

## 5th Meeting of the Scientific Committee

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### SC5-DW10

Preliminary ecological risk assessment for the effects of demersal and midwater trawl, demersal line, dropline and demersal gillnet gears on deepwater chondrichthyans in the South Pacific Ocean

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PRELIMINARY ASSESSMENT

Executive Summary

This paper summarises the preliminary work completed towards a quantitative ecological risk assessment for the effects of fishing on deepwater chondrichthyans in the South Pacific Regional Fisheries Management Organisation (SPRFMO) Convention Area. Gears assessed include demersal and midwater trawl, line gears (demersal longline and dropline) and gillnet gears. The outputs of the preliminary Productivity-Susceptibility Analysis (PSA) are expected to change based on refinement of the attributes used in the analysis, including through a process of expert input.

The work completed includes the review of literature and fishing histories to identify the chondrichthyans that may be impacted by deep water fishing gears and a preliminary PSA for these species (based on the methods of Stobutzki et al. 2002 and Hobday et al. 2011). PSA provides an initial process to rank order the potential risk to species from the effects of fishing. This serves two purposes for the Scientific Committee:

- 1. semi-quantitative assessment the proportion of species considered to be a high risk in comparison to low risk; and
- 2. prioritisation of the the species for quantitative analyses based on potential risk and data availability.

Ecological units assessed

One hundred and thirty-seven chondrichthyans were included in the species list. These included all sharks, batoids and chimaeras likely to occur in and interact with fisheries in the SPRFMO area. The species list was compiled various sources, including the FAO Species Catalogue *Deep-sea Cartilaginous Fishes of the Southeastern Pacific Ocean* (Ebert 2013), *Rays of the World* (Last et al. 2016) and a qualitative risk assessment of the impact of commercial fishing on New Zealand chondrichthyans (Ford et al. 2015).

Results

There were 127 species assessed in the preliminary PSA. Ninety-six species were considered to have robust attribute data and 31 were considered to be data deficient. Data deficient species are defined as those with =>3 (out of 11) missing productivity or susceptibility attributes. PSA results are presented for all species and with the removal of data deficient species (i.e. robust species data only). Using the productivity and susceptibility assumptions presented herein, the analyses identified 63 species (42 if only robust attribute data used) as being at high risk to the effects of fishing (Table 1 and Table 2). Demersal longline, dropline and gillnet gears resulted in a higher number of species in the high relative potential risk category compared to demersal and midwater trawl gears (Table 1). This does not necessarily mean that gillnet and line gears cause a greater level of fishing mortality; rather, that they can theoretically lead to greater exploitation based on the productivity and susceptibility attributes used for the analysis, which will be iteratively refined.

Table 1. Count of chondrichthyans species in each PSA relative potential risk category for each SPRFMO gear type

Relative potential risk	Demersal trawl		Midwater trawl		Demersal longline		Dropline		Gillnet*	
	All	Robust	All	Robust	All	Robust	All	Robust	All	Robust
High	22	13	18	10	56	37	56	37	45	25
Medium	87	65	83	61	62	50	62	50	81	70
Low	18	18	26	25	9	9	9	9	1	1

\* Gillnet fishing banned in 2010. Note – dropline susceptibility attributes have not yet been explicitly defined and are assumed to be the same as demersal longline.

## PRELIMINARY ASSESSMENT

**Table 2. Chondrichthyans species in the SPRFMO area identified at highest potential risk to the effects of fishing by the PSA for each gear type**

Species	Demersal trawl		Midwater trawl		Demersal longline & dropline		Gillnet	
	Atributes		Atributes		Atributes		Atributes	
	All	≥8	All	≥8	All	≥8	All	≥8
<i>Aculeola nigra</i>								
<i>Amblyraja doellojuradoi</i>								
<i>Amblyraja frerichsi</i>								
<i>Amblyraja hyperborea</i>								
<i>Apristurus ampliceps</i>								
<i>Apristurus australis</i>								
<i>Apristurus exsanguis</i>								
<i>Apristurus melanoasper</i>								
<i>Bathyraja brachyurops</i>								
<i>Bathyraja cousseauae</i>								
<i>Bathyraja macloviana</i>								
<i>Bathyraja meridionalis</i>								
<i>Bathyraja multispinis</i>								
<i>Bathyraja peruana</i>								
<i>Bathyraja schroederi</i>								
<i>Bathyraja shuntovi</i>								
<i>Brochiraja spinifera</i>								
<i>Bythaelurus dawsoni</i>								
<i>Centrophorus harrissoni</i>								
<i>Centrophorus squamosus</i>								
<i>Centrophorus zeehaani</i>								
<i>Centroselachus crepidater</i>								
<i>Chimaera carophila</i>								
<i>Chimaera lignaria</i>								
<i>Chimaera orientalis</i>								
<i>Chimaera panthera</i>								
<i>Chlamydoselachus anguineus</i>								
<i>Cirrhigaleus australis</i>								
<i>Cirrhigaleus barbifer</i>								
<i>Dalatias licha</i>								
<i>Dasyatis thetidis</i>								
<i>Deania calceus</i>								
<i>Deania quadrispinosa</i>								
<i>Dipturus gudgeri</i>								
<i>Dipturus innominatus</i>								
<i>Echinorhinus brucus</i>								
<i>Echinorhinus cookei</i>								
<i>Etmopterus litvinovi</i>								
<i>Etmopterus viator</i>								
<i>Gollum attenuatus</i>								
<i>Heteroscymnoides marleyi</i>								
<i>Hexanchus nakamurai</i>								

## PRELIMINARY ASSESSMENT

Species	Demersal trawl		Midwater trawl		Demersal longline & dropline		Gillnet	
	Attributes		Attributes		Attributes		Attributes	
	All	≥8	All	≥8	All	≥8	All	≥8
<i>Hydrolagus lemures</i>								
<i>Hydrolagus melanophasma</i>								
<i>Isurus oxyrinchus</i>								
<i>Lamna nasus</i>								
<i>Mitsukurina owstoni</i>								
<i>Odontaspis ferox</i>								
<i>Pristiophorus cirratus</i>								
<i>Pseudotriakis microdon</i>								
<i>Rhinochimaera africana</i>								
<i>Rhinochimaera pacifica</i>								
<i>Scymnodon plunketi</i>								
<i>Scymnodon ringens</i>								
<i>Somniosus antarcticus</i>								
<i>Somniosus longus</i>								
<i>Squalus acanthias</i>								
<i>Squalus cholorculus</i>								
<i>Squalus griffini</i>								
<i>Squalus montalbani</i>								
<i>Tetronarce tremens</i>								
<i>Torpedo macneilli</i>								
<i>Zearaja chilensis</i>								

## Scientific advice arising from the PSA

- Approximately 50% of the deepwater chondrichthyans assessed were categorised at high relative potential risk to the effects of fishing.
- The number of species assessed to be at high relative potential risk from line and gillnet gears is greater than for trawl gears.
- The information on productivity and susceptibility was assessed to be data deficient for 25% of the species evaluated.
- The PSA included the following assumptions that limit the interpretation for management advice. These are:

1. Species distributions in relation to the total area of the SPRFMO fisheries

The PSA method assumes that:

- I. fishing interactions for the species assessed only occur within the SPRFMO area, even for species with distributions that extend beyond SPRFMO boundaries;
- II. within SPRFMO boundaries fishing effort is homogenously distributed and occurs across the fishery area; and
- III. species are homogenously distributed across their ranges.

Consequently, species with a worldwide distribution are more likely to be assigned a low risk (as overlap with SPRFMO fisheries is low relative to species with distributions that partly or wholly occurred within the SPRFMO area). High risk is

## PRELIMINARY ASSESSMENT

more likely to be assigned to species with distributions fully within the SPRFMO area.

### 2. Selectivity attributes were assumed to be the same for sharks, batoids and chimaeras

Behavioural and morphological characteristics vary markedly both between and within these groups, meaning that susceptibility to capture by different gears will also differ. Given that 65 percent of the species included were either sharks or chimaeras, which generally share roughly similar morphology and on which most selectivity attributes were based, this may result in a degree of uncertainty around the susceptibility risk scores for batoids. The analysis could be refined by using different selectivity assumptions based on behaviour, morphology or other characteristics.

### 3. Productivity knowledge gaps

Biological information is lacking for many species. Productivity attributes were often assumed from cogenetic species (and sometimes species from the same family). These assumptions are identified in the underlying datasets.

It is likely that many deepwater chondrichthyans will have unique and complex stock structuring. Knowledge of stock structure is limited, particularly on the high seas. It is likely that the effects of fishing on deepwater chondrichthyans over broad spatial scales will be very different to the effects of fishing at sub-population or local geographic scales.

### 4. High false positive rate

The method is intentionally precautionary and tends to result in more false positives (species assessed to be high risk that are actually low risk). This is due to the assumptions above and where knowledge is absent ascribing the highest risk score for missing productivity and susceptibility attributes.

- The 42 species scored as high risk with robust data are prioritised for analyses that estimate current fishing mortality (e.g. SAFE (Zhou et al. 2008)). This analysis should be the focus of the 2018 workplan.

## Recommendations

It is recommended that the Scientific Committee:

- **Requests** Members with bottom fisheries to continue collaborations and apply more quantitative risk assessment methods to estimate current fishing mortalities (or proxy) for their SPRFMO bottom fisheries;
- **Requests** Members collaborating on the above analyses to develop advice for the Scientific Committee on the effects of fishing on deepwater chondrichthyans;
- **Adopts** the proposed work plan outlined;
- **Recommends** to the Commission that the committee's workplan and roadmap are amended to include the work described above.

# PRELIMINARY ASSESSMENT

## Contents

Executive Summary .....	2
Ecological units assessed .....	2
Results .....	2
Scientific advice arising from the PSA .....	4
Recommendations .....	5
Overview .....	8
ERAEF framework .....	8
The hierarchical approach .....	8
Conceptual model .....	8
Stakeholder engagement process .....	8
Broad discussion of ERA methods .....	9
Methodology for assigning risk scores to productivity attributes .....	10
Methodology for assigning risk scores to susceptibility attributes .....	11
Availability .....	11
Encounterability .....	12
Selectivity .....	12
Post capture mortality .....	13
Data sources .....	14
Species list and attributes .....	14
Spatial .....	15
PSA results .....	15
Units excluded from analysis and reasons for exclusion .....	15
PSA charts and tables .....	15
Demersal trawl sub-fishery .....	15
Midwater trawl subfishery .....	21
Demersal longline and dropline subfishery .....	27
Gillnet subfishery .....	33
Next steps - SAFE methodology .....	39
Cumulative impacts .....	40
Next steps – 2018 Work Plan .....	40
Discussion and implications .....	40
Summary of findings .....	40
Relevance to management .....	41
References .....	42
Appendix 1 .....	54
Appendix 2 .....	55

PRELIMINARY ASSESSMENT

Appendix 3 ..... 59

PRELIMINARY ASSESSMENT

# PRELIMINARY ASSESSMENT

## Overview

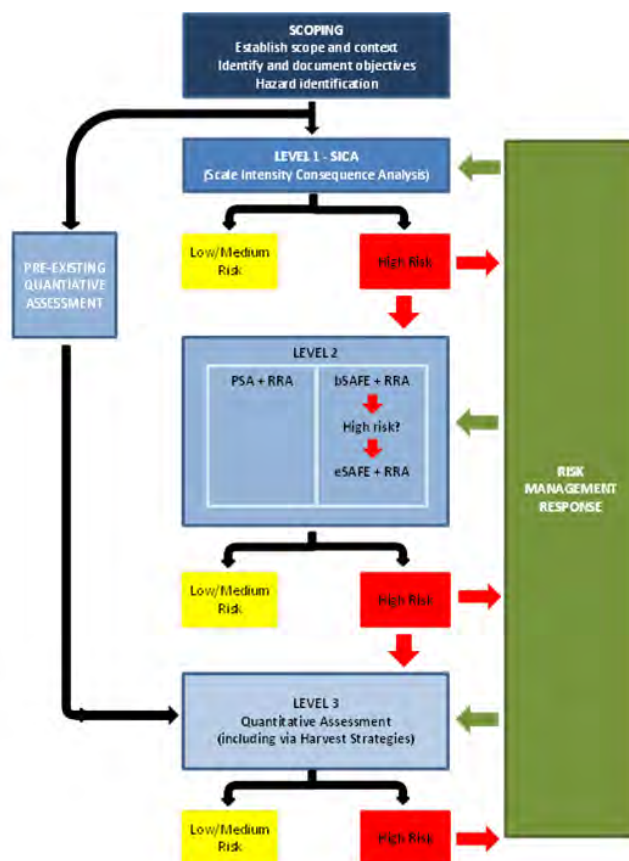
### ERAEF framework

#### The hierarchical approach

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).

#### Conceptual model

**Figure 1 Structure of the level 3 hierarchical Ecological Risk Assessment for the Effects of Fishing (ERAEF) methodology framework**



Note: SICA – Scale Intensity Consequence Analysis; PSA – Productivity Susceptibility Analysis; SAFE – Sustainability Assessment for Fishing Effects; RRA – Residual Risk Analysis. T1 – Tier 1. eSAFE may be used for species classified as high risk by bSAFE.

#### Stakeholder engagement process

Stakeholder participation is an important component at all levels of the ERAEF hierarchical process. 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). This ERA will include dissemination and presentation of methodology and results to the SPRFMO Scientific Committee, as well as intersessional dissemination of results and opportunities for stakeholders to provide input and feedback.

## PRELIMINARY ASSESSMENT

### Broad discussion of ERA methods

Level 1 (Scale, Intensity and Consequence Analysis; SICA) assessments 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 (Productivity-Susceptibility Analysis; PSA) is a risk based approach that is based on scoring species (or other units of analysis, including habitats and ecological communities) 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 ( $q$ ). PSA analyses use seven productivity attributes that are assigned at ordinal scales between 1 and 3, with the total productivity score an average of the seven. This is based on the premise that the level of impact that a species can sustain is based on its productivity. Because species-specific information on productivity is often lacking, estimates can be derived from similar (e.g. cogenetic) species. This is an important limitation of the method and highlights the need to engage stakeholders in the process so that estimates of certain life history attributes, and the additional uncertainty this may result in, are transparent and understood. Susceptibility is fishery-dependent and 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 SICA and PSA provide a useful screening tool, but they do not provide absolute estimates of risk from fishing. The Level 3 (Sustainability Assessment for Fishing Effects; 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 ( $u$ , 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 PSA susceptibility attributes (spatial distribution, encounterability, selectivity and post-capture mortality), the SAFE assessment integrates these into three parameters: spatial overlap, catchability and post capture mortality (as described by Zhou et al. (2009)) to determine the fishing mortality rate.

Comparisons between PSA and SAFE analyses for the same fisheries and species support the recognition that the PSA generally avoids false negatives (species assessed to be low risk that are actually high risk) but can result in many false positives (species assessed to be high risk that are actually low risk). Despite this limitation, a higher level of false positives in the PSA analyses is the result of applying the precautionary principle (as well as the method itself), which states that the absence of adequate scientific information shall not be used as a reason for postponing or failing to take management action. The SAFE method generally achieves less false positives, but as noted by Hobday et al. (2011), false positives and false negatives can arise.

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. Key differences between PSA and SAFE analyses are described in Table 2.

PRELIMINARY ASSESSMENT

Table 2 Key differences between PSA and SAFE analyses

	PSA	SAFE
Risk assessed	Relative risk of overfishing	Quantitative assessment of fishing mortality using reference points
Strengths	Transparent (easy to apply and understand)  Suitable for protected species  Widely used	Can often be used for teleosts and chondrichthyans  Quantitative reference points for fishing mortality  Cumulative risk can be determined
Limitations	No explicit reference points  Can detect if a species may be overfished but provides no assessment of biomass  Can lack accuracy: False positives are more likely than false negatives  Tends to overestimate fishing mortality	Can detect if a species may be overfished but provides no assessment of biomass  Accuracy: False negatives slightly higher than false positives, but both are relatively low  Requires more data, time and \$

Adapted from Hobday et al. 2011

Appendix 1 highlights other key differences between PSA and SAFE assessments.

Methodology for assigning risk scores to productivity attributes

The PSA 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.

$$P = average(A1,A2,A3 \dots A7)$$

Table 3 shows 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.

Table 3 Productivity scores for seven species attributes used in this PSA

Attribute	Low productivity (high risk, score –3)	Medium productivity (medium risk, score –2)	High productivity (low risk, score –1)
1. Average age at maturity	>15 years	5–15 years	<5 years
2. Average maximum age	>25 years	10–25 years	<10 years
3. Fecundity	<10 pups/egg cases per year	10-20 pups/egg cases per year	>20 pups/egg cases per year
4. Average maximum size	>300 cm	100–300 cm	<100 cm
5. Average size at maturity	>200 cm	40-200 cm	<40 cm

PRELIMINARY ASSESSMENT

6. Reproductive strategy	Live bearer	Egg case layer	Broadcast spawner (teleosts) <b>a</b>
7. Trophic level	>3.25	2.75–3.25	<2.75

Source: Modified from Hobday et al. 2011 to reflect scores and ranges relevant to chondrichthyans (and not teleosts, birds, etc.). **a** No chondrichthyans were scored a 1 (low risk) for the reproductive strategy productivity attribute.

Methodology for assigning risk scores to susceptibility attributes

Susceptibility is fishery-dependent and is estimated from four factors: availability (*A*; spatial distribution), encounterability (*E*; overlap between a species depth range and the fishing gears used), selectivity (*S*; potential for capture by different gears), and post capture survival (or post capture mortality; *PCM*). A multiplicative approach is used for susceptibility factors because it is assumed that a low risk for one factor acts to reduce overall risk, as per:

$$S = A \times E \times S \times PCM$$

Missing attributes are scored a 3 (high risk), in line with the precautionary principle. These are identified in red in the PSA risk scores tables.

Table 4 Cutoff scores for susceptibility attributes

Attribute	Low susceptibility (low risk, score = 1)	Medium susceptibility (medium risk, score = 2)	High susceptibility (high risk, score = 3)
Availability	Globally distributed	Restricted to same hemisphere/ocean basin as fishery	Restricted to same area as fishery
Encounterability	Low overlap with fishing gear	Medium overlap with fishing gear	High overlap with fishing gear
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 in length  Line: 80-200 cm in length  Gillnet: 80-130 cm in length
Post-capture mortality (scores may vary by fishery and gear type)	Evidence of post capture release and survival	Released alive	Retained species, or majority dead when released

Source: Adapted from Hobday et al. 2011

The determination of cutoff scores associated with these susceptibility attributes is discussed in more detail below.

Availability

Availability considers the overlap of fishing effort with a species distribution. In this PSA, availability of chondrichthyans to the five sub-fisheries in the south Pacific Ocean was based on the species distribution in relation to the total area of the SPRFMO fisheries, such that species with a worldwide distribution were assigned a low risk (as overlap with SPRFMO fisheries was low relative to species with distributions that partly or wholly occurred within the SPRFMO area). Medium risk was assigned to species with distributions within and outside the SPRFMO area (but not globally distributed), and high risk was assigned to species with distributions fully within the SPRFMO area.

PRELIMINARY ASSESSMENT

This is a key limitation of the analysis and makes a number of assumptions, namely that fishing effort and species are homogenously distributed, and also that fishing effort occurs across the entire area.

Encounterability

Encounterability considers the likelihood that a species will encounter fishing gear that is used within the depth range of that species. Higher risk corresponds to gear being deployed at the core depth range of a species.

Table 5 shows encounterability scores for different depth categories for the four sub-fisheries assessed in the PSA.

Table 5 Encounterability scores for different depth categories for the four sub-fisheries

Depth code	Depth bin (standard)	Demersal Trawl	Midwater Trawl	Demersal longline	Gillnet
1	0-110				
2	110-250				
3	250-565				
4	565-820				
5	820-1100				
6	1100-3000				

Encounterability risk categorisations were based on fishing effort records and expert knowledge. Ideally, these scores should be workshopped with as many stakeholders as is practical. At the time of writing, information on likely depth ranges of gillnet operations was unavailable. In line with the precautionary principle, high potential risk was assumed for most depths in which gillnet gears could potentially be used. Exploration of sensitivities around setting different scores for different depths would help to refine this analysis.

Selectivity

Selectivity considers the potential of the gear to capture or retain species. Figures 5a, 5b and 5c show selectivity scores used in the PSA. The selectivity of each species is based on its size and the characteristics of the gear, with size being considered as the main factor in a species ability to outswim or break free at larger sizes. Because of the variability in behavioural and morphological characteristics of sharks, rays and other chondrichthyans (e.g. size, shape, swimming speed, strength, teeth structure, skin texture etc.), it may be useful to explore sensitivities around selectivity and escapement assumptions, and whether the assumptions used are reasonable assumptions for most species.

Figure 5a Risk scores for demersal and midwater trawl selectivity based on length (cm)



Risk scores for demersal and midwater trawl selectivity were based on other studies (refs).

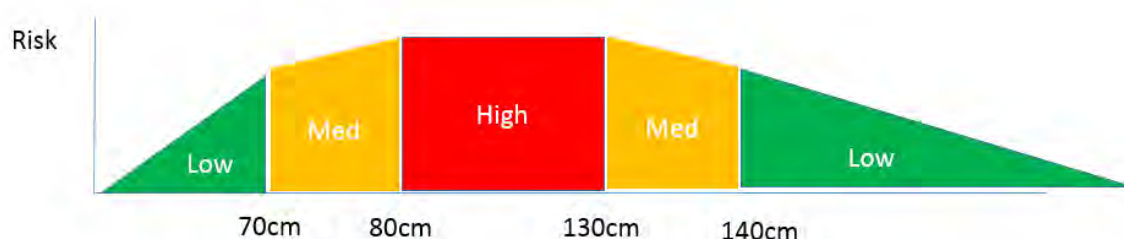
## PRELIMINARY ASSESSMENT

**Figure 5b Risk scores for longline selectivity based on length (cm)**



Risk scores for longline selectivity were estimated using knowledge of average hook sizes (14/0–16/0) and discussions with chondrichthyans experts. Animals larger than 200 cm were thought to be more likely to escape (or break free) (C. Simpfendorfer, pers. comm. 2017). These estimates could be strengthened by using better data on gear specifics and consideration of selectivity on a species by species basis, but this may be impractical depending on the level of analysis and the objectives of the study.

**Figure 5c Risk scores for gillnet selectivity based on length (cm)**



The gillnet mesh size used for targeting deepwater sharks (including *Centroscyrnus coelolepis*, which is caught in this fishery) was assumed to be 160 mm but could range from 120–220mm. Gillnet selectivity risk scores were estimated 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. Exploration of sensitivities around these assumptions may be important, particularly for rays, which may have quite different morphological and behavioural characteristics. Roughly two-thirds of the species included in this analysis were sharks or chimaeras, which were assumed to share roughly similar morphological characteristics (i.e. long and relatively torpedo-shaped). This was thought to be suitable assumption for the purposes of the initial analysis. However, the analysis could be strengthened by considering different selectivities for sharks, batoids and chimaeras, and sensitivities run on these selectivities would likely highlight some key limitations of these assumptions.

