8th Meeting of the Scientific Committee (SC8)

Tenerife, Spain, 22-31 March 2023

SC-08-17

Fishery Summary: alfonsino (*Beryx splendens, Beryx decadactylus, Beryx* spp.) 2023

The SIOFA Secretariat

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Abstract

This paper presents the SIOFA fishery summary for alfonsino (*Beryx splendens, Beryx decadactylus, Beryx* spp.) 2023.
A template of the Fishery Summary type of document was first presented to and approved by SERAWG4 and SC7 in 2022, and it was adapted to this species as requested by SC7.

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Recommendations

The SIOFA Secretariat recommends that the SC8:

- **notes** the work done by the Secretariat in preparing the SIOFA Fishery Summary for alfonsino 2023.
- **provides** any comments or edits to the SIOFA Fishery Summary for alfonsino 2023 during the SC meeting.
- **endorses** the SIOFA Fishery Summary for alfonsino 2023 and **recommends** that this is further developed for SC9 and before publication.
- **considers** the frequency with which the Secretariat is to update the SIOFA Fishery Summary for alfonsino 2023.

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Fishery Summary: alfonsino (*Beryx splendens, Beryx decadactylus, Beryx* spp.) 2023

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Prepared by the SIOFA Secretariat

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Contents

1. Purpose of this document

The SIOFA Fisheries Summaries are public document that describe specific SIOFA fisheries in the SIOFA Area (Figure 1) and summarizes the available information for each species, and their biology and ecology. This document is targeted at the general public and institutions and countries wanting to better understand SIOFA fisheries.

The SIOFA Ecosystem Summary (link) provides more detailed information on effects of SIOFA fisheries on ecosystems and species in the SIOFA Area. The SIOFA Fisheries Overview (link) integrates these documents and describes general trends for the main fisheries in the SIOFA Area.

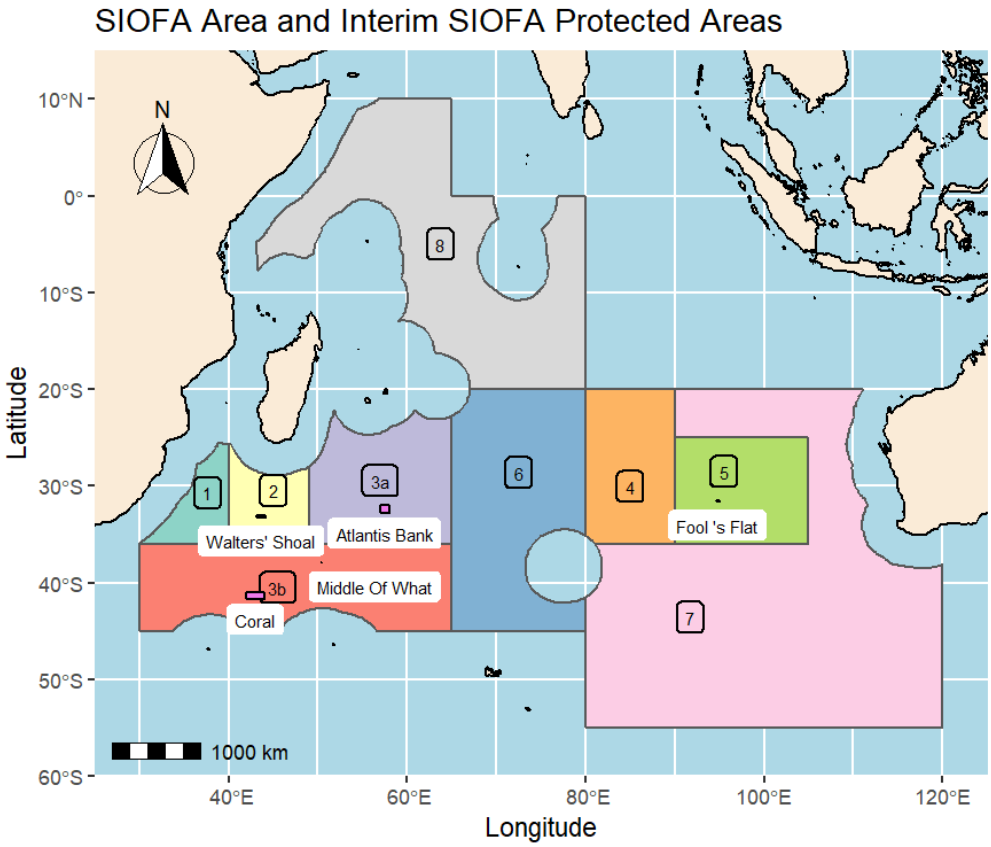

Figure 1 – The SIOFA Area and subareas (source: SIOFA Spatial Database). The subarea numbers and colour codes are used consistently throughout this Summary to identify subareas. The map highlights SIOFA Interim Protection Areas (in magenta) as defined in Annex 3 of CMM 2020/01. The interim protection areas have been labelled by name for easier recognition.

2. Data sources - Data availability

There are thirteen Contracting Parties, Cooperating non Contracting Parties, and Participating Fisheries Entities of SIOFA (CCPs) that are the members of SIOFA. The SIOFA Secretariat receives data from CCPs pertaining to their fishing activities, biological sampling, and observer reports as per CMM 2021/02 (Conservation and Management Measure for the Collection, Reporting, Verification and Exchange of Data relating to fishing activities in the Agreement Area). The SIOFA Secretariat acts as custodian for these data on behalf of its members. Requests to release or publish these data (e.g., for scientific purposes) is regulated under CMM 2016/03 (Conservation and Management Measure for Data Confidentiality and Procedures for access and use of data). Data requests can be made through the Secretariat (secretariat@siofa.org).

The SIOFA databases are organized as follows:

- AggregatedCatchEffort: this database contains the catch and effort data aggregated at different spatial resolutions, varying from the whole SIOFA Area to 20' squares, for years from 2000 to 2019.
- HBHCatchEffort: this database contains haul-by-haul catch and effort data at recorded at a range of spatial resolutions, varying from degrees to seconds, for the years from 1998 to 2021.
- SIOFA Observer Database: this database contains data from Scientific Observers including biological sampling and operational data, for the years 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., boundaries of the SIOFA Subareas, Management Unit boundaries, etc.). 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 in the AggregatedCatchEffort and HBHCatchEffort databases.

Further data (e.g., the number of active vessels) are available from Annual National Reports that SIOFA CCPs submit to the Scientific Committee each year. These are available from the SIOFA website (https://siofa.org/meetings/groups/Scientific%20Committee%20Meeting).

3. Species Summary

Common name	Alfonsino, splendid alfonsino
Scientific name	*Beryx* spp., *Beryx splendens, Beryx decadactylus*
Scientific synonyms	
FAO species code	ALF, BYS, BXD
Year of this report	2023
Assessment Areas/ Management Units	West (subareas 1, 2, 3a, 3b) and East (subareas 4 and 5)
Assessment method	Unstandardised CPUE trend analysis
Most recent assessment	2020
Year of next assessment	2023
Harvest strategy	Not defined
Summary of current stock status	For both the East and West alfonsino stocks, there is a high degree of confidence that the stocks are not overfished (i.e. $B>B_{msy}$) and overfishing is not occurring (i.e. $F<F_{msy}$). Stocks are estimated to be healthy at approximately 60% of their pre-exploitation biomass.

This report describes the alfonsino fishery in the SIOFA Area and available biological parameters for alfonsino. Collectively, alfonsino includes both the splendid alfonsino (BYS, *Beryx splendens,* and alfonsino (BXD, *Beryx decadactylus*) species, as well as catch not identified to the species level (ALF, *Beryx* spp.). For the remainder of this report 'alfonsino' and the generic code ALF refer collectively to ALF, BYS, and BXD

Management advice for this species is given in the last Report of the SIOFA Scientific Committee (SC7 report) and management decisions are summarised in the Report of the SIOFA Meeting of Parties (MoP9 report).

A harvest strategy for the alfonsino stocks in the SIOFA area has not yet been developed.

