Committee on habitats of significance.

8.5 Fishing in SIOFA protected areas

Annex 3 of SIOFA CMM 01-2020 lists five Interim Protected Areas (IPAs) and their coordinates (Figure 24). These areas were first instituted in 2018 through SIOFA CMM 01-2018 and entered into force on 10 August 2018. CCPs are provisionally required to abide by the specified fisheries restrictions to fisheries inside these areas until the adoption of a dedicated research and management plan, referred to in paragraph 6 e, SIOFA CMM 01-2020.

Current restrictions to fisheries in IPAs include a prohibition for CCPs to engage in bottom fishing, exclusion of line and trap fishing, and an obligation to have a Scientific Observer onboard at all times while fishing in those areas.

According to SIOFA CMM 01-2020, when the Meeting of the Parties adopts a revised SIOFA protocol for protected area designation after advice from the Scientific Committee arising from its review referred to in paragraph 6 d., the Meeting of the Parties shall also review Annex 3 of CMM 01-2020, taking into account advice of the Scientific Committee.

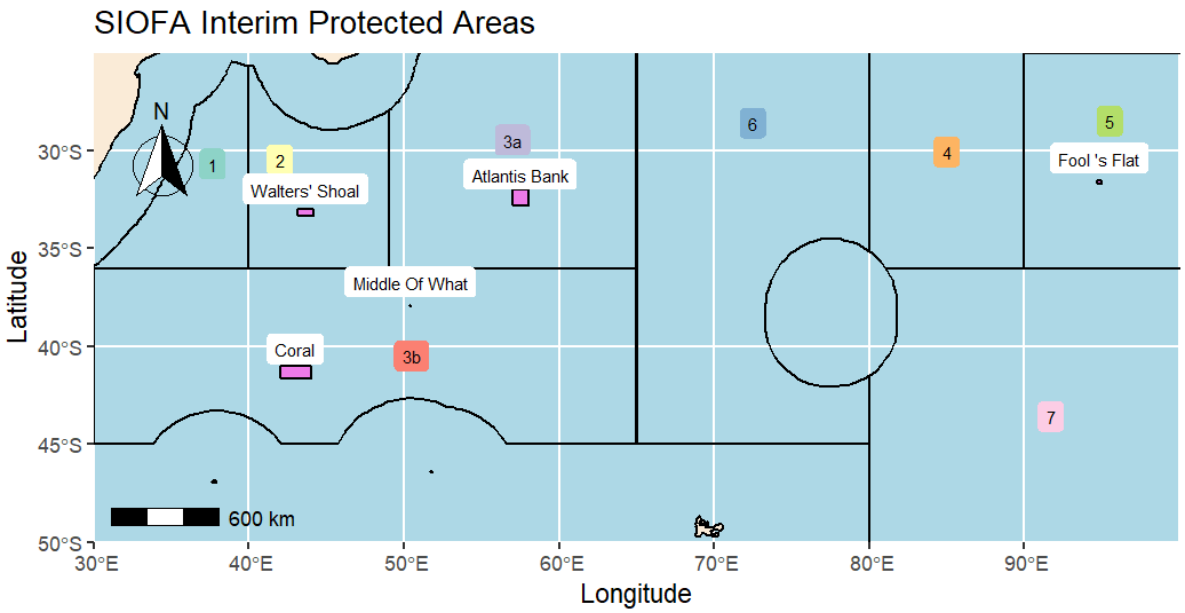


Figure 24 – Map of the SIOFA Interim Protection Areas (in magenta) as defined in CMM 01-2020 (Source: Annex 3 of SIOFA CMM 01-2020). Each area has been labelled by name for easier recognition, as some are barely visible on a map of this large scale.

A total of 125 fishing events have been recorded to occur in SIOFA IPAs in 2013–2021, but the number of fishing events significantly decreased after the institution of the IPAs in late 2018 (Figure 25). Before the institution of the IPAs multiple gear types were used, but after adoption of the IPAs in 2018 only lines were used, consistent with the gear restrictions in CMM 01-2020 (Figure 25). No fishing was recorded within IPAs in 2021.