### Post capture mortality

Post capture mortality (PCM) considers the condition and subsequent level of survival of chondrichthyans that are captured and released (or discarded). PCM can vary with sub-fishery based on different gears and other fishery characteristics. PCM has been estimated using knowledge or assumptions about whether a species is targeted, byproduct, bycatch or is a protected, threatened or endangered species, as per the following:

- Target: high risk
- Byproduct: high risk
- Bycatch: taxa/fishery dependent
- Protected species: taxa/fishery dependent.

## PRELIMINARY ASSESSMENT

For target and byproduct species, which are often retained, it is assumed that survival is generally zero (thus, high risk). Species that are discarded may or may not survive. Due to the characteristics of deepwater fishing, it is assumed that post capture survival for all deepwater chondrichthyans is zero. Further research would be needed to refine these assumptions.

### Data sources

#### Species list and attributes

The list of deepwater chondrichthyans occurring in the SPRFMO Convention Area was compiled using various sources, including the *FAO Species Catalogue for Fishery Purposes: Deep-sea Cartilaginous Fishes of the southeastern Pacific Ocean* (Ebert 2016), *Rays of the World* (Last et al. 2016), a qualitative assessment of fishing risk to deepwater chondrichthyans in New Zealand (Ford et al. 2015) and recent published literature on new species in the region. Internationally-recognised chondrichthyans experts were also consulted. The list of species included in the PSA is provided at Appendix 2.

Comprehensive biological attribute data for chondrichthyans (sharks, batoids and chimaeras) was compiled and included:

- Species number (1-N)
- Species CAAB code (Codes for Australian Aquatic Biota – CSIRO)
- Scientific name
- Common 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 pups/egg cases
- Maximum estimated number of pups/egg cases
- 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 (2016), peer-reviewed literature and data held by shark experts at JCU. Biological attributes for cogenetic (or sometimes cofamily) species were used as a proxy for species for which biological attribute data were unavailable. These are identified in the underlying datasets. Minimum and maximum depth ranges for species were compiled using various sources, including Ebert (2016) and peer-reviewed literature.

PRELIMINARY ASSESSMENT

Spatial

The SAFE analysis will require fishing effort (footprint) data for all bottom fishing undertaken in the SPRFMO 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 (Geonetwork database). Where these were unavailable, maps were sourced from the IUCN Red List.

PSA results

Units excluded from analysis and reasons for exclusion

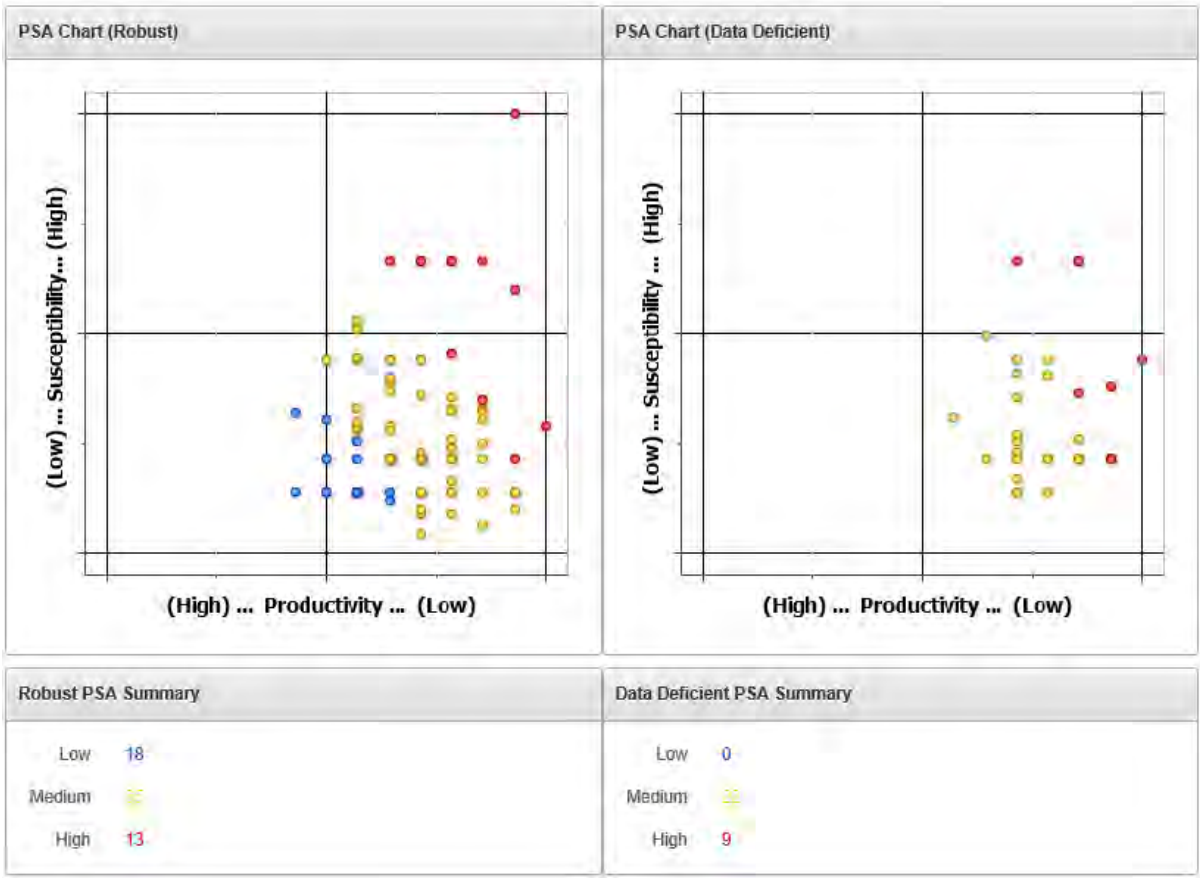
Initially, species were identified with geographical distributions or depth ranges within those distributions that could potentially interact with fisheries in the south Pacific Ocean. Some of these were excluded for a variety of reasons, including that they were endemic to countries’ exclusive economic zones (i.e. distribution was not thought to extend into the high seas); because they were particularly rare and there may have only been a handful of records in the south Pacific area; or because of their depth ranges and known distributions indicating that they were unlikely to be found within the SPRFMO area or interact with the fishing gears being assessed.

The resulting list of 127 species (Appendix 2) was retained for the PSA assessment. Because the PSA assessment is intended to indicate potential relative risk and was intended to be complementary to the SAFE assessment, no further units were excluded from the PSA.

PSA charts and tables

Demersal trawl sub-fishery

Figure 6 PSA charts for ‘robust’ and ‘data deficient’ chondrichthyans species in the SPRFMO Convention Area) for demersal trawl gears



## PRELIMINARY ASSESSMENT

Table 6 PSA risk scores for chondrichthyans species that could interact with demersal trawl gears in the SPRFMO Convention Area

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Isurus oxyrinchus</i>	Shortfin Mako	2	3	3	3	3	3	3	3	3	3	3	2.86	3	1	4.14	High
<i>Etmopterus viator</i>	-	3	3	3	3	2	3	3	3	2.731	3	2	2.86	2.2	2	3.61	High
<i>Heteroscymnoides marleyi</i>	-	3	3	3	3	1	3	3	3	3	3	2	2.71	2.33	4	3.57	High
<i>Centrophorus squamosus</i>	Leafscale Gulper Shark	3	3	3	2	2	3	3	2	3	3	3	2.71	2.33	0	3.57	High
<i>Apristurus ampliceps</i>	-	3	3	3	3	2	2	3	3	3	3	2	2.71	2.33	5	3.57	High
<i>Mitsukurina owstoni</i>	-	3	3	3	3	3	3	3	2	3	3	2	3	1.88	5	3.54	High
<i>Hexanchus nakamurai</i>	Bigeye Sixgill Shark	2	3	3	2	2	3	3	2	3	3	3	2.57	2.33	0	3.47	High
<i>Squalus acanthias</i>	Whitespotted Dogfish	2	3	3	2	2	3	3	3	3	3	2	2.57	2.33	1	3.47	High
<i>Somniosus antarcticus</i>	Southern Sleeper Shark	3	3	3	3	3	3	3	2	3	2	2	3	1.58	0	3.39	High
<i>Chimaera carophila</i>	-	2	3	3	2	2	2	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Dasyatis thetidis</i>	Black Stingray	2	2	3	2	2	3	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Torpedo macneilli</i>	Short-tail Torpedo Ray	2	2	3	2	2	3	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Apristurus exsanguis</i>	-	3	3	3	1	2	2	3	3	3	3	2	2.43	2.33	3	3.37	High
<i>Squalus montalbani</i>	-	3	3	3	3	2	3	3	3	1.752	3	2	2.86	1.76	3	3.36	High
<i>Tetronarce tremens</i>	-	2	2	3	1	2	3	3	3	3	3	2	2.29	2.33	1	3.27	High
<i>Somniosus longus</i>	-	3	3	3	2	2	3	3	3	1.67	3	2	2.71	1.73	3	3.22	High
<i>Rhinochimaera africana</i>	-	3	3	3	2	2	2	3	3	2.088	3	2	2.57	1.91	0	3.2	High
<i>Scymnodon plunketi</i>	Plunket's Dogfish	3	3	3	2	2	3	3	2	1.6	3	3	2.71	1.7	0	3.2	High
<i>Lamna nasus</i>	Porbeagle	2	3	3	3	3	3	3	1	3	3	2	2.86	1.43	0	3.2	High
<i>Squalus griffini</i>	-	3	3	3	3	2	3	3	3	1	3	2	2.86	1.43	3	3.2	High
<i>Gollum attenuatus</i>	-	3	3	3	3	2	3	3	3	1	3	2	2.86	1.43	5	3.2	High
<i>Echinorhinus cookei</i>	-	3	3	2	3	3	3	3	3	1	3	2	2.86	1.43	5	3.2	High
<i>Euprotomicroides zantedeschia</i>	-	3	3	3	1	2	3	3	3	3	2	2	2.57	1.88	3	3.18	Medium
<i>Scymnodon ringens</i>	-	3	3	3	2	2	3	3	3	1.521	3	2	2.71	1.66	1	3.18	Medium
<i>Deania calceus</i>	Brier Shark	3	3	3	2	2	3	3	2	1.49	3	3	2.71	1.65	0	3.17	Medium
<i>Chlamydoselachus anguineus</i>	Frill Shark	3	3	3	2	2	3	3	2	1.417	3	3	2.71	1.61	2	3.15	Medium

## PRELIMINARY ASSESSMENT

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Squalus cholorculus</i>	-	2	2	3	3	2	3	3	3	1.862	3	2	2.57	1.81	3	3.14	Medium
<i>Odontaspis ferox</i>	Smalltooth Sandtiger Shark; Sandtiger Shark	2	3	3	3	3	3	3	2	1	3	2	2.86	1.28	0	3.13	Medium
<i>Echinorhinus brucus</i>	Bramble Shark	3	3	3	2	3	3	3	2	1	3	2	2.86	1.28	2	3.13	Medium
<i>Pseudotriakis microdon</i>	False Catshark	3	3	3	2	3	3	3	2	1	3	2	2.86	1.28	2	3.13	Medium
<i>Apristurus melanoasper</i>	-	3	3	3	3	2	2	3	2	1.819	3	2	2.71	1.52	4	3.11	Medium
<i>Hexanchus griseus</i>	Bluntnose Sixgill Shark	2	3	3	3	3	3	3	1	3	1	3	2.86	1.2	0	3.1	Medium
<i>Deania quadrispinosa</i>	Longsnout Dogfish	3	3	3	2	2	3	3	2	1.76	3	2	2.71	1.5	0	3.1	Medium
<i>Rhinochimaera pacifica</i>	Pacific Spookfish	3	3	3	1	2	3	3	3	1.64	3	2	2.57	1.71	1	3.09	Medium
<i>Squalus megalops</i>	Piked Spurdog; Spikey Dogfish	2	3	3	1	2	3	3	2	3	2	3	2.43	1.88	0	3.07	Medium
<i>Zameus squamulosus</i>	Velvet Dogfish	2	3	3	1	2	3	3	2	3	3	2	2.43	1.88	0	3.07	Medium
<i>Squaliolus aliae</i>	Smalleye Pygmy Shark	3	3	3	1	1	3	3	3	3	2	2	2.43	1.88	3	3.07	Medium
<i>Chimaera lignaria</i>	-	3	3	3	2	2	2	3	3	1.521	3	2	2.57	1.66	1	3.06	Medium
<i>Cirrhigaleus australis</i>	-	3	3	3	2	2	3	3	3	1	3	2	2.71	1.43	1	3.06	Medium
<i>Bythaelurus dawsoni</i>	-	3	3	3	3	2	2	3	3	1	3	2	2.71	1.43	5	3.06	Medium
<i>Apristurus australis</i>	-	3	3	3	3	2	2	3	3	1	3	2	2.71	1.43	5	3.06	Medium
<i>Amblyraja frerichsi</i>	-	3	3	3	3	2	2	3	3	1	3	2	2.71	1.43	3	3.06	Medium
<i>Centrophorus zeehaani</i>	Southern Dogfish	2	3	3	2	2	3	3	3	1	3	3	2.57	1.65	1	3.05	Medium
<i>Apristurus sinensis</i>	-	3	3	3	1	2	2	3	3	2.829	2	2	2.43	1.82	3	3.04	Medium
<i>Chimaera orientalis</i>	-	2	2	3	3	2	2	2	3	2.249	3	2	2.29	1.99	3	3.03	Medium
<i>Alopias superciliosus</i>	Bigeye Thresher Shark	2	2	3	3	3	3	3	1	3	2	2	2.71	1.28	0	3	Medium
<i>Dalatias licha</i>	Black Shark	2	3	3	2	2	3	3	2	1.212	3	3	2.57	1.52	0	2.99	Medium
<i>Brochiraja spinifera</i>	-	3	3	3	1	2	2	3	3	1.651	3	2	2.43	1.72	1	2.98	Medium
<i>Dipturus innominatus</i>	-	2	2	3	3	2	2	3	3	1.638	3	2	2.43	1.71	3	2.97	Medium
<i>Dipturus acrobelus</i>	Deepwater Skate	1	2	3	2	2	2	3	3	2.415	3	2	2.14	2.06	1	2.97	Medium
<i>Centroselachus crepidater</i>	Golden Dogfish	2	3	3	2	2	3	3	2	1.133	3	3	2.57	1.48	0	2.97	Medium
<i>Rajella challengerii</i>	-	2	3	3	1	2	2	3	3	3	2	2	2.29	1.88	1	2.96	Medium
<i>Rajella sadowskii</i>	-	2	3	3	1	2	2	3	3	3	2	2	2.29	1.88	1	2.96	Medium

## PRELIMINARY ASSESSMENT

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Aculeola nigra</i>	-	2	2	3	3	2	3	3	3	1	3	2	2.57	1.43	3	2.94	Medium
<i>Dipturus wengi</i>	Weng's Skate	2	2	3	1	2	2	3	3	2.312	3	2	2.14	2.02	1	2.94	Medium
<i>Cirrhigaleus barbifer</i>	-	2	3	3	2	2	3	3	3	1	3	2	2.57	1.43	1	2.94	Medium
<i>Centrophorus harrissoni</i>	Harrisson's Dogfish	2	3	3	2	2	3	3	3	1	3	2	2.57	1.43	1	2.94	Medium
<i>Cetorhinus maximus</i>	Basking Shark	2	3	3	3	3	3	2	1	3	1	2	2.71	1.13	0	2.94	Medium
<i>Heptranchias perlo</i>	Sharpenose Sevengill Shark	2	3	3	2	2	3	3	1	3	3	2	2.57	1.43	0	2.94	Medium
<i>Etmopterus litvinovi</i>	-	2	2	3	3	2	3	3	3	1	3	2	2.57	1.43	3	2.94	Medium
<i>Centroscyllium kamoharai</i>	-	2	2	3	1	2	3	3	3	2.743	2	2	2.29	1.8	1	2.91	Medium
<i>Bathyraja shuntovi</i>	-	2	2	3	2	2	2	3	3	1.797	3	2	2.29	1.78	1	2.9	Medium
<i>Etmopterus baxteri</i>	Southern Lanternshark	3	3	3	1	2	3	3	2	1.76	2	2	2.57	1.33	0	2.89	Medium
<i>Hydrolagus melanophasma</i>	-	2	2	3	3	2	2	3	3	1.261	3	2	2.43	1.54	3	2.88	Medium
<i>Bathyrajaousseauae</i>	-	2	2	3	2	2	2	3	3	1.691	3	2	2.29	1.74	1	2.88	Medium
<i>Centrophorus moluccensis</i>	Endeavour Dogfish	3	3	3	1	2	3	3	2	1	3	2	2.57	1.28	0	2.87	Medium
<i>Harriotta raleighana</i>	Bigspine Spookfish	3	3	3	2	2	2	3	2	1	3	2	2.57	1.28	0	2.87	Medium
<i>Oxynotus bruniensis</i>	Prickly Dogfish	3	3	3	1	2	3	3	3	1	2	2	2.57	1.28	3	2.87	Medium
<i>Apristurus pinguis</i>	-	3	3	3	1	2	2	3	3	1.776	2	2	2.43	1.51	3	2.86	Medium
<i>Hydrolagus homonycteris</i>	Black whitefin	2	2	3	1	2	2	3	3	2.029	3	2	2.14	1.89	1	2.86	Medium
<i>Notoraja azurea</i>	Blue Skate	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Apristurus brunneus</i>	-	3	3	3	1	2	2	3	3	1.617	2	2	2.43	1.46	3	2.83	Medium
<i>Etmopterus bigelowi</i>	Smooth Lanternshark	3	3	3	1	2	3	3	2	1	2	2	2.57	1.18	0	2.83	Medium
<i>Centroscymnus owstonii</i>	Owston's Dogfish	2	3	3	1	2	3	3	2	1.627	3	2	2.43	1.46	0	2.83	Medium
<i>Hydrolagus trolli</i>	-	2	2	3	3	2	2	3	2	1.532	3	2	2.43	1.43	2	2.82	Medium
<i>Hydrolagus lemmings</i>	Blackfin Ghostshark	3	3	3	1	2	2	3	3	1	3	2	2.43	1.43	1	2.82	Medium
<i>Pristiophorus cirratus</i>	Common Sawshark	2	2	3	2	2	3	3	3	1	3	2	2.43	1.43	1	2.82	Medium
<i>Bathyraja brachyurops</i>	-	2	2	3	3	2	2	3	3	1	3	2	2.43	1.43	3	2.82	Medium
<i>Zearaja chilensis</i>	-	2	3	3	2	2	2	3	3	1	3	2	2.43	1.43	1	2.82	Medium
<i>Amblyraja hyperborea</i>	-	2	3	3	2	2	2	3	3	1	3	2	2.43	1.43	1	2.82	Medium

## PRELIMINARY ASSESSMENT

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Chimaera panthera</i>	-	2	3	3	2	2	2	3	3	1	3	2	2.43	1.43	1	2.82	Medium
<i>Bathyrāja schroederi</i>	-	2	2	3	2	2	2	3	3	1.348	3	2	2.29	1.58	1	2.78	Medium
<i>Apristurus kampae</i>	-	3	3	3	1	2	2	3	3	1.203	2	2	2.43	1.34	3	2.77	Medium
<i>Etmopterus lucifer</i>	Blackbelly Lanternshark	2	3	3	1	1	3	3	3	1.951	2	2	2.29	1.56	1	2.77	Medium
<i>Parmaturus macmillani</i>	-	3	3	3	1	2	2	3	3	1	2	2	2.43	1.28	2	2.75	Medium
<i>Figaro boardmani</i>	Australian Sawtail Catshark;Sawtail Catshark	3	3	3	1	2	2	3	3	1	2	2	2.43	1.28	3	2.75	Medium
<i>Bythaelurus canescens</i>	-	3	3	3	1	2	2	3	3	1	2	2	2.43	1.28	3	2.75	Medium
<i>Rajella nigerrima</i>	-	3	3	3	1	2	2	3	3	1	2	2	2.43	1.28	1	2.75	Medium
<i>Rajella eisenhardti</i>	-	3	3	3	1	2	2	3	3	1	2	2	2.43	1.28	1	2.75	Medium
<i>Gurgesiella furvescens</i>	-	3	3	3	1	2	2	3	3	1	2	2	2.43	1.28	2	2.75	Medium
<i>Brochiraja heuresa</i>	-	2	2	3	1	1	2	3	3	3	2	2	2	1.88	1	2.74	Medium
<i>Brochiraja microspinifera</i>	-	2	2	3	1	1	2	3	3	3	2	2	2	1.88	1	2.74	Medium
<i>Notoraja alisae</i>	-	2	2	3	1	2	2	3	3	2.291	2	2	2.14	1.66	1	2.71	Medium
<i>Centroscymnus coelolepis</i>	Portuguese Dogfish	2	3	3	1	2	3	3	1	1	3	3	2.43	1.2	0	2.71	Medium
<i>Harriotta haeckeli</i>	-	3	3	3	1	2	2	3	2	1	2	2	2.43	1.18	0	2.7	Medium
<i>Dipturus gudgeri</i>	Bight Skate	2	2	3	2	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Pseudocarcharias kamoharai</i>	Crocodile Shark	1	2	3	2	2	3	3	1	3	3	2	2.29	1.43	0	2.7	Medium
<i>Bathyrāja macloviana</i>	-	2	2	3	3	2	2	2	3	1	3	2	2.29	1.43	3	2.7	Medium
<i>Bathyrāja peruana</i>	-	2	2	3	2	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Bathyrāja multispinis</i>	-	2	2	3	2	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Bathyrāja meridionalis</i>	-	2	2	3	2	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Amblyrāja doellojuradoi</i>	-	2	3	3	1	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Bathyrāja richardsoni</i>	-	2	2	3	2	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Bathyrāja spinosissima</i>	-	2	2	3	2	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Zearaja nasuta</i>	-	1	1	3	3	2	2	3	3	1.43	3	2	2.14	1.62	3	2.68	Medium
<i>Hydrolagus macrophthalmus</i>	-	2	2	3	1	2	2	3	3	2.082	2	2	2.14	1.6	1	2.67	Medium
<i>Euprotomicrus bispinatus</i>	Pygmy Shark	3	3	3	1	1	3	3	1	1.184	2	2	2.43	1.09	2	2.66	Medium

