2nd Meeting of the Southern Indian Ocean Fisheries Agreement (SIOFA) Scientific Committee

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SC-02-09 [01]

Ecological risk assessment for deepwater sharks in the Southern Indian Ocean

Relates to agenda item: 9

Working paper ☒ info paper ☐

Delegation of Australia

Abstract

This working paper presents progress towards the development of a quantitative ecological risk assessment (ERA) for deepwater sharks in the SIOFA area. The proposed ERA method is the Sustainability Assessment for Fishing Effects (SAFE) method of Zhou and Griffiths (2008). This method provides an absolute measure of risk to species by estimating both a fishing mortality rate and associated quantitative reference point.

Recommendations *(working papers only)*

1. That the Scientific Committee note the progress made by Australia (and Japan) towards an ERA for deepwater sharks in the southern Indian Ocean

2. That the Scientific Committee note the preliminary outcomes of the ERA (ongoing)

3. That the Scientific Committee note the Australian Government's concerns around use of deepwater gillnets in the SIOFA Area, as raised at SIOFA SC 1

4. That the Scientific Committee acknowledge Australia's gratitude for the assistance provided by the Southern Indian Ocean Deepsea Fishers' Association in the provision of data to support the ERA.

Contents

Introduction

This paper updates the SIOFA SC on progress towards an ecological risk assessment (ERA) for deepwater sharks in the southern Indian Ocean. Over the last decade, Australia has applied an ecological risk assessment for the effects of fishing (ERAEF) framework to its Commonwealth fisheries (Zhou and Griffiths 2008; Zhou et al. 2007) and now seeks to develop a Sustainability Assessment For Fishing Effects (SAFE) Level 3 ERA (Zhou and Griffiths 2008) for species and associated fishing gears in the southern Indian Ocean. This approach is intended to be complementary to the Japan-led Productivity-Susceptibility Assessment (PSA) Level 2 by estimating $F_{CURRENT}/F_{MSY}$ ratios, where sufficient data are available.

The ERAEF framework consists of three levels of assessment. Higher levels of assessment (e.g. SAFE) have less uncertainty but increased costs and data requirements relative to lower levels (Hobday et al. 2011). The rationale behind pursuing a Level 3 assessment rather than a Level 2 for the southern Indian Ocean is that the latter tend to give more false positives because species lacking data are automatically assigned a high risk (Hobday et al. 2011). For example, Zhou et al. (2016) showed that in comparison to quantitative stock assessments, there was an overall misclassification rate of 50% for the Level 2 PSA and 11% for the Level 3 SAFE (all overestimating risk) for relevant species. In other words, the SAFE Level 3 analyses, where applicable, may help to resolve some of the uncertainty and potential subjectivity of a PSA Level 2 assessment.

The proposed approach for the Level 3 assessment is to undertake a ‘worst case’ scenario whereby it is assumed that fishing with all gear types (demersal/midwater trawl, line gears and deepwater gillnets) has occurred within the entire SIOFA bottom fishing footprint (for all nations that bottom fished) for the past 5 years (2011-2016). This will indicate if any species could exceed F_{CRASH}. If there are indications that this may be the case for some species, greater spatial complexity can be added to explore finer resolution fishing impacts. This approach will clearly overestimate fishing mortality, similar to the Level 2 assessment (Zhou et al. 2016).

Despite potential overestimations of fishing mortality and hence risk, the Level 3 SAFE accords with the precautionary principle, which states that the absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures.

Background and context

At SIOFA SC 1, the SC discussed the negative impact of large-scale pelagic driftnets (drift gillnets) and deepwater gillnets on target, non-target, threatened, endangered and protected (TEP) species and deep sea habitats. The discussion considered background information to assist with developing recommendations for the 2016 Meeting of the Parties (MoP) on a binding measure on the use of large-scale pelagic driftnets and deepwater gillnets. The main issues of concern in relation to large-scale pelagic driftnets included the gear’s highly non-selective nature, lack of data to estimate mortality of bycatch and negative impacts resulting from nets or net fragments lost or abandoned (i.e. ghost fishing). Issues of concern in relation to deepwater gillnets included risks to deepwater shark populations that exhibit low-productivity life history characteristics (i.e. slow growth, high longevity, late maturity and low fecundity), lack of data and ghost fishing.