Alfonsino is assessed through an age structured production model fitted to standardised CPUE trends, separately for two management units, comprising an 'east' stock and a 'west' stock (see Brandão et al. 2021). The SIOFA Scientific Committee has recommended additional research to better define the stock structure of alfonsino in the SIOFA area, and standardised data collection to improve estimation of ageing and biological parameters.

4. Biological Summary

The most common species of alfonsinos caught in the SIOFA area is splendid alfonsino (BYS, *Beryx splendens*), but sometimes catch of another species (alfonsino, BXD, *Beryx decadactylus*) or not identified to the species level (ALF, *Beryx* spp.) are also reported. The data on all alfonsinos has been aggregated, and is presented here, at the highest taxonomical resolution.

Alfonsinos are schooling benthopelagic fishes found at a depth range of 25–1300 m, but more commonly at 400–600 m, generally in aggregations over rocky bottoms or underwater features. Alfonsinos have a global distribution in temperate and tropical waters of all oceans (Busakhin 1982).

Alfonsinos are moderately selective feeders that forage primarily in the mesopelagic layers, preying primarily on mesopelagic crustaceans at smaller sizes and on fishes when they are larger (Horn et al. 2010). Adults occur primarily near the ocean floor (but ascending to feed in midwater during the night), and often aggregate around underwater topographic features, particularly during spawning, which occurs in the Austral summer, primarily December – February (Cook Islands 2021).

The species is oviparous, spawning in batches. Females are serial spawners and release eggs 10-12 times at intervals of about four days during the spawning season. Females produce 270 000-675 000 eggs per spawning event. Eggs hatch after about 8 days. Eggs, larvae and juveniles are pelagic. Alfonsino reaches maturity at approximately 23-44 cm and 5-6 y of age, and reach a maximum age of around 20 years (FAO 2016).

5. Description of the fishery

5.1 Fleet and gear

Alfonsino are targeted in the SIOFA Area using midwater trawls in association with underwater topographic features where the species tend to aggregate. There are effectively two distinct alfonsino fisheries in the SIOFA area: the first uses benthopelagic trawls that are deployed in association with, but generally not in contact with, the ocean floor, whereas the second uses fully pelagic trawl gear. Fisheries using these distinct gears operate in relatively distinct areas (denoted 'east' and 'west' in Figure 2 below) with relatively minor levels of overlap. The CCPs that have participated in the alfonsino fishery (2000-2021) are Australia, Cook Islands, Japan, and Korea and the EU. In recent years, participation in the fishery has involved no more than three vessels per year.

5.2 Fishing areas

Alfonsino fisheries occur at subtropical and temperate latitudes across the extent of the SIOFA area, including SIOFA subareas 1, 2, 3a, 3b, 4, and 5 (Figure 1). The majority of fishing effort and catch have occurred in the West area (subareas 1, 2, 3a and 3b). Fishing occurs mainly in association with underwater topographic features.

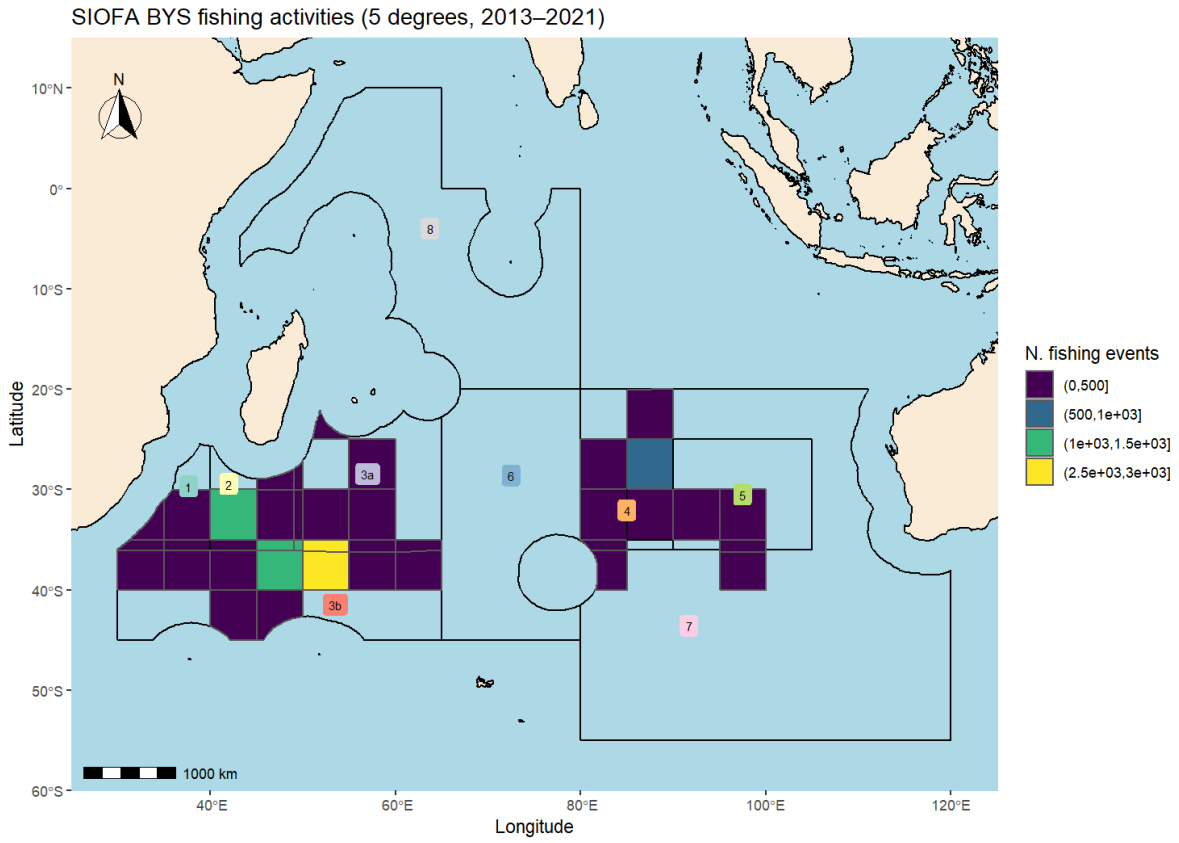

Figure 1 – Spatial distribution of fishing events that caught alfonsino in the SIOFA Area, derived from haul-by-haul level fishing data, aggregated at a 5 x5 degree resolution (source: SIOFA HBHCatchEffort databases 2013–2021). This map represents all fishing events that caught any ALF, BYS or BXD, irrespective of declared target species.

5.3 Assessment Areas

For purposes of stock assessment, two management units have been defined, the 'West' fishery and the 'East' fishery; see Figure 2 below (Brandão et al. 2021). The majority of catches, and all of the catch in recent years, have come from The West fishery which includes SIOFA subareas 1, 2, 3a, and 3b; a much lower level of catch has historically come from the East, which includes subareas 4 and 5.

