SERAWG-02-INFO-04

2nd Meeting of the Stock and Ecological Risk Assessment Working Group

(SERAWG2)

25-27 March 2020, Saint Gilles, Réunion

Relates to agenda item:3   Info paper

TERMS OF REFERENCE (TOR)

PROVISION OF SCIENTIFIC SERVICES FOR A CONSULTANT

ON CPUE EVALUATION AND STOCK ASSESSMENT ON SPLENDID ALFONSINO

TO SIOFA SERA-WG

SIOFA Secretariat

CALL FOR A CONSULTANT ON CPUE EVALUATION AND STOCK ASSESSMENT

TERMS OF REFERENCE (TOR) FOR THE PROVISION OF SCIENTIFIC SERVICES

TO SIOFA SERA-WG (STOCK AND ECOLOGICAL RISK ASSESSMENT ASSESSMENTS WORKING GROUP)

Southern Indian Ocean Fisheries Agreement (SIOFA) calls for a short-term consultancy to evaluate CPUE series and undertake stock assessments of splendid alfonsino *(Beryx splendens)* (BYS) [*] in the SIOFA Convention Area (CA) to provide management advice. This document describes the backgrounds and ToR.

Contents

Separate zipped folder (12 papers listed in 9. References)

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(*) Three alfa code defined by FAO-ASFIS (Aquatic Sciences and Fisheries Information System)

1. INTRODUCTION

SIOFA Scientific Committee (SC) was tasked to provide management advice for important species (orange roughy, splendid alfonsino and Patagonian toothfish) by the 5th session of the Meeting of Party (MoP), July 2019 (CMM2018/01). Although the SC4 (March 2019) planned to do stock assessments of splendid alfonsino, the acoustic data to be used abundance indices were not ready, thus stock assessments were postponed to the SC5 in March-April 2020.

In the intersessional discussion following the SC5, after the available acoustic data were investigated, the SC decided that the acoustic data were not yet ready to be used in a stock assessment. This was based on the limited tempo-spatial coverage of the data that had been catalogued and more time was required to catalogue and make available all acoustic data. The resources required to process and analyse the acoustic data, were also not available. The SC will investigate the use of acoustic data when appropriate resources are available. Then the SC decided to evaluate the appropriateness of using CPUE series as abundance indices for stock assessments.

Under such circumstances, SIOFA calls for a short-term consultancy to evaluate the CPUE series, including applying appropriate standardisation and conduct stock assessments either with CPUE series (if plausible) or without CPUE series (if not plausible) for splendid alfonsino in the SIOFA CA to provide management advice.

The activities and associated deadlines are described in this TOR. The Consultant should ask any questions and clarifications to the Executive Secretary (Thierry CLOT, thierry@siofa.org) for administrative matters and to the SERA-WG Co-Chair (manager) (Tom Nishida, Japan, tom.nishida.9691@gmail.com) for the technical matters.

2. MANAGEMENTS UNITS

The SC discussed the appropriate management units (stock structures for the assessments) of splendid alfonsino in SIOFA CA considering the fishing grounds and oceanographic conditions (especially currents driven the monsoons). As a conclusion, until further scientific evidence (e.g., genetic analyses) is available, the SC agreed to two

tentative hypothetical splendid alfonsino management units, i.e., "WEST' and "EAST" with the boundary of 80°E, which is also the border between FAO Fisheries Statistical Area F51 and F57. "WEST" region includes fishing grounds in SIOFA areas 1, 2, 3a, 3b and 6, while "EAST" for 4, 5 and 7 (Fig 1).
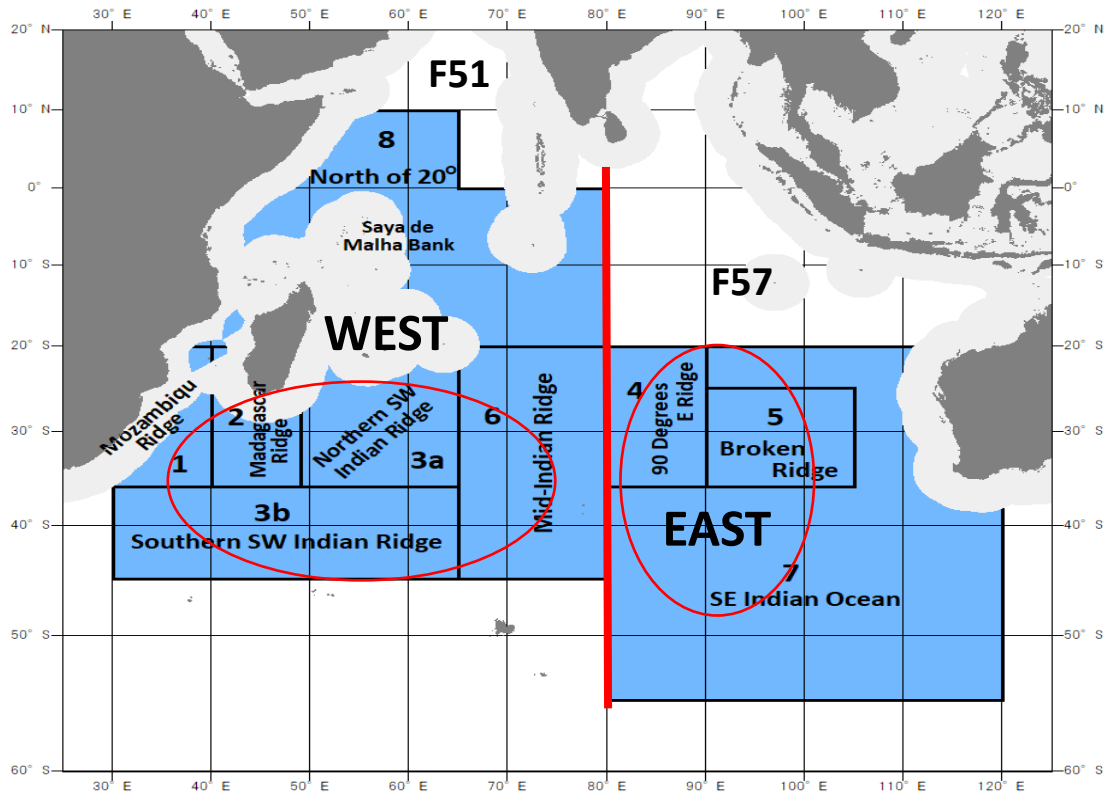
Fig 1 Provisional management units (WEST and EAST) for splendid alfonsino stock assessments and managements, overlaid with SIOFA statistical areas and FAO Fisheries statistical areas (F51 and F57)