SIOFA SC 1 noted there is a requirement to follow the principles of the precautionary approach, whereby the absence of adequate scientific information shall not be used as a reason for postponing or failing to implement conservation and management measures (Article 4(c)) of the SIOFA Agreement. In this context, a ban on the use of large scale pelagic driftnets and deepwater gillnets in the SIOFA area would be consistent with current UNGA Resolutions, the FAO International Plan of Action (IPOA) on Sharks and conservation and management measures taken by other regional fisheries management organisations (RFMOs). The Deep Sea Conservation Coalition noted its strong support for prohibitions on both large scale pelagic driftnets and deepwater gillnets.

SIOFA SC1 also considered that a prohibition on deepwater gillnets would not necessarily preclude their future use, but that if deepwater gillnet fishing occurred it would be on the basis of having a robust ERA undertaken, and with an agreed harvest strategy with clear harvest control rules.

Noting the available information on the potential impact of large scale pelagic driftnets on target, non-target, threatened, endangered and protected (TEP) species and deep sea habitats, the SIOFA SC1 agreed to recommend that the MoP prohibit the use of large scale pelagic driftnets in accordance with the UNGA moratorium. This recommendation was adopted by the MoP.

In response to the MoP's request to consider *Recommendation 15-01 Interim Recommendation for Deepwater Gillnets in the Southern Indian Ocean Fisheries Agreement Area*, the SIOFA SC 1 was unable to reach consensus advice on this issue. It included the task of undertaking an ERA in its work plan to quantify the impacts of fishing by deep-water gillnets on sharks before the provision of advice to the MoP[1]. Australia and Japan have since made progress on the development of ERAs for deepwater sharks in the southern Indian Ocean.

The fishery

The declaration of exclusive economic zones in the 1970s led to a major expansion of fishing effort into the high seas. During this time, the main target stocks in what is now the SIOFA Area included alfonsinos (*Beryx spp.*), rubyfishes and butterfishes (*Centrolophus niger* and *Hyperoglyphe antarctica*). There was a major increase in effort in the fishery in the late 1990s, with sources placing the number of active vessels between 30 and 50 (Sanders 2009). Most of the effort at this time was targeted at orange roughy (*Hoplostethus atlanticus*) using demersal trawl, but many of these vessels were not successful because of a lack of operational skills and knowledge, financial support, in addition to poor gear design and quality (Sanders 2009).

Other bottom fisheries in the SIOFA Area include some mid-water trawling, primarily for alfonsino (*Beryx splendens*), and longlining for deepwater snappers (*Etelis* and *Lethrinidae spp.).* It has been reported that there have been vessels targeting deep-sea sharks using gillnets at various times in the fishery's history (Sanders 2009).

The following section will eventually be populated with more general information on the SIOFA bottom fishery. Detailed descriptions of gears used in the area can be found in Williams et al. (2011).

[1] Though the adoption of CMM 2016/15, the Meeting of the Parties adopted a recommendation that deepwater gillnets not be used in the Agreement Area by any vessel flying the flag of a Contracting Party, CNCP or Participating Fishing Entity until such time as the Meeting of the Parties has received a recommendation from the Scientific Committee.

Australia's fishery

A small number of Australian fishing vessels target demersal fish species in association with seamounts, ridges and other features in the southern Indian Ocean. Deep-sea trawlers from Australia were reportedly fishing in the SIOFA Area before 1999. In 1999, there was a substantial increase in deep-sea trawling in the area after orange roughy stocks were discovered (Japp & James 2005). Australian vessels have reported catch from within the SIOFA Area since 1999.

Trawl gears

Most fishing by Australian vessels in the SIOFA Area is undertaken with midwater and demersal trawl gears. Midwater trawl gears usually have a sacrificial footrope in case the net touches the sea floor, suggesting that midwater trawl gears can touch the seabed occasionally (Williams et al. 2011).