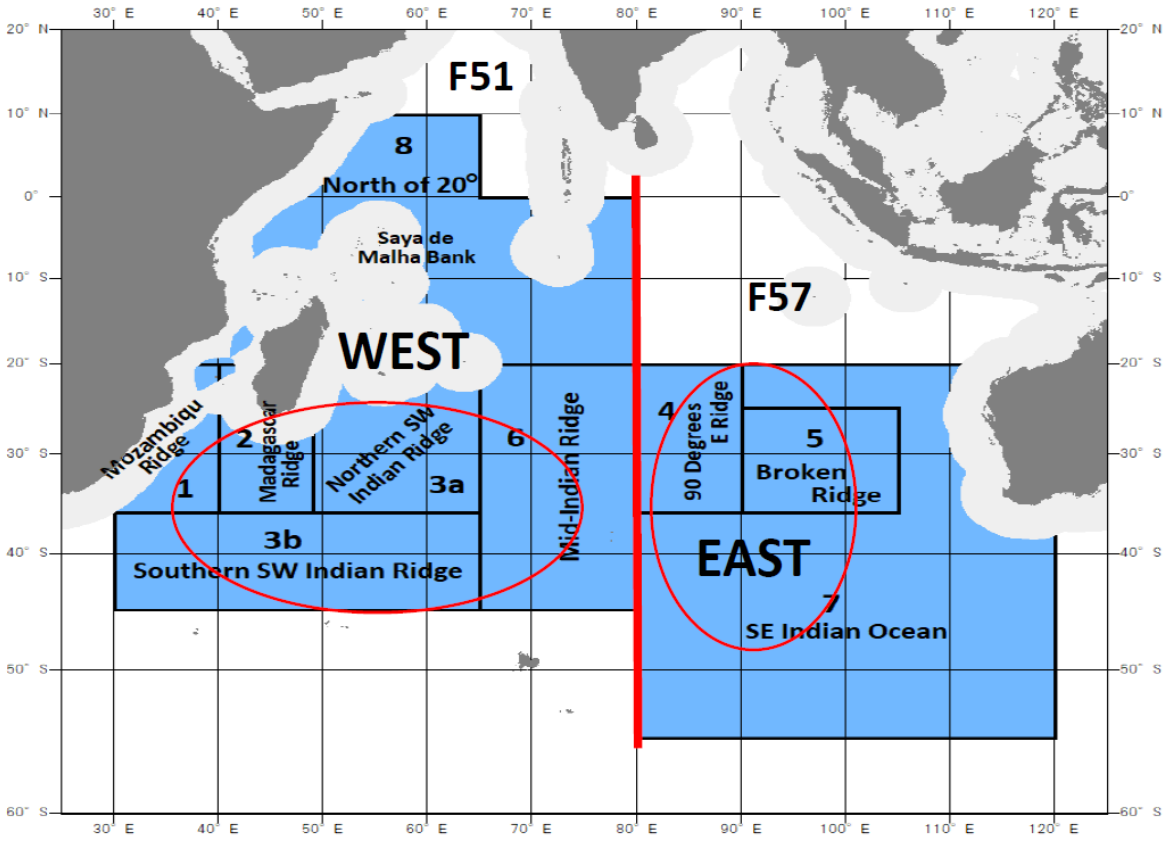

Figure 2 – Map of SIOFA subareas and management units used for assessments for alfonsino (source: Brandão et al. (2021)). Labels indicate names of individual subareas.. Red ovals labelled West and East denote the grouping of subareas into two larger management units for purposes of stock assessment.

5.4 Catch and effort

Note that fishing effort and catches reported in this section are intended to represent total catch of alfonsino (including ALF, BYS and BXD), irrespective of whether each particular fishing event had been targeting alfonsino or not. Consequently, CPUE represents the CPUE of all operations that caught alfonsino even as bycatch, so if the share of operations actively targeting alfonsino increases, then CPUE is likely to increase as well. In this context CPUE as depicted here cannot be considered a reliable index of abundance. In contrast, the stock assessment analyses described by Brandão et al. (2021) used CPUE standardisation, and separated these data by management unit (West vs East) to derive an index of abundance.

Catches of alfonsino have fluctuated between about 3000 and 5000 t between 2013 and 2021 (Figure 3a), with the average annual catch in recent years (2017–2021) being approximately 4000 t. In recent years, up to three vessels participated in the SIOFA alfonsino fishery, so variability in fleet deployment can cause moderate fluctuations in catch and effort.

Effort levels have decreased in recent years, from a high in 2015 (Figure 3a). Alfonsino is mostly caught in the western SIOFA area, mainly subareas 2, 3a and 3b (Figure 3b).

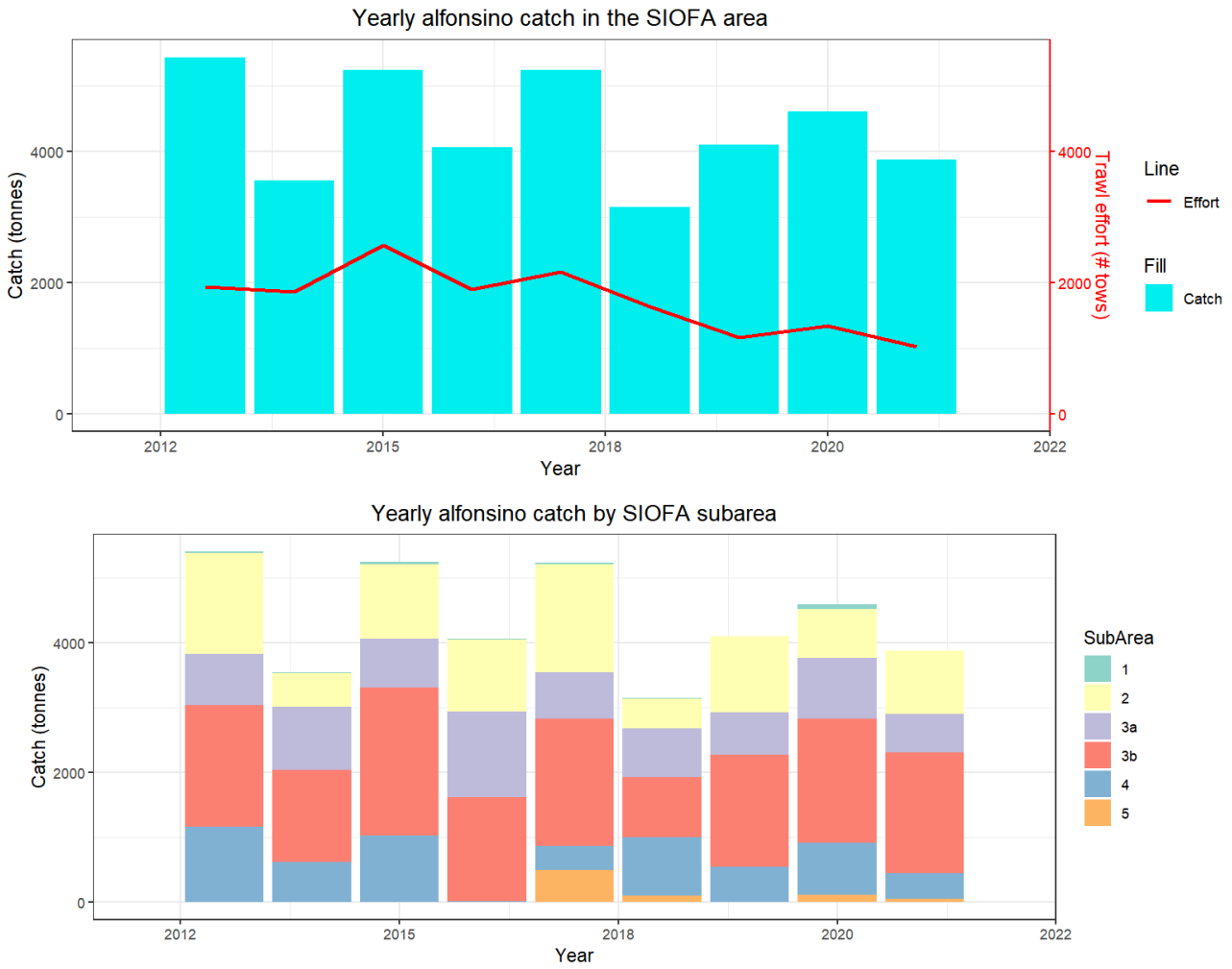

Figure 3a and b – Annual effort (number of alfonsino target tows) and catch of alfonsino (tonnes) and in the SIOFA area (upper panel, a) and in different SIOFA subareas (lower panel, b) (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2021).

Recent years have seen lower levels of effort with roughly stable catches (Figure 3), so unstandardised catch per units of effort (CPUE) have increased somewhat (Figure 4). Standardised CPUE indices have been used in the assessments described by Brandão et al. (2021) however these authors caution that problems with data quality will affect the ability of these data to serve as an index of abundance. These authors recommend improved data collection, for example haul by haul rather than daily-aggregated catch data, as well as increased biological sampling, to improve the alfonsino stock assessment.