3. EVALUATION OF CPUE SERIES

3.1 Nominal CPUE

The SC did an initial investigation of the tempo-spatial coverage of catch and effort (CPUE) data from the parties that had fished for splendid alfonsino (Australia, Cook Islands, EU-Spain and Japan) for 20 years (1999-2018) available in the SIOFA database. It was resulted that nominal CPUE (catch and effort) covered almost all splendid

alfonsino fishing grounds. In addition, it was also confirmed that the temporal coverage of CPUE was almost 100%.

SC recognised potential limitations of using CPUE as an abundance index and could identify 4 factors of major uncertainties, i.e., (a) size of school aggregations, (b) skippers stop operations when schools are too large to avoid damages, (c) some vessels use acoustic devices (echo sounder and/or sonar) to detect schools, then only when schools are identified, trawl nets are deployed hence there are almost no 0 (zero) catches, while some vessels attempt hauling opportunistically without using acoustic devices, hence there are many 0 (zero) catches, and (d) there are different fishing tactics between mid-water and bottom trawls.

3.2 Investigation of nominal CPUE and CPUE standardisation

The Consultant shall conduct an investigation of the nominal CPUE series and apply appropriate standardizations with the aim of developing abundance indices that could be used in the stock assessments. In our case, if standardised annual CPUE trends among different fleets in the same area are statistically non-significant and they are negatively correlated against catch, they are likely plausible (representative of abundance). Same area can be the SIOFA statistical area (Fig 1) or its subset areas.

Before standardisation, nominal CPUE need to be scrutinized and plausible nominal CPUE needs to be screened and selected. This is because there are often abnormal nominal CPUE trends with many outliers, huge and sudden jumps/drops, zig-zag types, etc. During the screenings, nominal CPUE with shorter operation hours may need to be eliminated because some operations are attempted opportunistically in a very short time as explained above as one of uncertain factors. In addition, 0(zero) CPUE needs to be included for the screening process.

After the data screenings by data quality control (QC) (e.g. by removing outliers), some nominal CPUE will become plausible then such CPUE can be standardised. But if some still contains strange behaviours after QC and such nominal CPUE will not be plausible even they are standardized, then they need to be eliminated from candidates.

4

Using the selected nominal CPUE, standardisation will be conducted. The Consultant may consider using covariates such as year, season, sub-area, targeting correction factors (species compositions) and other available information. The Consultant should consider the proportion of zero catches and whether two steps zero inflated GLM (for example) needs to be applied to reduce biases caused by a high proportion of zero catches (for example > 30%).

While recognising the working period is limited, the Consultant should explore appropriate standardization approaches. These could include the approaches taken in the examples from demersal species attached in the References (all papers are available in the separate zipped folder).

4. STOCK ASSESSMENTS

4.1 Selection of stock assessment models and parameters

Stock assessments will be conducted separately for the two management units. The use of standardised CPUE in the stock assessments will be determined by the outcomes of Section 3.

If it was resulted that there were no any plausible CPUE series, then appropriate stock assessment models without abundance indices should be applied. There are limited number of methods available, including those shown in Table 1. In addition, the integrated stock assessment model such as CASAL may be applied without abundance indices as was implemented in orange roughy stock assessment for some features (management units). However, this was done through calibrations using information from other data rich features (e.g. plausible standardised CPUE for our case) and documented assumptions.

As references for various works in this TOR, Annex A provides available information such as catch, CPUE and biological information in the SIOFA CA and other waters (for some biological information) for stock assessments, which are based on the SIOFA database, the scoping study by Shotton (2019), the SC4 report (2019) and others.