## PRELIMINARY ASSESSMENT

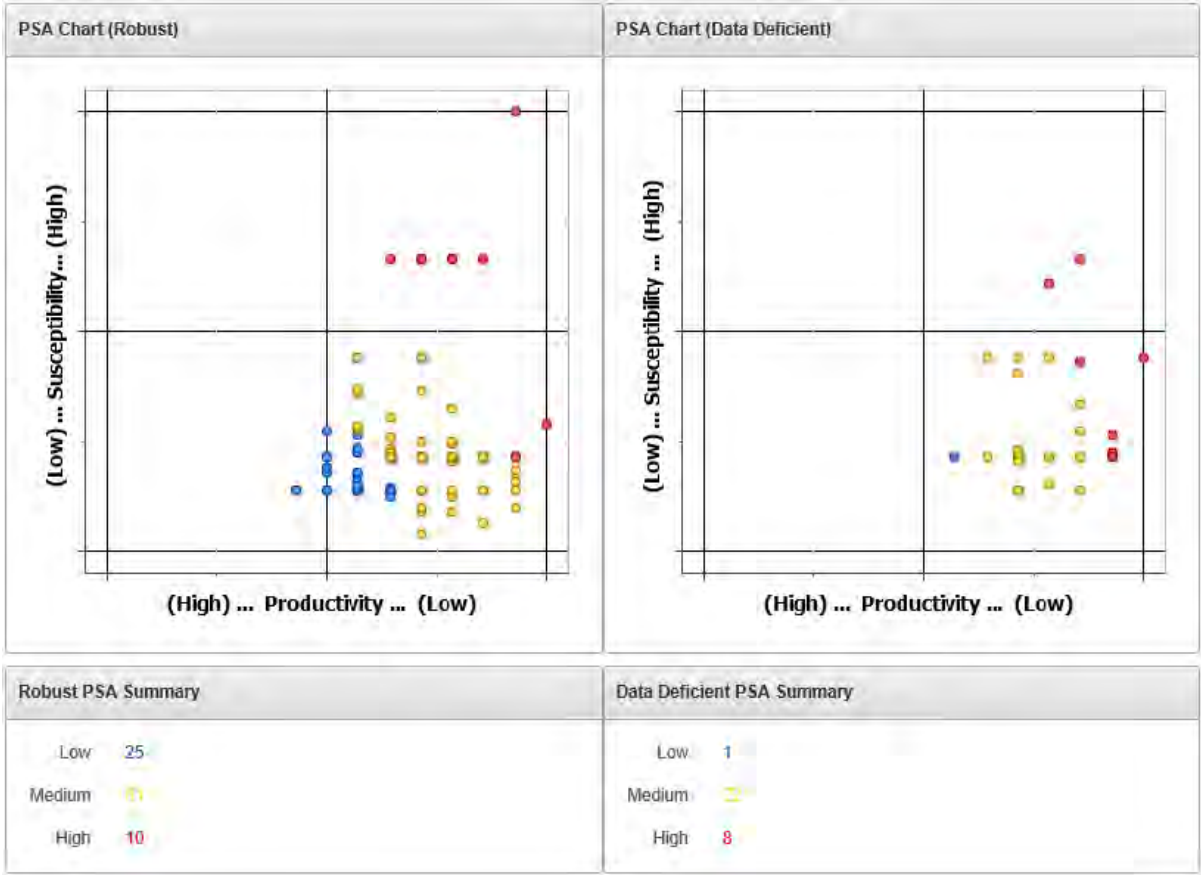
Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Brochiraja asperula</i>	-	2	2	3	1	2	2	3	3	1.936	2	2	2.14	1.56	1	2.65	Medium
<i>Hydrolagus bemisi</i>	-	2	2	3	1	2	2	3	3	1.314	3	2	2.14	1.57	1	2.65	Medium
<i>Centroscyllium nigrum</i>	-	2	2	3	1	1	3	3	3	1.798	2	2	2.14	1.51	1	2.62	Low
<i>Isistius brasiliensis</i>	Smalltooth Cookiecutter Shark	2	3	3	1	1	3	3	1	3	2	2	2.29	1.28	0	2.62	Low
<i>Etmopterus pusillus</i>	Slender Lanternshark	2	3	3	1	1	3	3	2	1.324	2	2	2.29	1.24	0	2.6	Low
<i>Brochiraja leviveneta</i>	-	2	2	3	1	1	2	3	3	2.133	2	2	2	1.61	1	2.57	Low
<i>Bathyraja albomaculata</i>	-	2	2	3	1	2	2	3	3	1	3	2	2.14	1.43	1	2.57	Low
<i>Brochiraja vitticauda</i>	-	2	2	3	1	2	2	3	3	1	2	2	2.14	1.28	1	2.49	Low
<i>Etmopterus molleri</i>	Moller's Lanternshark	1	3	3	1	1	3	3	3	1	2	2	2.14	1.28	1	2.49	Low
<i>Bathyraja longicauda</i>	-	2	2	3	1	2	2	3	3	1	2	2	2.14	1.28	1	2.49	Low
<i>Bathyraja aguja</i>	-	2	2	3	1	2	2	3	3	1	2	2	2.14	1.28	1	2.49	Low
<i>Arhynchobatis asperimus</i>	-	2	2	3	1	2	2	3	3	1	2	2	2.14	1.28	1	2.49	Low
<i>Hydrolagus novaezealandiae</i>	-	2	2	3	1	2	2	3	3	1	2	2	2.14	1.28	1	2.49	Low
<i>Centroscyllium granulatum</i>	-	2	2	3	1	1	3	3	3	1	2	2	2.14	1.28	1	2.49	Low
<i>Notoraja sapphira</i>	-	2	2	3	1	1	2	2	3	2.203	2	2	1.86	1.64	1	2.48	Low
<i>Bathyraja magellanica</i>	-	1	1	3	2	2	2	3	3	1	3	2	2	1.43	1	2.46	Low
<i>Dipturus canutus</i>	Grey Skate	1	2	3	1	2	2	3	3	1	3	2	2	1.43	1	2.46	Low
<i>Typhlonarke aysoni</i>	-	2	2	3	1	1	3	2	3	1	2	2	2	1.28	1	2.37	Low
<i>Notoraja martinezi</i>	-	2	2	3	1	2	2	2	3	1	2	2	2	1.28	1	2.37	Low
<i>Etmopterus pycnolepis</i>	-	1	1	3	1	1	3	3	3	1	2	2	1.86	1.28	1	2.26	Low

Note: Red denotes missing attributes, which are automatically scored a 3 (high risk).

PRELIMINARY ASSESSMENT

Midwater trawl subfishery

Figure 7 PSA charts for 'robust' and 'data deficient' chondrichthyans species in the SPRFMO Convention Area for midwater trawl gears



## PRELIMINARY ASSESSMENT

Table 7 PSA risk scores for chondrichthyans species that could interact with midwater trawl gears in the SPRFMO Convention Area

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Isurus oxyrinchus</i>	Shortfin Mako	2	3	3	3	3	3	3	3	3	3	3	2.86	3	1	4.14	High
<i>Heteroscymnoides marleyi</i>	-	3	3	3	3	1	3	3	3	3	3	2	2.71	2.33	4	3.57	High
<i>Centrophorus squamosus</i>	Leafscale Gulper Shark	3	3	3	2	2	3	3	2	3	3	3	2.71	2.33	0	3.57	High
<i>Mitsukurina owstoni</i>	-	3	3	3	3	3	3	3	2	3	3	2	3	1.88	5	3.54	High
<i>Hexanchus nakamurai</i>	Bigeye Sixgill Shark	2	3	3	2	2	3	3	2	3	3	3	2.57	2.33	0	3.47	High
<i>Squalus acanthias</i>	Whitespotted Dogfish	2	3	3	2	2	3	3	3	3	3	2	2.57	2.33	1	3.47	High
<i>Etmopterus litvinovi</i>	-	2	2	3	3	2	3	3	3	2.762	3	2	2.57	2.22	3	3.4	High
<i>Somniosus antarcticus</i>	Southern Sleeper Shark	3	3	3	3	3	3	3	2	3	2	2	3	1.58	0	3.39	High
<i>Torpedo macneilli</i>	Short-tail Torpedo Ray	2	2	3	2	2	3	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Dasyatis thetidis</i>	Black Stingray	2	2	3	2	2	3	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Apristurus australis</i>	-	3	3	3	3	2	2	3	3	1.966	3	2	2.71	1.86	5	3.29	High
<i>Tetronarce tremens</i>	-	2	2	3	1	2	3	3	3	3	3	2	2.29	2.33	1	3.27	High
<i>Squalus griffini</i>	-	3	3	3	3	2	3	3	3	1.241	3	2	2.86	1.53	3	3.24	High
<i>Echinorhinus cookei</i>	-	3	3	2	3	3	3	3	3	1.058	3	2	2.86	1.45	5	3.21	High
<i>Etmopterus viator</i>	-	3	3	3	3	2	3	3	3	1	3	2	2.86	1.43	2	3.2	High
<i>Lamna nasus</i>	Porbeagle	2	3	3	3	3	3	3	1	3	3	2	2.86	1.43	0	3.2	High
<i>Squalus montalbani</i>	-	3	3	3	3	2	3	3	3	1	3	2	2.86	1.43	3	3.2	High
<i>Gollum attenuatus</i>	-	3	3	3	3	2	3	3	3	1	3	2	2.86	1.43	5	3.2	High
<i>Euprotomicroides zantedeschia</i>	-	3	3	3	1	2	3	3	3	3	2	2	2.57	1.88	3	3.18	Medium
<i>Bythaelurus dawsoni</i>	-	3	3	3	3	2	2	3	3	1.543	3	2	2.71	1.67	5	3.18	Medium
<i>Echinorhinus brucus</i>	Bramble Shark	3	3	3	2	3	3	3	2	1.303	3	2	2.86	1.37	2	3.17	Medium
<i>Odontaspis ferox</i>	Smalltooth Sandtiger Shark; Sandtiger Shark	2	3	3	3	3	3	3	2	1.154	3	2	2.86	1.32	0	3.15	Medium
<i>Pseudotriakis microdon</i>	False Catshark	3	3	3	2	3	3	3	2	1	3	2	2.86	1.28	2	3.13	Medium
<i>Somniosus longus</i>	-	3	3	3	2	2	3	3	3	1.275	3	2	2.71	1.55	3	3.12	Medium
<i>Hexanchus griseus</i>	Bluntnose Sixgill Shark	2	3	3	3	3	3	3	1	3	1	3	2.86	1.2	0	3.1	Medium

## PRELIMINARY ASSESSMENT

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Rajella eisenhardtii</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	1	3.07	Medium
<i>Zameus squamulosus</i>	Velvet Dogfish	2	3	3	1	2	3	3	2	3	3	2	2.43	1.88	0	3.07	Medium
<i>Squaliolus aliae</i>	Smalleye Pygmy Shark	3	3	3	1	1	3	3	3	3	2	2	2.43	1.88	3	3.07	Medium
<i>Squalus megalops</i>	Piked Spurdog; Spikey Dogfish	2	3	3	1	2	3	3	2	3	2	3	2.43	1.88	0	3.07	Medium
<i>Rajella nigerrima</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	1	3.07	Medium
<i>Amblyraja freerichsi</i>	-	3	3	3	3	2	2	3	3	1	3	2	2.71	1.43	3	3.06	Medium
<i>Scymnodon plunketi</i>	Plunket's Dogfish	3	3	3	2	2	3	3	2	1	3	3	2.71	1.43	0	3.06	Medium
<i>Deania calceus</i>	Brier Shark	3	3	3	2	2	3	3	2	1	3	3	2.71	1.43	0	3.06	Medium
<i>Chlamydoselachus anguineus</i>	Frill Shark	3	3	3	2	2	3	3	2	1	3	3	2.71	1.43	2	3.06	Medium
<i>Cirrhigaleus australis</i>	-	3	3	3	2	2	3	3	3	1	3	2	2.71	1.43	1	3.06	Medium
<i>Scymnodon ringens</i>	-	3	3	3	2	2	3	3	3	1	3	2	2.71	1.43	1	3.06	Medium
<i>Apristurus ampliceps</i>	-	3	3	3	3	2	2	3	3	1	3	2	2.71	1.43	5	3.06	Medium
<i>Centrophorus zeehaani</i>	Southern Dogfish	2	3	3	2	2	3	3	3	1	3	3	2.57	1.65	1	3.05	Medium
<i>Apristurus exsanguis</i>	-	3	3	3	1	2	2	3	3	1.85	3	2	2.43	1.81	3	3.03	Medium
<i>Apristurus melanoasper</i>	-	3	3	3	3	2	2	3	2	1	3	2	2.71	1.28	4	3	Medium
<i>Deania quadrispinosa</i>	Longsnout Dogfish	3	3	3	2	2	3	3	2	1	3	2	2.71	1.28	0	3	Medium
<i>Alopias superciliosus</i>	Bigeye Thresher Shark	2	2	3	3	3	3	3	1	3	2	2	2.71	1.28	0	3	Medium
<i>Chimaera panthera</i>	-	2	3	3	2	2	2	3	3	1.674	3	2	2.43	1.73	1	2.98	Medium
<i>Centrophorus harrissoni</i>	Harrisson's Dogfish	2	3	3	2	2	3	3	3	1.175	3	2	2.57	1.5	1	2.98	Medium
<i>Rhinochimaera africana</i>	-	3	3	3	2	2	2	3	3	1.137	3	2	2.57	1.49	0	2.97	Medium
<i>Chimaera orientalis</i>	-	2	2	3	3	2	2	2	3	2.007	3	2	2.29	1.88	3	2.96	Medium
<i>Chimaera lignaria</i>	-	3	3	3	2	2	2	3	3	1	3	2	2.57	1.43	1	2.94	Medium
<i>Rhinochimaera pacifica</i>	Pacific Spookfish	3	3	3	1	2	3	3	3	1	3	2	2.57	1.43	1	2.94	Medium
<i>Cirrhigaleus barbifer</i>	-	2	3	3	2	2	3	3	3	1	3	2	2.57	1.43	1	2.94	Medium
<i>Centroselachus crepidater</i>	Golden Dogfish	2	3	3	2	2	3	3	2	1	3	3	2.57	1.43	0	2.94	Medium
<i>Dalatias licha</i>	Black Shark	2	3	3	2	2	3	3	2	1	3	3	2.57	1.43	0	2.94	Medium
<i>Cetorhinus maximus</i>	Basking Shark	2	3	3	3	3	3	2	1	3	1	2	2.71	1.13	0	2.94	Medium

## PRELIMINARY ASSESSMENT

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Heptranchias perlo</i>	Sharptooth Sevengill Shark	2	3	3	2	2	3	3	1	3	3	2	2.57	1.43	0	2.94	Medium
<i>Squalus cholorculus</i>	-	2	2	3	3	2	3	3	3	1.014	3	2	2.57	1.43	3	2.94	Medium
<i>Aculeola nigra</i>	-	2	2	3	3	2	3	3	3	1	3	2	2.57	1.43	3	2.94	Medium
<i>Centrophorus moluccensis</i>	Endeavour Dogfish	3	3	3	1	2	3	3	2	1.439	3	2	2.57	1.41	0	2.93	Medium
<i>Oxynotus bruniensis</i>	Prickly Dogfish	3	3	3	1	2	3	3	3	1.133	2	2	2.57	1.31	3	2.88	Medium
<i>Harriotta raleighana</i>	Bigspine Spookfish	3	3	3	2	2	2	3	2	1	3	2	2.57	1.28	0	2.87	Medium
<i>Gurgesiella furvescens</i>	-	3	3	3	1	2	2	3	3	1.758	2	2	2.43	1.5	2	2.86	Medium
<i>Etmopterus bigelowi</i>	Smooth Lanternshark	3	3	3	1	2	3	3	2	1.386	2	2	2.57	1.25	0	2.86	Medium
<i>Brochiraja vitticauda</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Bathyraja aguja</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Bythaelurus canescens</i>	-	3	3	3	1	2	2	3	3	1.604	2	2	2.43	1.46	3	2.83	Medium
<i>Etmopterus baxteri</i>	Southern Lanternshark	3	3	3	1	2	3	3	2	1	2	2	2.57	1.18	0	2.83	Medium
<i>Brochiraja spinifera</i>	-	3	3	3	1	2	2	3	3	1	3	2	2.43	1.43	1	2.82	Medium
<i>Hydrolagus leuromelas</i>	Blackfin Ghostshark	3	3	3	1	2	2	3	3	1	3	2	2.43	1.43	1	2.82	Medium
<i>Pristiophorus cirratus</i>	Common Sawshark	2	2	3	2	2	3	3	3	1	3	2	2.43	1.43	1	2.82	Medium
<i>Bathyraja brachyurops</i>	-	2	2	3	3	2	2	3	3	1	3	2	2.43	1.43	3	2.82	Medium
<i>Apristurus sinensis</i>	-	3	3	3	1	2	2	3	3	1.541	2	2	2.43	1.44	3	2.82	Medium
<i>Zearaja chilensis</i>	-	2	3	3	2	2	2	3	3	1	3	2	2.43	1.43	1	2.82	Medium
<i>Dipturus innominatus</i>	-	2	2	3	3	2	2	3	3	1	3	2	2.43	1.43	3	2.82	Medium
<i>Amblyraja hyperborea</i>	-	2	3	3	2	2	2	3	3	1	3	2	2.43	1.43	1	2.82	Medium
<i>Hydrolagus melanophasma</i>	-	2	2	3	3	2	2	3	3	1	3	2	2.43	1.43	3	2.82	Medium
<i>Chimaera carophila</i>	-	2	3	3	2	2	2	3	3	1	3	2	2.43	1.43	1	2.82	Medium
<i>Figaro boardmani</i>	Australian Sawtail Catshark;Sawtail Catshark	3	3	3	1	2	2	3	3	1.439	2	2	2.43	1.41	3	2.81	Medium
<i>Bathyraja peruana</i>	-	2	2	3	2	2	2	3	3	1.42	3	2	2.29	1.61	1	2.8	Medium
<i>Dipturus wengi</i>	Weng's Skate	2	2	3	1	2	2	3	3	1.708	3	2	2.14	1.74	1	2.76	Medium
<i>Hydrolagus trolli</i>	-	2	2	3	3	2	2	3	2	1	3	2	2.43	1.28	2	2.75	Medium
<i>Centroscymnus owstonii</i>	Owston's Dogfish	2	3	3	1	2	3	3	2	1	3	2	2.43	1.28	0	2.75	Medium

## PRELIMINARY ASSESSMENT

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Apristurus pinguis</i>	-	3	3	3	1	2	2	3	3	1	2	2	2.43	1.28	3	2.75	Medium
<i>Apristurus kampae</i>	-	3	3	3	1	2	2	3	3	1	2	2	2.43	1.28	3	2.75	Medium
<i>Apristurus brunneus</i>	-	3	3	3	1	2	2	3	3	1	2	2	2.43	1.28	3	2.75	Medium
<i>Amblyraja doellojuradoi</i>	-	2	3	3	1	2	2	3	3	1.222	3	2	2.29	1.52	1	2.75	Medium
<i>Hydrolagus bemisi</i>	-	2	2	3	1	2	2	3	3	1.657	3	2	2.14	1.72	1	2.75	Medium
<i>Parmaturus macmillani</i>	-	3	3	3	1	2	2	3	3	1	2	2	2.43	1.28	2	2.75	Medium
<i>Centroscyllium kamoharai</i>	-	2	2	3	1	2	3	3	3	1.657	2	2	2.29	1.47	1	2.72	Medium
<i>Bathyrāja cousseauae</i>	-	2	2	3	2	2	2	3	3	1.066	3	2	2.29	1.45	1	2.71	Medium
<i>Centroscymnus coelolepis</i>	Portuguese Dogfish	2	3	3	1	2	3	3	1	1	3	3	2.43	1.2	0	2.71	Medium
<i>Harriotta haeckeli</i>	-	3	3	3	1	2	2	3	2	1	2	2	2.43	1.18	0	2.7	Medium
<i>Dipturus gudgeri</i>	Bight Skate	2	2	3	2	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Pseudocarcharias kamoharai</i>	Crocodile Shark	1	2	3	2	2	3	3	1	3	3	2	2.29	1.43	0	2.7	Medium
<i>Bathyrāja macloviana</i>	-	2	2	3	3	2	2	2	3	1	3	2	2.29	1.43	3	2.7	Medium
<i>Bathyrāja multispinis</i>	-	2	2	3	2	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Bathyrāja meridionalis</i>	-	2	2	3	2	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Bathyrāja richardsoni</i>	-	2	2	3	2	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Bathyrāja schroederi</i>	-	2	2	3	2	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Bathyrāja shuntovi</i>	-	2	2	3	2	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Bathyrāja spinosissima</i>	-	2	2	3	2	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Euprotomicrus bispinatus</i>	Pygmy Shark	3	3	3	1	1	3	3	1	1	2	2	2.43	1.08	2	2.66	Medium
<i>Bathyrāja albomaculata</i>	-	2	2	3	1	2	2	3	3	1.303	3	2	2.14	1.56	1	2.65	Medium
<i>Dipturus acrobelus</i>	Deepwater Skate	1	2	3	2	2	2	3	3	1.315	3	2	2.14	1.57	1	2.65	Medium
<i>Etmopterus lucifer</i>	Blackbelly Lanternshark	2	3	3	1	1	3	3	3	1.062	2	2	2.29	1.29	1	2.63	Low
<i>Etmopterus molleri</i>	Moller's Lanternshark	1	3	3	1	1	3	3	3	1.865	2	2	2.14	1.53	1	2.63	Low
<i>Rajella challengerii</i>	-	2	3	3	1	2	2	3	3	1	2	2	2.29	1.28	1	2.62	Low
<i>Isistius brasiliensis</i>	Smalltooth Cookiecutter Shark	2	3	3	1	1	3	3	1	3	2	2	2.29	1.28	0	2.62	Low
<i>Rajella sadowskii</i>	-	2	3	3	1	2	2	3	3	1	2	2	2.29	1.28	1	2.62	Low