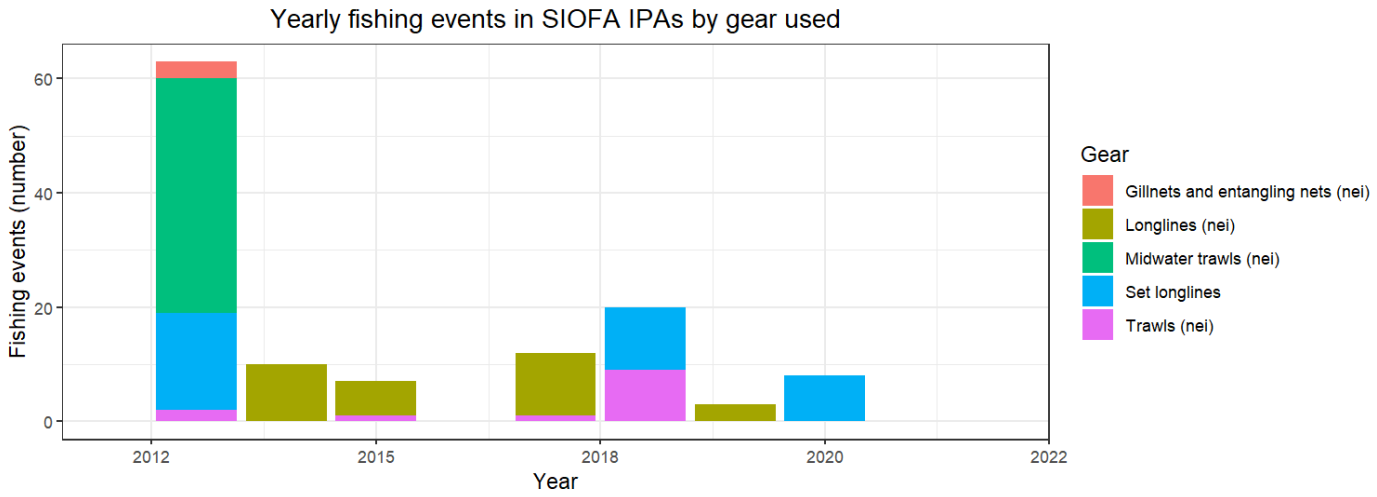


Figure 25 – Number of fishing events by gear in Interim Protected Areas (IPAs) per year (including from years before the IPAs were implemented) (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2021).

These events caught a range of species, but total catch weights in these locations have been relatively low (Figure 26). Splendid alfonsino (BYS) and kitefin shark (SCK) were the species that made the largest contribution to total catches in years when catch in IPAs was highest (2013, 2017 and 2018, Figure 26). No fishing was recorded within IPAs in 2021.

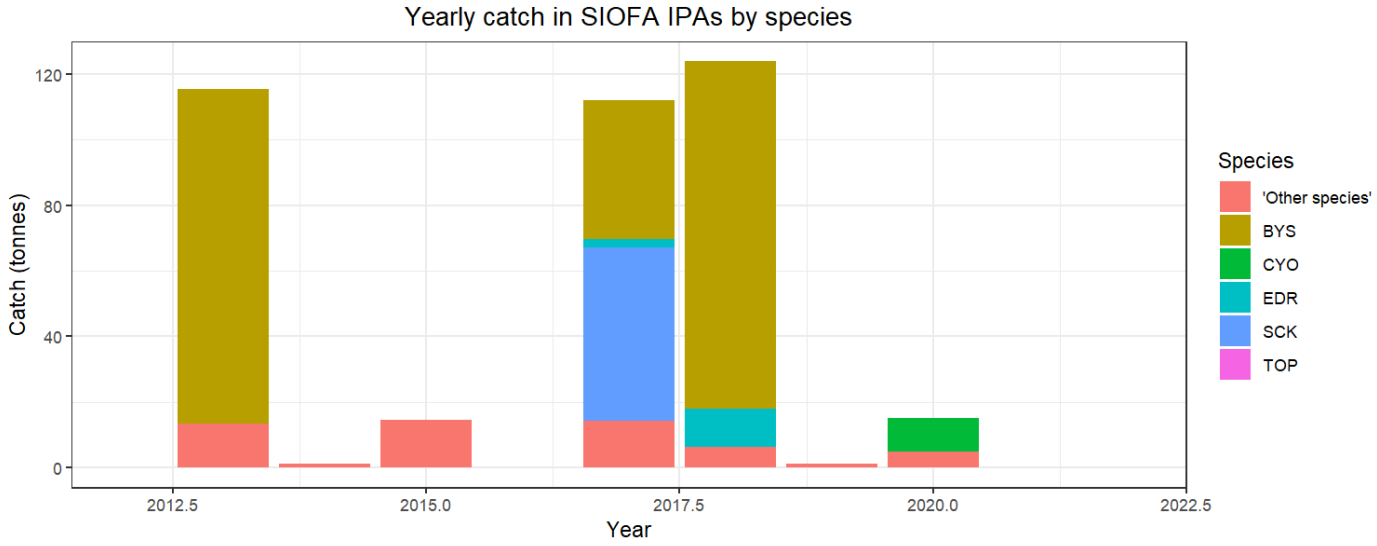


Figure 26 – Total catch (t) by species in Interim Protected Areas (IPAs) per year (including in years before the IPAs were implemented) (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2021). Only the top 5 species by weight (cumulatively over the history of the fisheries) are shown, indicated by their FAO species code (see Appendix C); other taxa are grouped and collectively labelled 'other species'. Figure D.3 in Appendix D provides a more detailed account of other species caught.