Table 1 Stock assessment models without abundance indices (examples)				
Type	**Time series data to estimate Biomass and relevant parameters**		**Snap shot for <u>management decisions</u>**	
models	**Cohort analysis without CPUE (age or size based)**	**Data poor (Stock Reduction Analyses)**	**Y/R (Yield Per recruit)**	**S/R (Spawning Per Recruit)**
INPUT	**Size, LW relation and growth equation for Catch -At-Age (Size)**	**Catch only**	**Weight + selectivity by age and M**	**Weight + selectivity + maturity by age and M**
Major OUTPUT **MSY**	NO (*)	YES	NO(*)	NO (*)
Biomass **F**	YES by age	YES	NO	NO
(*) MSY can be estimated by results of cohort and (Y/R or S/R) analyses				

4.2 First working paper on CPUE evaluation and selection of stock assessment models

The Consultant shall submit the 1st working paper (draft) on "Results of CPUE evaluation and Standardisation" and "Selection of stock assessments and parameters" to the SERA-WG, via the Secretariat for reviews. If the SERA-WG requests revisions, then the Consultant shall revise. The Consultant will make the final draft of the working paper and submit to the Secretariat for circulation. The relevant timelines are provided in Section 8.

4.3 Conduct of the stock assessments

The Consultant will conduct the stock assessments for each management unit and provide the appropriate outputs to evaluate the assessments and their uncertainty. Where possible the assessments should estimate MSY and advice on the associated uncertainty and robustness of MSY should be provided.

In addition, the Consultant shall carry out retrospective analyses to evaluate robustness of parameters estimated and risk assessments to estimate probabilities violating MSY levels for F and B (biomass) next 10 years in 9 different catch levels (current, ±10%, ±20%, ±30% and±40% of the current level) using stock assessment results.

4.4 Second working paper on the stock assessments

The Consultant shall submit the second working paper (draft) on "stock assessments, retrospective analyses and risk assessments" to the SERA-WG via the Secretariat. If the SERA-WG requests revisions, the Consultant shall revise. The Consultant will make the final draft and submit to the Secretariat for circulation. The relevant timelines are provided in Section 8.

5. WORKING PAPER AND PRESENTATION

The Consultant shall provide the above mentioned two working papers (final drafts) including recommendations to SERA-WG2 and present during the meeting. The Consultant shall make additional runs on stock assessments if requested during the meeting. Then the Consultant shall make the final working papers for SC5. These two working papers will be also presented by the Co-chair during the SC5 for discussion and recommendations to MoP.

6. DATA INPUTS AND OUTPUTS

The catch, CPUE, size, weight and all other available information will be provided by the Secretariat directly to the Consultant. SIOFA data confidentiality rules requires the Consultant to keep fine level data as confidential and that the Consultant shall delete all data after the termination of the contract (March 28, 2020).

Outline of catch, CPUE and size/weight in the SIOFA database and other biological information are provided in Annex A and 12 references papers are also provided in the separate zipped folder.

Before the termination of the contract (March 28, 2020), the Consultant shall provide the Secretariat a copy of all input and output files including executable files for SIOFA. These will be archived for future testing and replication if needed.

7. PAYMENT SCHEDULE

SIOFA will pay total 23,000 EURO for this service including honorarium (34 working days) and all the costs to attend the 2nd SERA-WG meeting in La Réunion (March 25-27, 2020) such as daily subsistence allowances during staying in La Réunion, the round-trip fees between the Consultant home country and the hotel in La Réunion and any other miscellaneous fees. 34 days working days includes 10 days for CPUE works and selection of stock assessment models and 24 days for stock assessments, retrospective analyses. and risk assessments.

The Secretariat will pay a half (EURO 11,500) within 10 days after the 1st report submitted to the Secretariat by Feb 16, 2020 and the rest (EURO 11,500) within 10 days of the closure of the 2nd SERA-WG meeting by April 6, 2020, subject fulfillments of conditions in TOR.

8. Timeline

Table 2 is the summary of timeline for all activities explained in the ToR.

Table 2 Timeline of activities

Month	Day		Secretariat	Consultant (34 working days)(excluding days for revisions and SERA-WG2 + SC5 meetings)	SERA-WG or SC
1	1-31		Call for the consultant and complete the contract		
2	1	Sat	1	Conduct "CPUE evaluations and standardisation" and "Selection of stock assessment models and parameters". Submission of the 1st working paper (draft) to SERA-WG via the Secretariat (10 days)	
2	2	Sun	2		
2	3	Mon	3		
2	4	Tue	4		
2	5	Wed	5		
2	6	Thu	6		
2	7	Fri	7		
2	8	Sat	8		
2	9	Sun	9		
2	10	Mon	10		
2	11	Tue			Review of the 1st working paper (draft) by SERA-WG
2	12	Wed			
2	13	Thu			
2	14	Fri		Revise the 1st working paper (draft) if SERA-WG requests. Make the final draft then submit to the Secretariat for circulation.	
2	15	Sat			
2	16	Sun	Circulate the 1st working paper (final draft)		
2	17	Mon	1	Conduct "stock assessments, retrospective analyses and risk assessments". Submission of the 2nd working paper (draft) (24 days)	
2	18	Tue	2		
2	19	Wed	3		
2	20	Thu	4		
2	21	Fri	5		
2	22	Sat	6		
2	23	Sun	7		
2	24	Mon	8		
2	25	Tue	9		
2	26	Wed	1st payment by this date		
2	27	Thu	11		
2	28	Fri	12		
2	29	Sat	13		
3	1	Sun	14		
3	2	Mon	15		
3	3	Tue	16		