Demersal and midwater trawling operations are generally highly targeted and consequently, highly selective. Trawl times are generally short, with operators targeting specific aggregations of fish in association with certain bottom features. Trawling by Australian vessels in the southern Indian Ocean is generally undertaken at depths of between 400 and 1400 m. Rough bottom is reportedly avoided as it can lead to snaring of and damage to nets, which can cause safety issues and can be expensive for operators. Shot duration (the time the net is on the bottom) can be as little as 2-5 minutes, with longer shots up to 15 minutes or more. Combined shoot-away and haul time averages around 1.5 hours, depending on depth, weather, current and other variables. Tows are sometimes abandoned if the net is too far off the main towline or the nature of the ground where the gear has migrated is unknown (Sanders 2009).

During 2011-2016, 6 Australian-flagged vessels were active in the area that used gears that could interact with deepwater chondrichthyans.

Line gears

Line fishing has historically been a minor component.

Deepwater gillnets

Permissible fishing gears have been specified by the Australian Fisheries Management Authority (AFMA) since 2008. Gillnetting was allowed up to 2008, but there are no records of gillnetting in the area after 1999 (Williams et al. 2011), and AFMA has since prohibited the use of deepwater gillnets by Australian-flagged vessels.

Methodology

ERA framework

The ERA framework applied extensively in Australia (and globally) involves a hierarchical approach that moves from a largely qualitative analysis (at Level 1) to a highly quantitative 'model-based' approach at Level 3 (Hobday et al. 2011). The hierarchical approach can lead to rapid identification of higher risk activities. The approach is also precautionary, in that fishing activities are assumed to be high risk if information is lacking or there is no evidence to the contrary (Hobday et al. 2007, in Hobday et al. 2011).

Level 1 (SICA – Scale intensity consequence analysis)

Level 1 analyses are not discussed here, but have been applied effectively in other similar contexts (e.g. Qualitative (Level 1) Risk Assessment of the impact of commercial fishing on New Zealand Chondrichthyans, Ford et al. 2015).

Level 2 (PSA – Productivity-Susceptibility Assessment)

Level 2 analyses are based on scoring species (or other units of analysis) with productivity and susceptibility attributes (Stobutzki et al. 2002, Hobday et al. 2011). The productivity attributes influence the intrinsic rate of increase (r) and the susceptibility attributes influence the catch/removal component, in particular the catchability (q). The Level 2 uses seven productivity attributes that are assigned at ordinal scales between 1 and 3, with the total productivity score an average of the seven (See Table 1). This is based on the premise that the level of impact that a species can sustain is based on its productivity.

Table 1 shows example PSA productivity scores for low, medium and high productivity species. While it is often assumed that deepwater sharks fall into the low productivity category, this may not always be the case. Attribute thresholds and associated productivity scores may need to be modified.

Table 1 Productivity scores for seven species attributes for the Ecological Risk Assessment Effects of Fishing (ERAEF) Level 2 Productivity Susceptibility Analysis (PSA) method

Attribute	Low productivity (high risk, score –3)	Medium productivity (medium risk, score –2	High productivity (low risk, score –1)
Average age at maturity	>15 years	5–15 years	<5 years
Average maximum age	>25 years	10–25 years	<10 years
Fecundity	<100 eggs per year	100–20,000 eggs per year	>20,000 eggs per year
Average maximum size	>300 cm	100–300 cm	<100 cm
Average size at maturity	>200 cm	40-200 cm	<40 cm
Reproductive strategy	Live bearer (and birds)	Demersal egg layer	Broadcast spawner
Trophic level	>3.25	2.75–3.25	<2.75

From Hobday et al. 2011

Susceptibility is estimated from four factors: availability (spatial distribution), encounterability (habitat and bathymetry overlap), selectivity and post capture survival (or post capture mortality). A multiplicative approach is used for susceptibility factors because it is assumed that a low risk for one factor acts to reduce overall risk. Missing attributes are scored a 3 (high risk), in line with the precautionary principle.

