Summary record

1st Meeting of the Southern Indian Ocean Fisheries Agreement (SIOFA) Scientific Committee's Ecological Risk Assessment Working Group

23-24 October 2017, CSIRO Castray Esplanade, Hobart

Meeting Room - Huon

Chair: Dr Simon Nicol (Australia)

(Note that results were still being refined as at December 2017 and results presented herein should be taken as indicative only. The relevant paper to SC3 will present results in more detail)

1. Opening

a. Opening statement from the Chair

b. Introduction of participants

The meeting commenced at 10.00am. Members of the SIOFA Ecological Risk Assessment Working Group (ERAWG) and other participants were welcomed and introduced. The Chair (Simon Nicol, Australia) gave a brief statement on the objectives of the workshop and detailed the anticipated outcomes. This included the objective to progress the ecological risk assessment for the effects of demersal trawl, midwater trawl, demersal line and demersal gillnet gears on deepwater chondrichthyans in the Southern Indian Ocean Fisheries Agreement area. The other main objective was to consider the workplan for the ERAWG. Participants who were present, and their affiliations and/or representation, are included at Appendix 1. The final agenda is included at Appendix 2. Actions arising from the meeting, and pertinent points, are boxed in this record.

2. Administrative arrangements

a. Adoption of the agenda

b. Confirmation of meeting documents

c. Appointment of rapporteur

d. Review of functions and ERAWG terms of reference

The agenda was adopted with minor changes to the structure such that results of the risk assessment for deepwater chondrichthyans would be presented before the discussion on the assumptions around productivity and susceptibility attributes used for the analysis. There were no substantive additions or removals from the agenda. The final agenda is included at Appendix 2. There were no meeting documents, but a presentation was developed for the meeting and a modified version will be provided to those who were unable to attend. Lee Georgeson (Australia) was appointed as rapporteur and Australia volunteered responsibility for providing the draft meeting report to the ERAWG. The review of functions and the ERAWG terms of reference were not discussed explicitly under this agenda item, but were reviewed throughout and at the end of the meeting. The ERAWG Terms of Reference are included at Appendix 3.

There was a general discussion under this agenda item about the confidentiality implications of, and requirements for, the risk assessment for deepwater chondrichthyans, that may also be relevant to broader data issues (including future risk assessments) undertaken under the auspices of the SIOFA SC and relevant working groups. It was queried whether the CSIRO online database (i.e. on which the ERA tool is built) was secure and what, if any, mechanisms could be used to protect confidentiality if access to the tool is shared more broadly. In response, it was noted that the online tool is password protected and that the back-end could only be interrogated by CSIRO. It was also noted that no spatial effort data are accessible in the front-end of the tool, such that information on location of fishing effort could not be interrogated. It was agreed to set up a SIOFA-ERAWG login for the online database 'front-end', and noted that the username and password would be sent to the working group and SC via email after the meeting and once results had been refined.

Cook Islands queried whether raw data could be destroyed at the end of the ERA process. In response, it was noted that CSIRO would not retain the raw fishing effort data but that the processed data could be maintained in the online tool, if desired. James Cook University (JCU) noted that there were no intellectual property or confidentiality issues related to CSIRO retaining the productivity attribute data within their database. The Chair noted that if it was determined that appropriate arrangements in SIOFA to maintain data confidentiality did not currently exist, other arrangements to protect confidentiality could be made (such as mutual data confidentiality arrangements).

Action: ERAWG members are encouraged to consider any confidentiality requirements for data provided, noting previous communication from Australia relating to data confidentiality protocols for the relevant project and Australia's commitment to the principles of SIOFA CMM 2017/02 Conservation and Management Measure for the Collection, Reporting, Verification and Exchange of Data relating to fishing activities in the Agreement Area (Data Standards).

3. Overview of Ecological Risk Assessment for the Effects of Fishing (ERAEF) Framework and methodology

CSIRO provided an overview of the general framework for this and other ERA processes. Under this framework, the importance of structuring and documenting the main issues that arise with the methodology and process was highlighted. Identification of the main issues arising with the process and methodology can be structured under the following areas:

- Data sources
- Data quality
- Data 'errors', relating to
    - Raw data
    - Processed data
    - Algorithm errors
    - Interpretation errors.

It was noted that fisheries that interact with many species are often characterised by limited information, which can necessitate the application of a risk-based approach such as Productivity-Susceptibility Analysis (PSA) or Sustainability Assessment for Fishing Effects (SAFE). CSIRO noted examples of where ecological risk assessment (ERA) has been applied globally and that ERA could be used for a variety of fishing gears, species and other ecological components.

CSIRO then introduced the hierarchical concept behind the ERA process and noted the decreasing level of uncertainty–but the increasing time and effort required–when moving through the hierarchical framework. The precautionary nature of the framework was also discussed, whereby lower levels in the hierarchy have a natural bias towards false positives (i.e. units assessed to be high risk that may actually be low risk) because of the assumption that missing information (for example, missing productivity or susceptibility attributes) results in a higher risk.

The working group discussed differences in the methodological aspects between PSA and SAFE, which are both based on the availability of information about the intrinsic rate of increase (*r*) of a particular species or population (as informed by the productivity attributes) and the catchability or removal (q) based on susceptibility to capture by various gears. The PSA assigns a risk score (1=low risk, 2=medium risk, 3=high risk) to each attribute. The PSA uses the average of the sum of seven productivity attributes and the product of four susceptibility attributes to give a two-dimensional representation of relative potential risk. The multiplicative nature of the susceptibility attributes was noted as it is assumed that low risk for one attribute acts to reduce overall risk.