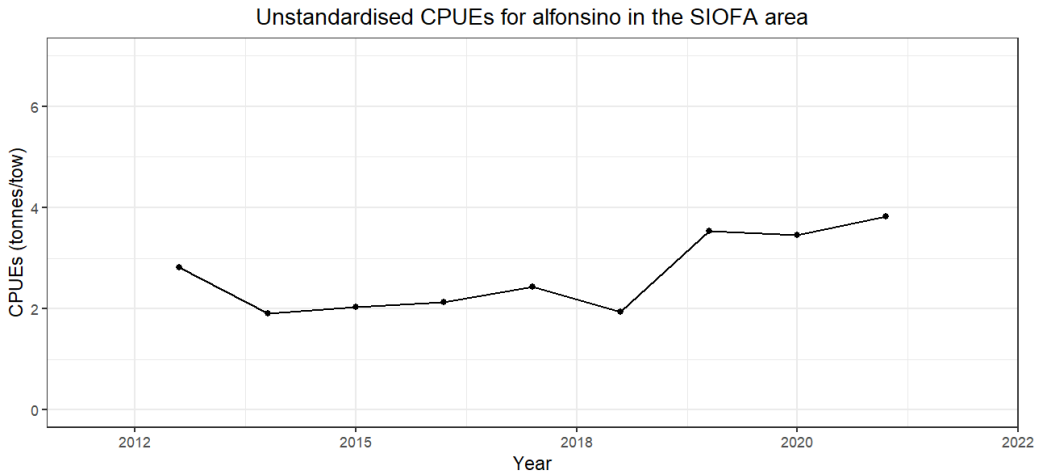

Figure 4 – Unstandardised catch per unit effort (CPUE) of alfonsino in the SIOFA area (tonnes/tow) (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2021), for all fishing events with non-zero catches of alfonsino.

For this section 'target catch' has been defined as fishing operations where BYS was declared as a target and BYS, BXD, or ALF were caught. All other species have been considered non-target. Note that target species was recorded by fishing vessels in the SIOFA area beginning in 2013, but has been recorded discontinuously, so that some fishing events have not been included in these figures. However, the unstandardised catch trends shown in these data cannot be considered a reliable index of abundance.

Target catch was spread across both assessment areas, but has been most consistent higher in the West fishery (Subareas 2, 3a, and 3b), especially in recent years (Figure 5). Catch of non-target species in alfonsino target fisheries was distributed similarly, with consistently higher catches in the West fishery (subareas 2, 3a, and 3b) and lower catches in the East (Figure 6), reflecting total effort patterns.

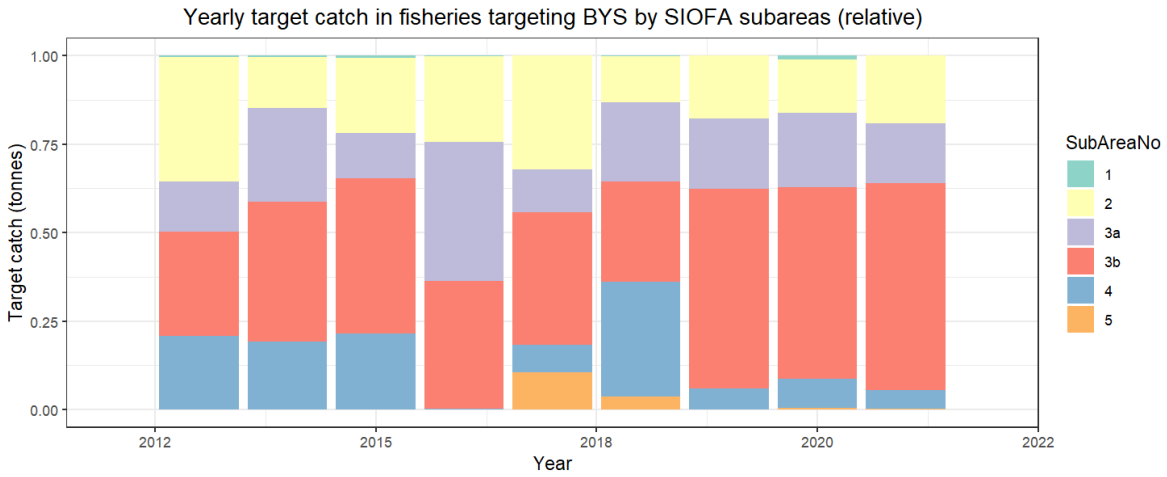

Figure 5 – Alfonsino target catch in different SIOFA subareas in relative terms (source: SIOFA AggregatedCatchEffort and HBHCatchEffort database 2013–2021), including all fishing events that declared alfonsino as a target. Catches reported without location information are not included.

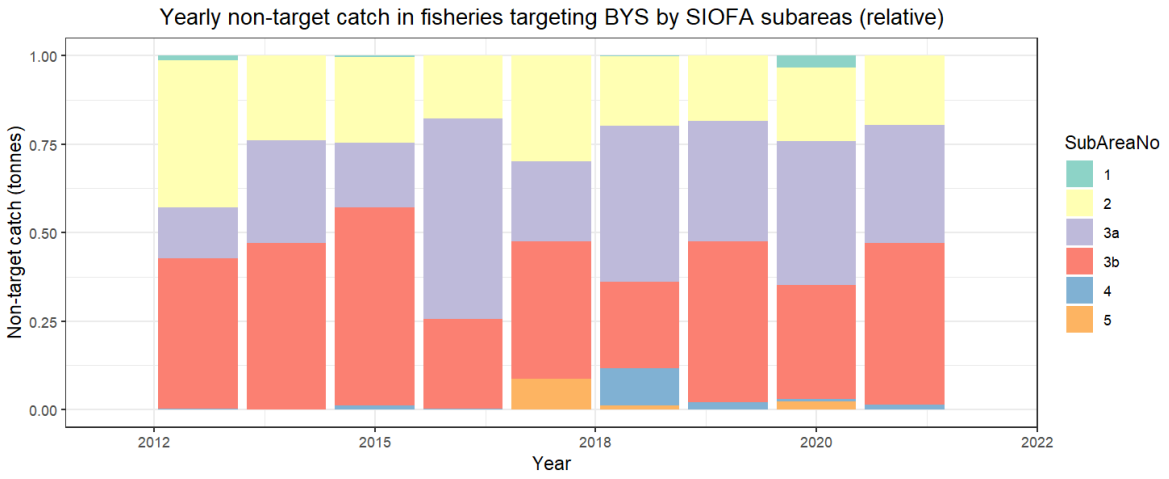

Figure 6 – Catch of all species other than ALF in the different SIOFA alfonsino assessment areas, by year (source: SIOFA AggregatedCatchEffort and HBHCatchEffort database 2013–2021), including all fishing events that declared alfonsino as a target. Catches reported without location information are not included.

Table 1 shows the catch history of SIOFA alfonsino catches in the different assessment areas from 1999-2018 (Brandão et al. 2020). Where reported catches are taken by a single vessel, the data is withheld for reasons of confidentiality.

Table 1 – Yearly catches of alfonsino (in tonnes) estimated to have been taken from the SIOFA area, disaggregated by fleet for years where such information is available, as compiled by Brandão et al. (2020).