9. Interactions with larger ecosystem processes

9.1 Climate change and environmental variability

No information is currently available on the impacts of climate change or environmental variability on SIOFA fisheries.

9.2 Trophic and ecosystem level effects

No information is currently available on the trophic interactions or other larger ecosystem effects of SIOFA fisheries.

10. References

Georgeson, L., C. L. Rigby, T. J. Emery M. Fuller, J. Hartog, J. Williams, C. A. Hobday, C. A. Duff, C. A. Simpendorfer, T. Okuda, I. C. Stobutzki, and S. J. Nicol. 2020. Ecological risks of demersal fishing on deepwater chondrichthyan populations in the Southern Indian and South Pacific Oceans. ICES Journal of Marine Science., 77(5) pp. 1711-1727. https://doi.org/10.1093/icesjms/fsaa019

Mormede, S. 2022. Calculating bottom fishing impact for trawl and longline gears in SIOFA. Pages 1–22. Confidential report to SIOFA.

11. Appendix A – Target fish species reported in SIOFA fisheries and included among target species referred to in this summary

FAO Code	Scientific name	Common name
AVR	*Aprion virescens*	Green jobfish
BWA	*Hyperoglyphe antarctica*	Bluenose warehou
BYS	*Beryx splendens*	Splendid alfonsino
CDL	*Epigonus* spp	Cardinal fishes nei
DPX	Perciformes	Demersal percomorphs nei
EDR	*Pseudopentaceros richardsoni*	Pelagic armourhead
EMP	*Lethrinidae*	Emperors(=Scavengers) nei
EPI	*Epigonus telescopus*	Black cardinal fish
GPX	*Epinephelus* spp	Groupers nei
GRO	*Actinopterygii*	Groundfishes nei
HAU	*Polyprion* spp	Hapuka
LEC	*Lepidocybium flavobrunneum*	Escolar
LHN	*Lethrinus nebulosus*	Spangled emperor
LUB	*Lutjanus sebae*	Emperor red snapper
LZX	*Lethrinus* spp	
NGX	*Carangoides* spp	
OIL	*Ruvettus pretiosus*	Oilfish
ORY	*Hoplostethus atlanticus*	Orange roughy
QXR	*Polysteganus baissaci*	Frenchman seabream
RYG	*Plagiogeneion rubiginosum*	Rubyfish
SDX	*Decapterus* spp	Scads nei
SEY	*Schedophilus velaini*	Violet warehou
SNA	*Lutjanus* spp	Snappers nei
SNX	*Lutjanidae*	Snappers, jobfishes nei
SSO	*Pseudocyttus maculatus*	Smooth oreo dory
SZX	*Saurida* spp	
TOP	*Dissostichus eleginoides*	Patagonian toothfish
TUN	*Thunnini*	Tunas nei
UHW	*Sepioteuthis* spp	Reef squids nei
WRF	*Polyprion americanus*	Wreckfish