Attributes used in a PSA

Productivity attributes

- Maximum age
- Age at maturity
- Size at maturity
- Annual fecundity
- Maximum size
- Reproductive strategy
- Trophic level

P = average(A_1,A_2,A_3...A_7)

Susceptibility attributes

- Availability
  - Overlap with fishery
  - Global distribution
- Encounterability
  - Water column position
  - Adult Habitat
- Selectivity
  - Size at Maturity
- Post-capture mortality
  - Expert/Observer data

S = A x E x S x PCM

The SAFE assessment varies from the PSA in that life history traits that inform natural mortality (M), growth rate and the intrinsic rate of increase (r) are related to biological reference points using formulae developed through the literature, as per:

$F_{msm} = r/2$, $F_{lim} = 0.75\ r$, and $F_{crash} = r$;

$F_{msm} = M$, $F_{lim} = 1.5\ M$, and $F_{crash} = 2M$;

$F_{msm} = M$, $F_{lim} = 1.5\ M$, and $F_{crash} = 2M$, where

$\ln(M) = -0.0152 - 0.279\ln(L_\infty) + 0.6543\ln(k) + 0.4634\ln(T)$ (Pauly 1980; Quinn and Deriso 1999);

$F_{msm} = M$, $F_{lim} = 1.5\ M$, and $F_{crash} = 2M$, where $\ln(M) = 1.44 - 0.982\ \ln(t_m)$ (Hoenig 1983).

$F_{msm} = M$, $F_{lim} = 1.5\ M$, and $F_{crash} = 2M$, where $M = 10^{0.566-0.718\ln(L_\infty)} + 0.02T$ (www.Fishbase.org);

$F_{msm} = M$, $F_{lim} = 1.5\ M$, and $F_{crash} = 2M$, where $M = 1.65/t_{mat}$ (Jensen 1996);

The model uses the average of the six methods. Where information is not available for one or more methods, the model uses the average of the remaining methods, and this is how variance/error is calculated on the susceptibility (i.e. fishing mortality) axis. It was noted that there are many instances in which these are unable to be defined, so the model simply uses whichever attributes are defined. The fewer of these attributes that are able to be defined using the six methods, the broader the variance on the susceptibility axis.

The susceptibility attributes used for the SAFE assessment are similar to the PSA, but again the biological reference points are used such that the susceptibility axis gives an indication of *u*, the fishing mortality rate. These reference points are expressed in more detail below:

1. *umsm* – Fishing mortality rate corresponding to maximum sustainable fishing mortality (*MSM*) at *Bmsm* (biomass that supports *MSM*, equivalent to *MSY*)
2. *ulim* – Fishing mortality rate corresponding to limit biomass *Blim*, where *Blim* is defined as 50% biomass that supports the *MSM*
3. *ucrash* – minimum unsustainable fishing mortality rate that theoretically may lead to population extinction in the long term

The result is that *u* can be considered against *msm, lim* and *crash*, giving an absolute measure of risk. Risk categories are assigned as per:

1. Low risk: *u* is less than *umsm*
2. Medium risk: *u* is greater than *umsm* but less than *ulim*
3. High risk: *u* is greater than *ulim* but less than *ucrash*
4. Extreme high risk: *u* us greater than *ucrash*

It was noted that it is possible to switch formulae on and off to explore sensitivities. However, the model has been tuned for both teleosts and chondrichthyans and automatically selects for either, so exploration of these sensitivities was deemed unnecessary for this assessment. It was noted that switching methods on and off in the model, or the exploration of different or novel methods, could form the basis for future research. For more on these underlying methods, see Zhou et al. 2007 (Chapter 2: Methodology).

The ERAWG discussed the implications of possible assessment outcomes for management, and noted that under the hierarchical approach there are essentially two options at each level: 1) implement management actions, or 2) obtain more information so that risk can be better understood at that particular tier, or the unit of analysis can be moved to a higher tier (e.g. from PSA to SAFE, or from SAFE to a fully quantitative assessment).

The trade-off between time/cost and risk are relevant considerations here and the ERAWG discussed the importance of framing the assessment process and its outputs against the intent of the analysis.

In this context, it was noted that this ERA process was primarily a prioritisation exercise to identify where more information may be required to inform actions to manage deepwater chondrichthyans in the SIOFA area. An example given for a possible management response for a species (or group of species) that were determined to be at extreme high risk was that the SIOFA SC may wish to recommend that vessel crew or observers that interact with these species are able to identify them correctly and collect the necessary biological information, with a view to providing information that may reduce the risk or provide input to a more robust assessment. It was reiterated that fisheries for high risk species could still exist but that management may require the development of appropriate harvest strategies (including harvest control rules) and adequate information for scientific assessment and management.

For additional information on the framework and methods, the ERAWG recommends the SC review the presentation developed for (and during) the workshop. Additionally, these methods are detailed in Zhou et al. 2007 (Chapter 2: Methodology), Hobday et al. 2011, Williams et al. 2011 and Zhou et al. 2016. Links to these and other relevant papers have been made available on the SIOFA ERAWG webpage, and are also accessible via the CSIRO online tool.

4. Overview of the deepwater sharks ecological risk assessment

ABARES provided background to the risk assessment for deepwater chondrichthyans in the SIOFA fishery. In collaboration with other members, Australia sought a binding measure on prohibition of deepwater gillnets in SIOFA through submission of a paper to SIOFA SC1 in 2015, citing the gear's non-selective nature, lack of data to estimate bycatch and the risk of ghost fishing. The submission noted particular concern for deepwater shark populations due to their generally slow growth, low productivity and other attributes that may make them vulnerable to overfishing.

SIOFA SC1 could not reach consensus and agreed that with appropriate information, a harvest strategy and harvest control rules, fishing for low productivity species could be managed sustainably regardless of gear used. In response, it was agreed that SC funding could be used for the current risk assessment.

It was also noted that there is a broader requirement from the SIOFA Meeting of the Parties to the SIOFA SC to assess impacts of fisheries on bycatch species, including teleosts. It was noted that the intention is to undertake a similar assessment for 'secondary' (e.g. bycatch including byproduct/discarded) stocks with which SIOFA bottom fisheries interact.