Month	Day		Secretariat	Consultant (34 working days)(excluding days for revisions and SERA-WG2 + SC5 meetings)	SERA-WG or SC
3	4	Wed	17	Conduct "stock assessments, retrospective analyses and risk assessments". Submission of the 2nd working paper (draft) (24 days)	
3	5	Thu	18		
3	6	Fri	19		
3	7	Sat	20		
3	8	Sun	21		
3	9	Mon	22		
3	10	Tue	23		
3	11	Wed	24		
3	12	Thu			Review of the 2nd working paper (draft) by SERA-WG and requests revisions if needed.
3	13	Fri			
3	14	Sat			
3	15	Sun		Revise the 2nd working paper (draft) if SERA-WG requests. Make the final draft then submit to the Secretariat for circulation.	
3	16	Mon			
3	17	Tue			
3	18	Wed	Circulate the 2nd working paper (final draft)		
3	19	Thu			
3	20	Fri			
3	21	Sat			
3	22	Sun			
3	23	Mon	WG-EPA02		
3	24	Tue			
3	25	Wed	WG-SERA02	Presentations and re-run if requested. Make the final working papers for SC5.	SERA-WG02 : Discussion and recommendation to SC5
3	26	Thu			
3	27	Fri			
3	28	Sat		Provide INPUT + OUTPT files to the Secretariat and delete all files	
3	29	Sun			
3	30	Mon	SC05		SC5: Discussion and recommendation to MoP
3	31	Tue			
4	1	Wed			
4	2	Thu			
4	3	Fri			
4	6	Mon	2nd payment by this date		

9. REFERENCES

Table 3 References (12). All are available in the separate zipped folder.

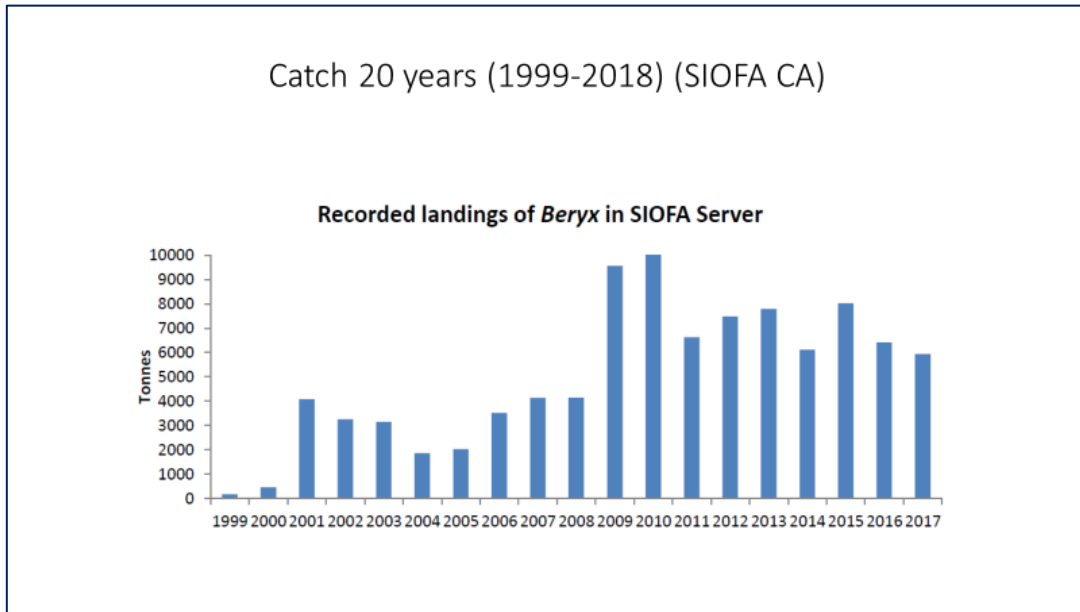| Species	No	title	authors	Journals	volumes and pages (year)	Outline
General	(1)	Definition of a directed fishing effort in a mixed-species trawl fishery, and its impact on stock assessments	Biseau	Aquat. Living Resour	No. 11(3), 119-136. (1998)	CPUE method
Splendid alfonsino (Beryx splendens)	(2)	Scoping study. Information Relevant to Future Stock Assessment of Alfonsino (*Beryx splendens*) In the SIOFA area of the Southern Indian Ocean	Shotton	SIOFA	SIOFA WG-SERA-01-13 (2018)	Scoping study
	(3)	Treatment of Zero Catches in CPUE Analysis	Shotton	SIOFA	SC-03-INFO-03 (2018)	0(Zero) catch problem
	(4)	Modeling the distribution of alfonsino, *Beryx splendens,* over the seamounts of New Caledonia	Lehodey et al.	Fishery Bulletin	No. 92(4), 748-759. (1994)	CPUE standardization (New Caledonia)
	(5)	GLOBAL REVIEW OF ALFONSINO (Beryx spp.), THEIR FISHERIES, BIOLOGY AND MANAGEMENT	Shotton	FAO Fisheries and Aquaculture Circular	No. C1084	Global review
orange roughy (Hoplostethus atlanticus)	(6)	Fishery characterisation and standardised CPUE analyses for alfonsino, Beryx splendens, (Lowe, 1834) (Berycidae), 1989–90 to 2009–10	MacGibbon	New Zealand Fisheries Assessment Report	2013/30	CPUE analyses (NZ)
	(7)	CPUE analysis and stock assessment of the Challenger Plateau orange roughy stock (ORH 7A) for the 2000-01 fishing year	Field, Francis	New Zealand Fisheries Assessment Report	2001/25	CPUE analyses (NZ)
	(8)	GLM standardised CPUE abundance indices for orange roughy off Namibia from 1994 now updated to include records up to 2005	Brandão, Butterworth	meeting document	DWFWG/WkShop/Feb06/Doc 2	document in WS (Namibia)
	(9)	Development of estimates of biomass and sustainable catches for orange roughy fisheries in the New Zealand region outside the EEZ: CPUE analyses, and application of the "seamount meta-analysis" approach	Clark et al.	New Zealand Fisheries Assessment Report	2010/19	CPUE analyses (NZ)
	(10)	Estimating orange roughy stock size on seamounts: a meta-analysis of physical seamount characteristics	Clark et al.	New Zealand Fisheries Assessment Report	2016/47	Stock biomass estimation (NZ)
	(11)	Using catch-per-unit-effort data to solve spatial problems in Orange Roughy abundance estimates	Schofield	Victorial Univ (NZ)	MS thesis (2015)	CPUE
	(12)	Investigating Priceless Orange Roughy (Hoplostethus atlanticus) Population Dynamics using Linear Models of Catch Per Unit Effort (CPUE)	Hall	Canterbury Univ (NZ)	MS thesis(2016)	CPUE