12. Appendix B – Common names, FAO species codes, and scientific names of sharks, referred to in this summary

FAO code	FAO common name	Scientific name
ALS	Silvertip shark	*Carcharhinus albimarginatus*
ASK	Angelsharks, sand devils nei	Squatinidae
BHY	Bathyraja rays nei	*Bathyraja* spp
BSH	Blue shark	*Prionace glauca*
BYR	Kerguelen sandpaper skate	*Bathyraja irrasa*
CAR	Cartilaginous fishes nei	Chondrichthyes
CLD	Sliteye shark	*Loxodon macrorhinus*
CVX	Ground sharks	*Carcharhiniformes*
CWM	Ghost sharks	*Chimaera* spp
CWO	Gulper sharks nei	*Centrophorus* spp
CWZ	Carcharhinus sharks nei	*Carcharhinus* spp
CYO	Portuguese dogfish	*Centroscymnus coelolepis*
CZI		*Centroscymnus* spp
DCA	Birdbeak dogfish	*Deania calcea*
DGX	Dogfish sharks nei	Squalidae
DGZ	Dogfishes nei	*Squalus* spp
DOP	Shortnose spurdog	*Squalus megalops*
ETE		*Etmopterus compagnoi*
ETF	Blackbelly lanternshark	*Etmopterus lucifer*
ETM	Southern lanternshark(Lucifer)	*Etmopterus granulosus*
GTF	Guitarfishes, etc. nei	*Rhinobatidae*
GUP	Gulper shark	*Centrophorus granulosus*
GUQ	Leafscale gulper shark	*Centrophorus squamosus*
HAG	Mud catshark	*Halaelurus lutarius*
HCM	Hooktooth shark	*Chaenogaleus macrostoma*
HOL	Chimaeras, etc. nei	Chimaeriformes
HXT	Sharpnose sevengill shark	*Heptranchias perlo*
JFB	Bigmouth skate	*Raja robertsi*
NTC	Broadnose sevengill shark	*Notorynchus cepedianus*
ORZ	Tawny nurse shark	*Nebrius ferrugineus*
PTM	False catshark	*Pseudotriakis microdon*
QUK	Shortspine spurdog	*Squalus mitsukurii*
RAJ	Rays and skates nei	Rajidae
RBI		*Rhinobatos irvinei*
RBY	Butterfly rays nei	*Gymnura* spp
RFA	Whiteleg skate	*Amblyraja taaf*
RME	Longhorned mobula	*Mobula eregoodootenkee*
RMV	Mobula nei	*Mobula* spp
RRY	Bowmouth guitarfish	*Rhina ancylostoma*
RSK	Requiem sharks nei	Carcharhinidae
RTE	Round ribbontail ray	*Taeniura meyeni*
RYE	Ornate eagle ray	*Aetomylaeus vespertilio*

FAO code	FAO common name	Scientific name
RZZ	Southern sleeper shark	*Somniosus antarcticus*
SBL	Bluntnose sixgill shark	*Hexanchus griseus*
SCK	Kitefin shark	*Dalatias licha*
SDV	Smooth-hounds nei	*Mustelus* spp
SHL	Lanternsharks nei	*Etmopterus* spp
SKA	Raja rays nei	*Raja* spp
SKH	Various sharks nei	Selachimorpha (Pleurotremata)
SKX	Sharks, rays, skates, etc. nei	Elasmobranchii
SMA	Shortfin mako	*Isurus oxyrinchus*
SON	Pacific sleeper shark	*Somniosus pacificus*
SOR	Little sleeper shark	*Somniosus rostratus*
SPK	Great hammerhead	*Sphyrna mokarran*
SPN	Hammerhead sharks nei	*Sphyrna* spp
SRX	Rays, stingrays, mantas nei	Rajiformes
SUN	Ocellated angelshark	*Squatina tergocellatoides*
TIG	Tiger shark	*Galeocerdo cuvier*

13. Appendix C – Common names, FAO species codes, and scientific names of VME taxa reported as incidental captures in SIOFA fisheries

FAO code	FAO common name	Scientific name
ADQ	Black coral	*Antipathes dichotoma*
AJZ	Soft corals	*Alcyonacea*
AQZ	Black corals and thorny corals	*Antipatharia*
ATX	Sea anemones	*Actiniaria*
AXT	Hydrocorals	*Stylasteridae*
AZN	Hydroids, hydromedusae	*Anthoathecata*
BVH	Brachiopods, lamp shells	*Brachiopoda*
BWV		*Paragorgiidae*
BWY		*Bathylasmatidae*
BZN	Bryozoans	*Bryozoa*
CNI	Cnidarians nei	*Cnidaria*
COR	Precious corals nei	*Corallium spp*
CSS	Hard corals, madrepores nei	*Scleractinia*
CVD	Pencil urchins	*Cidaridae*
CWD	Feather stars and sea lilies	*Crinoidea*
DMO	Siliceous sponges	*Demospongiae*
GGW	Gorgonians	*Gorgoniidae*
HQZ	Hydrozoans	*Hydrozoa*
HXY	Glass sponges	*Hexactinellida*
IQO		*Isididae*
KRH	Wire coral	*Cirrhipathes spp*
NTW	Sea pens	*Pennatulacea*
NYZ	0	*Nephtheidae*
OEQ	Basket stars	*Euryalida*
PFR		*Porifera*
QFY		*Chrysogorgiidae*
SPO	Sponges	*Spongiidae*
SSX	Sea squirts nei	*Ascidiacea*
SZS	Serpulid tube worms	*Serpulidae*
ZOT	Zoanthids	*Zoantharia*

14. Appendix D – Data included in figures and additional figures

Table D.1 – Total annual target and bycatch weight (in t) in the SIOFA Area (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2020)