5. Development of the species list and productivity attributes

James Cook University (JCU) detailed the development of the species list and collation of the species' productivity attributes. Deepwater sharks were defined as those with core distributions below 200m depth. The species list was developed using the FAO Guides to Deep-sea Cartilaginous Fishes of the Indian Ocean, Ebert et al. 2013, Last et al. 2016 and various other sources in the published literature. The ERAWG thanked the Southern Indian Ocean Deepsea Fishers' Association for providing sharks bycatch data and a number of photographs of deepwater chondrichthyans, which were used to refine the species list. There were initially over 200 species included in the species list, but this was iteratively reduced to a final list of 101 species. These species comprised sharks (76%), batoids (15%) and chimaeras (9%). As well as the depth definition, other reasons for exclusion included that certain species were particularly rare, were unlikely to interact with fishing gears, or were thought to be distributed within countries' exclusive economic zones and not within the SIOFA Area.

Species' productivity attribute information was compiled using various sources in the published literature (some of which is very recent). It was noted that references for these attributes are identified in the underlying productivity datasets. CSIRO agreed to provide a link to these references through the SIOFA portal of the online tool so that interested parties can check the veracity and currency of sources and propose others if desired. If necessary, different productivity assumptions could be included in the model at a later time.

The ERAWG discussed whether the SIOFA bycatch data provided were used to verify pup numbers and whether the collection of these data was valuable. The data provided noted if pups were present or absent but not their numbers. Pup numbers were derived from published literature.

> The ERAWG strongly emphasised that the collection of data on the number of pups per female and other biological data is extremely useful for understanding species biology and that this data collection should be continued and improved.

JCU noted that species distribution information was also recorded based on the overlap of the species with the SIOFA fishery. Three categories were collected: global, partial overlap or restricted (to SIOFA area) distribution. These data were used for the preliminary PSA that was presented to SIOFA SC2 in March 2017. However, this categorisation for the overlap of species distribution with the fishery area was replaced with spatially explicit effort data in the revised PSA and SAFE models.

JCU explained the process of assigning data from congeneric species to those species lacking data. Instances where this was done are identified in the underlying datasets. Generally, the use of proxy productivity attributes was based on a similarities in taxonomy, depth and size. Generally, species occurring at greater depths exhibit lower productivity. In some cases, size is related to productivity, and expert knowledge was used in these cases where information from congeneric or other species could be assumed using this characteristic.

For productivity attributes where data could not be assumed from congeneric species, these attributes were recorded as 'missing data'. These missing data and the proxy data are both identified in the underlying datasets. These can be identified through a downloadable attribute table, accessible via the online tool.

The habitat type for various species was also considered when developing the species list but it was noted that data on this was mostly lacking. Furthermore, the resolution in the model would not allow its use. It was noted that habitat type is not considered as a susceptibility attribute but that sensitivities could be run to explore this if there was an indication that risk for a particular species was assessed to be high. Where species were determined to be unlikely to be caught due to habitat types, they were generally excluded.

Dr Cassandra Rigby (JCU) was thanked for her efforts in compiling the productivity attribute data.

It was demonstrated that the compilation of productivity attribute data was built on a large literature base and with a high level of expert input. It was noted that this level of analysis is not generally typical for other ERAs.

6. Review of spatial data holdings and sources

ABARES provided an overview of fishing effort data provided by ERAWG members for the risk assessment. Fishing effort data was requested for all bottom fishing gears used from 2012-2016. Shark bycatch data were also requested. Fishing effort data were received from Australia, Cook Islands (2 out of three vessels), European Union and Japan. No fishing effort data were provided by Korea and France Overseas Territories prior to the meeting. It was noted that fishing effort by Korea and France Overseas Territories comprised up to a quarter of effort for some years for some gears. During the meeting, France Overseas Territories and Korea agreed to provide effort data for the assessment. These effort data will be included as soon as possible.

A summary of fleet composition and effort in the fishery is given below:

Table 2 Fleet composition in SIOFA fisheries, 2011–16

Flag	Gear	Year					
		2011	2012	2013	2014	2015	2016
Australia	Trawl	1	1	1	1	1*	1*
	Bottom Longline	0	0	0	0	1*	1*
Cook Islands	Trawl	3	3	2	2	2	2
European Union	Bottom Longline	2	2	2	1	1	2
	Gillnet	0	0	1	1	1	0
France Overseas Territories	Bottom Longline	2	2	2	2	2	2
Japan	Trawl	1	2	2	1	2	2
	Bottom Longline	0	0	1	0	0	0
Korea	Trawl	1	1	1	0	0	0
	Bottom Longline	1	1	3	0	0	0
Total Trawl		**6**	**7**	**6**	**4**	**4**	**4**
Total Bottom Longline		**5**	**5**	**8**	**3**	**2**	**4**
Total Gillnet				**1**	**1**	**1**	

* vessel is multipurpose (trawl and bottom longline)

Table 3 Fishing effort in SIOFA fisheries, 2011–15

Flag	Gear	2011	2012	2013	2014	2015
Australia	Trawl days	132	104	32	63	12
	Trawl hrs	294	252	62	106	14
	Longline hooks	0	0	0	0	1,800
Cook Islands	Trawl days	599	490	524	523	501
European Union	Longline hooks	na	na	na	na	2,221,000
	Gillnet km	0	0	5,442	4,945	1,121
France Overseas Territories	Longline hooks	509,414	503,478	731,883	634,682	443,492
Japan	Trawl days	58	90	118	126	356
	Trawl Hrs	550	528	1,001	707	2,260
	Longline hooks	0	0	96,480	0	0
Korea	Trawl days	50	238	217	0	0
	Trawl hrs	286	623	233	0	0
	Longline hooks	355,192	2,193,460	1,023,252	0	0
Total Trawl days		**839**	**922**	**891**	**712**	**869**
Total Trawl hrs*		**1130**	**1403**	**1,296**	**813**	**2,274**
Total hooks		**864,606**	**2,696,938**	**1,851,615**	**634,682**	**2,664,492**
Total Gillnet km		**0**	**0**	**5,442**	**4,945**	**1,121**

ABARES gave a brief overview of the species distribution data used for the risk assessment. These data included:

- 71 species maps from the FAO Geonetwork database
- 21 from IUCN Red List
- A number of maps from the aquamaps database
- Various sources in published literature for *B. bachi, B. tenuicephalus, E. alphus, C. willwatchi, C. didierae, C. buccanigella.*

It was noted that the main reason for using these sources was ease of access and comprehensiveness of holdings, and also noted that results could be quite variable depending on the source of spatial distribution data used.