Both the Level 1 (SICA) and Level 2 (PSA) provide a useful screening tool to prioritise species and habitats but they do not provide absolute estimates of risk from fishing.

Level 3 (SAFE – Sustainability Assessment for Fishing Effects)

The Level 3 SAFE method (Zhou et al. 2007, Zhou and Griffiths 2008, Zhou et al. 2009, Hobday et al. 2011) provides an absolute measure of risk by determining the fishing mortality rate (expressed as the fraction of the population that has died as a result of fishing), as well as quantitative reference points associated with it.

Instead of using the four Level 2 susceptibility attributes (spatial distribution, encounterability, selectivity and post-capture mortality), the Level 3 assessment can integrate these into three parameters: spatial overlap, catchability and post capture mortality as described by Zhou et al. (2009) to determine the fishing mortality rate F_{CURR} as:

$$F_{CURR} = \frac{N_1}{N_1 + N_0} q\,(1 - E)(1 - s)$$

Where N_1 and N_0 are the mean abundance of a species inside and outside the fished areas, respectively, *q* is the catch rate (capture efficiency), *E* is the escapement rate and *s* is the post-capture survival rate. The expression (N/N_1+N_0) is a more precise representation of 'availability', while similarly *q*(1-*E*) is a more precise representation of encounterability x selectivity. A key difference between the Level 2 and Level 3 assessment is that the Level 2 derives availability based on presence in grids that have been fished, whereas Level 3 uses the estimated actual area affected by fishing within grids (Zhou at al. 2016).

This fishing-induced mortality rate is then compared to sustainability reference points as described by Zhou et al. (2009). There are a number of methods to determine the reference point for F_{MSY} based on a species' natural mortality rate. For species with lower natural mortalities, the fishing mortality producing the maximum sustainable yield is assumed to be equal to natural mortality (M):

$$F_{MSY} = M$$

The second reference point F_{CRASH} is the minimum fishing mortality rate that leads to an unsustainable stock over the long term and according to the Graham-Schaefer production model is expressed as:

$$F_{CRASH} = 2F_{MSY}$$

Natural mortality (M) can be derived from the literature or may be estimated using empirical equations based on available attributes for each species such as: age at maturity, maximum age, asymptotic or maximum length, and growth rate. M can also be derived from cogeneric species for those species where M estimates are unavailable.

Comparison between PSA and SAFE

Comparisons between PSA and SAFE analyses for the same fisheries and species support the recognition that PSA generally avoids false negatives (species assessed to be low vulnerability that are actually high vulnerability) but can result in many false positives (species assessed to have high risk that are actually low risk). Despite this limitation of PSA analyses, a higher level of false positives is simply a result of applying the precautionary principle. The SAFE method generally achieves less bias, but as noted by Hobday et al. (2011), false positives and false negatives can and do arise. In comparing the classifications in both the Level 2 and Level 3 analyses to the Australian *Fishery status reports* (Woodhams et al. 2011, 2013), Zhou et al. (2016) identified an overall misclassification rate of 27% and 8% respectively, with all misclassifications false positives.

One of the main limitations of the PSA analyses is that it only provides a relative measure of risk among the species examined and gives no indication of whether the populations at highest risk are truly unsustainable and those identified at lowest risk are truly sustainable (Zhou et al. 2008). Conversely, one of the main limitations of the SAFE analyses is that it is not always explicit about uncertainties in key assumptions in the method, including spatial distribution and the movement of stocks (Hobday et al. 2011). Consequently, it is important to involve stakeholders so that these uncertainties can be explored and understood.

Appendix 1 highlights key differences between PSA and SAFE assessments.

Stakeholder engagement

Stakeholder participation is an important component on the ERAEF process, particularly at the more qualitative levels of the hierarchy. Stakeholder participation improves the assessment process, through for example, experts identifying species that may be incorrectly identified at high risk (e.g. expert overrides), while also increasing the probability that results are accepted more widely (Hobday et al. 2011).