Year	Target catch (t)	Shark catch (t)	Bycatch (t)
2013	7548.9	1249.9	969.3
2014	5825.3	1286.8	553.4
2015	11155.9	2067.5	23515.6
2016	13890.7	2724	11250.3
2017	15903.6	2121.1	2831.1
2018	11788.7	2071.2	503.7
2019	11198.2	1832.6	1021.7
2020	14454.2	1295.6	1305

Table D.2 – Total annual target catch weight (in t) in the SIOFA Area, by Subarea. (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2020)

	SIOFA Subarea								
Year	1	2	3a	3b	4	5	6	7	8
2013	23.8	2898.3	1098.7	2336.1	1178.8				8
2014	12.7	1371.4	1356.7	2424.1	630.4				
2015	231.2	2450.9	1036.8	5896.3	1057.7		30.9	3.6	147.7
2016	673.2	2051.2	1977	8300.5	29.7		13.2		141
2017	4728	2194.8	950.1	6991.1	382.6	500.2	18.1		72.3
2018	3634.8	1539.6	952.6	4171.5	914.5	100.6	28.4	347.2	23.4
2019	1758.2	2352.2	1040.8	4833.7	556.4	0.9	62	184.7	406.5
2020	5502.8	1560.2	1304.3	4506.4	814.6	214.9	35	77.8	406.1

Table D.3: Total catch of sharks (in t) per year and Subarea (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2020). Total catch includes both target catch and bycatch of all species.

	SIOFA Subarea								
Year	1	2	3a	3b	4	5	6	7	8
2013	61.4	1167.7		20.6					0.2
2014		1282.9		3.9					
2015	7.5	1685.4	10.5	95.7	2.7		32.2	3	200.2
2016	184.4	1878.1	3.2	387.8	1.1		5		70.4
2017	430.6	1121.7	5.2	451.4	1.4	0.4	9.8		97.9
2018	286.7	1456.1	18	199.6			38.2	0.2	71
2019	204.4	1055.3	28	263.5	1.2	5	51.5	9.2	213.9
2020	284	634	26.1	180.6	5.7	1.2	16.5	0.5	145.8

Table D.1 – Total incidental catch (in kg) of VME indicator taxa by fishing method and gear (source: SIOFA Observer and HBHCatchEffort databases 2013–2020).

Taxon	Bottom trawls (nei)	Handlines and hand-operated pole-and-lines	Longlines (nei)	Midwater trawls (nei)	Pots	Set longlines	Single boat bottom otter trawls	Trawls (nei)	Vertical lines
Acropora formosa		22.2							
Actiniaria	0.84					23.537	1.45		
Alcyonacea			0.151			19.07	1.12	1.005	
Animalia						0.01	1000		
Anthoathecatae	9					0.377	1	1	
Antipatharia	1.022					8.755	45.9	7.91	
Antipathes dichotoma	1.3						0.02	31.66	
Ascidiacea						2.225			
Asteroidea	0.14						12.66	0.5	
Bathylasmatidae						0.06			
Brachiopoda						0.28			
Brisingidae	0.025								
Bryozoa			0.44			5.2			
Chrysogorgiidae	0.055								
Cidaridae						0.035			
Cirrhipathes spp	0.1								
Cnidaria	5	22.8	0.92			0.2	28.97		
Corallium spp							5509.35		
Crinoidea	0.005					4.62			

Taxon	Bottom trawls (nei)	Handlines and hand-operated pole-and-lines	Longlines (nei)	Midwater trawls (nei)	Pots	Set longlines	Single boat bottom otter trawls	Trawls (nei)	Vertical lines
Crustacea						0.27			
Demospongiae			1.145			32.016	117		
Echinodermata	0.4					0.96			
Echinoidea						0.05	15.31	3.15	
Euryalida			0.675			8.412			
Gorgoniidae						94.3783	69.57	6.23	
Gorgonocephalus spp							2.83		
Heliopora coerulea		4.5							
Hexactinellida	25.63		0.03			13.3		2.85	
Holothuria spp						0.4			
Hydrozoa	10.322						2	0.77	
Invertebrata						6.43			0.9
Isididae	15.57		0.49					51.37	
Lithodidae						0			
Nephtheidae	0.1								
Ophiurida			0.1			1.48	1		
Ophiuroidea							1.51		
Paragorgiidae	0.09							2.215	
Pennatulacea	0.01					3.545	0.05	0.05	
Porifera	625.67			0.5		4.5	1848.7	6	
Rhopilema spp	1.65			5.2			14.4		
Scleractinia	426.53		0.15	3.8	0.2	161.139	751.93	1058.797	
Serpulidae						1.14			