ANNEX A SUMMARY OF AVAILABLE INFORMATION

Available information (11 types) related to the TOR is summarised here, based on the SIOFA database, the scoping study by Shotton (2018) (majority of biological information), the SC reports, National Reports and information on outsourcing works for age estimation by otoliths.

(1) Catch

Table 4 Summary of nominal catch (1980-2018)

(note) Majority of catch (yellow markers) are available in the SIOFA database

Inventory of Alfonsino nominal catch by trawl fisheries based on National Report + scoping study (yellow) + FAO F51 (orange)								
	Japan	**Australia**	**China**	**Cook Islands**	**Korea**	**EU-Spain**	**Ukraine**	**USSR**
1980								🟧
1981								🟧
1982								🟧
1983								🟧
1984								🟧
1985								🟧
1986								
1987								🟧
1988								
1989								
1990							🟧	
1991								
1992								
1993							🟧	
1994							🟧	
1995							🟧	
1996							🟧	
1997				🟨			🟧	
1998				🟨			🟧	
1999		🟨		🟨			🟧	
2000		🟨	🟨	🟨			🟧	
2001	🟨	🟨	🟨	🟨		🟨	🟧	
2002	🟨	🟨	🟨	🟨		🟨		
2003		🟨		🟨				
2004		🟨		🟨		🟧		
2005		🟨		🟨		🟧		
2006		🟨		🟨		🟧		
2007		🟨		🟨		🟧		
2008		🟨		🟨		🟧		
2009		🟨		🟨	🟨			
2010	🟨	🟨		🟨	🟨			
2011	🟨	🟨		🟨	🟨			
2012	🟨	🟨		🟨			🟨	
2013	🟨	🟨		🟨			🟨	
2014	🟨	🟨		🟨			🟨	
2015	🟨	🟨		🟨				
2016	🟨	🟨		🟨				
2017	🟨			🟨				
2018	🟨			🟨				

Catch 20 years (1999-2018) (SIOFA CA)

(2) CPUE

Table 5 Available CPUE (Trawl) (fine scale data) (SIOFA database) (1999-2018)

This information was used to investigate the coverages.

Year	Australia	Cook Islands	JAPAN	EU-SPAIN
1999	☐			
2000	☐			
2001	☐		☐	☐
2002	☐		☐	
2003	☐	☐		
2004	☐	☐		
2005	☐	☐		
2006	☐	☐		
2007	☐	☐		
2008	☐	☐		
2009	☐	☐	☐	
2010	☐	☐	☐	
2011	☐	☐	☐	
2012	☐	☐	☐	
2013	☐	☐	☐	
2014	☐	☐	☐	
2015	☐	☐	☐	
2016	☐	☐	☐	
2017		☐	☐	
2018		☐	☐	

(3) Size and weight data

The SIOFA has been accumulating size and weight data. The updated available information by MOP, year, sex and area (EAST and WEST) is under investigation and will be provided to the Consultant.