Data sources

Species list and attributes

The list of deepwater chondrichthyans for the southern Indian Ocean was compiled using various sources, including the FAO Species Catalogue for Fishery Purposes: Deep-sea Cartilaginous Fishes of the Indian Ocean volumes 1 and 2 (Ebert 2013a, b) and was partially validated using records provided by the Southern Indian Ocean Deepsea Fishers' Association. International chondrichthyans experts were also consulted on species identification and distribution, which resulted in a number of modifications to the identification of certain species in catch records and the inclusion of species in the final species list. The species list is provided at Appendix 2.

Australia engaged chondrichthyans experts from James Cook University (JCU) to compile comprehensive data on the life history attribute data for chondrichthyans (sharks, batoids and chimaeras), which included:

- Species number (1-N)
- Species CAAB code
- Scientific name
- Family name
- Role in fishery (e.g. target, bycatch)
- Minimum age at maturity (years), males and females
- Maximum age at maturity
- Maximum age (years), males and females
- Minimum estimated number of eggs
- Maximum estimated number of eggs
- Maximum size (cm)
- Maximum size (cm), males and females
- Minimum size at maturity (cm)
- Minimum size at maturity (cm), males and females
- Reproductive strategy
- Minimum trophic level
- Maximum trophic level
- Interbirth interval
- Intrinsic rate of increase
- Natural mortality.

Biological attribute data were compiled from a variety of sources, including Ebert (2013a, b), peer-reviewed literature and data held by shark experts at JCU. Biological attributes for cogeneric species were used as a proxy for species for which biological attribute data were unavailable. These are identified in the underlying datasets. An example of biological attribute data collected is included at Appendix 2.

Data – spatial

Spatial fishing effort data will be compiled using the fishing footprints for all bottom fishing undertaken in the SIOFA Area during 2011–2016, where available. Maps of species distribution were compiled using the FAO's Compilation of Aquatic Distribution Maps of Interest to Fisheries. Minimum and maximum depth ranges for species were compiled using various sources, including Ebert (2013a, b) and peer-reviewed literature.

Next steps

1. Obtain footprint data for all bottom fishing undertaken (all countries) in the SIOFA Area between 2011–2016
2. Consolidate GIS data for species distribution and overlay/mask fishing footprint. Filter overlap of distribution and fishing effort by species minimum and maximum depth ranges.
3. Consider and define the following assumptions (including for different gear types, where relevant):
    - Catchability and fishing mortality, as defined by:
        - Availability (A)
        - Encounterability (E)
        - Selectivity (S)
        - Post-capture mortality (D)
    - Consider appropriateness of risk categories (see Appendix 1).
4. Run assessment and provide results to stakeholders for consultation

The final report will be produced by ABARES in collaboration with CSIRO and JCU and will be made publicly available. It is anticipated that the final report will be finished by June 2017.

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Appendix 1

Comparison between PSA and SAFE.

	PSA	SAFE
Key assumptions	1. Risk is measured by productivity and susceptibility attributes; 2. Fish randomly or homogeneously distribute over their distribution range; 3. 3-level catchability: low, medium, and high; 4. Productivity relate to life history traits.	1. Risk is measured by fishing mortality and reference points; 2. Same as PSA; 3. 3-level catchability: 0.33, 0.67, and 1; 4. Reference points relate to life history traits.
Productivity or reference point axis	**Attributes used:** 1. Maximum length; 2. Age at maturity; 3. Maximum age; 4. Fecundity; 5. Size at maturity; 6. Reproductive strategy; 7. Trophic level.	**Attributes used:** 1. Same as PSA; 2. Same as PSA; 3. Same as PSA; 4. Natural mortality; 5. Growth rate; 6. Intrinsic population increase r.
	Scoring Rules: 1. Each attribute is divided into 1, 2, and 3 scores; 2. Uses genera average when species-specific attributes are missing; 3. Missing data scored as high; 4. Final score P = average of all attribute scores.	**Equations:** 1. $F_{msy} = r/2$; 2. Estimating M using 1–5 life history parameters above: $F_{msy} = 0.87M$ (teleost) and $F_{msy} = 0.41M$ (elasmobranch); 3. Mean F_{msy} = average all F_{msy}; 4. $F_{lim} = 1.5F_{msy}$ and $F_{crash} = 2F_{msy}$.
Susceptibility or fishing mortality axis	**Attributes used:** 1. Availability (A) 2. Encountability (E) 3. Selectivity (S) 4. Post-capture mortality (D)	**Fishing mortality:** 1. Availability (A) 2. Encountability (E) 3. Selectivity (S) 4. Post-capture mortality (D)
	Scoring Rules: Final score $S = A \times E \times S \times D$	**Scoring Rules:** Fishing mortality $F = A \times E \times S \times D$
Risk category	Divide possible scores into 1/3rds 1. Low risk: <2.64 2. Medium risk: 2.64–3.18 3. High risk: >3.18	1. Low risk: $F < F_{msy}$ 2. Medium risk: $F_{msy} < F < F_{lim}$ 3. High risk: $F > F_{lim}$