Taxon	Bottom trawls (nei)	Handlines and hand-operated pole-and-lines	Longlines (nei)	Midwater trawls (nei)	Pots	Set longlines	Single boat bottom otter trawls	Trawls (nei)	Vertical lines
Spongiidae	5.5						1112.35	61.99	
Stylasteridae	0.525		0.41			23.604	7		0.6
Zoanthidea						2.905			

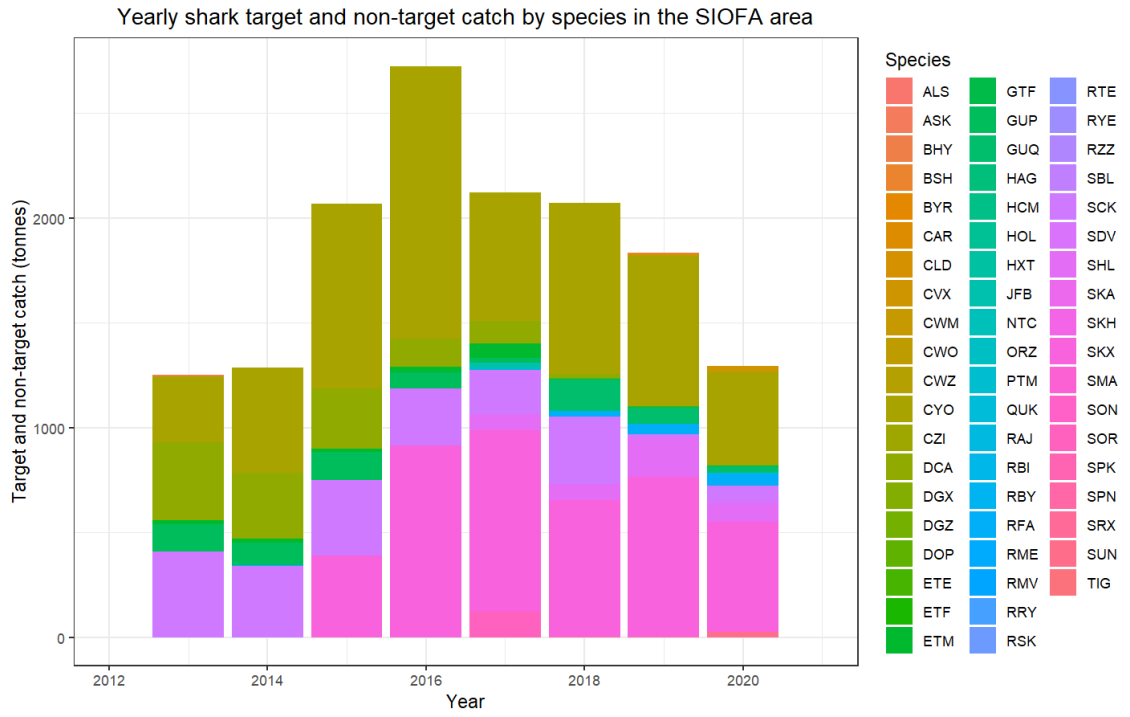


Figure D.1 – Yearly catch of sharks in the SIOFA Area by species (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2020). Species are indicated by their FAO species code (see Appendix B).