CSIRO gave a presentation on the spatial elements of the PSA and SAFE models. Using the available effort data, a flat layer of 20-minute resolution mesh blocks of fishing effort were created for most gears. The 'fished area' was defined as cells with at least one fishing operation. Japanese data was half a degree (30-minutes) for midwater trawl but 20 minute for longline.

The ERAWG queried the limitation that the use of a 20 minute resolution assumes that fishing takes place across the entire area. It was noted that, in reality, this is not the case, but that this is a precautionary approach. If species were assessed to be at high risk, finer resolution data could be used for particular gears, but the cost of doing so for all species (and processing all effort data at this resolution) could be prohibitively high and this cost may not be commensurate with the intended outcomes of the risk assessment.

CSIRO noted that the overlap is calculated on the percentage of the species distribution *within the SIOFA area* and not the percentage of overlap of effort with the entire species distribution. It was noted that the key reason for this was the potential for serial depletion within the population. Additionally, SIOFA may not have the flexibility to implement or guide management responses outside the fishery. It was noted that both PSA and SAFE methods assume that species are homogenously distributed across their ranges.

The use of the availability (S1) and encounterability (S2) attributes considers the three dimensional nature of species distribution (i.e. vertically and horizontally across their ranges). In relation to this, it was questioned whether there was a need to specify which distribution datasets are depth based (i.e. within a total distribution extent) or representative of the entire distribution with no depth filter. It was noted that this may be important, as the variation in results appeared to be more closely correlated to susceptibility attributes than to productivity attributes. It was noted that the model, at this resolution, is fairly robust to this variation and that it wouldn't necessarily require different interpretation of results based on different data sources.

Action: ABARES to send final fishing effort and species distribution data to CSIRO.

7. PSA and SAFE outputs

The ERAWG focused on the outputs of the SAFE assessment. A number of issues with these outputs were identified and it was agreed that more refinement was needed for the productivity and susceptibility attribute assumptions, and the associated risk categorisations. Despite these limitations, preliminary results are provided below.

PSA results

The following species were assessed to be at high relative potential risk in the PSA:

Species	Common name	DT	MWT	DLL	DGN
*Bythaelurus bachi**	-				
*Bythaelurus lutarius**	-				
Centrophorus granulosus	Gulper Shark				
Centroselachus crepidater	Golden Dogfish				
Dalatias licha	Black Shark				
Deania calceus	Brier Shark				
Deania profundorum	-				
Etmopterus viator	-				
Lamna nasus	Porbeagle				
*Mitsukurina owstoni**	-				
Odontaspis ferox	Sandtiger Shark				
Plesiobatis daviesi	Giant Stingaree				
Pseudotriakis microdon	False Catshark				
Scymnodon plunketi	Plunket's Dogfish				
Somniosus antarcticus	Southern Sleeper Shark				
Zameus squamulosus	Velvet Dogfish				

* = Missing three or more productivity and/or susceptibility attributes; DT = Demersal Trawl; MWT = Midwater Trawl; DLL = Demersal Longline; DGN = Demersal Gillnet.

SAFE results

The following species were assessed to be at high or extreme risk in the SAFE:

Species	Common name	DT	MWT	DLL	DGN
*Anacanthobatis marmorata**	-	E	E	E	E
*Bythaelurus bachi**	-	E	E	E	E
*Bythaelurus tenuicephalus**	-	E	E	E	E
Centrophorus granulosus	Gulper Shark	E	E	E	E
Centroselachus crepidater	Golden Dogfish	E	E	E	E
*Chlamydoselachus anguineus**	Frill Shark	E	E		E
Dalatias licha	Black Shark	E	E	E	H
Deania calceus	Brier Shark	E	E	E	E
Deania profundorum	-	E	E	E	E
Etmopterus alphus	-	H	H		
Etmopterus pusillus	Slender Lanternshark	E	E	E	E
Etmopterus viator	-	E			
*Euprotomicrus bispinatus**	Pygmy Shark	E	E		
*Heteroscymnoides marleyi**	-	E	E		E
*Mitsukurina owstoni**	-				E
Scymnodon plunketi	Plunket's Dogfish	E	E	E	H
Somniosus antarcticus	Southern Sleeper Shark	E	E	E	E
Zameus squamulosus	Velvet Dogfish	E	E	E	E

* = Missing three or more productivity and/or susceptibility attributes; DT = Demersal Trawl; MWT = Midwater Trawl; DLL = Demersal Longline; DGN = Demersal Gillnet; H = High Risk; E = Extreme High Risk.

It is recommended that when considering the plausibility of these risk scores, the online tool is used so that the various productivity and susceptibility assumptions, as well as the uncertainty associated with these risk categorisations (including the missing number of attributes), can be understood.

The ERAWG requests members to carefully study results using the tables above and the online tool and identify potential false positives (i.e. species assessed to be high risk that are actually low risk) and false negatives (i.e. species assessed to be low risk that may actually be high risk).

It was also agreed that a careful assessment of bycatch data would be required to assess the likelihood that certain gears interact with particular species, such that 'expert overrides' could be identified. Members are strongly encouraged to provide any additional bycatch data to assist in this process.

A number of species were identified as high risk due to missing productivity attribute data. These were generally rare or newly described species. It was discussed that these may be candidates for a greater focus on data collection, including identification and biological sampling.

It was noted that much of the variability in species risk scores in the SAFE assessment was due to susceptibility attributes and not productivity attributes. The key susceptibility attributes identified that appeared to influence variability on the susceptibility axis were S1 availability and S2 encounterability.

An important limitation of the applicability of the SAFE method to midwater trawl gears was identified, which relates to the modelling assumption that midwater trawl gears interact with the seafloor, and that the model considers species' depth ranges independently of the fact that most midwater trawl operations rarely contact the seafloor. Given that many species' habitats are at the bottom of the water column (noting that some species have diurnal or nocturnal vertical migrations), the method when applied to midwater trawl will tend to result in more false positives (i.e. overestimate risk). It was discussed that residual risks can be addressed through the systematic review of risk scores, and that this needed to be noted strongly in the report to the SIOFA SC.