(4) Sex ratio
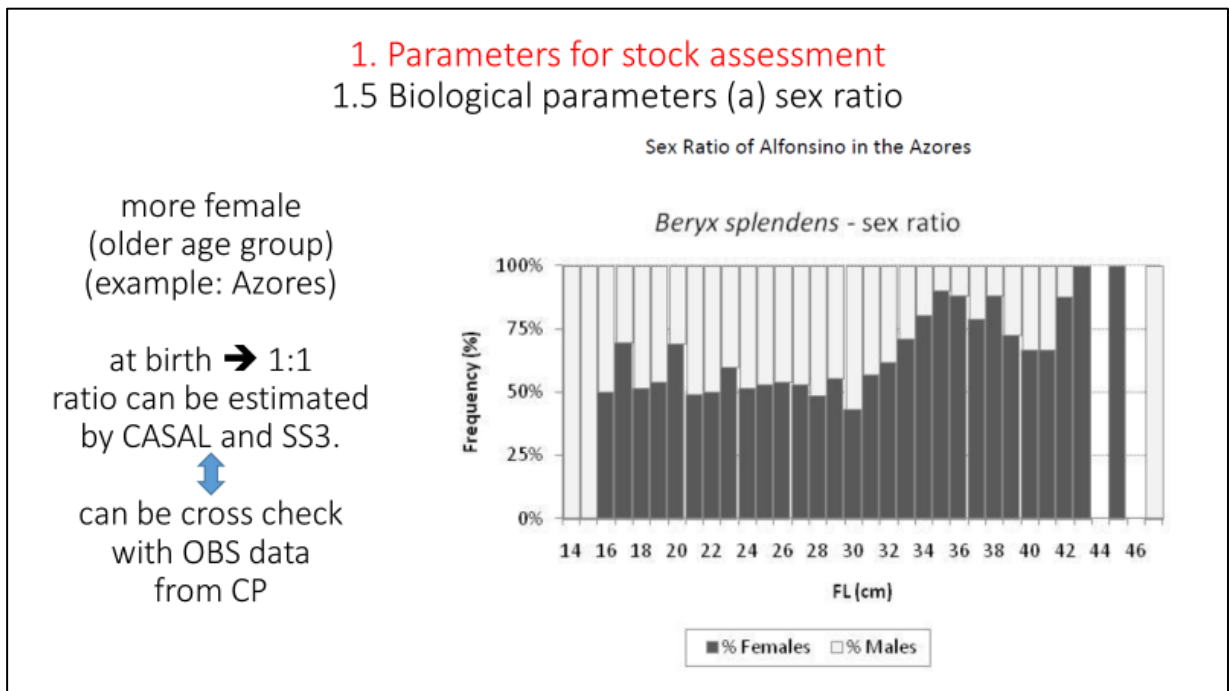
(5) Life span (max age)