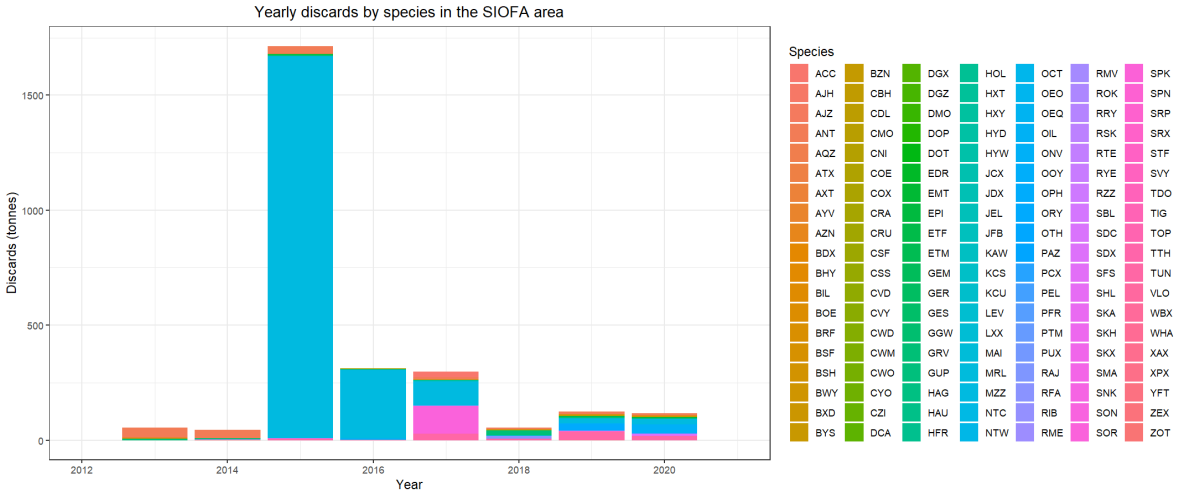


Figure D.2 – Yearly discards in the SIOFA Area by species (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2020). Species are indicated by their FAO species code.

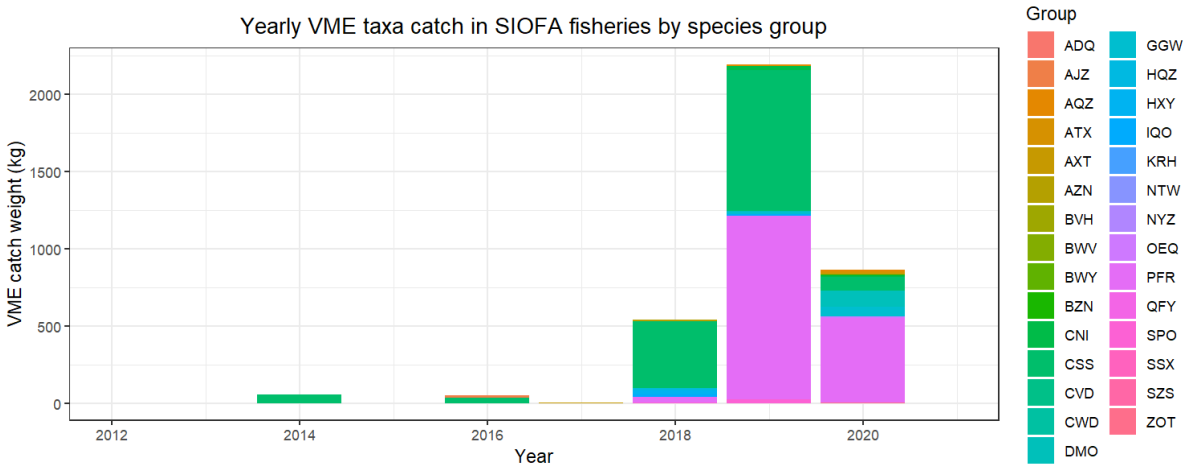


Figure D.3 – Yearly incidental catch of VME indicator taxa in the SIOFA Area by species group (source: SIOFA Observer and HBHCatchEffort databases 2013–2020). Species are indicated by their FAO species code.