## PRELIMINARY ASSESSMENT

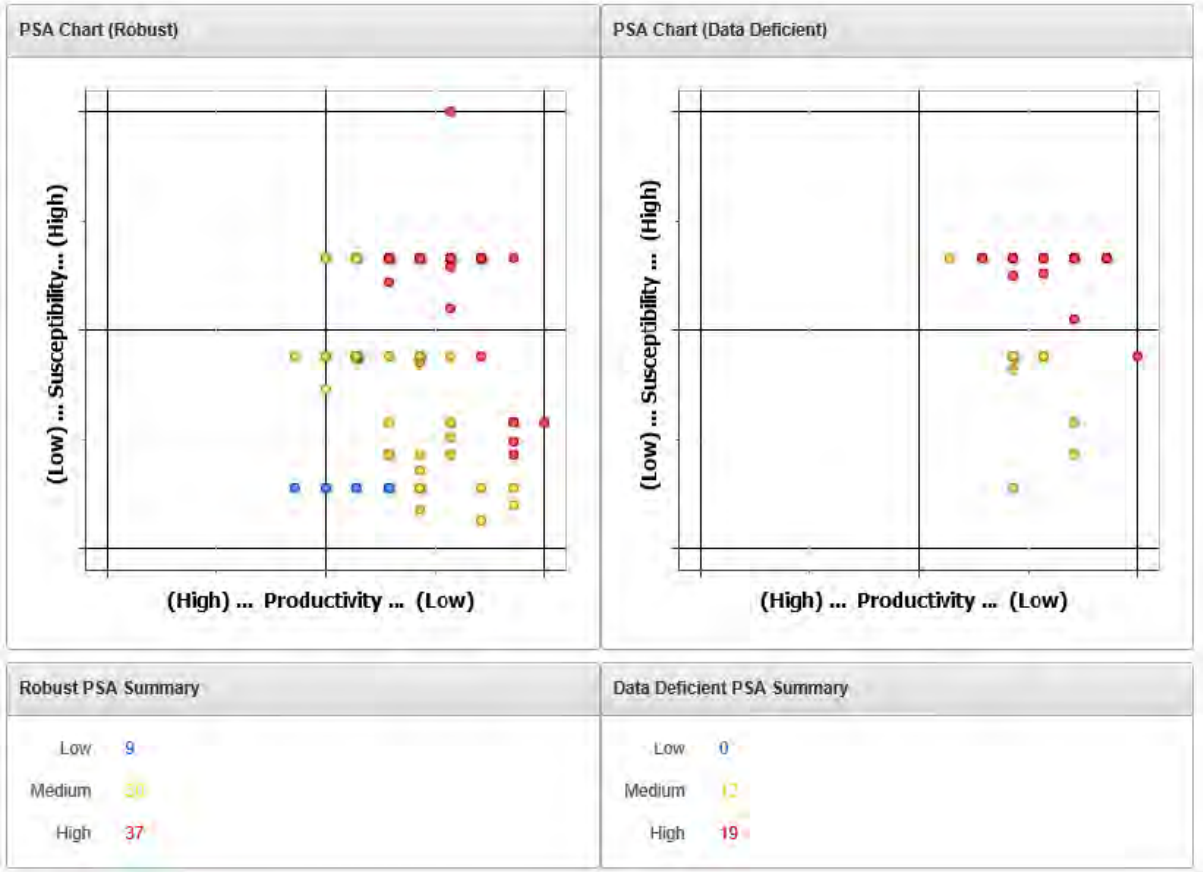
Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Etmopterus pusillus</i>	Slender Lanternshark	2	3	3	1	1	3	3	2	1.371	2	2	2.29	1.25	0	2.61	Low
<i>Hydrolagus homonycteris</i>	Black whitefin	2	2	3	1	2	2	3	3	1.105	3	2	2.14	1.47	1	2.6	Low
<i>Hydrolagus macrophthalmus</i>	-	2	2	3	1	2	2	3	3	1.589	2	2	2.14	1.45	1	2.58	Low
<i>Zearaja nasuta</i>	-	1	1	3	3	2	2	3	3	1	3	2	2.14	1.43	3	2.57	Low
<i>Centroscyllium nigrum</i>	-	2	2	3	1	1	3	3	3	1.287	2	2	2.14	1.36	1	2.54	Low
<i>Brochiraja microspinifera</i>	-	2	2	3	1	1	2	3	3	1.933	2	2	2	1.55	1	2.53	Low
<i>Hydrolagus novaezealandiae</i>	-	2	2	3	1	2	2	3	3	1.254	2	2	2.14	1.35	1	2.53	Low
<i>Arhynchobatis asperimus</i>	-	2	2	3	1	2	2	3	3	1.143	2	2	2.14	1.32	1	2.51	Low
<i>Brochiraja asperula</i>	-	2	2	3	1	2	2	3	3	1.055	2	2	2.14	1.29	1	2.5	Low
<i>Notoraja azurea</i>	Blue Skate	2	2	3	1	2	2	3	3	1.096	2	2	2.14	1.3	1	2.5	Low
<i>Centroscyllium granulatum</i>	-	2	2	3	1	1	3	3	3	1	2	2	2.14	1.28	1	2.49	Low
<i>Bathyraja longicauda</i>	-	2	2	3	1	2	2	3	3	1	2	2	2.14	1.28	1	2.49	Low
<i>Notoraja alisae</i>	-	2	2	3	1	2	2	3	3	1	2	2	2.14	1.28	1	2.49	Low
<i>Bathyraja magellanica</i>	-	1	1	3	2	2	2	3	3	1	3	2	2	1.43	1	2.46	Low
<i>Dipturus canutus</i>	Grey Skate	1	2	3	1	2	2	3	3	1	3	2	2	1.43	1	2.46	Low
<i>Typhlonarke aysoni</i>	-	2	2	3	1	1	3	2	3	1.358	2	2	2	1.38	1	2.43	Low
<i>Brochiraja leviveneta</i>	-	2	2	3	1	1	2	3	3	1.289	2	2	2	1.36	1	2.42	Low
<i>Brochiraja heuresa</i>	-	2	2	3	1	1	2	3	3	1	2	2	2	1.28	1	2.37	Low
<i>Notoraja martinezi</i>	-	2	2	3	1	2	2	2	3	1	2	2	2	1.28	1	2.37	Low
<i>Etmopterus pycnolepis</i>	-	1	1	3	1	1	3	3	3	1	2	2	1.86	1.28	1	2.26	Low
<i>Notoraja sapphira</i>	-	2	2	3	1	1	2	2	3	1	2	2	1.86	1.28	1	2.26	Low

Note: Red denotes missing attributes, which are automatically scored a 3 (high risk).

PRELIMINARY ASSESSMENT

Demersal longline and dropline subfishery

Figure 8 PSA charts for 'robust' and 'data deficient' chondrichthyans species in the SPRFMO Convention Area for demersal longline and dropline gears



## PRELIMINARY ASSESSMENT

Table 8 PSA risk scores for chondrichthyans species that could interact with demersal longline and dropline gears in the SPRFMO Convention Area

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Centrophorus zeehaani</i>	Southern Dogfish	2	3	3	2	2	3	3	3	3	3	3	2.57	3	1	3.95	High
<i>Echinorhinus cookei</i>	-	3	3	2	3	3	3	3	3	3	3	2	2.86	2.33	5	3.69	High
<i>Isurus oxyrinchus</i>	Shortfin Mako	2	3	3	3	3	3	3	3	3	2	3	2.86	2.33	1	3.69	High
<i>Squalus montalbani</i>	-	3	3	3	3	2	3	3	3	3	3	2	2.86	2.33	3	3.69	High
<i>Squalus griffini</i>	-	3	3	3	3	2	3	3	3	3	3	2	2.86	2.33	3	3.69	High
<i>Gollum attenuatus</i>	-	3	3	3	3	2	3	3	3	3	3	2	2.86	2.33	5	3.69	High
<i>Heteroscymnoides marleyi</i>	-	3	3	3	3	1	3	3	3	3	3	2	2.71	2.33	4	3.57	High
<i>Scymnodon plunketi</i>	Plunket's Dogfish	3	3	3	2	2	3	3	2	3	3	3	2.71	2.33	0	3.57	High
<i>Centrophorus squamosus</i>	Leafscale Gulper Shark	3	3	3	2	2	3	3	2	3	3	3	2.71	2.33	0	3.57	High
<i>Deania calceus</i>	Brier Shark	3	3	3	2	2	3	3	2	3	3	3	2.71	2.33	0	3.57	High
<i>Chlamydoselachus anguineus</i>	Frill Shark	3	3	3	2	2	3	3	2	3	3	3	2.71	2.33	2	3.57	High
<i>Somniosus longus</i>	-	3	3	3	2	2	3	3	3	3	3	2	2.71	2.33	3	3.57	High
<i>Cirrhigaleus australis</i>	-	3	3	3	2	2	3	3	3	3	3	2	2.71	2.33	1	3.57	High
<i>Scymnodon ringens</i>	-	3	3	3	2	2	3	3	3	3	3	2	2.71	2.33	1	3.57	High
<i>Bythaelurus dawsoni</i>	-	3	3	3	3	2	2	3	3	3	3	2	2.71	2.33	5	3.57	High
<i>Apristurus australis</i>	-	3	3	3	3	2	2	3	3	3	3	2	2.71	2.33	5	3.57	High
<i>Mitsukurina owstoni</i>	-	3	3	3	3	3	3	3	2	3	3	2	3	1.88	5	3.54	High
<i>Rhinochimaera africana</i>	-	3	3	3	2	2	2	3	3	3	3	2	2.57	2.33	0	3.47	High
<i>Rhinochimaera pacifica</i>	Pacific Spookfish	3	3	3	1	2	3	3	3	3	3	2	2.57	2.33	1	3.47	High
<i>Cirrhigaleus barbifer</i>	-	2	3	3	2	2	3	3	3	3	3	2	2.57	2.33	1	3.47	High
<i>Centrophorus harrissoni</i>	Harrisson's Dogfish	2	3	3	2	2	3	3	3	3	3	2	2.57	2.33	1	3.47	High
<i>Squalus acanthias</i>	Whitespotted Dogfish	2	3	3	2	2	3	3	3	3	3	2	2.57	2.33	1	3.47	High
<i>Dalatias licha</i>	Black Shark	2	3	3	2	2	3	3	2	3	3	3	2.57	2.33	0	3.47	High
<i>Hexanchus nakamurai</i>	Bigeye Sixgill Shark	2	3	3	2	2	3	3	2	3	3	3	2.57	2.33	0	3.47	High
<i>Squalus cholorculus</i>	-	2	2	3	3	2	3	3	3	3	3	2	2.57	2.33	3	3.47	High

## PRELIMINARY ASSESSMENT

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Aculeola nigra</i>	-	2	2	3	3	2	3	3	3	3	3	2	2.57	2.33	3	3.47	High
<i>Centroselachus crepidater</i>	Golden Dogfish	2	3	3	2	2	3	3	2	2.926	3	3	2.57	2.29	0	3.44	High
<i>Etmopterus litvinovi</i>	-	2	2	3	3	2	3	3	3	2.857	3	2	2.57	2.26	3	3.42	High
<i>Amblyraja freerichsi</i>	-	3	3	3	3	2	2	3	3	2.384	3	2	2.71	2.05	3	3.4	High
<i>Somniosus antarcticus</i>	Southern Sleeper Shark	3	3	3	3	3	3	3	2	3	2	2	3	1.58	0	3.39	High
<i>Brochiraja spinifera</i>	-	3	3	3	1	2	2	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Hydrolagus lemures</i>	Blackfin Ghostshark	3	3	3	1	2	2	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Torpedo macneilli</i>	Short-tail Torpedo Ray	2	2	3	2	2	3	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Pristiophorus cirratus</i>	Common Sawshark	2	2	3	2	2	3	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Bathyraja brachyurops</i>	-	2	2	3	3	2	2	3	3	3	3	2	2.43	2.33	3	3.37	High
<i>Zearaja chilensis</i>	-	2	3	3	2	2	2	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Dipturus innominatus</i>	-	2	2	3	3	2	2	3	3	3	3	2	2.43	2.33	3	3.37	High
<i>Hydrolagus melanophasma</i>	-	2	2	3	3	2	2	3	3	3	3	2	2.43	2.33	3	3.37	High
<i>Chimaera panthera</i>	-	2	3	3	2	2	2	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Chimaera lignaria</i>	-	3	3	3	2	2	2	3	3	2.5	3	2	2.57	2.1	1	3.32	High
<i>Apristurus exsanguis</i>	-	3	3	3	1	2	2	3	3	2.823	3	2	2.43	2.25	3	3.31	High
<i>Deania quadrispinosa</i>	Longsnout Dogfish	3	3	3	2	2	3	3	2	3	3	2	2.71	1.88	0	3.3	High
<i>Bathyraja shuntovi</i>	-	2	2	3	2	2	2	3	3	3	3	2	2.29	2.33	1	3.27	High
<i>Dipturus gudgeri</i>	Bight Skate	2	2	3	2	2	2	3	3	3	3	2	2.29	2.33	1	3.27	High
<i>Echinorhinus brucus</i>	Bramble Shark	3	3	3	2	3	3	3	2	3	2	2	2.86	1.58	2	3.27	High
<i>Odontaspis ferox</i>	Smalltooth Sandtiger Shark; Sandtiger Shark	2	3	3	3	3	3	3	2	3	2	2	2.86	1.58	0	3.27	High
<i>Bathyraja macloviana</i>	-	2	2	3	3	2	2	2	3	3	3	2	2.29	2.33	3	3.27	High
<i>Bathyraja cousseauae</i>	-	2	2	3	2	2	2	3	3	3	3	2	2.29	2.33	1	3.27	High
<i>Bathyraja peruana</i>	-	2	2	3	2	2	2	3	3	3	3	2	2.29	2.33	1	3.27	High
<i>Bathyraja multispinis</i>	-	2	2	3	2	2	2	3	3	3	3	2	2.29	2.33	1	3.27	High
<i>Tetronarce tremens</i>	-	2	2	3	1	2	3	3	3	3	3	2	2.29	2.33	1	3.27	High
<i>Amblyraja doellojuradoi</i>	-	2	3	3	1	2	2	3	3	3	3	2	2.29	2.33	1	3.27	High

## PRELIMINARY ASSESSMENT

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Chimaera orientalis</i>	-	2	2	3	3	2	2	2	3	3	2	2	2.29	2.33	3	3.27	High
<i>Pseudotriakis microdon</i>	False Catshark	3	3	3	2	3	3	3	2	2.575	2	2	2.86	1.49	2	3.22	High
<i>Etmopterus viator</i>	-	3	3	3	3	2	3	3	3	1	3	2	2.86	1.43	2	3.2	High
<i>Bathyraja meridionalis</i>	-	2	2	3	2	2	2	3	3	2.759	3	2	2.29	2.22	1	3.19	High
<i>Euprotomicroides zantedeschia</i>	-	3	3	3	1	2	3	3	3	3	2	2	2.57	1.88	3	3.18	Medium
<i>Oxynotus bruniensis</i>	Prickly Dogfish	3	3	3	1	2	3	3	3	3	2	2	2.57	1.88	3	3.18	Medium
<i>Centrophorus moluccensis</i>	Endeavour Dogfish	3	3	3	1	2	3	3	2	3	3	2	2.57	1.88	0	3.18	Medium
<i>Hydrolagus bemisi</i>	-	2	2	3	1	2	2	3	3	3	3	2	2.14	2.33	1	3.16	Medium
<i>Hydrolagus homonycteris</i>	Black whitefin	2	2	3	1	2	2	3	3	3	3	2	2.14	2.33	1	3.16	Medium
<i>Dipturus acrobelus</i>	Deepwater Skate	1	2	3	2	2	2	3	3	3	3	2	2.14	2.33	1	3.16	Medium
<i>Dipturus wengi</i>	Weng's Skate	2	2	3	1	2	2	3	3	3	3	2	2.14	2.33	1	3.16	Medium
<i>Bathyraja albomaculata</i>	-	2	2	3	1	2	2	3	3	3	3	2	2.14	2.33	1	3.16	Medium
<i>Zearaja nasuta</i>	-	1	1	3	3	2	2	3	3	3	3	2	2.14	2.33	3	3.16	Medium
<i>Apristurus melanoasper</i>	-	3	3	3	3	2	2	3	2	2.032	3	2	2.71	1.58	4	3.14	Medium
<i>Lamna nasus</i>	Porbeagle	2	3	3	3	3	3	3	1	3	2	2	2.86	1.28	0	3.13	Medium
<i>Hexanchus griseus</i>	Bluntnose Sixgill Shark	2	3	3	3	3	3	3	1	3	1	3	2.86	1.2	0	3.1	Medium
<i>Gurgesiella furvescens</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	2	3.07	Medium
<i>Dasyatis thetidis</i>	Black Stingray	2	2	3	2	2	3	3	3	3	2	2	2.43	1.88	1	3.07	Medium
<i>Dipturus canutus</i>	Grey Skate	1	2	3	1	2	2	3	3	3	3	2	2	2.33	1	3.07	Medium
<i>Zameus squamulosus</i>	Velvet Dogfish	2	3	3	1	2	3	3	2	3	3	2	2.43	1.88	0	3.07	Medium
<i>Centroscymnus owstonii</i>	Owston's Dogfish	2	3	3	1	2	3	3	2	3	3	2	2.43	1.88	0	3.07	Medium
<i>Squaliolus aliae</i>	Smalleye Pygmy Shark	3	3	3	1	1	3	3	3	3	2	2	2.43	1.88	3	3.07	Medium
<i>Squalus megalops</i>	Piked Spurdog; Spikey Dogfish	2	3	3	1	2	3	3	2	3	2	3	2.43	1.88	0	3.07	Medium
<i>Figaro boardmani</i>	Australian Sawtail Catshark; Sawtail Catshark	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	3	3.07	Medium
<i>Bathyraja magellanica</i>	-	1	1	3	2	2	2	3	3	3	3	2	2	2.33	1	3.07	Medium
<i>Bythaelurus canescens</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	3	3.07	Medium
<i>Apristurus kampae</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	3	3.07	Medium

## PRELIMINARY ASSESSMENT

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Apristurus brunneus</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	3	3.07	Medium
<i>Rajella nigerrima</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	1	3.07	Medium
<i>Apristurus ampliceps</i>	-	3	3	3	3	2	2	3	3	1	3	2	2.71	1.43	5	3.06	Medium
<i>Amblyraja hyperborea</i>	-	2	3	3	2	2	2	3	3	1.943	3	2	2.43	1.85	1	3.05	Medium
<i>Apristurus sinensis</i>	-	3	3	3	1	2	2	3	3	2.829	2	2	2.43	1.82	3	3.04	Medium
<i>Etmopterus baxteri</i>	Southern Lanternshark	3	3	3	1	2	3	3	2	3	2	2	2.57	1.58	0	3.02	Medium
<i>Etmopterus bigelowi</i>	Smooth Lanternshark	3	3	3	1	2	3	3	2	3	2	2	2.57	1.58	0	3.02	Medium
<i>Alopias superciliosus</i>	Bigeye Thresher Shark	2	2	3	3	3	3	3	1	3	2	2	2.71	1.28	0	3	Medium
<i>Harriotta raleighana</i>	Bigspine Spookfish	3	3	3	2	2	2	3	2	1.778	3	2	2.57	1.51	0	2.98	Medium
<i>Centroscyllium kamoharai</i>	-	2	2	3	1	2	3	3	3	3	2	2	2.29	1.88	1	2.96	Medium
<i>Etmopterus lucifer</i>	Blackbelly Lanternshark	2	3	3	1	1	3	3	3	3	2	2	2.29	1.88	1	2.96	Medium
<i>Heptranchias perlo</i>	Sharpnose Sevengill Shark	2	3	3	2	2	3	3	1	3	3	2	2.57	1.43	0	2.94	Medium
<i>Cetorhinus maximus</i>	Basking Shark	2	3	3	3	3	3	2	1	3	1	2	2.71	1.13	0	2.94	Medium
<i>Brochiraja asperula</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Etmopterus molleri</i>	Moller's Lanternshark	1	3	3	1	1	3	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Bathyraja longicauda</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Bathyraja aguja</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Arhynchobatis asperimus</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Centroscyllium nigrum</i>	-	2	2	3	1	1	3	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Centroscyllium granulatum</i>	-	2	2	3	1	1	3	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Hydrolagus novaezealandiae</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Hydrolagus macrophthalmus</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Brochiraja vitticauda</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Chimaera carophila</i>	-	2	3	3	2	2	2	3	3	1	3	2	2.43	1.43	1	2.82	Medium
<i>Etmopterus pusillus</i>	Slender Lanternshark	2	3	3	1	1	3	3	2	3	2	2	2.29	1.58	0	2.78	Medium
<i>Centroscymnus coelolepis</i>	Portuguese Dogfish	2	3	3	1	2	3	3	1	1.692	3	3	2.43	1.36	0	2.78	Medium