1. Parameters for stock assessment
1.5 Biological parameters (b) Life span
huge differences (gaps) ➔ affect stock assessment
➔ need basic ageing study using otolith (SIOFA OBS data)
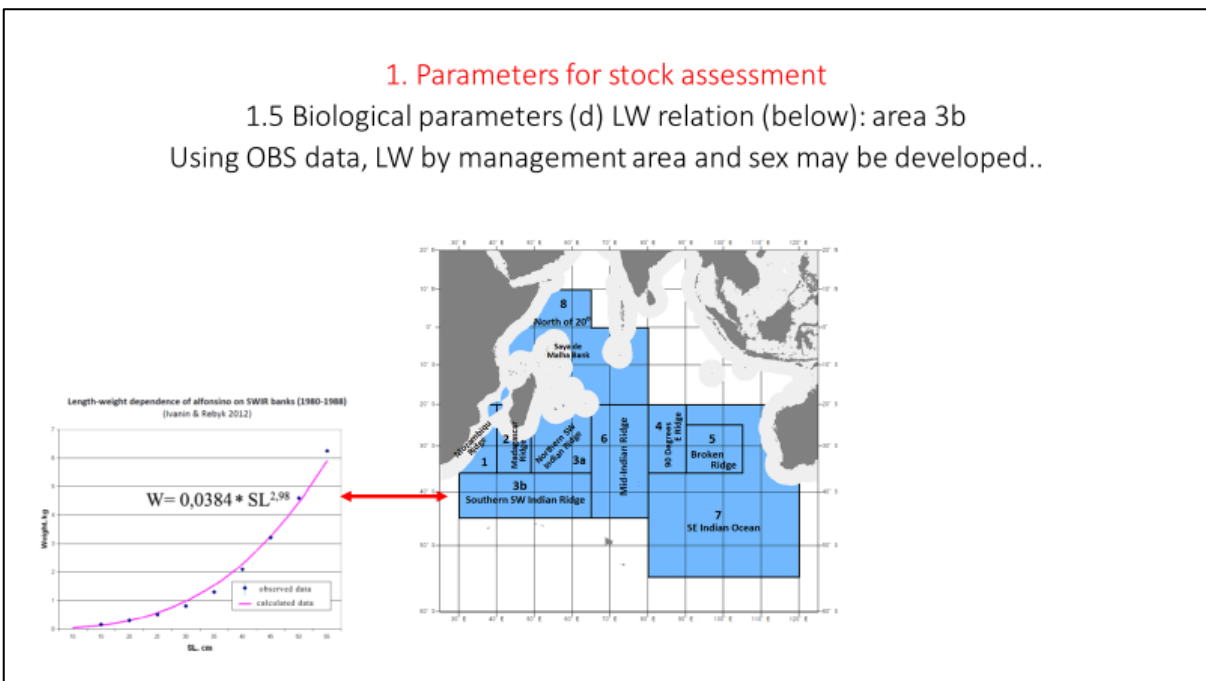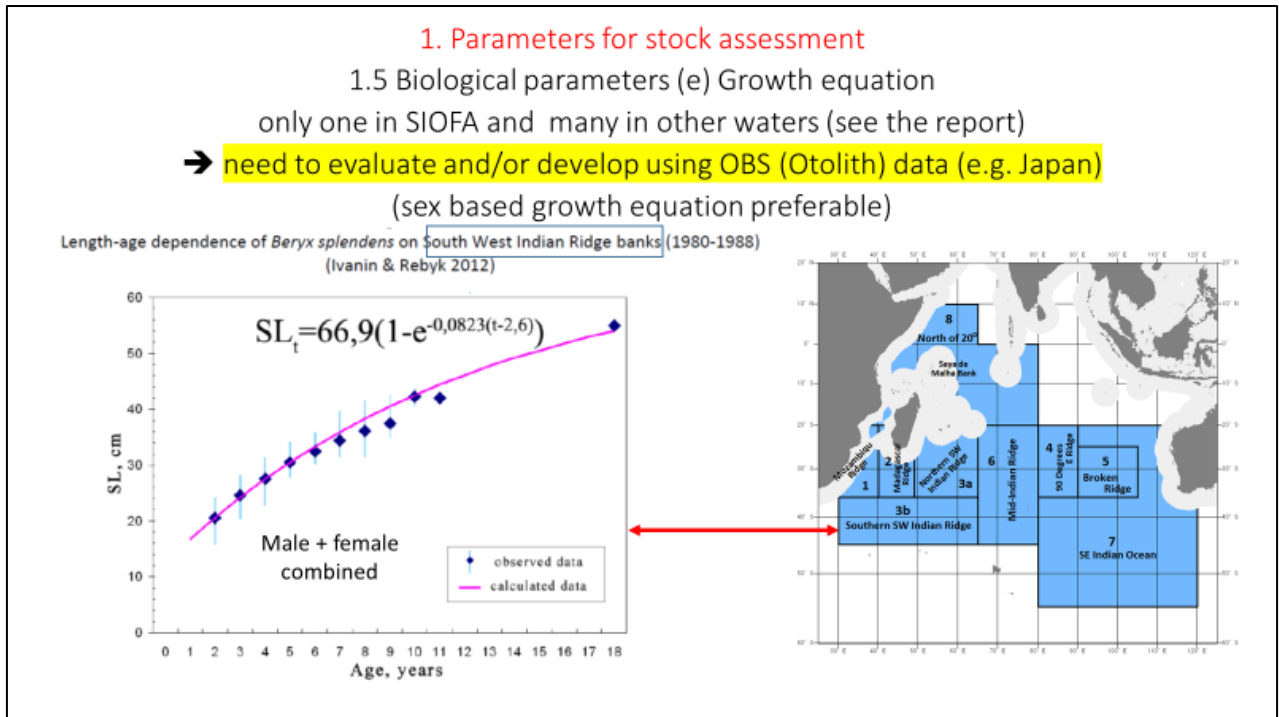
Ocean	area	Source	sex	sample	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	note
Indian	SW(SW Indian Ridge)	Ivanin and Rebyk (2012)	male											37 cm															1,556g
			female																				55 cm						6,260g
Atantic	Central east	?	?																										
	NE(Azores)	Isidra (1966)	?	more for larger											50 cm														Loo=53 cm
	NE(Madeira)	?	?	more for smaller												45 cm													
	NE (Canaries)	?	?	more for smaller																									
Pacific	Japan	Adachi et al (2000)	?																										

(6) LW relationship

1. Parameters for stock assessment
1.5 Biological parameters (d) LW relation (below): area 3b
Using OBS data, LW by management area and sex may be developed..

Length-weight dependence of alfonsino on SWIR banks (1980-1988)
(Ivanin & Rebyk 2012)

$W = 0,0384 * SL^{2,98}$

(7) Growth equation

1. Parameters for stock assessment
1.5 Biological parameters (e) Growth equation
only one in SIOFA and many in other waters (see the report)
➔ need to evaluate and/or develop using OBS (Otolith) data (e.g. Japan)
(sex based growth equation preferable)

Length-age dependence of *Beryx splendens* on South West Indian Ridge banks (1980-1988)
(Ivanin & Rebyk 2012)

$$SL_t = 66{,}9(1 - e^{-0{,}0823(t-2{,}6)})$$

Male + female combined

observed data
calculated data

**Additional information on age estimation and growth equation**

Age estimation by otoliths from Australia, Cook Islands and Korea has been outsourced. The table below shows the breakdowns of target numbers to be read for each management unit (EAST and WEST) and by sex. The total number (968) is the max number based on the available budget.