Year	West				East			
	S1	S2	S3	Other and non-member	S1	S2	S3	Non-member
1977								522
1978								92
1979								
1980				20.0				
1981				2 524.0				120
1982				921.0				2
1983				852.0				
1984				57.0				
1985				3.0				
1986								
1987				2.0				
1988				16.0				9
1989								
1990								
1991								
1992				314.0				
1993				462.0				
1994				1 534.0				
1995				2 249.0				
1996				3 079.0				
1997				1 031.0				
1998				859.0				

1999			147.9	1 964.0			26.8	
2000			390.2	1 589.0			0.0	
2001		2 986.5	6.4	594.4			1 070.5	
2002		37.3	105.4			248.7	2 871.1	
2003	353.8		3.4		911.5		1 605.9	
2004	141.6		44.7	7.9			824.8	
2005	391.8		32.1	10.1	828.1		182.3	
2006			17.6		164.3		202.6	
2007			96.8	1.2			190.3	
2008			33.1	16.8			173.7	
2009	1 828.5	1 204.2	62.3		368.9		0.0	
2010	2 033.4	977.3	16.2		1 713.9		30.9	
2011	2 672.9	612.3	58.0	147.0	747.2		531.9	
2012	3 101.3	104.5	235.6	561.0	1 244.2	191	46.4	
2013	2 184.0	1 262.8	88.8	718.3	1 127.5	2.1	29.0	
2014	2 405.1	452.1	75.8	1.7	615.4			
2015	2 096.7	2 119.4		0.5	690.7	276.4	59.8	
2016	1 529.6	1 976.9	1.4				12.9	
2017	2 392.7	1 971.8			803.1	80.6		
2018	1 090.4	1 066.3	0.04		692.0	300		
Total	22 221.7	14 771.4	1 415.5	19 535.0	9 906.9	1 098.8	7 858.8	745.0
Grand total	57 943.6				19 609.5			

5.4.1 Catch limits

There are currently no catch limits set for alfonsino in the SIOFA area or for either of the management units.

5.5 Illegal Unreported and Unregulated (IUU) catch

No claims of Illegal Unreported and Unregulated (IUU) catches of alfonsino have been reported to SIOFA.

5.6 Other sources of fishing mortality

Some mortality associated with escapement from trawl nets is likely to occur, mostly of small fish that escape through the trawl mesh. The level of mortality associated with escapement is unknown.

6. Stock assessment and status

6.1 Stock assessment and status

An age structured production model fitted to catch histories and standardised CPUE time series was completed in 2020 (Brandão et al. 2020, 2021).

Due to data limitations, only deterministic models were possible, which assumed no variation in annual recruitment about the predictions from a standard Beverton-Holt stock-recruitment relationship. The models utilised catch data for each fleet for which data were available, with catches beginning in 1977. Relative abundance indices were obtained from standardised CPUE time series; the preferred standardisation used negative binomial models for catch series with few zeroes, and hurdle-negative binomial models for series with large numbers of zeroes.

Stock structure was assumed to correspond to the management units labelled West (subareas 1, 2, 3a and 3b) and East (subareas 4 and 5).

The assessment concluded with high certainty that neither the West nor the East stock was overfished (i.e. $B > B_{msy}$) nor was either stock experiencing overfishing (i.e. $F < F_{msy}$). Both stocks were estimated to be at about 60% of their pre-exploitation spawning stock biomass levels (i.e. $B / B_o = 0.6$). These results are insensitive to all sensitivities explored, except for changes in the value assumed for natural mortality (M). Modelled relative biomass trajectories are shown in Figure 7.

The base case value of M used was 0.2; sensitivities examined the consequences of M = 0.15 and M = 0.25. In the base case projections, alfonsino biomass remained well above the MSY level even assuming constant catches for 20 years at levels 40% higher than recent high in 2018. However in the low-productivity sensitivity, projections suggested that biomass could drop below the MSY level within 10 years.

Due to limited data availability, the same selectivity function was used for all of the different fleets (i.e. countries) in in all locations. New data are available to improve this assumption when the stock assessment is updated.

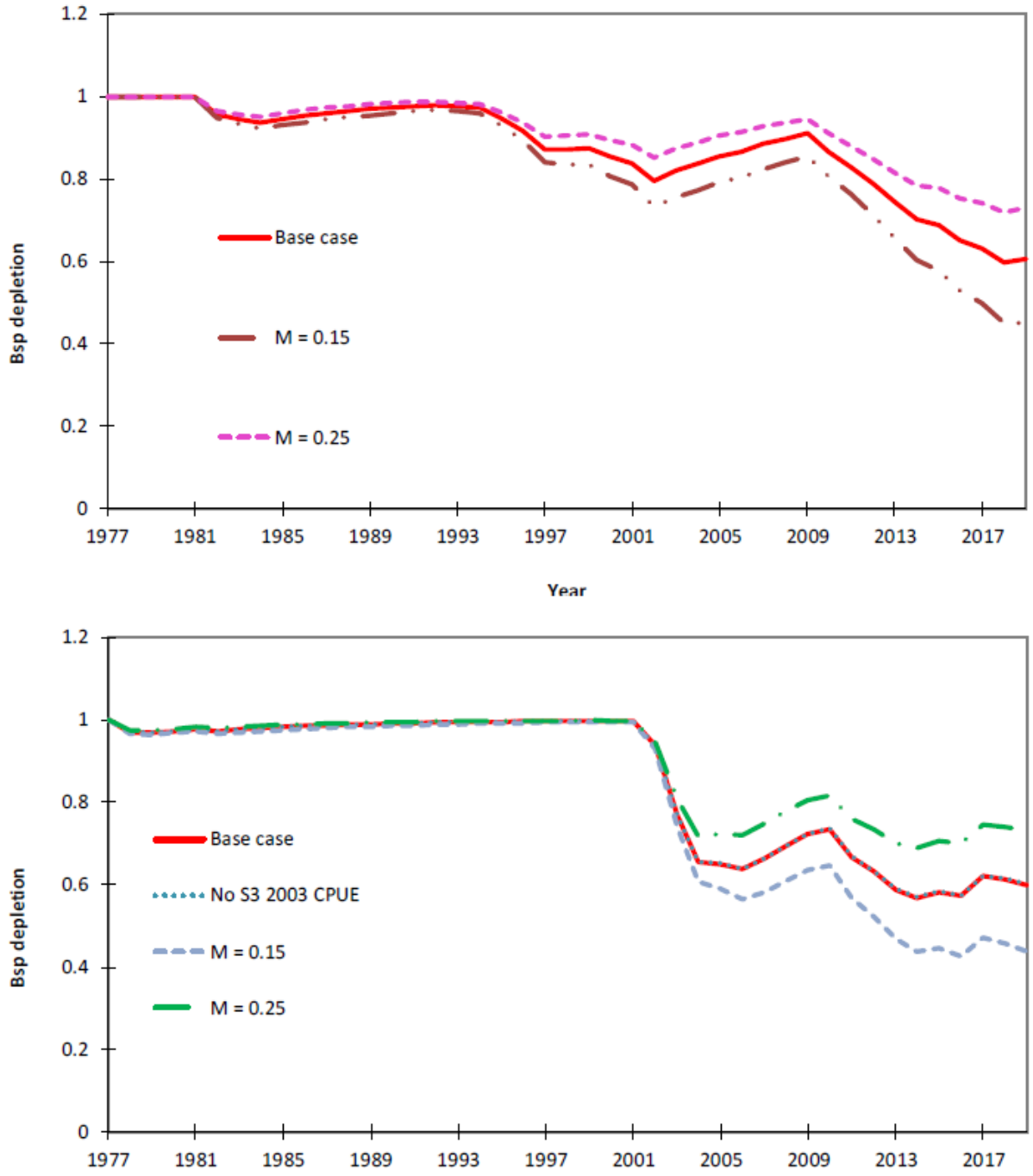

Figure 7 Spawning biomass depletion estimated for the West (top) and East (bottom) alfonsino stocks, showing base case (M=0.2) and alternate natural mortality sensitivities. From Brandão et al. (2021).

6.2 Harvest strategy and reference points

Harvest strategies for alfonsino in the SIOFA Area have not yet been agreed upon. Interim reference points for alfonsino were adopted by the Scientific Committee for scientific reporting purposes, but not necessarily for management, were a target reference point of BMSY using a proxy of = 0.4*B0, and a limit reference point of 0.2*B0 (SC6 report, para 125).

For a range of species, Butterworth et al. (2021) discusses the relative merits and drawbacks of adopting either a harvest strategy based on either i) a constant catch consistent with recent 'status quo' catch levels; or ii) a simple harvest strategy based on an estimate of B_{msy} and thus F_{msy}, or iii) a constant fisheries mortality (F) consistent with recent 'status quo' F values.