The ERAWG again reiterated that the preliminary results were not an indication of actual fishing mortality, but rather a theoretical representation of potential risk. It was agreed that results, at this stage, appeared to be more a reflection of the extent of the overlap of species distribution (in three dimensions) with fishing effort, thus giving estimates of higher potential risk for fisheries with a broader effort distribution (vertically and over space).

8. Productivity and susceptibility attribute assumptions and risk categorisations

Productivity (P) attribute and risk categorisation assumptions

CSIRO demonstrated the risk categorisation assumptions for the productivity attributes. These are included below.

Attribute	Low productivity (high risk, score 3)	Medium productivity (medium risk, score 2)	High productivity (low risk, score 1)
P1. Average age at maturity	>15 years	5–15 years	<5 years
P2. Average maximum age	>25 years	10–25 years	<10 years
P3. Fecundity	<10 pups/egg cases per year	10-20 pups/egg cases per year	>20 pups/egg cases per year
P4. Average maximum size (rescaled for deepwater chondrichthyans)	>200 cm	70–200 cm	<70 cm
P5. Average size at maturity (rescaled for deepwater chondrichthyans)	>150 cm	40–150 cm	<40 cm
P6. Reproductive strategy	Live bearer	Egg case layer	Broadcast spawner (teleosts)
P7. Trophic level	>3.25	2.75–3.25	<2.75

JCU expressed concerns about the average maximum size and size at maturity attributes (P4 and P5), as size is rarely a realistic indicator of productivity for deepwater chondrichthyans. Small and large deepwater chondrichthyans can both exhibit similar productivity risk. In response, it was noted that these attributes were based on frequency of sizes across >2000 Australian species, including teleosts and chondrichthyans. To partially resolve this issue, it was suggested and agreed to refine the P4 and P5 risk categorisations based on a more relevant database of deepwater chondrichthyans held by JCU. This database includes deepwater chondrichthyans within and outside the fishery. It was noted that this change in the risk categorisation for these attributes based on more relevant data should also be relevant to the parallel ERA for deepwater chondrichthyans in the south Pacific.

The ERAWG discussed the general replacement of productivity attributes with attributes that may be more relevant to deepwater sharks. It was noted that the contribution to *r* intrinsic rate of increase from each productivity attribute could be validated based on the variance in the patterns around the expected relationship/contribution to *r*. Weighting of productivity attributes was discussed but it was agreed that it was probably not necessary for this analysis. However, it was noted that this is done in other ERA processes (internationally), and that this could form the basis for future research.

No other changes were made to productivity attribute assumptions or risk categorisations.

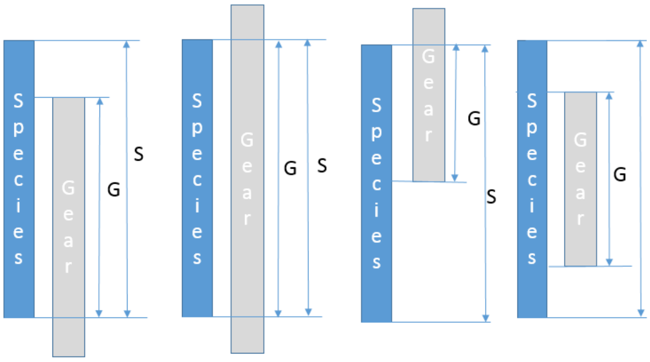
<u>Susceptibility attribute and risk categorisation assumptions</u>

The risk categorisation for the availability attribute was as follows.

Attribute	Low susceptibility (low risk, score = 1)	Medium susceptibility (medium risk, score = 2)	High susceptibility (high risk, score = 3)
S1. Availability	<10% horizontal overlap	10-30% horizontal overlap	>30% horizontal overlap
S2. Encounterability	Low vertical overlap with fishing gear (<10%) based on middle 90% of the gear depth range*	Medium vertical overlap with fishing gear (10-30%) based on middle 90% of the gear depth range*	High vertical overlap with fishing gear (>30%) based on middle 90% of the gear depth range*
S3. Selectivity (scores vary by gear type)	Demersal and midwater trawl: 0-15 cm; > 500 cm in length Line: 0-40 cm; >500 cm in length Gillnet: 0-70 cm; >140 cm in length	Demersal and midwater trawl: 15-30 cm; 400-500 cm in length Line: 40-80 cm; 200-500 cm in length Gillnet: 79-80 cm; 130-140 cm in length	Demersal and midwater trawl: 30-400 cm in length Line: 80-200 cm in length Gillnet: 80-130 cm in length
S4. Post-capture mortality (scores may vary by fishery and gear type)	Evidence of post capture release and survival	Released alive in most cases	Retained species, or majority dead when released

* Ranges are included below

CSIRO noted that there are number of different methods for the encounterability attribute. Given that depth data for fishing operations and species depth ranges was available, the ERAWG selected a method for calculating encounterability risk based on the vertical overlap between fishing effort and species depth ranges. The ERAWG agreed to use the middle 90 percent (i.e. from the 5^{th} to 95^{th} percentiles) of fishing depth records for each gear as the 'core depth range'. Outliers, zeros and data deemed to be unfeasible were consequently discarded. A graphical representation of the encounterability method is included below.