Number of otoliths to be read (from Australia, Cook Islands and Korea)						
		management unit				
		WEST		ESAT		
bin #	size range FL (cm)	FEMALE	MALE	FEMALE	MALE	
1	< 20	36	37	40	42	
2	20≤ <25	36	37	40		
3	25≤ <30	36	37	40	42	
4	30≤ <35	36	32	40	42	
5	35≤ <40	36	37	40	42	
6	40≤ <45	36	37	40	42	
7	45≤	36	37	12	0	grand total
Total		252	254	252	210	968

The partial results for EAST will be available by the mid of January 2020. The rest will be completed by April 2020.

According to the timeline (Section 8), the Consultant will select stock assessment models and relevant parameters by Feb 10, 2020. If the growth equations were selected as one of parameters, there are three options to apply the growth equation, i.e., (a) provisional growth equation based on the partial ageing results from the EAST, (b) growth equation estimated by Japan, i.e., Japan completed age estimations using their otoliths from WEST and if they can provide the growth equation and (c) use the growth equation in WEST by Ivanin and Rebyk (2012) shown in the slide in the previous page. Under such circumstances, the appropriate approach (option) will be discussed with the Consultant and SERA-WG and confirmed by February 10.

(8) M (natural mortality)
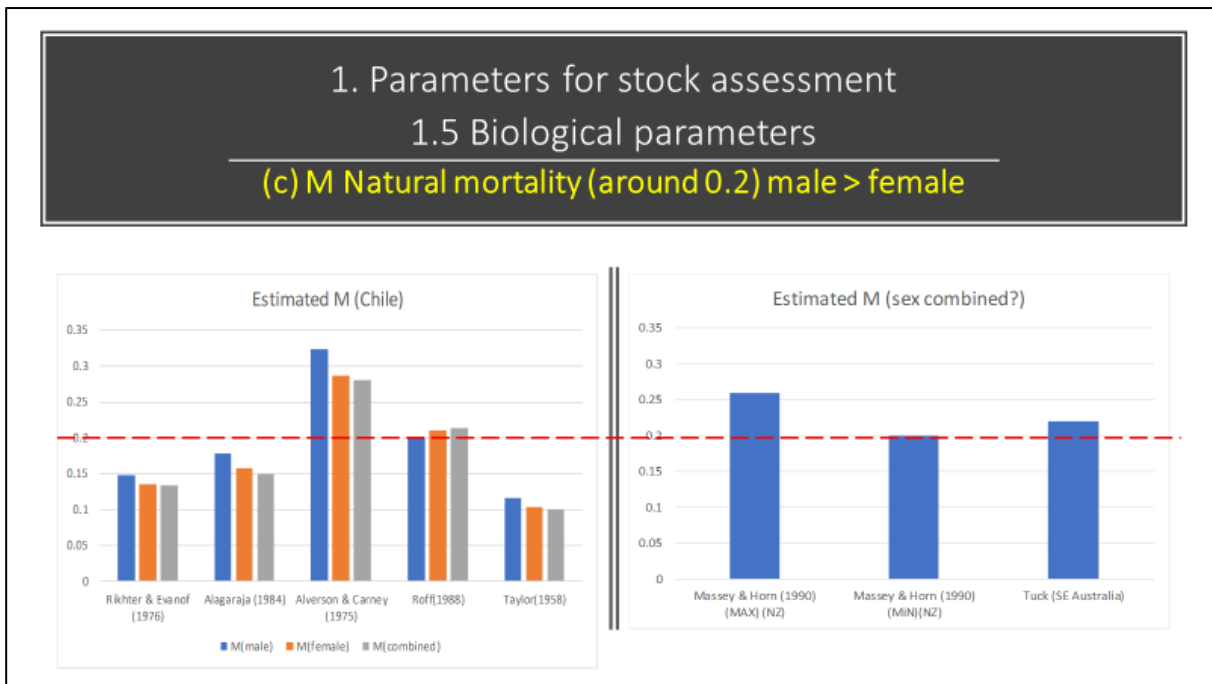
(9) Maturity-at-size

1. Parameters for stock assessment

1.5 Biological parameters (f) maturity-at-size (L50%) Female: around 33cm
(none from Indian Ocean ➔ need to develop with OBS data)

Ocean	Area	Authors	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Atlantic	Azores	Pereira & Pinho (2012)													35.5								
			23.0																				
	Canary Islands	González et al. (2003)									31.3												
	Madeira													34.6									
Pacific	New Caledonia	Lehodey et al. (1977)											33.2										
	Chile	Guerrero & Arana (2009)											33.1										
		Flores et al. (2012)															36.9						
																							43.7
		Gili et al. (2002)																		40.4			

(10)   Maturity-At-Age

1. Parameters for stock assessment
1.5 Biological parameters (f) maturity-at-Age (Age50%) Female: 6-7 years
(none from Indian Ocean ➔ need to develop with OBS data)

Ocean	Country	Ajthors	sex	1	2	3	4	5	6	7	8	9	10
Pacifc	Australia		?										
	New Caledonia	Lehodey et al. (1977)	M							7.5			
			F						5.9				
	Chile	Flores et al. (2012)	F							7.4			
			F									9.6	

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(11) Fecundity

1. Parameters for stock assessment

1.5 Biological parameters (g) Fecundity

Scoping study➔ Actual numbers on fecundity
(many information)

⬇

For the stock assessments

Fecundity is proportional to female weight at age (size)