Specifically for alfonsino, Butterworth et al. (2021) and Brandão et al. (2022) note that approach i) generates stable TACs but may result in some foregone catch levels in the short term because current biomass is thought to be substantially higher than B_{msy}. They note that approach ii) is likely to result in higher inter-annual TAC variability (relative to approach iii), reflecting uncertainty regarding B_o.

7. Data collection

Catch and effort data collected are collected and submitted by the different CCPs participating in the fishery. A summary of these data is not available at this time.

Scientific observer data are collected as a requirement of CMM2021/02, submitted by different CCPs participating in the fishery. A summary of these data is not available at this time.

7.1 Biological data summaries

A summary of biological measurements collected by fisheries observers, and the proportion of the catch measured per year, are shown in Table 2.

Table 2 – Summary of the number of fish of SIOFA main target species measured by scientific observers in 2013–2020 for length, and their fraction of their total catch (sources: SIOFA Observer database 2013–2020, Cook Island 2020 data, and Chinese Taipei National Report 2020). The fraction of the catch measured (%, 2 decimals precision) was derived considering the average weight of an individual measured in every given year. N/A marks years/species for which a given measure or ratio was not available.

	Alfonsino	
Year	**N. of individuals measured**	**% of catch measured**
2013	990	0.02
2014	792	0.03
2015	500	0.02
2016	9608	0.33
2017	39863	N/A
2018	24014	1.40
2019	32245	1.24
2020	22923	0.80

7.2 Tag data

SIOFA does not require or conduct any tagging of alfonsino. Tagging of alfonsino is not considered feasible due to high and unquantifiable release mortality of alfonsino captured in trawls.

8. Summaries of abundance indices and other observational data

8.1 Scaled length frequencies

Fish from across the SIOFA area were sampled for otoliths by the Cook Islands fleet so that a length and age frequency could be constructed and growth parameters established (Cook Islands 2021). The scaled age frequencies are shown in Figure 8.

8.2 Scaled age frequencies

Fish from across the SIOFA area were sampled for otoliths by the Cook Islands fleet so that an age frequency could be constructed and growth parameters established (Cook Islands 2021). The scaled age frequencies are shown in Figure 8.

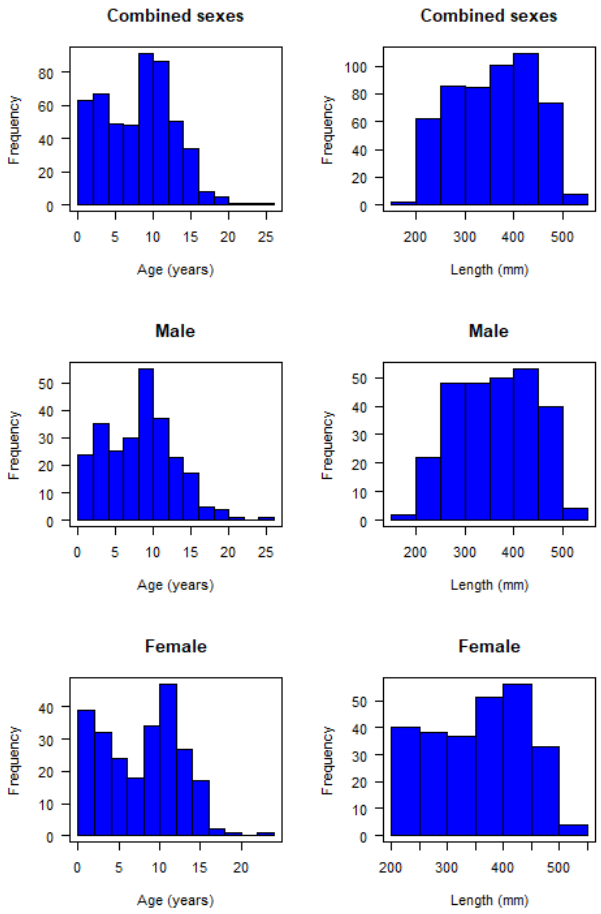

Figure 8. Age and length sample distribution of alfonsino collected from the Cook Islands trawl fleet (Cook Island 2021)

8.3 CPUE indices

Recent years have seen lower levels of effort (hauls) with consistent catches (Figure 3a), so unstandardised catch per unit of effort (CPUE) has been rising slightly (Figure 4).

Standardised CPUE indices developed for the stock assessment described by Brandão et al. (2021) used a negative binomial model for series with few zero catches, and a Hurdle-Negative Binomial for series with a large number of zero catches (Brandão and Butterworth 2020). The utility of the CPUE indices as an index of abundance is limited by the fact that catch data are aggregated on a daily basis rather than reported on a haul by haul basis.

8.4 Acoustic biomass indices

The SIOFA Scientific Committee is considering the feasibility of utilising acoustic survey methods to assess alfonsino in the SIOFA area.

8.5 Trawl survey indices

No trawl surveys have been undertaken for alfonsino in the SIOFA Area.

8.6 Tag based abundance estimates

SIOFA does not require or conduct tagging of alfonsino and no alfonsino tagging experiments in the SIOFA Area have been reported to SIOFA, hence no tag-based abundance indices of abundance are not available. It is not considered feasible to utilise tag-based methods to assess the status of alfonsino.

9. Biological parameters

Biological parameters including growth and maturity have been estimated for alfonsino in the SIOFA area by the Cook Islands (2021). Other stock assessment parameters have been estimated by Brandao et al. (2020). These are summarised in Table 3.

Table 3: Biological parameters for alfonsino used in the most recent stock assessment by Brandão et al. (2020) or as subsequently updated by Cook Islands (2021).

Relationship	Parameter (units)	Area	Value			References
			Both	Male	Female	
Natural mortality	M (y^{-1})	all	0.2			Brandão et al. (2021)
Von Bertalanffy growth coefficient	t_0 (y)		-5.114			Cook Islands (2021)
	k (y^{-1})		0.068			Cook Islands (2021)
	L_∞ (cm)		61.3			Cook Islands (2021)
	c.v.					
Length-weight	a ($t.cm^{-1}$)					
	b					
Maturity	a_{50} ($\pm a_{to95}$)		6			Brandão et al. (2021)
Stock recruitment relationship			Beverton-Holt			Brandão et al. (2021)
Stock recruitment steepness	h		0.75			Brandão et al. (2021)
Recruitment variability	σ_R		stable			
Ageing error type	Normal					
Ageing error parameters	c.v.					

9.1 Natural mortality

The base case of the most recent stock assessment (Brandão et al. 2021) assumes a natural mortality M = 0.2 for alfonsino.

9.2 Growth parameters

Growth parameters have been investigated by the Cook Islands (2021) and are shown below in Table 4.

Sampling occurred from 2009 -2020, with 45,062 fish being sampled across all months of the year. The samples were collected from a wide area in the south central Indian Ocean in five broad regions. It was found that there is no difference between the male, female and combined-sex growth curves; for this reason only the combined sex parameters and figures are shown. Note that these revised growth parameters are slightly different from those used in the most recent stock assessment described in Brandão et al. (2020 and 2021).

The SIOFA Scientific Committee has endorsed the recommendation that these updated values are appropriate for use in future stock assessments. The SC also recommended that CCPs implement stratified otolith sampling protocols to ensure that otoliths continue to be collected across the full size-range of fish.

Table 4 – Growth parameters for alfonsino in the SIOFA Area (Cook Island 2021). Note that growth and maturity curves were derived independently for male and female fish but were found to be statistically indistinguishable from the combined sex growth curve. As a consequence only the combined-sex parameters are shown.

Parameter	Combined sex	Male	Female
L-inf	61.3		
k	.068		
to	-5.114		
L_{50}	38		

9.3 Length/age relationship

The length-age relationship for alfonsino in the SIOFA area was updated by the Cook Islands in 2021, using otoliths collected from five regions broadly spread across the SIOFA area (see Cook Islands 2021). This relationship is reproduced in Figure 9.