## PRELIMINARY ASSESSMENT

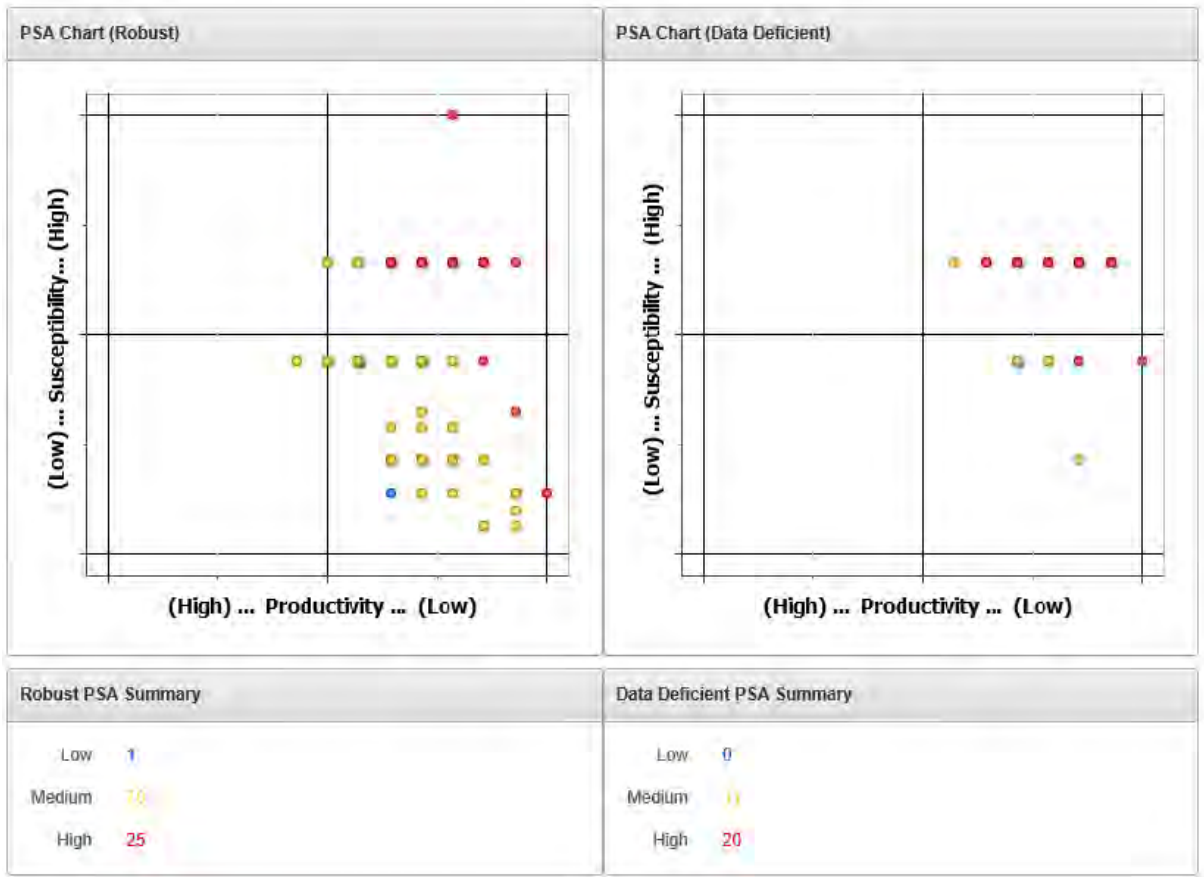
Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Hydrolagus trolli</i>	-	2	2	3	3	2	2	3	2	1.007	3	2	2.43	1.28	2	2.75	Medium
<i>Euprotomiscus bispinatus</i>	Pygmy Shark	3	3	3	1	1	3	3	1	3	2	2	2.43	1.28	2	2.75	Medium
<i>Apristurus pinguis</i>	-	3	3	3	1	2	2	3	3	1	2	2	2.43	1.28	3	2.75	Medium
<i>Rajella eisenhardti</i>	-	3	3	3	1	2	2	3	3	1	2	2	2.43	1.28	1	2.75	Medium
<i>Parmaturus macmillani</i>	-	3	3	3	1	2	2	3	3	1	2	2	2.43	1.28	2	2.75	Medium
<i>Brochiraja leviveneta</i>	-	2	2	3	1	1	2	3	3	3	2	2	2	1.88	1	2.74	Medium
<i>Typhlonarke aysoni</i>	-	2	2	3	1	1	3	2	3	3	2	2	2	1.88	1	2.74	Medium
<i>Harriotta haeckeli</i>	-	3	3	3	1	2	2	3	2	1	2	2	2.43	1.18	0	2.7	Medium
<i>Pseudocarcharias kamoharai</i>	Crocodile Shark	1	2	3	2	2	3	3	1	3	3	2	2.29	1.43	0	2.7	Medium
<i>Bathyraja richardsoni</i>	-	2	2	3	2	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Bathyraja schroederi</i>	-	2	2	3	2	2	2	3	3	1	3	2	2.29	1.43	1	2.7	Medium
<i>Brochiraja microspinifera</i>	-	2	2	3	1	1	2	3	3	2.5	2	2	2	1.73	1	2.64	Medium
<i>Etmopterus pycnolepis</i>	-	1	1	3	1	1	3	3	3	3	2	2	1.86	1.88	1	2.64	Medium
<i>Bathyraja spinosissima</i>	-	2	2	3	2	2	2	3	3	1	2	2	2.29	1.28	1	2.62	Low
<i>Isistius brasiliensis</i>	Smalltooth Cookiecutter Shark	2	3	3	1	1	3	3	1	3	2	2	2.29	1.28	0	2.62	Low
<i>Rajella sadowskii</i>	-	2	3	3	1	2	2	3	3	1	2	2	2.29	1.28	1	2.62	Low
<i>Rajella challengerii</i>	-	2	3	3	1	2	2	3	3	1	2	2	2.29	1.28	1	2.62	Low
<i>Notoraja alisae</i>	-	2	2	3	1	2	2	3	3	1	2	2	2.14	1.28	1	2.49	Low
<i>Notoraja azurea</i>	Blue Skate	2	2	3	1	2	2	3	3	1	2	2	2.14	1.28	1	2.49	Low
<i>Brochiraja heuresa</i>	-	2	2	3	1	1	2	3	3	1	2	2	2	1.28	1	2.37	Low
<i>Notoraja martinezi</i>	-	2	2	3	1	2	2	2	3	1	2	2	2	1.28	1	2.37	Low
<i>Notoraja sapphira</i>	-	2	2	3	1	1	2	2	3	1	2	2	1.86	1.28	1	2.26	Low

Note: Red denotes missing attributes, which are automatically scored a 3 (high risk).

PRELIMINARY ASSESSMENT

Gillnet subfishery

Figure 9 PSA charts for 'robust' and 'data deficient' chondrichthyans species in the SPRFMO Convention Area for gillnet gears



## PRELIMINARY ASSESSMENT

Table 9 PSA risk scores for chondrichthyans species that could interact with gillnet gears in the SPRFMO Convention Area

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Centrophorus zeehaani</i>	Southern Dogfish	2	3	3	2	2	3	3	3	3	3	3	2.57	3	1	3.95	High
<i>Etmopterus viator</i>	-	3	3	3	3	2	3	3	3	3	3	2	2.86	2.33	2	3.69	High
<i>Squalus montalbani</i>	-	3	3	3	3	2	3	3	3	3	3	2	2.86	2.33	3	3.69	High
<i>Squalus griffini</i>	-	3	3	3	3	2	3	3	3	3	3	2	2.86	2.33	3	3.69	High
<i>Gollum attenuatus</i>	-	3	3	3	3	2	3	3	3	3	3	2	2.86	2.33	5	3.69	High
<i>Echinorhinus cookei</i>	-	3	3	2	3	3	3	3	3	3	3	2	2.86	2.33	5	3.69	High
<i>Heteroscymnoides marleyi</i>	-	3	3	3	3	1	3	3	3	3	3	2	2.71	2.33	4	3.57	High
<i>Scymnodon plunketi</i>	Plunket's Dogfish	3	3	3	2	2	3	3	2	3	3	3	2.71	2.33	0	3.57	High
<i>Deania calceus</i>	Brier Shark	3	3	3	2	2	3	3	2	3	3	3	2.71	2.33	0	3.57	High
<i>Cirrhigaleus australis</i>	-	3	3	3	2	2	3	3	3	3	3	2	2.71	2.33	1	3.57	High
<i>Scymnodon ringens</i>	-	3	3	3	2	2	3	3	3	3	3	2	2.71	2.33	1	3.57	High
<i>Bythaelurus dawsoni</i>	-	3	3	3	3	2	2	3	3	3	3	2	2.71	2.33	5	3.57	High
<i>Apristurus australis</i>	-	3	3	3	3	2	2	3	3	3	3	2	2.71	2.33	5	3.57	High
<i>Apristurus ampliceps</i>	-	3	3	3	3	2	2	3	3	3	3	2	2.71	2.33	5	3.57	High
<i>Amblyraja freerichsi</i>	-	3	3	3	3	2	2	3	3	3	3	2	2.71	2.33	3	3.57	High
<i>Mitsukurina owstoni</i>	-	3	3	3	3	3	3	3	2	3	3	2	3	1.88	5	3.54	High
<i>Aculeola nigra</i>	-	2	2	3	3	2	3	3	3	3	3	2	2.57	2.33	3	3.47	High
<i>Rhinochimaera pacifica</i>	Pacific Spookfish	3	3	3	1	2	3	3	3	3	3	2	2.57	2.33	1	3.47	High
<i>Cirrhigaleus barbifer</i>	-	2	3	3	2	2	3	3	3	3	3	2	2.57	2.33	1	3.47	High
<i>Centroselachus crepidater</i>	Golden Dogfish	2	3	3	2	2	3	3	2	3	3	3	2.57	2.33	0	3.47	High
<i>Centrophorus harrissoni</i>	Harrisson's Dogfish	2	3	3	2	2	3	3	3	3	3	2	2.57	2.33	1	3.47	High
<i>Squalus acanthias</i>	Whitespotted Dogfish	2	3	3	2	2	3	3	3	3	3	2	2.57	2.33	1	3.47	High
<i>Squalus cholorculus</i>	-	2	2	3	3	2	3	3	3	3	3	2	2.57	2.33	3	3.47	High
<i>Etmopterus litvinovi</i>	-	2	2	3	3	2	3	3	3	3	3	2	2.57	2.33	3	3.47	High
<i>Brochiraja spinifera</i>	-	3	3	3	1	2	2	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Hydrolagus lemmings</i>	Blackfin Ghostshark	3	3	3	1	2	2	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Bathyrhaja brachyurops</i>	-	2	2	3	3	2	2	3	3	3	3	2	2.43	2.33	3	3.37	High
<i>Apristurus exsangui</i>	-	3	3	3	1	2	2	3	3	3	3	2	2.43	2.33	3	3.37	High

## PRELIMINARY ASSESSMENT

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Dipturus innominatus</i>	-	2	2	3	3	2	2	3	3	3	3	2	2.43	2.33	3	3.37	High
<i>Amblyraja hyperborea</i>	-	2	3	3	2	2	2	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Hydrolagus melanophasma</i>	-	2	2	3	3	2	2	3	3	3	3	2	2.43	2.33	3	3.37	High
<i>Chimaera panthera</i>	-	2	3	3	2	2	2	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Chimaera carophila</i>	-	2	3	3	2	2	2	3	3	3	3	2	2.43	2.33	1	3.37	High
<i>Apristurus melanoasper</i>	-	3	3	3	3	2	2	3	2	3	3	2	2.71	1.88	4	3.3	High
<i>Deania quadrispinosa</i>	Longsnout Dogfish	3	3	3	2	2	3	3	2	3	3	2	2.71	1.88	0	3.3	High
<i>Isurus oxyrinchus</i>	Shortfin Mako	2	3	3	3	3	3	3	3	3	1	3	2.86	1.65	1	3.3	High
<i>Bathyraja schroederi</i>	-	2	2	3	2	2	2	3	3	3	3	2	2.29	2.33	1	3.27	High
<i>Bathyraja macloviana</i>	-	2	2	3	3	2	2	2	3	3	3	2	2.29	2.33	3	3.27	High
<i>Bathyraja cousseauae</i>	-	2	2	3	2	2	2	3	3	3	3	2	2.29	2.33	1	3.27	High
<i>Bathyraja peruana</i>	-	2	2	3	2	2	2	3	3	3	3	2	2.29	2.33	1	3.27	High
<i>Bathyraja multispinis</i>	-	2	2	3	2	2	2	3	3	3	3	2	2.29	2.33	1	3.27	High
<i>Tetronarce tremens</i>	-	2	2	3	1	2	3	3	3	3	3	2	2.29	2.33	1	3.27	High
<i>Amblyraja doellojuradoi</i>	-	2	3	3	1	2	2	3	3	3	3	2	2.29	2.33	1	3.27	High
<i>Chimaera orientalis</i>	-	2	2	3	3	2	2	2	3	3	3	2	2.29	2.33	3	3.27	High
<i>Somniosus antarcticus</i>	Southern Sleeper Shark	3	3	3	3	3	3	3	2	3	1	2	3	1.28	0	3.26	High
<i>Euprotomicroides zantedeschia</i>	-	3	3	3	1	2	3	3	3	3	2	2	2.57	1.88	3	3.18	Medium
<i>Harriotta raleighana</i>	Bigspine Spookfish	3	3	3	2	2	2	3	2	3	3	2	2.57	1.88	0	3.18	Medium
<i>Oxynotus bruniensis</i>	Prickly Dogfish	3	3	3	1	2	3	3	3	3	2	2	2.57	1.88	3	3.18	Medium
<i>Centrophorus moluccensis</i>	Endeavour Dogfish	3	3	3	1	2	3	3	2	3	3	2	2.57	1.88	0	3.18	Medium
<i>Hydrolagus bemisi</i>	-	2	2	3	1	2	2	3	3	3	3	2	2.14	2.33	1	3.16	Medium
<i>Hydrolagus homonycteris</i>	Black whitefin	2	2	3	1	2	2	3	3	3	3	2	2.14	2.33	1	3.16	Medium
<i>Dipturus acrobelus</i>	Deepwater Skate	1	2	3	2	2	2	3	3	3	3	2	2.14	2.33	1	3.16	Medium
<i>Dipturus wengi</i>	Weng's Skate	2	2	3	1	2	2	3	3	3	3	2	2.14	2.33	1	3.16	Medium
<i>Bathyraja albomaculata</i>	-	2	2	3	1	2	2	3	3	3	3	2	2.14	2.33	1	3.16	Medium
<i>Zearaja nasuta</i>	-	1	1	3	3	2	2	3	3	3	3	2	2.14	2.33	3	3.16	Medium
<i>Odontaspis ferox</i>	Smalltooth Sandtiger Shark; Sandtiger Shark	2	3	3	3	3	3	3	2	3	1	2	2.86	1.28	0	3.13	Medium

## PRELIMINARY ASSESSMENT

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Echinorhinus brucus</i>	Bramble Shark	3	3	3	2	3	3	3	2	3	1	2	2.86	1.28	2	3.13	Medium
<i>Pseudotriakis microdon</i>	False Catshark	3	3	3	2	3	3	3	2	3	1	2	2.86	1.28	2	3.13	Medium
<i>Hexanchus griseus</i>	Bluntnose Sixgill Shark	2	3	3	3	3	3	3	1	3	1	3	2.86	1.2	0	3.1	Medium
<i>Lamna nasus</i>	Porbeagle	2	3	3	3	3	3	3	1	3	1	2	2.86	1.13	0	3.08	Medium
<i>Hydrolagus trolli</i>	-	2	2	3	3	2	2	3	2	3	3	2	2.43	1.88	2	3.07	Medium
<i>Dipturus canutus</i>	Grey Skate	1	2	3	1	2	2	3	3	3	3	2	2	2.33	1	3.07	Medium
<i>Zameus squamulosus</i>	Velvet Dogfish	2	3	3	1	2	3	3	2	3	3	2	2.43	1.88	0	3.07	Medium
<i>Centroscymnus owstonii</i>	Owston's Dogfish	2	3	3	1	2	3	3	2	3	3	2	2.43	1.88	0	3.07	Medium
<i>Squaliolus aliae</i>	Smalleye Pygmy Shark	3	3	3	1	1	3	3	3	3	2	2	2.43	1.88	3	3.07	Medium
<i>Squalus megalops</i>	Piked Spurdog; Spikey Dogfish	2	3	3	1	2	3	3	2	3	2	3	2.43	1.88	0	3.07	Medium
<i>Figaro boardmani</i>	Australian Sawtail Catshark; Sawtail Catshark	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	3	3.07	Medium
<i>Bathyraja magellanica</i>	-	1	1	3	2	2	2	3	3	3	3	2	2	2.33	1	3.07	Medium
<i>Bythaelurus canescens</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	3	3.07	Medium
<i>Apristurus sinensis</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	3	3.07	Medium
<i>Apristurus pinguis</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	3	3.07	Medium
<i>Apristurus kampae</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	3	3.07	Medium
<i>Apristurus brunneus</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	3	3.07	Medium
<i>Rajella nigerima</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	1	3.07	Medium
<i>Rajella eisenhardti</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	1	3.07	Medium
<i>Gurgesiella furvescens</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	2	3.07	Medium
<i>Parmaturus macmillani</i>	-	3	3	3	1	2	2	3	3	3	2	2	2.43	1.88	2	3.07	Medium
<i>Somniosus longus</i>	-	3	3	3	2	2	3	3	3	3	1	2	2.71	1.43	3	3.06	Medium
<i>Centrophorus squamosus</i>	Leafscale Gulper Shark	3	3	3	2	2	3	3	2	3	1	3	2.71	1.43	0	3.06	Medium
<i>Chlamydoselachus anguineus</i>	Frill Shark	3	3	3	2	2	3	3	2	3	1	3	2.71	1.43	2	3.06	Medium
<i>Etmopterus baxteri</i>	Southern Lanternshark	3	3	3	1	2	3	3	2	3	2	2	2.57	1.58	0	3.02	Medium
<i>Etmopterus bigelowi</i>	Smooth Lanternshark	3	3	3	1	2	3	3	2	3	2	2	2.57	1.58	0	3.02	Medium
<i>Bathyraja shuntovi</i>	-	2	2	3	2	2	2	3	3	3	2	2	2.29	1.88	1	2.96	Medium
<i>Etmopterus lucifer</i>	Blackbelly Lanternshark	2	3	3	1	1	3	3	3	3	2	2	2.29	1.88	1	2.96	Medium

## PRELIMINARY ASSESSMENT

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Rajella sadowskii</i>	-	2	3	3	1	2	2	3	3	3	2	2	2.29	1.88	1	2.96	Medium
<i>Rajella challengerii</i>	-	2	3	3	1	2	2	3	3	3	2	2	2.29	1.88	1	2.96	Medium
<i>Centroscyllium kamoharai</i>	-	2	2	3	1	2	3	3	3	3	2	2	2.29	1.88	1	2.96	Medium
<i>Rhinochimaera africana</i>	-	3	3	3	2	2	2	3	3	3	1	2	2.57	1.43	0	2.94	Medium
<i>Centroscymnus coelolepis</i>	Portuguese Dogfish	2	3	3	1	2	3	3	1	3	3	3	2.43	1.65	0	2.94	Medium
<i>Dalatias licha</i>	Black Shark	2	3	3	2	2	3	3	2	3	1	3	2.57	1.43	0	2.94	Medium
<i>Alopias superciliosus</i>	Bigeye Thresher Shark	2	2	3	3	3	3	3	1	3	1	2	2.71	1.13	0	2.94	Medium
<i>Cetorhinus maximus</i>	Basking Shark	2	3	3	3	3	3	2	1	3	1	2	2.71	1.13	0	2.94	Medium
<i>Hexanchus nakamurai</i>	Bigeye Sixgill Shark	2	3	3	2	2	3	3	2	3	1	3	2.57	1.43	0	2.94	Medium
<i>Chimaera lignaria</i>	-	3	3	3	2	2	2	3	3	3	1	2	2.57	1.43	1	2.94	Medium
<i>Harriotta haeckeli</i>	-	3	3	3	1	2	2	3	2	3	2	2	2.43	1.58	0	2.9	Medium
<i>Heptranchias perlo</i>	Sharpnose Sevengill Shark	2	3	3	2	2	3	3	1	3	2	2	2.57	1.28	0	2.87	Medium
<i>Brochiraja asperula</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Notoraja azurea</i>	Blue Skate	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Etmopterus molleri</i>	Moller's Lanternshark	1	3	3	1	1	3	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Bathyraja longicauda</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Bathyraja aguja</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Arhynchobatis asperrimus</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Notoraja alisae</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Centroscyllium nigrum</i>	-	2	2	3	1	1	3	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Centroscyllium granulatum</i>	-	2	2	3	1	1	3	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Hydrolagus novaezealandiae</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Hydrolagus macrophthalmus</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Brochiraja vitticauda</i>	-	2	2	3	1	2	2	3	3	3	2	2	2.14	1.88	1	2.85	Medium
<i>Zearaja chilensis</i>	-	2	3	3	2	2	2	3	3	3	1	2	2.43	1.43	1	2.82	Medium
<i>Dasyatis thetidis</i>	Black Stingray	2	2	3	2	2	3	3	3	3	1	2	2.43	1.43	1	2.82	Medium
<i>Torpedo macneilli</i>	Short-tail Torpedo Ray	2	2	3	2	2	3	3	3	3	1	2	2.43	1.43	1	2.82	Medium
<i>Pristiophorus cirratus</i>	Common Sawshark	2	2	3	2	2	3	3	3	3	1	2	2.43	1.43	1	2.82	Medium

## PRELIMINARY ASSESSMENT

Scientific name	Common name	P 1	P 2	P 3	P 4	P 5	P 6	P 7	S 1	S 2	S 3	S 4	Prod. Score	Susc. Score	Missing attributes	PSA 2D	Risk Category
<i>Etmopterus pusillus</i>	Slender Lanternshark	2	3	3	1	1	3	3	2	3	2	2	2.29	1.58	0	2.78	Medium
<i>Euprotomicrus bispinatus</i>	Pygmy Shark	3	3	3	1	1	3	3	1	3	2	2	2.43	1.28	2	2.75	Medium
<i>Brochiraja heuresa</i>	-	2	2	3	1	1	2	3	3	3	2	2	2	1.88	1	2.74	Medium
<i>Notoraja martinezi</i>	-	2	2	3	1	2	2	2	3	3	2	2	2	1.88	1	2.74	Medium
<i>Typhlonarke aysoni</i>	-	2	2	3	1	1	3	2	3	3	2	2	2	1.88	1	2.74	Medium
<i>Brochiraja microspinifera</i>	-	2	2	3	1	1	2	3	3	3	2	2	2	1.88	1	2.74	Medium
<i>Brochiraja leviveneta</i>	-	2	2	3	1	1	2	3	3	3	2	2	2	1.88	1	2.74	Medium
<i>Bathyraja richardsoni</i>	-	2	2	3	2	2	2	3	3	3	1	2	2.29	1.43	1	2.7	Medium
<i>Dipturus gudgeri</i>	Bight Skate	2	2	3	2	2	2	3	3	3	1	2	2.29	1.43	1	2.7	Medium
<i>Pseudocarcharias kamoharai</i>	Crocodile Shark	1	2	3	2	2	3	3	1	3	3	2	2.29	1.43	0	2.7	Medium
<i>Bathyraja meridionalis</i>	-	2	2	3	2	2	2	3	3	3	1	2	2.29	1.43	1	2.7	Medium
<i>Bathyraja spinosissima</i>	-	2	2	3	2	2	2	3	3	3	1	2	2.29	1.43	1	2.7	Medium
<i>Etmopterus pycnolepis</i>	-	1	1	3	1	1	3	3	3	3	2	2	1.86	1.88	1	2.64	Medium
<i>Notoraja sapphira</i>	-	2	2	3	1	1	2	2	3	3	2	2	1.86	1.88	1	2.64	Medium
<i>Isistius brasiliensis</i>	Smalltooth Cookiecutter Shark	2	3	3	1	1	3	3	1	3	2	2	2.29	1.28	0	2.62	Low

## PRELIMINARY ASSESSMENT

### Next steps - SAFE methodology

A key difference between the PSA and SAFE assessment is that the PSA derives availability based on presence of species in grids that are assumed to have been fished (although for the SPRFMO PSA assessment this was simply expressed as high, medium or low overlap, as the total area is assumed to have homogenously-distributed fishing effort), whereas SAFE can use the estimated actual area affected by fishing within grids (Zhou et al. 2016). Consequently, the PSA assessment overestimates fishing mortality and provides an indication of *potential relative* risk. The 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  $u$  (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 PSA susceptibility attributes (spatial distribution, encounterability, selectivity and post-capture mortality), the SAFE assessment integrates these into three parameters: spatial overlap, catchability and post capture mortality as described by Zhou et al. (2009) to determine the fishing mortality  $F_{CURR}$  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 (i.e. spatial overlap), respectively,  $q$  is the catch rate ('catchability'),  $E$  is the escapement rate (i.e. the amount of the population that does not get caught by fishing) and  $s$  is the post-capture survival rate.