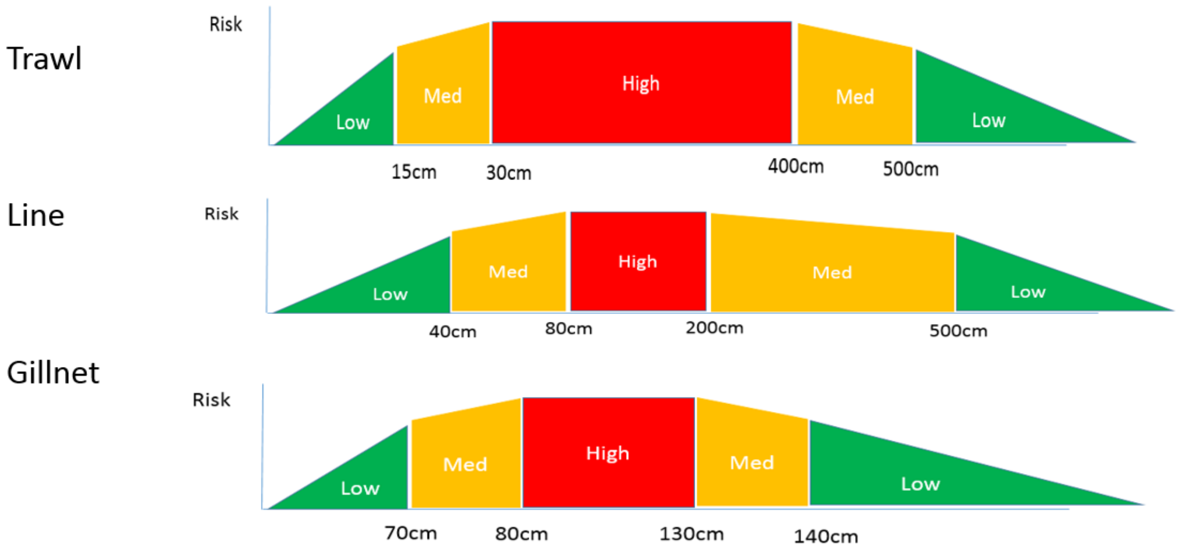


E=G/S
E<0.1, low, score of 1
0.1>E>0.3, medium, continuous between 1 and 3
E>0.3, high, score of 3

The agreement to use the middle 90 percent of depth records translated into the following depth ranges for the encounterability attribute:

Gear	Fishery ID	Depth Min (m)	Depth Max (m)
Demersal Trawl	96	700	1235
Midwater Trawl	97	430	970
Demersal Longline	98	837	1435
Gillnet	110	810	1390

ABARES and CSIRO presented the selectivity assumptions for each gear. These are presented graphically below.



Trawl selectivity assumptions are based on the methods of Zhou et al. 2007. Line selectivity assumptions are based on an assumed hook size of 14-16/0. The risk categorisations were informed by input from expert shark scientists. Gillnet selectivity risk scores were estimated in part using a study of gummy shark (*Mustelus antarcticus*) selectivity (Kirkwood and Walker 1986), using the assumption that morphology (and thus, selectivity) of many of the more commonly caught chondrichthyans was roughly similar to gummy shark. Given that most of the species assessed were sharks (i.e. relativity long and torpedo-shaped), this was deemed to be a suitable assumption for the intent of this assessment. However, it was noted that exploration of sensitivities around different selectivity curves for the various species could be done in future if deemed necessary. The gillnet mesh size used for targeting deepwater sharks (including *Centrophorus squamosus* and *Centroscymnus coelolepis*, both of which are caught in this fishery) was assumed to be 160 mm but could range from 120–220mm.

It was suggested that there may be some data from gulper shark catch records in the Australian Southern and Eastern Scalefish and Shark Fishery that may be able to inform these selectivity attribute assumptions.

The ERAWG also discussed the implications of different selectivity curves for sharks, rays and chimaeras. ABARES and JCU noted that most of the species included in the assessment were sharks, on which selectivity assumptions were based, but that this may be a suitable assumption depending on the intention of the assessment. It was noted that sensitivities around using different selectivity assumptions could be explored if deemed necessary, but that information to inform selection of different selectivity assumptions for sharks, rays and chimaeras was limited. The ERAWG suggested to leave this open to input from the SIOFA SC. It was also suggested to have a closer look at bycatch data records provided to inform the frequency of interactions with the various species.

The ERAWG requests the SIOFA SC to consider the selectivity assumptions and, if necessary, propose any amendments.

The ERAWG discussed the assumptions around post capture mortality. The default in the algorithm is to assign high risk to target or byproduct species and medium risk to bycatch species. The attribution of low risk is generally taxa dependent (for example, may include air breathing protected species), but this category was not used for this assessment. Australia and James Cook University expressed concern over this assumption for deepwater chondrichthyans, noting that in the absence of information to suggest otherwise (and in line with the precautionary principle) that the preference was for species in this ERA to be assigned a high risk for PCM.

Consensus was unable to be reached, and the ERAWG agreed to ask the SIOFA SC to provide advice on PCM risk categorisations for the species included in the assessment.

9. Systematic review of species' risk scores and identification of expert overrides

The ERAWG reviewed preliminary risk scores from the PSA and SAFE assessments, which were based on the existing model assumptions. The ERAWG discussed that there a still a number of assumptions on which general SC agreement is needed before the models can be updated and systematic review of risk scores can take place.

It was agreed that the outputs of this meeting, as well as further discussion between ABARES and key stakeholders who were not present at the meeting, would be needed before a final risk categorisation of species can be systematically reviewed.

10. Ecological Risk Assessment Working Group Workplan

The following workplan was devised for 2017–18.

Objective
The goal of ecological risk assessment is to develop an understanding of priority species within a fishery. Comparisons between fisheries with these methods are less valid, as these are relative risk – care must be taken in making comparative decisions based on different fishery results. The outcome from an ERA is to develop a set of actions that would ultimately reduce or demonstrate a reduction of risk to satisfactory levels (sustainable fishery where no species is at risk of recruitment overfishing).