From Zhou et al. 2016. Note that assumptions may be different to those above depending on different requirements for different assessments.

Appendix 2

Species list for which attribute data are available

Scientific Name

Alopias superciliosus
Anacanthobatis marmorata
Indobatis ori
Bathyraja smithii
Bathyraja tunae
Notoraja lira
Carcharhinus altimus
Centrophorus granulosus
Centrophorus isodon
Centrophorus lusitanicus
Centrophorus moluccensis
Centrophorus squamosus
Centrophorus uyato
Deania calcea
Deania profundorum
Deania quadrispinosa
Cetorhinus maximus
Chimaera notafricana
Hydrolagus africanus
Hydrolagus trolli
Chlamydoselachus africana
Chlamydoselachus anguineus
Dalatias licha
Euprotomicrus bispinatus
Heteroscymnoides marleyi
Isistius brasiliensis
Echinorhinus brucus
Etmopterus alphus
Etmopterus bigelowi
Etmopterus brachyurus
Etmopterus compagnoi
Etmopterus gracilispinis
Etmopterus granulosus
Etmopterus pusillus
Etmopterus sculptus
Etmopterus sentosus
Etmopterus viator
Cruriraja hulleyi
Cruriraja parcomaculata
Fenestraja maceachrani
Heptranchias perlo
Hexanchus griseus
Hexanchus nakamurai
Hexatrygon bickelli
Lamna nasus
Mitsukurina owstoni
Benthobatis moresbyi
Odontaspis ferox
Odontaspis noronhai
Oxynotus centrina
Plesiobatis daviesi
Pliotrema warreni
Pristiophorus nancyae
Eridacnis sinuans
Pseudocarcharias kamoharai
Pseudotriakis microdon
Dipturus crosnieri
Dipturus stenorhynchus
Leucoraja wallacei
Okamejei heemstrai
Rajella caudaspinosa
Rhinobatos holcorhynchus
Harriotta haeckeli
Harriotta raleighana
Rhinochimaera africana
Apristurus indicus
Apristurus investigatoris
Apristurus longicephalus
Apristurus melanoasper
Apristurus microps
Apristurus saldanha
Bythaelurus bachi
Bythaelurus clevai
Bythaelurus lutarius
Bythaelurus naylori
Bythaelurus tenuicephalus
Cephaloscyllium sufflans
Holohalaelurus favus
Holohalaelurus grennian
Holohalaelurus melanostigma
Holohalaelurus punctatus
Holohalaelurus regani
Parmaturus macmillani
Scyliorhinus capensis

Scyliorhinus comoroensis
Centroscymnus coelolepis
Centroscymnus owstoni
Centroselachus crepidater
Scymnodalatias albicauda
Scymnodon plunketi
Somniosus antarcticus
Zameus squamulosus
Cirrhigaleus asper
Squalus blainville
Squalus lalannei
Squalus megalops
Squalus mitsukurii
Squatina africana