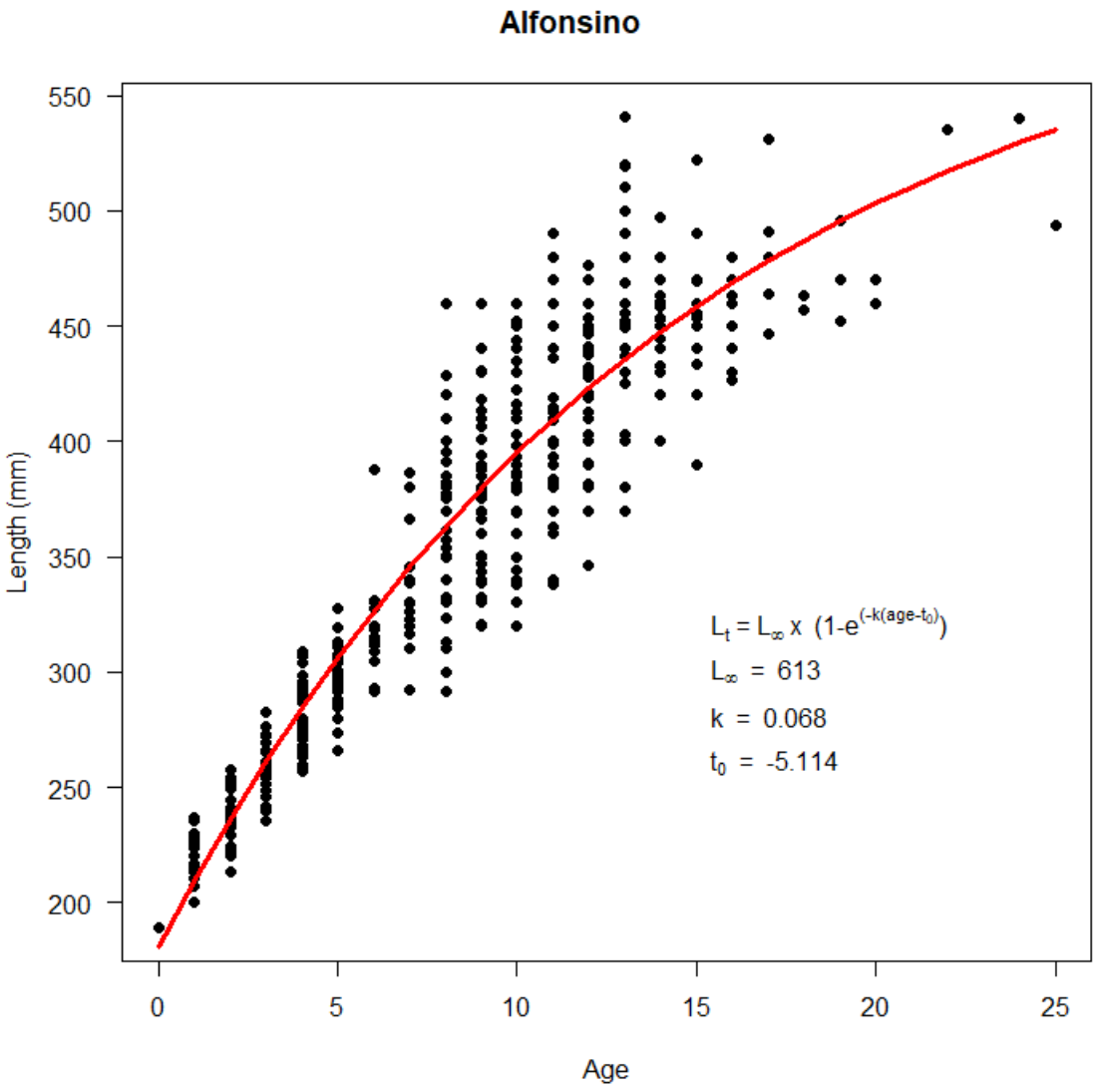

Figure 9 Length-at-age of alfonsino samples (both sexes combined) in the Indian Ocean showing all samples with readability scores of 1-3 and the fitted von Bertalanffy growth curve, along with the derived growth parameters (from Cook Islands 2021).

9.4 Maturity and spawning

Between 2009 and 2020, 45,062 individual alfonsino were sampled for length and maturity across all months of the year. The samples were collected from across a wide area in the south-central Indian Ocean, and used to estimate updated age, growth, and maturity information for alfonsino (Cook Islands 2021).

Gonad mass increases substantially with fish length. The monthly gonadosomatic index (GSI) trends show that alfonsino have a distinct spawning season through the Austral summer with the bulk of spawning taking place from December to February. The estimated L50 size-at-maturity was 38cm for both males and females which coincides with an age of 9 years.

For fish below the size-at-50% maturity the sex ratio is approximately balanced; however, after the onset of maturity the sex ratio becomes skewed in favour of females, which may reflect differential mortality of male and female fish (Cook Island 2021).

9.5 Stock recruitment relationship

The stock-recruitment relationship for alfonsino has not yet been investigated in the SIOFA Agreement area.

9.6 Tag parameters

SIOFA does not require or conduct any tagging for alfonsino.

10. Target/non-target catch and ecosystem impacts

Non-target fish catch commonly refers to the capture of all fish species that were not intended as a target in a given fishing event. All fish caught but not declared as targets (CMM 2021/02) are considered non-target catch for the purpose of this section.

10.1 Alfonsino target vs non-target catch

The total/nontarget catch ratio in the alfonsino fisheries was estimated based on target declarations to identify fishing operations that targeted alfonsino. Note that this has excluded fishing operations where targets were not declared.

Target vs. non-target catch is depicted in Figure 10. The species identity of these non-target catches in alfonsino target hauls is shown in Figure 11.