Necessarily, methods for estimating fishing impacts varies depending on the fishery characteristics, including the configuration of gears. Zhou et al. (2007) provides the different methods used for trawl, auto-longline and gillnet fisheries, with these methods being applied for the current analysis.

This fishing-induced mortality rate is then compared to sustainability reference points as described by Zhou et al. (2007). These reference points have been defined as:

- Low risk: fishing mortality rate  $u$  is less than  $uMSM$
- Medium risk: fishing mortality rate is greater than  $uMSM$  but less than  $uLIM$
- High risk: fishing mortality rate is greater than  $uLIM$  but less than  $uCRASH$
- Extreme high risk: fishing mortality rate is greater than  $uCRASH$ .

where:

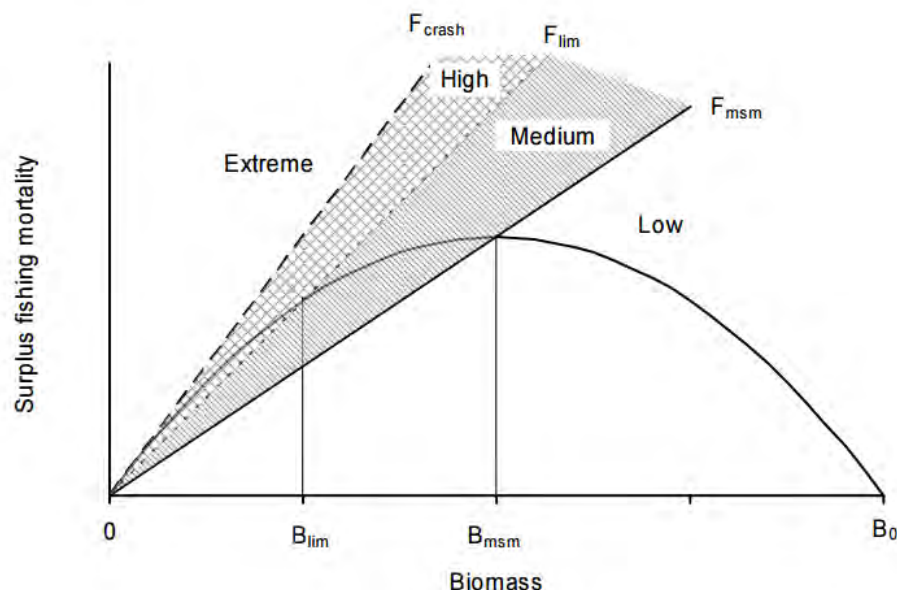
- $uMSM$  = fishing mortality rate corresponding to the maximum sustainable fishing mortality (MSM) at BMSM (biomass that supports MSM);
- $uLIM$  = fishing mortality rate corresponding to the limit biomass BLIM, where BLIM is defined as  $0.5BMSM$ ; and
- $uCRASH$  = minimum unsustainable fishing mortality rate that, theoretically, will lead to population extinction in the long term (Zhou et al. 2007, see Figure 10).

Note that  $u$  is derived from the instantaneous fishing mortality  $F_{CURR}$  using the formula:  $u = 1 - \exp(-F)$ .

An average of six methods is used for determining the reference point for FMSM (see Zhou et al. 2007). Some of these methods may be more appropriate to teleosts than to chondrichthyans (or other animals, habitats or communities). Sensitivities exploring the use of a subset of these methods (or different methods altogether) may provide different results, and could be an area for future research. However, exploring different these sensitivities was not done in this analysis.

## PRELIMINARY ASSESSMENT

**Figure 10 Stock productivity, reference points and ecological risk assessment categories for deepwater chondrichthyans assessed in SAFE ecological risk assessment**



Source: Zhou et al. 2007

### Cumulative impacts

Theoretically, cumulative impacts can be derived by adding together fishing impacts by multiple fisheries. This was not done for this assessment but may improve future analyses.

### Next steps – 2018 Work Plan

To enable the SAFE analysis, bottom fishing Members will need to provide:

- 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).
- 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.

These data are required from Australia and New Zealand. Once these data are provided, the next steps are to:

- Critically review the species to be excluded from the final analysis (i.e. those that are not currently likely to interact with SPRFMO fisheries)
- Critically review the productivity and susceptibility attributes for those species retained.
- Agree to the final SAFE analyses and timetable for SC report preparation and clearance requirements of each agency.
- Develop a workplan for other relevant tasks for the SPRFMO Deepwater Working Group.

## Discussion and implications

### Summary of findings

This analysis helps to categorise potential relative risk and absolute risk of overexploitation of deepwater chondrichthyans in the SPRFMO Convention Area that could interact with demersal trawl, midwater trawl, demersal longline, dropline and gillnet gears. The combination of the low productivity of many deepwater chondrichthyans and the susceptibility to some gears places a number of species in the high risk category. For the PSA, differences in risk were noted between

PRELIMINARY ASSESSMENT

different gears, with gillnet and line gears producing higher potential relative risks than those posed by demersal and midwater trawl gears. In reality, this does not mean that gillnet and line gears cause a greater level of fishing mortality; rather, that they can theoretically lead to greater exploitation based on the productivity and susceptibility attributes used for the analysis.

The analysis highlights the need for better information on the biology of many species, particularly in terms of their productivity, distribution and other life history attributes. A large knowledge gap also exists in the understanding of stock structuring. It is likely that the impacts of fishing over population and sub-population scales will be quite different than impacts of fishing over the entire distribution of species. This issue is highlighted by the concentration of fishing effort on particular features and within existing fishing footprints. The analysis also highlights the need for better catch and effort data so that species can be identified with greater certainty, and so that estimates of fishing mortality can be made more accurate in future studies. Another area of data paucity exists around the preferred habitat of many species in terms of their vertical distributions, and it is likely that estimates of risk and fishing mortality could be further refined by having better information about species’ preferred depth ranges.

Relevance to management

Internationally, there has been limited progress on setting harvest strategies for low value, including byproduct and bycatch, species. Most deepwater chondrichthyans encountered in the SPRFMO Convention Area fall into these categories. Consequently, little has been done to establish assessment methods and associated estimates of fishing mortality and reference points. A high level of uncertainty in the input parameters for estimating fishing mortality and reference points means that there is also a high level of uncertainty around the assessment outputs. To link these outputs with particular management outcomes or objectives requires a precautionary, but pragmatic approach. Thus, higher importance may be given to species with higher confidence that they are indeed in the correct risk category, but this may go against the fundamental principles of a precautionary approach. To overcome this problem, management actions need to be such that they 1) incentivise the collection of information on low confidence species and 2) place the onus of this information collection on the entities exploiting (or seeking to exploit) particular species.

A framework such as that presented by Zhou et al. (2007) may provide a useful mechanism to approach management of both bycatch/byproduct and target deepwater chondrichthyans species (and other species, habitats or communities), as it includes clearly defined ecological consequences and associated management rules against the explicit reference points derived from a SAFE assessment.

	$F < F_{msm}$	$F_{lim} > F > F_{msm}$	$F_{crash} > F > F_{lim}$	$F > F_{crash}$
ERA risk	Low (L)	Medium (M)	High (H)	Extreme high (E)
Ecological consequence	Overfishing not occurring. May keep population above 50% of virgin level	Overfishing is occurring but population can be sustainable	May drive population to very low levels in longer term	Population is unsustainable in long term – possibility of extinction
Management rule	Reduction of F not needed	Reduction in F may be required if this level of F occurs over seven consecutive years	Reduce fishing mortality below $F_{msm}$ if this F occurs in five consecutive years	Reduce fishing mortality below $F_{msm}$ if this F occurs in three consecutive years

Source: Zhou et al. 2007

## PRELIMINARY ASSESSMENT

The benefits of this analysis are not only that it provides the first assessment of the risks from fishing to deepwater chondrichthyans in the SPRFMO Convention Area, but a demonstration of the application of a method for the assessment of the risks of fishing to other species and ecosystems with which SPRFMO fisheries interact.

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## PRELIMINARY ASSESSMENT

## Appendix 1

Comparison between PSA and SAFE.

	PSA	SAFE
Key assumptions	<ol style="list-style-type: none"> <li>1. Risk is measured by productivity and susceptibility attributes;</li> <li>2. Fish randomly or homogeneously distribute over their distribution range;</li> <li>3. 3-level catchability: low, medium, and high;</li> <li>4. Productivity relate to life history traits.</li> </ol>	<ol style="list-style-type: none"> <li>1. Risk is measured by fishing mortality and reference points;</li> <li>2. Same as PSA;</li> <li>3. 3-level catchability: 0.33, 0.67, and 1;</li> <li>4. Reference points relate to life history traits.</li> </ol>
Productivity or reference point axis	<p><b>Attributes used:</b></p> <ol style="list-style-type: none"> <li>1. Maximum length;</li> <li>2. Age at maturity;</li> <li>3. Maximum age;</li> <li>4. Fecundity;</li> <li>5. Size at maturity;</li> <li>6. Reproductive strategy;</li> <li>7. Trophic level.</li> </ol> <p><b>Scoring Rules:</b></p> <ol style="list-style-type: none"> <li>1. Each attribute is divided into 1, 2, and 3 scores;</li> <li>2. Uses genera average when species-specific attributes are missing;</li> <li>3. Missing data scored as high;</li> <li>4. Final score <math>P = \text{average of all attribute scores}</math>.</li> </ol>	<p><b>Attributes used:</b></p> <ol style="list-style-type: none"> <li>1. Same as PSA;</li> <li>2. Same as PSA;</li> <li>3. Same as PSA;</li> <li>4. Natural mortality;</li> <li>5. Growth rate;</li> <li>6. Intrinsic population increase <math>r</math>.</li> </ol> <p><b>Equations:</b></p> <ol style="list-style-type: none"> <li>1. <math>F_{msy} = r/2</math>;</li> <li>2. Estimating <math>M</math> using 1–5 life history parameters above:  <math>F_{msy} = 0.87 M</math> (teleost) and  <math>F_{msy} = 0.41 M</math> (elasmobranch);</li> <li>3. Mean <math>F_{msy} = \text{average all } F_{msy}</math>;</li> <li>4. <math>F_{lim} = 1.5 F_{msy}</math> and <math>F_{crash} = 2 F_{msy}</math>.</li> </ol>
Susceptibility or fishing mortality axis	<p><b>Attributes used:</b></p> <ol style="list-style-type: none"> <li>1. Availability (A)</li> <li>2. Encounterability (E)</li> <li>3. Selectivity (S)</li> <li>4. Post-capture mortality (D)</li> </ol> <p><b>Scoring Rules:</b></p> <p>Final score  <math>S = A \times E \times S \times D</math></p>	<p><b>Fishing mortality:</b></p> <ol style="list-style-type: none"> <li>1. Availability (A)</li> <li>2. Encounterability (E)</li> <li>3. Selectivity (S)</li> <li>4. Post-capture mortality (D)</li> </ol> <p><b>Scoring Rules:</b></p> <p>Fishing mortality  <math>F = A \times E \times S \times D</math></p>
Risk category	<p>Divide possible scores into 1/3<sup>rd</sup>s</p> <ol style="list-style-type: none"> <li>1. Low risk: <math>&lt;2.64</math></li> <li>2. Medium risk: <math>2.64-3.18</math></li> <li>3. High risk: <math>&gt;3.18</math></li> </ol>	<ol style="list-style-type: none"> <li>1. Low risk: <math>F &lt; F_{msy}</math></li> <li>2. Medium risk: <math>F_{msy} &lt; F &lt; F_{lim}</math></li> <li>3. High risk: <math>F &gt; F_{lim}</math></li> </ol>

## PRELIMINARY ASSESSMENT

## Appendix 2

**List of deepwater chondrichthyans thought to occur in the South Pacific Regional Fisheries Management Organisation Convention Area**

Species	Family	Shark/batoid/chimaera
<i>Aculeola nigra</i>	Etmopteridae	S
<i>Alopias superciliosus</i>	Alopiidae	S
<i>Amblyraja doellojuradoi</i>	Rajidae	B
<i>Amblyraja frerichsi</i>	Rajidae	B
<i>Amblyraja hyperborea</i>	Rajidae	B
<i>Apristurus ampliceps</i>	Scyliorhinidae	S
<i>Apristurus australis</i>	Scyliorhinidae	S
<i>Apristurus brunneus</i>	Scyliorhinidae	S
<i>Apristurus exsanguis</i>	Scyliorhinidae	S
<i>Apristurus kampae</i>	Scyliorhinidae	S
<i>Apristurus melanoasper</i>	Scyliorhinidae	S
<i>Apristurus nasutus</i>	Scyliorhinidae	S
<i>Apristurus pinguis</i>	Scyliorhinidae	S
<i>Apristurus sinensis</i>	Scyliorhinidae	S
<i>Arhynchobatis asperimus</i>	Arhynchobatidae	B
<i>Bathyraja aguja</i>	Arhynchobatidae	B
<i>Bathyraja albomaculata</i>	Arhynchobatidae	B
<i>Bathyraja brachyurops</i>	Arhynchobatidae	B
<i>Bathyraja cousseauae</i>	Arhynchobatidae	B
<i>Bathyraja griseocauda</i>	Arhynchobatidae	B
<i>Bathyraja longicauda</i>	Arhynchobatidae	B
<i>Bathyraja macloviana</i>	Arhynchobatidae	B
<i>Bathyraja magellanica</i>	Arhynchobatidae	B
<i>Bathyraja meridionalis</i>	Arhynchobatidae	B
<i>Bathyraja multispinis</i>	Arhynchobatidae	B
<i>Bathyraja peruana</i>	Arhynchobatidae	B
<i>Bathyraja richardsoni</i>	Arhynchobatidae	B
<i>Bathyraja schroederi</i>	Arhynchobatidae	B
<i>Bathyraja shuntovi</i>	Arhynchobatidae	B
<i>Bathyraja spinosissima</i>	Arhynchobatidae	B
<i>Bathytoshia lata</i>	Dasyatidae	B
<i>Brochiraja albilabiata</i>	Arhynchobatidae	B
<i>Brochiraja asperula</i>	Arhynchobatidae	B
<i>Brochiraja heuresa</i>	Arhynchobatidae	B
<i>Brochiraja leviveneta</i>	Arhynchobatidae	B
<i>Brochiraja microspiniifera</i>	Arhynchobatidae	B
<i>Brochiraja spinifera</i>	Arhynchobatidae	B
<i>Brochiraja vitticauda</i>	Arhynchobatidae	B
<i>Bythaelurus canescens</i>	Scyliorhinidae	S
<i>Bythaelurus dawsoni</i>	Scyliorhinidae	S
<i>Centrophorus harrissoni</i>	Centrophoridae	S

## PRELIMINARY ASSESSMENT

<i>Centrophorus moluccensis</i>	Centrophoridae	S
<i>Centrophorus squamosus</i>	Centrophoridae	S
<i>Centrophorus zeehaani</i>	Centrophoridae	S
<i>Centroscyllium granulatum</i>	Etmopteridae	S
<i>Centroscyllium kamoharai</i>	Etmopteridae	S
<i>Centroscyllium nigrum</i>	Etmopteridae	S
<i>Centroscyrnus coelolepis</i>	Somniosidae	S
<i>Centroscyrnus owstoni</i>	Somniosidae	S
<i>Centroselachus crepidater</i>	Somniosidae	S
<i>Cephaloscyllium isabellum</i>	Scyliorhinidae	S
<i>Cetorhinus maximus</i>	Cetorhinidae	S
<i>Chimaera carophila</i>	Chimaeridae	C
<i>Chimaera lignaria</i>	Chimaeridae	C
<i>Chimaera orientalis</i>	Chimaeridae	C
<i>Chimaera panthera</i>	Chimaeridae	C
<i>Chlamydoselachus anguineus</i>	Chlamydoselachidae	S
<i>Cirrhigaleus australis</i>	Squalidae	S
<i>Cirrhigaleus barbifer</i>	Squalidae	S
<i>Dalatias licha</i>	Dalatiidae	S
<i>Deania calcea</i>	Centrophoridae	S
<i>Deania hystricosa</i>	Centrophoridae	S
<i>Deania quadrispinosa</i>	Centrophoridae	S
<i>Dipturus acrobatus</i>	Rajidae	B
<i>Dipturus canutus</i>	Rajidae	B
<i>Dipturus gudgeri</i>	Rajidae	B
<i>Dipturus innominatus</i>	Rajidae	B
<i>Dipturus trachydermus</i>	Rajidae	B
<i>Dipturus wengi</i>	Rajidae	B
<i>Echinorhinus brucus</i>	Echinorhinidae	S
<i>Echinorhinus cookei</i>	Echinorhinidae	S
<i>Etmopterus bigelowi</i>	Etmopteridae	S
<i>Etmopterus granulosus</i>	Etmopteridae	S
<i>Etmopterus litvinovi</i>	Etmopteridae	S
<i>Etmopterus lucifer</i>	Etmopteridae	S
<i>Etmopterus molleri</i>	Etmopteridae	S
<i>Etmopterus pusillus</i>	Etmopteridae	S
<i>Etmopterus pycnolepis</i>	Etmopteridae	S
<i>Etmopterus viator</i>	Etmopteridae	S
<i>Euprotomicroides zantedeschia</i>	Dalatiidae	S
<i>Euprotomicrus bispinatus</i>	Dalatiidae	S
<i>Figaro boardmani</i>	Scyliorhinidae	S
<i>Galeorhinus galeus</i>	Triakidae	S
<i>Gollum attenuatus</i>	Pseudotriakidae	S
<i>Gurgesiella furvescens</i>	Gurgesiellidae	B
<i>Harriotta haeckeli</i>	Rhinochimaeridae	C
<i>Harriotta raleighana</i>	Rhinochimaeridae	C

## PRELIMINARY ASSESSMENT

<i>Heptranchias perlo</i>	Hexanchidae	S
<i>Heteroscymnoides marleyi</i>	Dalatiidae	S
<i>Hexanchus griseus</i>	Hexanchidae	S
<i>Hexanchus nakamurai</i>	Hexanchidae	S
<i>Hydrolagus bemisi</i>	Chimaeridae	C
<i>Hydrolagus homonycteris</i>	Chimaeridae	C
<i>Hydrolagus lemures</i>	Chimaeridae	C
<i>Hydrolagus macrophthalmus</i>	Chimaeridae	C
<i>Hydrolagus melanophasma</i>	Chimaeridae	C
<i>Hydrolagus novaezealandiae</i>	Chimaeridae	C
<i>Hydrolagus trolli</i>	Chimaeridae	C
<i>Isistius brasiliensis</i>	Dalatiidae	S
<i>Isurus oxyrinchus</i>	Lamnidae	S
<i>Lamna nasus</i>	Lamnidae	S
<i>Mitsukurina owstoni</i>	Mitsukurinidae	S
<i>Notoraja alisae</i>	Arhynchobatidae	B
<i>Notoraja azurea</i>	Arhynchobatidae	B
<i>Notoraja martinezi</i>	Arhynchobatidae	B
<i>Notoraja sapphira</i>	Arhynchobatidae	B
<i>Odontaspis ferox</i>	Odontaspidae	S
<i>Oxynotus bruniensis</i>	Oxynotidae	S
<i>Parmaturus macmillani</i>	Scyliorhinidae	S
<i>Pristiophorus cirratus</i>	Pristiophoridae	S
<i>Psammobatis scobina</i>	Arhynchobatidae	B
<i>Pseudocarcharias kamoharai</i>	Pseudocarchariidae	S
<i>Pseudotriakis microdon</i>	Pseudotriakidae	S
<i>Rajella challengerii</i>	Rajidae	B
<i>Rajella eisenhardti</i>	Rajidae	B
<i>Rajella nigerrima</i>	Rajidae	B
<i>Rajella sadowskii</i>	Rajidae	B
<i>Rhinochimaera africana</i>	Rhinochimaeridae	C
<i>Rhinochimaera pacifica</i>	Rhinochimaeridae	C
<i>Scymnodalatias albicauda</i>	Somniosidae	S
<i>Scymnodon plunketi</i>	Somniosidae	S
<i>Scymnodon ringens</i>	Somniosidae	S
<i>Somniosus antarcticus</i>	Somniosidae	S
<i>Somniosus longus</i>	Somniosidae	S
<i>Squaliolus aliae</i>	Dalatiidae	S
<i>Squalus acanthias</i>	Squalidae	S
<i>Squalus cholorculus</i>	Squalidae	S
<i>Squalus griffini</i>	Squalidae	S
<i>Squalus megalops</i>	Squalidae	S
<i>Squalus mitsukurii</i>	Squalidae	S
<i>Squalus montalbani</i>	Squalidae	S
<i>Tetronarce nobiliana</i>	Torpedinidae	B
<i>Tetronarce tremens</i>	Torpedinidae	B

PRELIMINARY ASSESSMENT

<i>Typhlonarke aysoni</i>	Torpedinidae	B
<i>Zameus squamulosus</i>	Somniosidae	S
<i>Zearaja chilensis</i>	Rajidae	B
<i>Zearaja nasuta</i>	Rajidae	B

Note: This list includes 137 species. One hundred and twenty-seven of these were retained for the PSA.