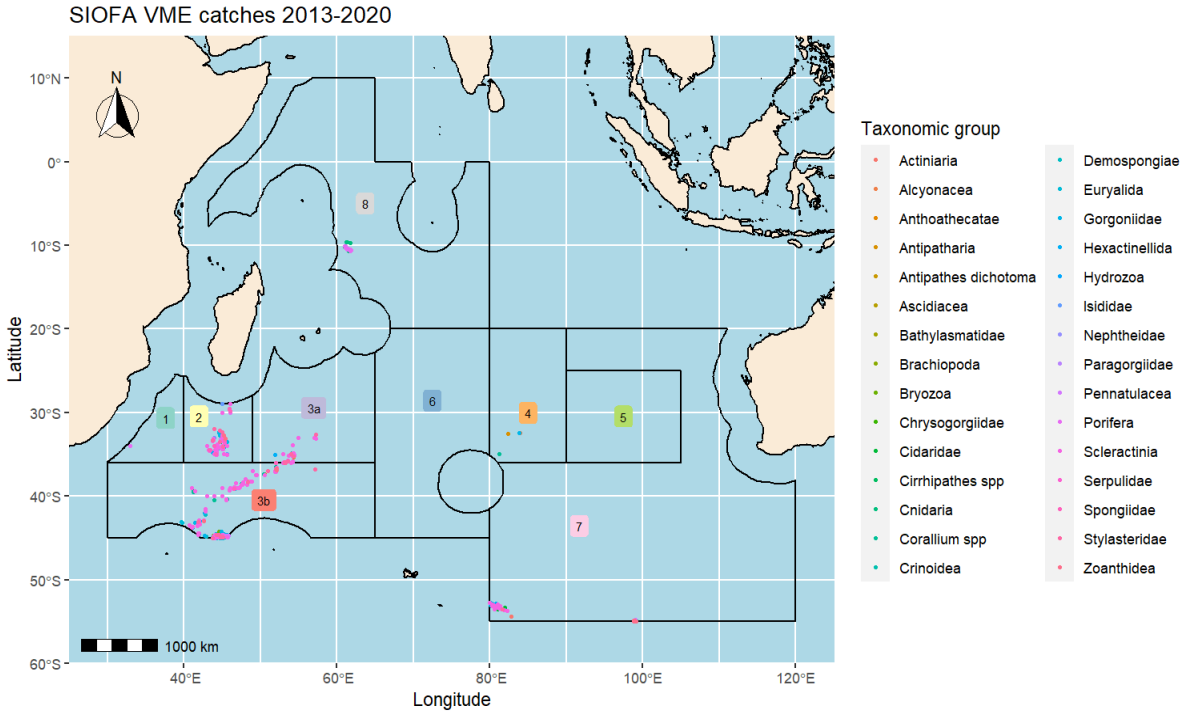


Figure D.4 – Incidental catch of VME indicator taxa reported in the SIOFA Area, mapped by taxonomic group (source: SIOFA Observer and HBHCatchEffort databases 2013–2020).

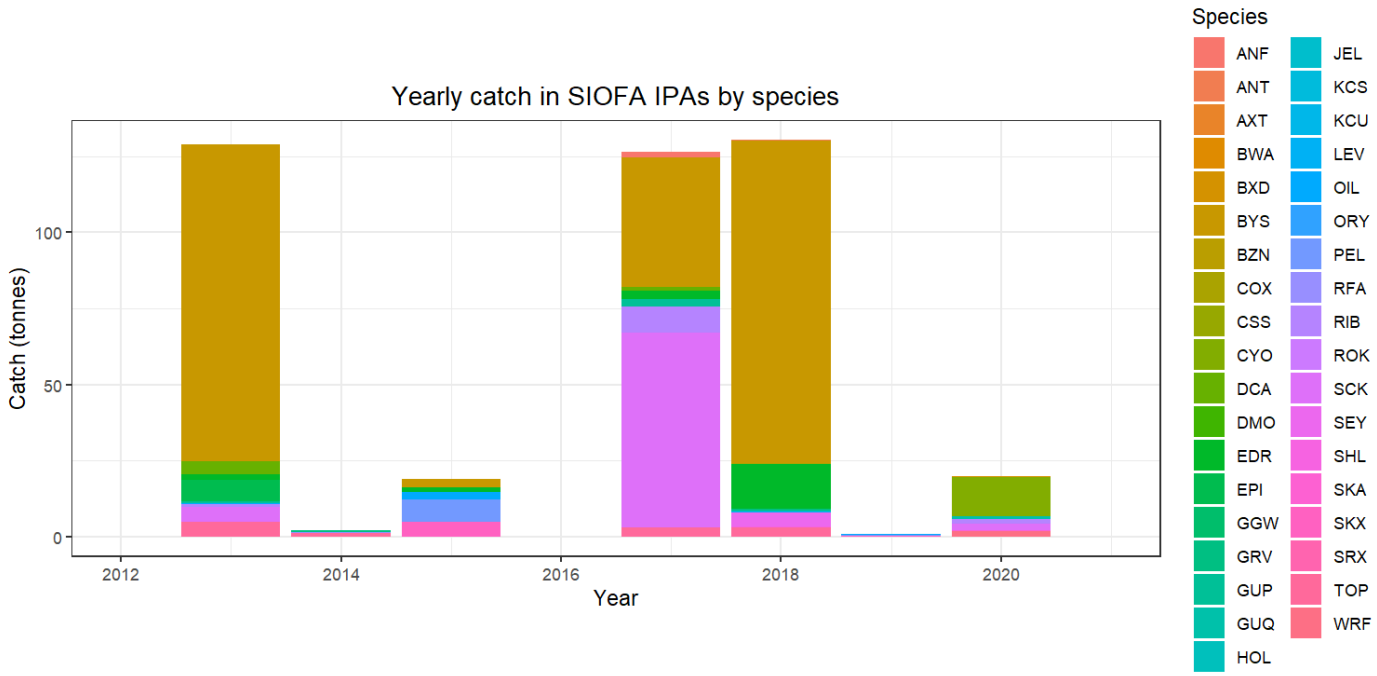


Figure D.5 – Total fish catch (in t) by species in Interim Protected Areas (IPAs) per year (including in years before the IPAs were implemented) (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2020).