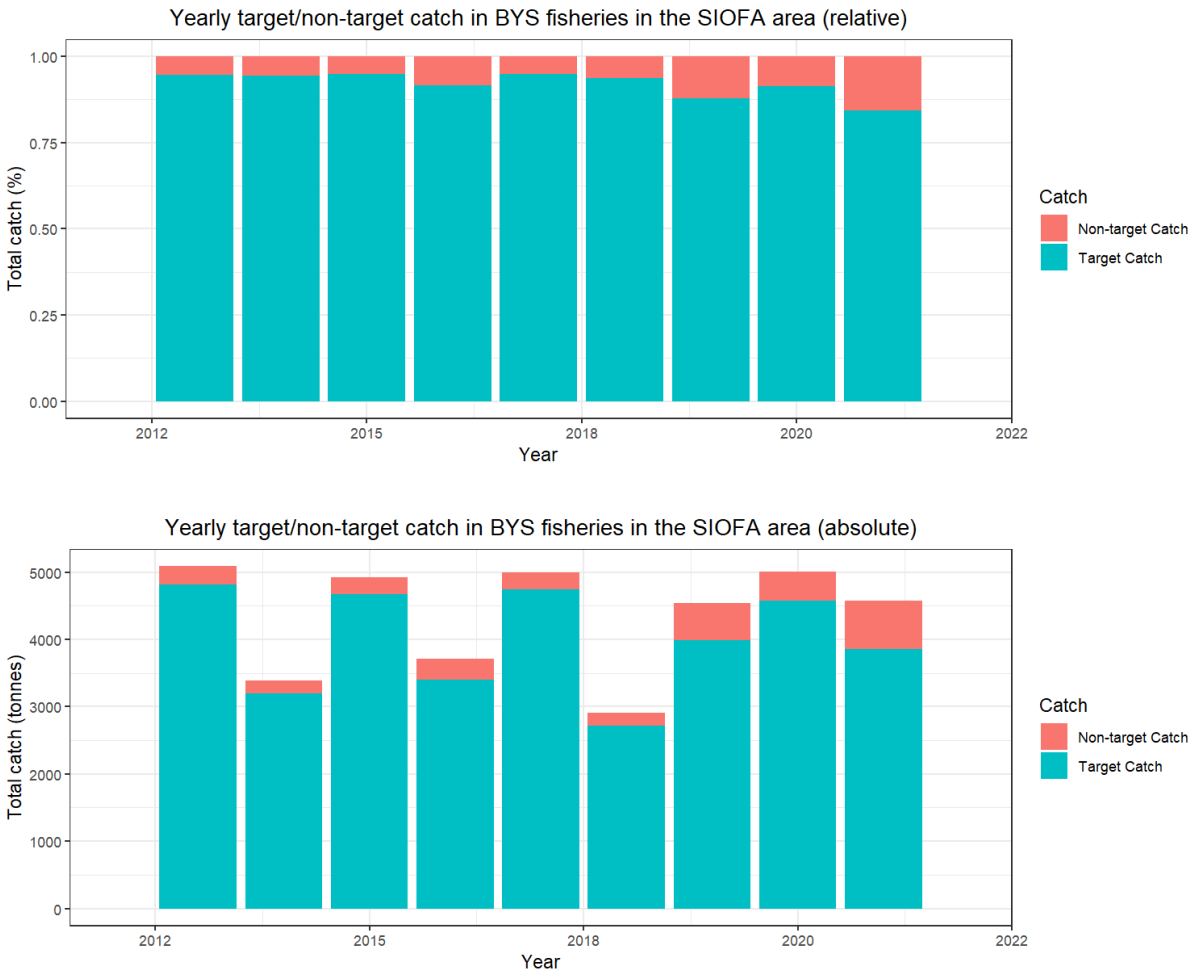

Figure 10a and b – Total catch of alfonsino and other non-target species in SIOFA fisheries that targeted alfonsino, shown as relative values (upper panel, a) and absolute values (lower panel, b) (source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2021).

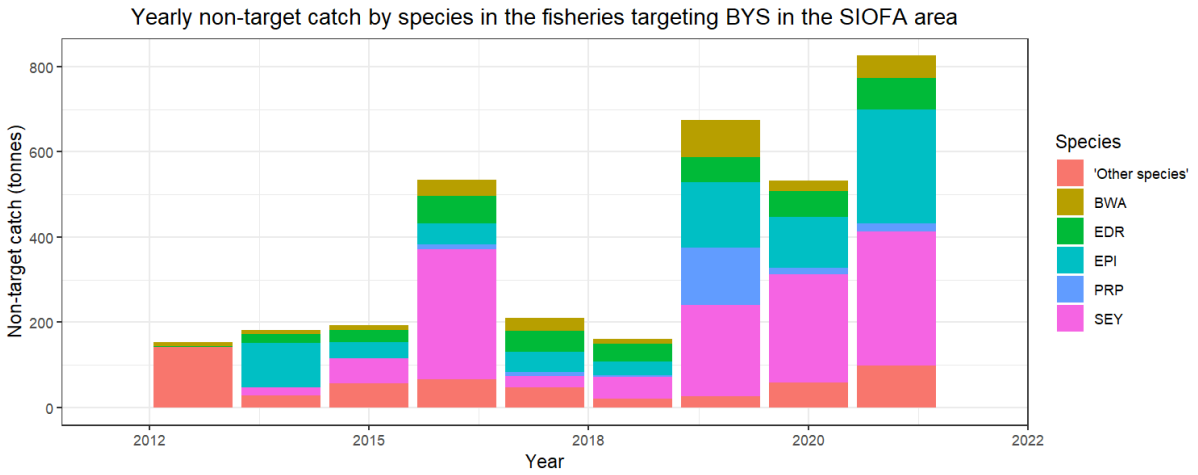

Figure 11 – Yearly catch weights of non-target species in fisheries targeting alfonsino in the SIOFA area, by species

(source: SIOFA AggregatedCatchEffort and HBHCatchEffort databases 2013–2020). Only the top 5 species by weight (cumulatively in the full database) are shown individually (identified by their 3-letter FAO code). All other species are grouped under 'other species.

Non-target catch of shark species is shown in Figure 12, however shark catches were only reported in the years 2015-2019. The most caught species by weight were sleeper sharks (*Somniosus* spp., SOR, SON).

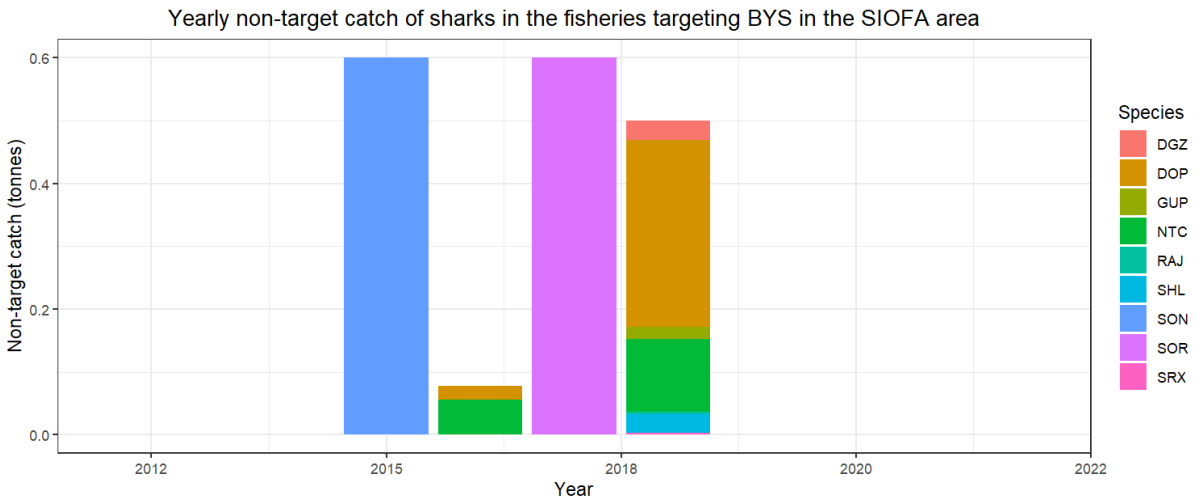

Figure 12 – Reported non-target catches of shark species in fisheries targeting alfonsino.

10.2 Target/non-target catch by SIOFA subarea

These data are not available broken down by SIOFA subarea at this time, they are partly reported in Section 3.4.

10.3 Target/non-target catch in management units

The majority of alfonsino catches are from the West management unit, including SIOFA subareas subareas 2, 3a and 3b. A much smaller proportion of alfonsino catches are reported from the East management unit, including subareas 4 and 5 (see Figure 3b). Orange roughy are frequently caught as bycatch in trawls targeting alfonsino.

10.4 Incidental catch of VME taxa and other invertebrates

Alfonsino are targeted using midwater or pelagic trawls that rarely or never contact the ocean floor. As such, VME incidental capture rare in this fishery. A detailed VME incidental capture analysis is not available at this time.

11. Interactions with seabirds, mammals, turtles, sharks and other species of concern

Note that to date, captures of protected species in the SIOFA area have not been characterised on a per-fishery basis. Protected species captures in the SIOFA area as a whole are characterised in the SIOFA Ecosystems summary.

11.1 Seabirds

Seabird captures and interactions have not been characterised specifically for alfonsino fisheries at this time.

Provisions for the mitigation of accidental capture of seabirds in alfonsino fisheries are in CMM 2022/13 (Conservation and Management Measure on mitigation of seabird's bycatch in demersal longlines and other demersal fishing gears fisheries (Mitigation of Seabirds Bycatch)).

11.2 Marine mammals

Marine mammal captures and interactions have not been characterised specifically for alfonsino fisheries at this time.

11.3 Turtles

Turtle captures and interactions have not been characterised specifically for alfonsino fisheries at this time.

11.4 Sharks

Shark captures and interactions have not been characterised specifically for alfonsino fisheries at this time.

12. Effects of the fishery on the ecosystem

The effects of this fishery on the ecosystems are unknown.

13. References

Brandão, A., Butterworth, D.S. and Johnston, S. 2020. Age-Structured Production Model (ASPM) assessments of the Alfonsino (*Beryx splendens*) resource in the SIOFA area of the Southern Indian Ocean. 2nd Meeting of the Stock and Ecological Risk Assessment Working Group (SERAWG2). SERAWG2-02-14, 39pp.

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