Example attribute data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	
1	**Species n**	**CAAB co**	**Scientific Name**	**Family Name**	**Role in fishe**	**Min Age M**	**Min Age Mat**	**Min Age Ma**	**Max Age Matu**	**Max Age**	**Max Age**	**Min est no eg**	**Max est no e**	**Max siz**	**Max Size**	**Max size**	**Min size M**	**Min Size Mat**	**Min Size Ma**	**Repr St**	**Min Troph**	**Max Tropl**	**k M**	**k F**	**Sbirth**	**Interbirt**	**Intrinsic ir**	**Depth Min**	**Depth max**	**Co**
2	1	3.7E+07	*Alopias superciliosus*	Alopidae	Bycatch		9	12.3	13.4	19	20	2	4		484	410		279	350.8	LB	4.2	4.2	0.088	0.092	100	*1*	0.118	0	723	Rec
3	2		*Anacanthobatis marmorata*	Anacanthobatidae	Discard?									29				23	23	DS	3.6	3.6				*1*		200	433	Ma
4	3		*Indobatis ori*	Anacanthobatidae	Bycatch									42.9				42.9	38.7	DS	3.6	3.6				*1*		1000	1725	We
5	4		*Bathyraja smithii*	Arhynchobatidae	Bycatch		*8.6*	*9.4*	*9.4*	*15*	*17*	*6*	*37*	120				95	87.5	DS	4.3	4.3	*0.12*	*0.087*	12	1		250	1040	Ebe
6	5		*Bathyraja tunae*	Arhynchobatidae	Bycatch		*22*	*23*	*23*	*35*	*37*	*4*	*12*	96.6				84	81	DS	4	4	0.027	0.024	31	1		1700	2240	May
7	6		*Notoraja lira*	Arhynchobatidae	Discard?		*7.3*	*6.8*	*6.8*	*18*	*17*	*10*	*10*	*55*				*45*	*45*	DS	3.7	3.7	*0.185*	*0.237*	*14*	1		1050	1050	Las
8	7	3.7E+07	*Carcharhinus altimus*	Carcharhinidae	Byproduct		*10.5*	*14.8*	*14.8*	*27.4*	*32.2*	3	15	300				190	225	LB	4.3	4.3	*0.04*	*0.02*	75	1.5		0	810	Kyr
9	8	3.7E+07	*Centrophorus granulosus*	Centrophoridae	Byproduct		8.5	16.5	16.5	25	39	1	8		172.5	124		105	138	LB	4.1	4.1	0.107	0.096	38	2	0.0384	50	1500	Am
10	9		*Centrophorus isodon*	Centrophoridae	Bycatch?		*8.5*	*16.5*	*16.5*	*25*	*39*	2	2		87.5	108.2		81	99.9	LB	4.4	4.4	*0.107*	*0.096*	33	*2.5*		435	770	Ebe
11	10		*Centrophorus lusitanicus*	Centrophoridae	Byproduct		*8.5*	*16.5*	*16.5*	*25*	*39*	1	6	100				75	86	LB	4.4	4.4	*0.107*	*0.096*	35	*2.5*		300	1400	C. I
12	11	3.7E+07	*Centrophorus moluccensis*	Centrophoridae	Bycatch		*8.5*	20	20	*25*	*39*	1	2	101.7				67	85	LB	4.3	4.3	*0.107*	*0.096*	35	*2.5*	0.08	128	823	Gra
13	12	3.7E+07	*Centrophorus squamosus*	Centrophoridae	Target, byproduct		30	35	35	54	70	2	10		122	164		94	102	LB	4.2	4.2	0.025	0.025	40	*2.5*	0.0175	0	3366	C. F
14	13		*Centrophorus uyato*	Centrophoridae	Discard?		*8.5*	*16.5*	*16.5*	*25*	*39*	1.5	1.5		93	112		80	100	LB	4.5	4.5	*0.107*	*0.096*	45	3		50	1400	RL/
15	14	3.7E+07	*Deania calcea*	Centrophoridae	Byproduct		14	22	36	32	36	1	17		94	162		73	94	LB	4.2	4.2	0.049	0.051	30	*2.5*	0.0237	60	1490	Am
16	15		*Deania profundorum*	Centrophoridae	Discard		*14*	*22*	*36*	*32*	*36*	5	7	97				43	62	LB	4.2	4.2	*0.049*	*0.051*	31	*2.5*		205	1800	C. F