PRELIMINARY ASSESSMENT

## PRELIMINARY ASSESSMENT

## Appendix 3

**Caveats around the use of cogeneric or cofamily productivity attributes, and associated references, for chondrichthyans species that may interact with demersal trawl, midwater trawl, demersal longline, dropline and gillnet gears in the SPRFMO Convention Area**

Scientific name	Family	FAO Common name	Comment
<i>Alopias superciliosus</i>	Alopiidae	Bigeye thresher	Red List Assessment (RLA) - Amorim et al. 2009 - gestation 12 months. Interbirth interval estimated as 1 year based on cogeneric <i>A. vulpinus</i> .
<i>Arhynchobatis asperimus</i>	Arhynchobatidae	Longtail skate	C. Rigby - Interbirth interval estimated from cofamily species. Kyne & Simpfendorfer 2007 - there are no estimates of annual fecundity for the softnose skates (this family). This is the only species in this genus. No data on Smat F so Smat M used as proxy data. Of Arynchobatidae with age/growth data, most similar size and depth is <i>Bathyraja albomaculata</i> (96 cm and 55-861 m). Amat, Amax, k, min/max no. eggs all proxy data from <i>B. albomaculata</i> . Min/max no eggs is ovarian fecundity.
<i>Bathyraja aguja</i>	Arhynchobatidae	-	Ebert 2016 - Smax at least 78 cm. No data on Smat F so Smat M used as proxy data. C. Rigby - Interbirth interval estimated from cogeneric species. Of <i>Bathyraja</i> with age/growth data, most similar size and depth is <i>Bathyraja albomaculata</i> (96 cm and 55-861 m). Amat, Amax, k, min/max no. eggs (ovarian fecundity) all proxy data from <i>B. albomaculata</i> .
<i>Bathyraja albomaculata</i>	Arhynchobatidae	-	Ruocco et al. 2006 - year round egg laying. Min/max no. eggs is ovarian fecundity.
<i>Bathyraja brachyurops</i>	Arhynchobatidae	Broadnose skate	C. Rigby - Interbirth interval estimated from cogeneric species. Min/max no eggs is ovarian fecundity from Kyne & Simpfendorfer 2007 - average of two most similar sized <i>Bathyraja</i> ( <i>B. aleutica</i> and <i>B. parmifera</i> ).
<i>Bathyraja cousseauae</i>	Arhynchobatidae	-	No data on Smat F so Smat M used as proxy data. C. Rigby - Interbirth interval estimated by from cogeneric species. Ebert 2016 - RLA (McCormack et al. 2007). Status is Near Threatened due to intense and increasing fisheries targeting skates in the region where this species occurs. RLA - this species previously mistaken for <i>B. brachyurops</i> and only described in 2004. As it was previously identified as <i>B. brachyurops</i> that is of similar size but shallower maximum depth (125 cm and 604 m), Amat, Amax, k all proxy data from <i>B. brachyurops</i> . Min/max no eggs is ovarian fecundity from Kyne & Simpfendorfer 2007 - average of two most similar sized <i>Bathyraja</i> ( <i>B. aleutica</i> and <i>B. parmifera</i> ).
<i>Bathyraja griseocauda</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cogeneric species. Min/max no eggs is ovarian fecundity from Kyne & Simpfendorfer 2007 - most similar sized <i>Bathyraja</i> ( <i>B. lindbergi</i> ).
<i>Bathyraja longicauda</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cogeneric species. Ebert 2016 - Sbirth unknown, smallest free-swimming individual 18.3 cm. Last et al. 2016 - only known from a few specimens. No data on Smat F so Smat M used as proxy data. Of <i>Bathyraja</i> with age/growth data, most similar size and depth is <i>Bathyraja albomaculata</i> (96 cm and 55-861 m). Amat, Amax, k, min/max no eggs (ovarian fecundity) all proxy data from <i>B. albomaculata</i> .

## PRELIMINARY ASSESSMENT

<i>Bathyraja macloviana</i>	Arhynchobatidae	Patagonian skate	C. Rigby - Interbirth interval estimated from cogeneric species. Other Bathyraja with age/growth data, most similar size and depth is <i>B. kincaidii</i> - which occurs deeper (64 cm and 55-1372 m) than <i>B. macloviana</i> . Proxy data Amat, Amax, k. from <i>B. kincaidii</i> . Min/max no. eggs is ovarian fecundity estimated from other small Bathyraja - <i>B. taranetzi</i> (Kyne & Simpfendorfer 2007).
<i>Bathyraja magellanica</i>	Arhynchobatidae	-	C. Rigby- Interbirth interval estimated from cogeneric species. Min/max no eggs is ovarian fecundity. Ebert 2016- estimated Amat and Amax, but could not find this in the published literature - it may be unpublished data. A proxy for k was used from the other Bathyraja with age/growth data that had the youngest Amat - <i>B. kincaidii</i> - which is smaller and occurs deeper (64 cm and 55-1372 m) than <i>B. magellanica</i> .
<i>Bathyraja meridionalis</i>	Arhynchobatidae	Dark-belly skate	C. Rigby - Interbirth interval estimated from cogeneric species. Ebert 2016 -taken as bycatch in longline fisheries, especially for Patagonian toothfish. RLA (Stehmann & Pompert 2009) - it is one of the most commonly caught skates in this fishery off the Falkland Islands. Of Bathyraja with age/growth data, only one that occurs to a similar very deep depth is <i>Bathyraja trachura</i> (400-2550 m), though it is much smaller (87 cm). Amat, Amax, k proxy data from <i>B. trachura</i> as depth is important with respect to growth rates (Rigby & Simpfendorfer 2015). Min/max no. eggs (ovarian fecundity) and Sbirth proxy from more similar sized <i>B. aleutica</i> .
<i>Bathyraja multispinis</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cogeneric species. Ebert 2016 - Sbirth unknown, smallest free-swimming individual 12.6 cm; in Argentina and Uruguay it is a regular bycatch in hake fisheries with a decline in biomass reported; It is also taken as bycatch in southern Chile. Of Bathyraja with age/growth data, most similar size and depth is <i>Bathyraja brachyurops</i> (125 cm and 28-604 m). Amat, Amax, k proxy data from <i>B. brachyurops</i> . Min/max no eggs is ovarian fecundity from Kyne & Simpfendorfer 2007 - average of two more similar sized Bathyraja ( <i>B. aleutica</i> and <i>B. parmifera</i> ).
<i>Bathyraja peruana</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cogeneric species. No data on Smat M so Smat F used as proxy data. Ebert 2016 - Sbirth unknown, smallest free-swimming individual 17.3 cm; uncommon species. Of Bathyraja with age/growth data, most similar size and depth is <i>Bathyraja albomaculata</i> (96 cm and 55-861 m). Amat, Amax, k, min/max no. eggs (ovarian fecundity) all proxy data from <i>B. albomaculata</i> .
<i>Bathyraja richardsoni</i>	Arhynchobatidae	Richardson's ray	C. Rigby - Interbirth interval estimated from cogeneric species. No data on Smat F so Smat M used as proxy data. Of Bathyraja with age/growth data, only one that occurs to a similar very deep depth is <i>Bathyraja trachura</i> (400-2550 m), though it is much smaller (87 cm). Amat, Amax, k proxy data from <i>B. trachura</i> as depth is important with respect to growth rates (Rigby & Simpfendorfer 2015). Min/max no. eggs (ovarian fecundity) proxy from more similar sized <i>B. aleutica</i> ( <i>B. griseocauda</i> is larger again at Smax 160 cm but has no fecundity data).
<i>Bathyraja schroederi</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cogeneric species. Ebert 2016 - Sbirth unknown, smallest free-swimming individual 24.6 cm; of no interest to fisheries, possibly taken as bycatch; rare species only known from a few specimens. Of Bathyraja with age/growth data, only one that occurs to a similar very deep depth is <i>Bathyraja trachura</i> (400-2550 m), though it is smaller (87 cm). Amat, Amax, k proxy data from <i>B. trachura</i> as depth is important with respect to growth rates (Rigby & Simpfendorfer 2015). Min/max no. eggs (ovarian fecundity) proxy from Kyne & Simpfendorfer 2007 - average of two more similar sized Bathyraja ( <i>B. aleutica</i> and <i>B. parmifera</i> ).
<i>Bathyraja shuntovi</i>	Arhynchobatidae	Longnose deep-sea skate	C. Rigby - Interbirth interval estimated from cogeneric species. No data on Smat F so Smat M used as proxy data. RLA (Francis & McCormack 2009) -large trawlers target orange roughy and hoki over this species' depth and geographic range; range of this species may extend deeper than 1500 m. Of Bathyraja with age/growth data, most similar size and depth is <i>Bathyraja parmifera</i> (119 cm and 20-1425 m). Amat, AMax, k, Sbirth and min/max no eggs (ovarian fecundity) all proxy data from <i>B. parmifera</i> .
<i>Bathyraja spinosissima</i>	Arhynchobatidae	Spiny skate	C. Rigby - Interbirth interval estimated from cogeneric species. Ebert 2016 - ROV observations show this skate is quite abundant in the deeper waters where it prefers habitat with large boulders and steep rocky reefs; egg cases deposited in clutches in boulder fields; very rarely seen in trawl bycatch, could be caught by longlines; Smat M likely greater than 150 cm. No data on Smat F so Smat M used

## PRELIMINARY ASSESSMENT

			as proxy data. Of <i>Bathyrāja</i> with age/growth data, only one that occurs to a similar very deep depth is <i>Bathyrāja trachura</i> (400-2550 m), though it is smaller (87 cm). Amat, Amax, k proxy data from <i>B. trachura</i> as depth is important with respect to growth rates (Rigby & Simpfendorfer 2015). Min/max no. eggs (ovarian fecundity) proxy from more similar sized <i>B. aleutica</i> ( <i>B. griseocauda</i> is larger again at Smax 160 cm but has no fecundity data).
<i>Brochiraja albilabiata</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cogenetic species. Inhabits depth range of trawlers targeting orange roughy and oreos, only currently known from four specimens within NZ EEZ from Three Kings Trough. No data on Smat - Kyne & Simpfendorfer 2007 - for all Arhynchobatidae, Smat was >80% Smax, therefore estimated SmatM and Smat F as 80% Smax. Of Arhynchobatidae with age/growth data, most similar size and depth is <i>Bathyrāja albomaculata</i> which is larger (96cm and 55-861 m). Amat, AMax, k, Sbirth, min/max no eggs (ovarian fecundity) all proxy data from <i>B. albomaculata</i> .
<i>Brochiraja asperula</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cofamily species. No data on Smat F so Smat M used as proxy data. Of Arhynchobatidae with age/growth data, most similar size and depth is <i>Bathyrāja kincaidii</i> which is smaller though similar depth (64 cm and 55-1372 m). Amat (from Smat on growth curve), AMax, k all proxy data from <i>B. kincaidii</i> . No fecundity data for <i>B. kincaidii</i> , Sbirth, min/max no eggs (ovarian fecundity) proxy data from <i>B. taranetzi</i> - next most similar sized cofamily species with fecundity data.
<i>Brochiraja heuresa</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cofamily species. No data on Smat F so Smat M used as proxy data. Of Arhynchobatidae with age/growth data, most similar size and depth is <i>Bathyrāja kincaidii</i> which is larger though similar depth (64 cm and 55-1372 m). Amat (from Smat on growth curve), AMax, k all proxy data from <i>B. kincaidii</i> . No fecundity data for <i>B. kincaidii</i> , min/max no eggs (ovarian fecundity) and Sbirth proxy data from <i>B. taranetzi</i> - next most similar sized cofamily species with fecundity data.
<i>Brochiraja leviveneta</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cofamilyspecies. No data on Smat F so Smat M used as proxy data. RLA 2009 - taken as occasional trawl bycatch and discarded in New Zealand trawl fisheries for orange roughy, oreos and hoki. Ford et al. 2015 - taken inside EEZ and adjacent to EEZ. Of Arhynchobatidae with age/growth data, most similar size and depth is <i>Bathyrāja kincaidii</i> which is larger though similar depth (64 cm and 55-1372 m). Amat (from Smat on growth curve), AMax, k all proxy data from <i>B. kincaidii</i> . No fecundity data for <i>B. kincaidii</i> , Sbirth, min/max no eggs (ovarian fecundity) proxy data from <i>B. taranetzi</i> - next most similar sized cofamilyspecies with fecundity data.
<i>Brochiraja microspinifera</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cofamily species. No data on Smat F so Smat M used as proxy data. Last et al. 2016 - NZ endemic, smallest member of this genus. RLA (Stevens 2009b) - taken as occasional trawl bycatch and discarded in New Zealand trawl fisheries for orange roughy, oreos and hoki. Ford et al. 2015 - taken inside EEZ and adjacent to EEZ. Of Arhynchobatidae with age/growth data, smallest species with similar depth is <i>Bathyrāja kincaidii</i> which is larger (64 cm and 55-1372 m). Amat (from Smat on growth curve), AMax, k all proxy data from <i>B. kincaidii</i> . No fecundity data for <i>B. kincaidii</i> , Sbirth, min/max no eggs (ovarian fecundity) proxy data from <i>B. taranetzi</i> - next smallest cofamilyspecies with fecundity data.
<i>Brochiraja spinifera</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cofamily species. No data on Smat F so Smat M used as proxy data. Last et al. 2016 - NZ endemic, bycatch in the orange roughy fishery. RLA (Francis et al. 2009) - found throughout NZ and on adjacent seamounts and plateaus. Of Arhynchobatidae with age/growth data, most similar size and depth is <i>Bathyrāja minispinosa</i> which is larger (90 cm and 150-1420 m). Amat, AMax, k, Sbirth, min/max no eggs (ovarian fecundity) all proxy data from <i>B. minispinosa</i> .
<i>Brochiraja vitticauda</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cofamily species. Last et al. 2016 - only known from two individuals on West Norfolk Ridge. No data on Smat - Kyne & Simpfendorfer 2007 - for all Arhynchobatidae, Smat was >80% Smax, therefore estimated SmatM and Smat F as 80% Smax. Of Arhynchobatidae with age/growth data, most similar size and depth is <i>Bathyrāja albomaculata</i> which is larger (96cm and 55-861 m). Amat, AMax, k, Sbirth, min/max no eggs (ovarian fecundity) all proxy data from <i>B. albomaculata</i> .

## PRELIMINARY ASSESSMENT

<i>Notoraja alisae</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cofamily species. No data on Smat F so Smat M used as proxy data. Last et al. 2016 - caught rarely. Of Arynchobatidae with age/growth data, most similar size and depth is <i>Bathyraja kincaidii</i> which is larger and occurs a bit deeper (64 cm and 55-1372 m). Amat (from Smat on growth curve), AMax, k all proxy data from <i>B. kincaidii</i> . No fecundity data for <i>B. kincaidii</i> , Sbirth, min/max no eggs (ovarian fecundity) proxy data from <i>B. taranetzi</i> - next smallest cofamilly species with fecundity data.
<i>Notoraja azurea</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cofamily species. No data on Smat F so Smat M used as proxy data. RLA (James & Ebert 2015) - recently described as endemic to temperate Australia, currently little to no effort in Australian waters at depth range of this species; if South Tasman Rise fishery reopens, could pose a threat to this species. Of Arynchobatidae with age/growth data, most similar size and depth is <i>Bathyraja kincaidii</i> (64 cm and 55-1372 m). Amat (from Smat on growth curve), AMax, k all proxy data from <i>B. kincaidii</i> . No fecundity data for <i>B. kincaidii</i> , min/max no eggs (ovarian fecundity) proxy data from <i>B. taranetzi</i> - next smallest cofamilly species with fecundity data.
<i>Notoraja martinezi</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cofamily species. No data on Smat F so Smat M used as proxy data. Not in Fishbase or RLA. Ebert 2016 - little known species, Sbirth unknown, smallest free-swimming individual 24.3 cm; of no interest to fisheries. Of Arynchobatidae with age/growth data, smallest species with similar depth is <i>Bathyraja kincaidii</i> which is larger (64 cm and 55-1372 m). Amat (from Smat on growth curve), Amax, k all proxy data from <i>B. kincaidii</i> . No fecundity data for <i>B. kincaidii</i> , min/max no eggs (ovarian fecundity) proxy data from <i>B. taranetzi</i> - next smallest cofamilly species with fecundity data. No trophic level in fish base so proxy data used from <i>N. sapphira</i> .
<i>Notoraja sapphira</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cofamily species. No data on Smat F so Smat M used as proxy data. Ford et al. 2015 - not caught in New Zealand waters, known only from Norfolk Ridge (five specimens). RLA (Kemper & Ebert 2011) - not known to be commercially targeted or caught as bycatch, depth range likely keeps it out of operating depths of most trawl fisheries. C. Rigby - fisheries can operate to 1500 m in SPRFMO area (SPRFMO website). Of Arynchobatidae with age/growth data, smallest species with similar depth is <i>Bathyraja kincaidii</i> which is larger (64 cm and 55-1372 m). Amat (from Smat on growth curve), Amax, k, Sbirth all proxy data from <i>B. kincaidii</i> . No fecundity data for <i>B. kincaidii</i> , Sbirth, min/max no eggs (ovarian fecundity) proxy data from <i>B. taranetzi</i> - next smallest cofamily species with fecundity data.
<i>Psammobatis scobina</i>	Arhynchobatidae	-	C. Rigby - Interbirth interval estimated from cofamily species. Ebert 2016 - taken as bycatch and discarded in bottom trawl fisheries, nothing known of its biology. Most similar in size and depth range to <i>P. rudis</i> , SmatM/F, ovarian fecundity from <i>P. rudis</i> . Of Arynchobatidae with age/growth data, most similar size and depth is <i>Bathyraja kincaidii</i> which is larger and occurs to a deeper maximum depth but also occurs in more shallow water (64 cm and 55-1372 m). Amat (from Smat on growth curve), AMax, k all proxy data from <i>B. kincaidii</i> . No fecundity data for <i>B. kincaidii</i> , Sbirth, proxy data from <i>B. taranetzi</i> - next most similar sized cofamilly species with Sbirth (could not find <i>Psammobatis</i> species of similar size with known Sbirth).
<i>Centrophorus harrissoni</i>	Centrophoridae	Dumb gulper shark	Interbirth interval estimated as 2-3 years (Graham & Daley 2011). Whitley 2007 age and growth data is unvalidated, although the growth curve was lacking a good size range, it produced a growth parameter similar to that of <i>C. granulosus</i> .
<i>Centrophorus moluccensis</i>	Centrophoridae	Smallfin gulper shark	Graham & Daley 2011 - Interbirth interval estimated. RLA (Graham & Kyne 2013) - estimated probable late age at first maturity >20 years. C Rigby - assumed this is for female as related to fecundity. Of other Centrophorus, <i>C. granulosus</i> most similar in size, it is larger but other Centrophorus even larger ( <i>C. granulosus</i> 1500 m occurs deeper than <i>C. moluccensis</i> ). Amat, Amax, k proxy from <i>C. granulosus</i> (Kyne & Simpfendorfer 2007- see comments for <i>C. granulosus</i> ). Intrinsic rate of growth r from Forrest and Walters 2009.

## PRELIMINARY ASSESSMENT

<i>Centrophorus squamosus</i>	Centrophoridae	Leafscale gulper shark	C. Rigby - Interbirth interval estimated from cogenetic species. Garcia et al. 2008 - k taken from invariant equations using Amat in Jensen 1996, so k is a rough estimate. Simpfendorfer and Kyne 2009 - r2M1.25b is intrinsic rebound potential incorporating density dependence.
<i>Centrophorus zeehaani</i>	Centrophoridae	-	Interbirth interval estimated as 2-3 years (Graham & Daley 2011). Amax from estimates by a working group and likely referring to Amax of 46 years by radiometric dating (Fenton 2001), hence no growth curves. Of other Centrophorus with age/growth data, <i>C. harrissoni</i> most similar in size and depth range. k is proxy from <i>C. harrissoni</i> (Whitely 2007 - see comments for <i>C. harrissoni</i> ).
<i>Deania calcea</i>	Centrophoridae	Birdbeak dogfish	Amax and Amat used external band data as Irvine et al. 2012 stated growth model better fit with length-at-age data from external bands. Irvine et al. 2012 - Interbirth interval estimated. Simpfendorfer and Kyne 2009 - r2M1.25b is intrinsic rebound potential incorporating density dependence (Pacific Ocean). Age at maturity and longevity greater than that reported in Parker & Francis 2012 which used internal bands and also used S. Irvine to age reference sets, kept Irvine estimates as maybe Irvine sampled older animals.
<i>Deania hystricosa</i>	Centrophoridae	Rough longnose dogfish	Of other Deania, <i>D. quadrispinosa</i> most similar Smax and depth range. Amax, Amat, K, litter size, Sbirth proxy from <i>D. quadrispinosa</i> . C. Rigby - Interbirth interval estimated based on cogenetic species. <i>D. hystricosa</i> litter size unknown but one female with 12 large eggs (Ebert et al. 2013), proxy data of 8-13 pups does not conflict with this.
<i>Deania quadrispinosa</i>	Centrophoridae	Longsnout dogfish	Kyne & Simpfendorfer 2007 - Interbirth interval estimated. Amat, Amax, k proxy data from cogenetic <i>D. calcea</i> (Irvine et al. 2012) which has larger SmaxF but similar Smat and occurs at similar max depth (60-1490 m) as <i>D. quadrispinosa</i> . Intrinsic rate of growth r from Forrest and Walters 2009.
<i>Cetorhinus maximus</i>	Cetorhinidae	Basking shark	Ebert 2013 - Previous age estimates for this species are now known to be erroneous as vertebral bands are associated with growth and not age. Fowler et al. 2005 - Interbirth interval estimated and age estimates. C. Rigby - though Amat and Amax are likely to be incorrect, included them as no other data available. Ebert et al. 2013 - only one litter of six pups has been reported.
<i>Chimaera carophila</i>	Chimaeridae	-	Of chimaerids with age/growth data, this species more similar in size to <i>C. monstrosa</i> (119 cm TL) than the larger <i>C. liganaria</i> (142 cm TL). As this species is relatively large, used the <i>C. monstrosa</i> proxy data from the <i>C. monstrosa</i> study with larger animals (Calis et al. 2005 - up to 74 cm PSCFL). There are two studies of <i>C. monstrosa</i> that report different growth rates and Amax but similar Amat - perhaps due to different lengths in studies (Calis et al. 2005 - up to 74 cm PSCFL and Moura et al. 2004 - up to 57 cm PSCFL). Kyne & Simpfendorfer 2007 - interbirth interval- chimaerids may be reproductively active throughout the year. No trophic level in fish base so proxy data used from <i>C. monstrosa</i> . Min/max no. eggs is ovarian fecundity.
<i>Chimaera liganaria</i>	Chimaeridae	-	Kyne & Simpfendorfer 2007 - interbirth interval - chimaerids may be reproductively active throughout the year. Min/max no. eggs is ovarian fecundity. Sbirth proxy data from <i>C. monstrosa</i> (Calis et al. 2005).
<i>Chimaera orientalis</i>	Chimaeridae	-	Ebert 2016 - Biology unknown, known only from four specimens. Kyne & Simpfendorfer 2007 - interbirth interval - chimaerids may be reproductively active throughout the year. For this smaller chimaerid used proxy data from <i>C. monstrosa</i> (Moura et al. 2004) as that study had smaller animals (up to 57 cm PSCFL). Smat, Amat, Amax, k, Sbirth. Smat - based on this being 80% of TL (as in Moura et al. 2004). Amat - calculated Amat from Moura et al. 2004 VBGF. Min/max no. eggs is ovarian fecundity proxy from Moura et al. 2004.
<i>Chimaera panthera</i>	Chimaeridae	-	RLA (Duffy 2003) - NZ endemic- vulnerable to trawling and longlining but little fishing effort throughout its range. Of chimaerids with age/growth data, this species more similar in size to <i>C. monstrosa</i> (119 cm TL) than the larger <i>C. liganaria</i> (142 cm TL). As this species is relatively large used the <i>C. monstrosa</i> proxy data for the <i>C. monstrosa</i> study with larger animals (Calis et al. 2005- up to 74 cm PSCFL). There are two studies of <i>C. monstrosa</i> that report different growth rates and Amax but similar Amat - perhaps due to different lengths in studies (Calis et al. 2005 - up to 74 cm PSCFL and Moura et al. 2004 - up to 57 cm PSCFL). Kyne & Simpfendorfer