The workplan is to:

1. Develop PSA and SAFE assessments for four fisheries/gear types in SIOFA
    a. Obtain data on
        i. Catch distribution for each fleet and nation (ABARES)
        ii. Depth distribution for each fishing gear (ABARES)
        iii. Species distribution maps for species (ABARES)
        iv. Biological attributes for species gathered (JCU)
    b. Load the data into the assessment tool
        i. Calculating attributes and overlaps (CSIRO)
        ii. Provide access to tool for each nation/SIOFA
    c. Draft a report
        i. Include examples of responses that might be considered by the SC in response to high risk species.
            1. Observer efforts
            2. Gather more data
            3. Check records
            4. Undertake sensitivities
2. Seek feedback from SIOFA nations
    a. Workshop SC – Reunion meeting (March 2017)
        i. Preliminary PSA discussion
    b. Workshop 1 ERAWG – Oct 2017 – Hobart - Agenda
        i. Discuss results
        ii. Check scoring
        iii. Develop residual risk methods – false positives with rationale. Use Australian ERAEF and apply these to the "high" risk species.
            1. Residual risk guidelines can account for limitations in Level 2 Ecological Risk Assessment (ERA) process. In particular, residual risk guidelines were developed to better account for existing management arrangements that mitigate certain risk and additional information on direct mortality not appropriately considered by Product Susceptibility Analysis (PSA) or SAFE. In response, nine residual risk guidelines were developed to account for these limitations, improving the assessment of risk for species that interact with each fishery. Once completed, ERA and residual risk assessments will determine priorities and allow fisheries managers to better make informed and consistent decisions about the future management of each fishery. These 9 guidelines are:
                a. Risk rating due to missing/incorrect information
                b. Additional scientific assessment
                c. At risk due to missing attributes

        d. At risk with spatial assumptions
        e. At risk but with a zero or negligible level of interaction/capture
            i. And needs to be for a reasonable observer coverage (>10%?) to be able to be used as an override.
        f. Effort and catch management arrangements for target and byproduct species
        g. Management arrangements to mitigate against the level of bycatch
        h. Limits on associated species through other management arrangements
        i. Management arrangements relating to seasonal, spatial and depth closures.

3. Out of session
    a. Video hook-up with all nations to explain the tool. Summary presentation for members unable to attend ERAWG workshop 1.
        i. There are some remaining questions here around how to display fishing effort overlap with species' distribution maps – confidentiality restrictions may prevent this being done visually but there may be other options.
    b. Methods development
        i. Scoring rubric
            1. PCM – 2 (and ask for opinion on "3")
            2. Sizes (JCU providing update)
    c. SIOFA nations – we expect they will
        i. Use the tool to explore risk
    d. Add some more detail to the tool (CSIRO)
        i. Reference set for attributes
        ii. Remove SAFE explore option.
        iii. Add SAFE equations (or a count for how many used for F)
    e. Develop a list of "issues" in existing species list and seek explanation for issues.
        i. Back and forward
        ii. Do residual risk – where data are available and "easy" – if not, gather that data outside this workplan
        iii. Invite SIOFA review of these issues
    f. Finalise a list of priority species for consideration by the SIOFA SC
        i. Draft Final Report for WG

11. Next steps and advice to the Scientific Committee

The outcomes from this agenda item are encapsulated in the proposed workplan for the deepwater sharks risk assessment and associated actions identified throughout the meeting.

12. Meeting summary and adoption of meeting report

The meeting report was not finalised or adopted during the meeting. It was agreed that the meeting report would be circulated to participants within one week of the meeting.

13. Other business

There was a discussion around access to the online tool and it was agreed that until results had been further refined, it was best if access to the online tool was restricted to the ERAWG.

Cook Islands queried the need to consider data from IOTC for sharks that may interact with both fisheries and where there is some cumulative impact.

The meeting Chair agreed to liaise with other RFMOs to establish a common workplan to consider the inclusion of other data. This would include writing to the IOTC secretariat to ask whether there are any bycatch records of deepwater sharks that may warrant consideration of cumulative risk.

There was a brief discussion around the terminology used (e.g. 'risk assessment') and whether this could be replaced with different terminology (e.g. 'prioritisation assessment'). It was noted that if the intent of the project is to identify current information gaps and that it is framed appropriately then the risk of misinterpretation of results and outputs is lowered.

The Chair suggested a general paper may be useful for SC3 outlining the tools that are being used particularly in relation to possible extension of the methods to teleost stocks.

Action: ABARES to follow up with Korea on data availability and how it could be provided.

Action: ABARES to compile draft ERA report mid-Dec 2018, send draft report to SC mid-Jan 2018, 1 month for comments before submission to secretariat in mid-Feb 2018.

14. Meeting close

The meeting was closed at 10.25am on 24 October 2017.

Key references

1. Zhou, S, Smith, T & Fuller M 2007, Rapid quantitative risk assessment for fish species in selected Commonwealth fisheries, CSIRO for AFMA, available here
2. Hobday, A. J., A. D. M. Smith, I. Stobutzki, C. Bulman, R. Daley, J. Dambacher, R. Deng, J. Dowdney, M. Fuller, D. Furlani, S. P. Griffiths, D. Johnson, R. Kenyon, I. A. Knuckey, S. D. Ling, R. Pitcher, K. J. Sainsbury, M. Sporcic, T. Smith, T. Walker, S. Wayte, H. Webb, A. Williams, B. S. Wise and S. Zhou (2011). Ecological Risk Assessment for the Effects of Fishing. Fisheries Research 108: 372–384. Available here
3. Williams, A., J. Dowdney, A. D. M. Smith, A. J. Hobday and M. Fuller (2011). Evaluating impacts of fishing on benthic habitats: a risk assessment framework applied to Australian fisheries. Fisheries Research 112(3): 154-167. doi:10.1016/j.fishres.2011.01.028. Available here
4. Zhou, S., A. J. Hobday, C. M. Dichmont and A. D. M. Smith (2016). Ecological risk assessments for the effects of fishing: a comparison and validation of PSA and SAFE. Fisheries Research: http://dx.doi.org/10.1016/j.fishres.2016.07.015. Available here

Appendix 1 – List of meeting participants

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Appendix 2 – Final agenda

Final Agenda

1st Meeting of the Southern Indian Ocean Fisheries Agreement (SIOFA) Scientific Committee's Ecological Risk Assessment Working Group

23-24 October 2017, CSIRO Castray Esplanade, Hobart

Meeting Details – Huon Room, Commencing 10 am 23 October 2017

Chair: Dr Simon Nicol

The provisional agenda for the 1st meeting of the SIOFA Scientific Committee's Ecological Risk Assessment Working Group has been developed to focus on the areas of work identified in SIOFA SC1 and SC2 meeting reports, the Scientific Committee Work Plan (MoP3 Annex G) and Research Plan (SC1 Annex G) and the ERAWG's terms of reference (included at Attachment 1).

1. Opening

a. Opening statement from the Chair

b. Introduction of participants

2. Administrative arrangements

a. Adoption of the agenda

b. Confirmation of meeting documents

c. Appointment of rapporteurs

d. Review of functions and ERAWG terms of reference

3. Overview of Ecological Risk Assessment for the Effects of Fishing (ERAEF) Framework

CSIRO will provide an overview of the ERAEF framework, detailing the hierarchical approach and PSA (including bSAFE/eSAFE) methods.

4. Overview of the deepwater sharks ecological risk assessment

ABARES will provide a brief overview of the context of the preliminary ecological risk assessment for the effects of demersal, midwater trawl, line and gillnet fishing on deepwater sharks in the southern Indian Ocean, and links to other processes (e.g. the concurrent assessment for the South Pacific Ocean) and broader ERA processes.

5. Development of the species list and productivity attributes

James Cook University will provide an overview of how the list of deepwater shark species that could interact with fisheries in the southern Indian Ocean was developed. JCU will then detail the process for the compilation of productivity attributes and the assumptions used.

6. Susceptibility attribute assumptions

ABARES will detail the susceptibility attribute assumptions used for the preliminary assessment.

7. Review of spatial data holdings and sources

ABARES and CSIRO will provide a summary of spatial data (including species distribution data and fishing effort data) collected and received for use in the level 3 SAFE assessment

8. PSA and bSAFE/eSAFE outputs

ABARES and CSIRO will provide a brief overview of the outputs from the level 2 Productivity Susceptibility Analysis

CSIRO will provide an overview of the preliminary bSAFE/eSAFE outputs

9. Systematic review of species' risk scores and identification of expert overrides

The ERAWG will systematically review species' risk scores and identify possible false positives (or false negatives) and identify any potential expert overrides.

10. Ecological Risk Assessment Working Group Workplan

The ERAWG will develop and formalise a work plan for the 2017/2018

11. Next steps and advice to the Scientific Committee

The ERAWG will identify next steps and discuss potential advice to the Scientific Committee (see Attachment 1 for guidance)

12. Meeting summary and adoption of meeting report

This will include a summary presentation to be provided to members who could not attend for discussion at a future webinar before the SIOFA SC3 meeting.

13. Other business

14. Meeting close

Appendix 3 – Workplan and terms of reference

SIOFA Ecological Risk Assessment Working Group

Objectives and background

Paragraph 6a of CMM 2016/01 actions the SIOFA Scientific Committee to provide advice and recommendations to the Meeting of the Parties on the status of stocks of principal deep-sea fishery resources targeted, and, to the extent possible, taken as bycatch and caught incidentally in these deep-sea fisheries, including straddling fishery resources by 2019.

The SIOFA Scientific Committee has proposed that ecological risk assessment is a practical approach for addressing the potential and current effects of fishing on target stocks and also those caught incidentally in SIOFA's deep-sea fisheries. The SC recommended that a working group be established under the SIOFA Scientific Committee to progress work related to ecological risk assessments required to address this action.

Initially, the working group will focus on an ERA for deepwater sharks in the SIOFA Agreement Area. This ERA could be used as a model for future ERAs, or for example, as a basis for the expansion of the deepwater sharks ERA to all relevant species across the SIOFA area (where data are available).

Such a model will be useful in promoting engagement of scientists in the ERA process, which is fundamental to success.

Under these Terms of Reference, participants will commit to involvement in the process. All 'rules' of the ERA WG will be consistent with the SC Terms of Reference, and so are not included here. The ERA WG ToR will be focused on the practical aspects of progressing work related to ERAs in SIOFA.

Terms of Reference

1. The ERA-IWG will be tasked with developing a research and review plan for implementation of ERAs and related processes for progressing the objectives of the SIOFA SC and Meeting of the Parties. In the short-term, the ERA WG will:
    a. Assist with the timely provision of data to support the implementation of the ERAs for deepwater chondrichthyans being undertaken by Australia and Japan.
    b. Assist with review of methods and outputs used for the deepwater chondrichthyans ERAs and provide advice to the SC on the applicability of the methods to be used more broadly across SIOFA fisheries.

In the medium to long-term, the ERA-IWG will:

2. To facilitate timely development of ERA processes, participants agree to provide the necessary and available data within two months of a request, noting that appropriate data confidentiality protocols (as per CMM 2016/03 and domestic data and privacy policies) will apply
3. The requesting party will need to confer with the data custodian to ensure the appropriate data confidentiality agreements and other relevant processes are followed.
4. All other rules of the ERA-IWG will be consistent with the SC Terms of Reference.

Current workplan

Interim dates and other issues for deepwater sharks ERA:

- Within two months of the close of SIOFA SC2, participants agree to provide the following data:

    - Fishing effort footprint for demersal and midwater trawl, line gears and gillnet gears for the period 2011–2016, where available, at a 20 minute (or finer) resolution (as shapefiles)
    - If finer scale data can be provided, the mid-point of a polygon will be selected and a 20 minute cell used for the first run (i.e. the 'worst case scenario')
    - Shark catch data for the aforementioned gears, to be used for 1) verifying the species list and 2) understanding the potential susceptibility of various sharks to certain gears
- The ERA-IWG will prepare and submit a working paper on the deepwater chondrichthyans ERAs to SC3 for review and consideration. The paper will be co-authored by the ERA WG/SIOFA SC.
- Provide advice to the SIOFA secretariat on the design needs of SIOFA data bases for the purposes of ecological risk assessment.
- This working paper will form the first draft of a scientific paper on the deepwater chondrichthyans ERAs for intended publication in a scientific journal. The paper will be co-authored by all contributing scientists to the ERA WG/SIOFA SC. Intended publication date will be late 2018.