## PRELIMINARY ASSESSMENT

			2007 - interbirth interval - chimaerids may be reproductively active throughout the year. Min/max no. eggs is proxy ovarian fecundity from Moura et al. 2004.
<i>Hydrolagus bemisi</i>	Chimaeridae	-	RLA (Francis 2003b) - NZ endemic managed by ITQ since 1998, population is probably relatively stable. Kyne & Simpfendorfer 2007 - interbirth interval - chimaerids may be reproductively active throughout the year. Age/growth of two aged holocephalans ( <i>H. colliei</i> - teeth and <i>H. ogilby</i> - dorsal fin spine) has not been validated. Used <i>H. colliei</i> as proxy data as it occurs deeper than <i>H. ogilby</i> . Amat, Amax, k based on <i>H. colliei</i> from King & McPhie 2015 that used teeth for ageing. Min/max no. eggs is proxy ovarian fecundity of <i>H. colliei</i> ; annual fecundity of <i>H. colliei</i> was estimated as 19.5-28.9 egg cases laid annually (Barnett et al. 2009) but ovarian fecundity used here for consistency with cogeneric species. C. Rigby - Sbirth estimated at 13% of TL based on relative Sbirth of species <i>H. barbouri</i> (Kyne & Simpfendorfer 2007) and <i>H. colliei</i> (Barnett et al. 2009).
<i>Hydrolagus homonycteris</i>	Chimaeridae	-	Last & Stevens 2009 - once taken in orange roughly trawls off Tasmania, flesh is good quality eating, probably closely related to <i>H. trolli</i> . Kyne & Simpfendorfer 2007 - interbirth interval - chimaerids may be reproductively active throughout the year. Age/growth of two aged holocephalans ( <i>H. colliei</i> - teeth and <i>H. ogilby</i> - dorsal fin spine) has not been validated. Used <i>H. colliei</i> as proxy data as it occurs deeper than <i>H. ogilby</i> . Amat, Amax, k based on <i>H. colliei</i> from King & McPhie 2015 that used teeth for ageing. Min/max no. eggs based on ovarian fecundity - min this species, max cogeneric <i>H. colliei</i> (Barnett et al. 2009). C. Rigby - Sbirth estimated at 13% of TL based on relative Sbirth of species <i>H. barbouri</i> (Kyne & Simpfendorfer 2007) and <i>H. colliei</i> (Barnett et al. 2009).
<i>Hydrolagus lemures</i>	Chimaeridae	Blackfin ghostshark	This species is closely related to <i>H. ogilby</i> and proxy Amat, Amax, k is used from <i>H. ogilby</i> where dorsal fin spine was used for ageing. Kyne & Simpfendorfer 2007 - interbirth interval - chimaerids may be reproductively active throughout the year. Min/max no eggs is ovarian fecundity for this species. C. Rigby - Interbirth interval estimated from cogeneric species. C. Rigby - Sbirth estimated at 13% of TL based on relative Sbirth of species <i>H. barbouri</i> (Kyne & Simpfendorfer 2007) and <i>H. colliei</i> (Barnett et al. 2009).
<i>Hydrolagus macrophthalmus</i>	Chimaeridae	-	RLA (Dagit 2006) - only known from two specimens off Chile but probably more widespread. Kyne & Simpfendorfer 2007 - interbirth interval - chimaerids may be reproductively active throughout the year. Age/growth of two aged holocephalans ( <i>H. colliei</i> - teeth and <i>H. ogilby</i> - dorsal fin spine) has not been validated. Used <i>H. colliei</i> as proxy data as it occurs deeper than <i>H. ogilby</i> . Amat, Amax, k based on <i>H. colliei</i> from King & McPhie 2015 that used teeth for ageing. Min/max no. eggs is proxy ovarian fecundity of <i>H. colliei</i> ; annual fecundity of <i>H. colliei</i> was estimated as 19.5-28.9 egg cases laid annually (Barnett et al. 2009) but ovarian fecundity used here for consistency with cogeneric species. C. Rigby - Sbirth estimated at 13% of TL based on relative Sbirth of species <i>H. barbouri</i> (Kyne & Simpfendorfer 2007) and <i>H. colliei</i> (Barnett et al. 2009).
<i>Hydrolagus melanophasma</i>	Chimaeridae	-	Kyne & Simpfendorfer 2007 - interbirth interval - chimaerids may be reproductively active throughout the year. Used <i>H. colliei</i> as proxy data as it occurs deeper than <i>H. ogilby</i> . Amat, Amax, k based on <i>H. colliei</i> from King & McPhie 2015 that used teeth for ageing. Min/max no. eggs is proxy ovarian fecundity of <i>H. colliei</i> ; annual fecundity of <i>H. colliei</i> was estimated as 19.5-28.9 egg cases laid annually (Barnett et al. 2009) but ovarian fecundity used here for consistency with cogeneric species. C. Rigby - Sbirth estimated at 13% of TL based on relative Sbirth of species <i>H. barbouri</i> (Kyne & Simpfendorfer 2007) and <i>H. colliei</i> (Barnett et al. 2009). Smat estimated at 80% of TL (Kyne & Simpfendorfer 2007).
<i>Hydrolagus novaezealandiae</i>	Chimaeridae	Dark ghost shark	RLA (Francis 2003c) - endemic NZ large commercially caught by trawlers under ITQ (~2000 tonnes per annum from Chatham Rise) since 1988, biomass variable but possibly increasing. Used <i>H. colliei</i> as proxy data as it occurs deeper than <i>H. ogilby</i> . Amat, Amax, k based on <i>H. colliei</i> from King & McPhie 2015 that used teeth for ageing. Min/max no. eggs is proxy ovarian fecundity of <i>H. colliei</i> ; annual fecundity of <i>H. colliei</i> was estimated as 19.5-28.9 egg cases laid annually (Barnett et al. 2009) but ovarian fecundity used here for consistency with cogeneric species. C. Rigby - Sbirth estimated at 13% of TL based on relative Sbirth of species <i>H. barbouri</i> (Kyne & Simpfendorfer 2007) and <i>H. colliei</i> (Barnett et al. 2009). Kyne & Simpfendorfer 2007 - interbirth interval - chimaerids may be reproductively active throughout the year.

## PRELIMINARY ASSESSMENT

<i>Hydrolagus trolli</i>	Chimaeridae	-	RLA (Compagno & Dagit 2015)-this species may be wide-ranging in the Southern Ocean. C. Rigby-interbirth interval estimated from cogenetic species. Used <i>H. colliei</i> as proxy data as it occurs deeper than <i>H. ogilbyi</i> . Amat, Amax, k based on <i>H. colliei</i> from King & McPhie 2015 that used teeth for ageing. Min/max no. eggs is proxy ovarian fecundity of <i>H. colliei</i> ; annual fecundity of <i>H. colliei</i> was estimated as 19.5-28.9 egg cases laid annually (Barnett et al. 2009) but ovarian fecundity used here for consistency with cogenetic species. C. Rigby- Sbirth estimated at 13% of TL based on relative Sbirth of species <i>H. barbouri</i> -Kyne & Simpfendorfer 2007 and <i>H. colliei</i> -Barnett et al. 2009.
<i>Chlamydoselachus anguineus</i>	Chlamydoselachidae	Friiled shark	Tanaka et al. 1990- suggested gestation may be 3.5 years, Ebert et al. 2013 gestation probably one to two years. C. Rigby's comment - so used 2 years as rough mid point between estimates.
<i>Dalatis licha</i>	Dalatiidae	Kitefin shark	Garcia et al. 2008-estimated Amax and Amat from k values of da Silva 1988 but k values (based on length modes and embryo growth) do not seem to be correct and no later studies refer to it. However as there are no age and growth data for any other species of Dalatiidae, used the Amax, Amat and k from Garcia et al. 2008. Interbirth interval estimated from da Silva 1988 - gestation 2 years, and Daley et al. 2002-suggests a resting period so C. Rigby estimated it at 2.5 years. Intrinsic rate of growth r from Forrest and Walters 2009.
<i>Euprotomicroides zantedeschia</i>	Dalatiidae	Taillight shark	Ebert 2016- dwarf oceanic shark known only from four specimens- two off Chile taken in midwater trawl. Sbirth proxy data from other most similar sized kitefin shark with known Sbirth ( <i>Isistius brasiliensis</i> ). C. Rigby - interbirth interval estimated from <i>D. licha</i> . C. Rigby- as slightly larger than to <i>E. bispinatus</i> , but small litters suggested, estimated same litter size as <i>E. bispinatus</i> . Have not used proxy age/growth from <i>D. lichas</i> as low confidence in that data.
<i>Euprotomiscrus bispinatus</i>	Dalatiidae	Pygmy shark	All data on this species comes from Hubbs et al. 1967. C. Rigby - interbirth interval estimated from <i>D. licha</i> . Have not used proxy age/growth from <i>D. lichas</i> as low confidence in that data.
<i>Heteroscymnoides marleyi</i>	Dalatiidae	Longnose pygmy shark	Ebert 2013- a rare species known only from six specimens; reproduction assumed yolk-sac viviparous; likely small litters suggested by large neonate (12.8 cm) and small adult size. C. Rigby- as slightly larger than <i>E. bispinatus</i> , but small litters suggested, estimated same litter size as <i>E. bispinatus</i> . C. Rigby - interbirth interval estimated from <i>D. licha</i> . Have not used proxy age/growth from <i>D. licha</i> as low confidence in that data. C. Rigby- no Smat F so used Smat M.
<i>Isistius brasiliensis</i>	Dalatiidae	Cookie cutter shark	C. Rigby - interbirth interval estimated from <i>D. licha</i> . Have not used proxy age/growth from <i>D. licha</i> as low confidence in that data. Ebert 2016- used for fishmeal in eastern Atlantic, may be of negative interest to fisheries as they gouge flesh from target species.
<i>Squaliolus aliae</i>	Dalatiidae	Smalleye pygmy shark	Ebert et al. 2013- one of the smallest living sharks, too small to be threatened by fisheries, but a common bycatch of trawl fisheries in the west Pacific. RLA (KYne & Heupel 2015)-east Australian specimens have been collected from bottom trawls. C. Rigby- Smat F unknown so used proxy Smat M. Have not used proxy age/growth from <i>D. licha</i> as low confidence in that data. C. Rigby - interbirth interval estimated from <i>D. licha</i> . No proxy for min/max no eggs as it is one of the smallest sharks.
<i>Bathytoshia lata</i>	Dasyatidae	-	Last et al. 2016- previously in genus Dasyatis. Large Indo-Pacific stingrays previously known as <i>Dasyatis thetidis</i> , <i>D. usheiei</i> and eastern Atlantic populations of <i>D. centroura</i> are the same as this species. All lengths are DW (cannot find any DW-TL relationships). Litter size for <i>D. centroura</i> . Carpenter & Angelis 2016- <i>D. centroura</i> - bycatch with its meat utilised. C. Rigby - interbirth interval based on cogenetic species. Amax for <i>D. centroura</i> (Mediterranean) specimen 179 DW. From age/growth of other Dasyatis species - <i>D. americana</i> most similar in size but very shallow- used the deepest <i>Dasyatis dipterura</i> for Amat and k. Also, <i>D. dipterura</i> has Amax F 28 years Amax M 19 years which is closer to Amax <i>D. centroura</i> than Amax <i>D. americana</i> (F 13 years, M 12 years).

## PRELIMINARY ASSESSMENT

<i>Echinorhinus brucus</i>	Echinorhinidae	Bramble shark	Ebert 2013- may be retained for liver oil. Smat for Indian waters. Akhilesh et al. 2013- this species caught on trawl and longline; non-seasonal reproductive cycle, nothing known about reproductive cycle for this species or other echinorhinid- <i>E. cookei</i> . C. Rigby - interbirth interval estimated from other deepwater shark families.
<i>Echinorhinus cookei</i>	Echinorhinidae	Prickly shark	Ebert 2016- litter size of 114 from one 305 cm female. Akhilesh et al. 2013- nothing known about reproductive cycle for this species or <i>E. brucus</i> . C. Rigby -interbirth interval estimated from other deepwater shark families.
<i>Aculeola nigra</i>	Etmopteridae	Hooktooth dogfish	C. Rigby - interbirth interval based on other etmopterids.No age/growth data for any species in this genera. Of Etmopteridae with age/growth, this species is most similar in size and depth range to <i>E. pusillus</i> (50 cm and 274-1120 m). Amat, Amax, k proxy data from <i>E. pusillus</i> .
<i>Centroscyllium granulatum</i>	Etmopteridae	Granular dogfish	C. Rigby - interbirth interval based on cofamily species. No Smat F so used Smat M. No age/growth proxy data for this genera. Of Etmopteridae with age/growth, this species is most similar in size and depth range to <i>E. pusillus</i> . Amat, Amax, k proxy data from <i>E. pusillus</i> .
<i>Centroscyllium kamoharai</i>	Etmopteridae	Bareskin dogfish	C. Rigby - interbirth interval based on cofamily species. No Smat F so used Smat M. No Age/growth proxy data for this genera. Of Etmopteridae with age/growth, this species is most similar in size and depth range to <i>E. pusillus</i> . Amat, Amax, k proxy data from <i>E. pusillus</i> .
<i>Centroscyllium nigrum</i>	Etmopteridae	Combtooth dogfish	C. Rigby - interbirth interval based on cofamily species. No Smat F so used Smat M. No Age/growth proxy data for this genera. Of Etmopteridae with age/growth, this species is most similar in size and depth range to <i>E. pusillus</i> . Amat, Amax, k proxy data from <i>E. pusillus</i> .
<i>Etmopterus bigelowi</i>	Etmopteridae	Blurred smooth lantern shark	Gianeti et al. 2009-Litter size based on one record of nine early term embryos in each uterus. Of other Etmopterus with age/growth data, <i>E.granulosus</i> most similar in size (but to a deeper depth 220-1430 m than <i>E. bigelow</i> ). Amat, Amax, k, Interbirth interval,proxy from <i>E. granulosus</i> (Ebert 2013, Irvine et al. 2006b).
<i>Etmopterus granulosus</i>	Etmopteridae	Southern lanternshark(Lucifer)	Weigmann 2016 - <i>Etmopterus baxteri</i> Garrick 1957 is a junior synonym of <i>E. granulosus</i> . Intrinsic rate of growth r from Forrest and Walters 2009.
<i>Etmopterus litvinovi</i>	Etmopteridae	-	Ebert et al. 2013- nominal records from SE Pacific likely a different species, confirmed from NZ. C. Rigby- Interbirth interval estimated from Coelho & Erizini 2007 and cogenetic species. Of Etmopterus with age/growth data, <i>E. litvinovi</i> is most similar in size and depth to <i>E. pusillus</i> . Proxy data from <i>E. pusillus</i> for Amat, Amax, k, min/max no eggs. Smat estimated as 75% TL based on average %TL of other Etmopterus species in Kyne & Simpfendorfer 2007.
<i>Etmopterus lucifer</i>	Etmopteridae	Blackbelly lanternshark	Ford et al. 2015- In NZ abundance indices are stable or increasing over last five years.C. Rigby-interbirth interval based on cogenetic species.
<i>Etmopterus molleri</i>	Etmopteridae	Mollers lantern shark	Coelho & Erizini 2008- Interbirth interval estimated. No Smat F so used Smat M. Of Etmopterus with age/growth data, <i>E. molleri</i> is most similar in size and depth to <i>E. spinax</i> . Proxy data from <i>E. spinax</i> for Amat, Amax, k, min/max no. eggs- used Coelho & Erizini 2008 as they aged using dorsal fin spines as this generally a more reliable age structure than vertebrae in squalids. Gennari & Scacco 2007 used vertebrae for ageing.
<i>Etmopterus pusillus</i>	Etmopteridae	Smooth lanternshark	C. Rigby- Interbirth interval estimated from Coelho & Erizini 2007 and cogenetic species.

## PRELIMINARY ASSESSMENT

<i>Etmopterus pycnolepis</i>	Etmopteridae	-	Ebert 2016- known only from a few specimens. C. Rigby- Interbirth interval estimated from Coelho & Erizini 2007 and cogeneric species. Of Etmopterus with age/growth data, <i>E. pycnolepis</i> is most similar in size and depth to <i>E. spinax</i> . Proxy data from <i>E. spinax</i> for Amat, Amax, k, min/max no. eggs- used Coelho & Erizini 2008 as they aged using dorsal fin spines as this generally a more reliable age structure than vertebrae in squalids. Gennari & Scacco 2007 used vertebrae for ageing. Sbirth proxy from <i>E. molleri</i> . Smat estimated as 75% TL based on average %TL of other Etmopterus species in Kyne & Simpfendorfer 2007.
<i>Etmopterus viator</i>	Etmopteridae	-	Straube et al. 2011 - in <i>E. spinax</i> clade but closer in Smax, Smat and Sbirth to <i>E. granulosus</i> and <i>E. granulosus</i> has a more similar max depth (220-1430 m). Amat, Amax, k, Interbirth interval, proxy from <i>E. granulosus</i> (Ebert 2013, Irvine et al. 2006b).
<i>Gurgesiella furvescens</i>	Gurgesiellidae	-	C. Rigby- interbirth interval and min/max no eggs (ovarian fecundity) estimated from other skates. No age/growth or max/min no eggs data for any species from this Family.
<i>Heptranchias perlo</i>	Hexanchidae	Sharpnose sevengill shark	Kyne & Simpfendorfer -no defined reproductive cycle and a non-continuous reproductive cycle (Tanaka and Mizue 1977). C. Rigby- Interbirth interval estimated based on cogeneric species. Only age/growth data for this family is for <i>Notorynchus cepedianus</i> that is a shallow species (1-136 m) and Smax 296 cm and Smat M 150 cm, Smat F 220 cm. Amat, Amax, k proxy data from <i>N. cepedianus</i> (Van Dykhuizen & Mollet 1992, Cortes 2000) but have low confidence that the data is suitable for this deepwater hexanchid species.
<i>Hexanchus griseus</i>	Hexanchidae	Bluntnose sixgill shark	Ebert 2013-Interbirth interval estimated- 12 month gestation and 12 month resting phase. Kyne & Simpfendorfer 2007- this species is one of the most fecund elasmobranchs; Sbirth 56-74 cm. Only age/growth data for this family is for <i>Notorynchus cepedianus</i> that is a shallow species (1-136 m) and Smax 296 cm and Smat M 150 cm, Smat F 220 cm. Amat, Amax, k proxy data from <i>N. cepedianus</i> (Van Dykhuizen & Mollet 1992, Cortes 2000) but have low confidence that the data is suitable for this deepwater hexanchid species.
<i>Hexanchus nakamurai</i>	Hexanchidae	Bigeyed sixgill shark	Carpenter & Angelis 2016- possibly used for fishmeal and for human consumption. C. Rigby - Interbirth interval based on cogeneric species. Only age/growth data for this family is for <i>Notorynchus cepedianus</i> that is a shallow species (1-136 m) and Smax 296 cm and Smat M 150 cm, Smat F 220 cm. Amat, Amax, k proxy data from <i>N. cepedianus</i> (Van Dykhuizen & Mollet 1992, Cortes 2000) but have low confidence that the data is suitable for this deepwater hexanchid species.
<i>Isurus oxyrinchus</i>	Lamnidae	Shortfin mako	Ebert et al. 2013-Taken in target and bycatch fisheries for its valuable meat. Many different parameters for this species, one band per year formation validated by bomb radiocarbon (Ardizzone et al. 2006) so used k values from Natanson et al. 2006 as these are using validated ages and have growth values that are in the range of other studies with one band per year.
<i>Lamna nasus</i>	Lamnidae	Porbeagle	Max age was from bomb radiocarbon male so used this as proxy for female. Francis and Duffy 2005 were in FL, converted to TL. Reproductive cycle probably annual but could be biennial (Francis & Stevens 2000). Four is average litter size with 1-4 reported in Francis & Stevens 2000, used Ebert et al. 2013 as the litter size range as that gives a mean closer to 4.
<i>Mitsukurina owstoni</i>	Mitsukurinidae	Goblin shark	Kyne & Simpfendorfer 2007- no gravid females observed, reproduction assumed oophagous and small litters as with other lamnoid sharks. Parsons et al. 2002- Smax, female estimated from regression of snout-eye length from photo. Ebert 2013-bycatch of deepwater trawl and longline, utilised dried-salted. RLA (Duffy et al. 2004)- also caught in bottom-set gillnet. Ebert 2013- Sbirth uncertain but smallest free-swimming individual was an 81.7 cm male. This family only has this single species so no age/growth data available from cogeneric/cofamily species.
<i>Odontaspis ferox</i>	Odontaspidae	Smalltooth sand tiger	Kyne & Simpfendorfer 2007- litter size unknown but assumed to be two and biennial based on inshore cogeneric species, <i>Carcharias taurus</i> ; interbirth interval estimated based on cogeneric species. Amax from cogeneric species, <i>C. taurus</i> in western North Atlantic and southwestern Indian Oceans (Passerotti et al. 2014). Amat and k from cogeneric, <i>C. taurus</i> from western North Atlantic (Goldman et al. 2006).

## PRELIMINARY ASSESSMENT

<i>Oxynotus bruniensis</i>	Oxynotidae	Prickly dogfish	No age/growth data for any species in this family. Ford et al. 2015- Chatham Rise abundance index shows no clear trend over the last 5 years. Finucci et al. 2016a- mostly discarded although ~25 t was landed from 2009-2014. C. Rigby- interbirth interval estimated based on cogenetic species.
<i>Pristiophorus cirratus</i>	Pristiophoridae	Longnose sawshark	No Amat (Walker & Hudson 2005) nor was any Amat stated in the later published RLA (Walker 2016). Walker & Hudson 2005 FRDC report with appendices on age and reproduction missing and cannot access them. Last & Stevens 2009- Australian catches limited by combined quota with <i>Pristiophorus nudipinnis</i> of about 300 t, flesh is good quality.
<i>Pseudocarcharias kamoharai</i>	Pseudocarchariidae	Crocodile shark	Ebert et al. 2013-RLA status is Threatened, population depletion likely as a result of bycatch in pelagic longline fisheries. White 2007- no reproductive seasonality evident. C. Rigby -Interbirth interval estimated based on Lessa et al. 2016 that states-observations suggest a resting phase...oophagous species such as this probably do not mate and become impregnated every year, but would skip years.
<i>Gollum attenuatus</i>	Pseudotriakidae	Slender smooth-hound	Kyne & Simpfendorfer 2007- Interbirth interval estimated for cogenetic <i>P. microdon</i> . Not aware of any age/growth data for any species from this family.
<i>Pseudotriakis microdon</i>	Pseudotriakidae	False catshark	Kyne & Simpfendorfer 2007- Interbirth interval estimated. Not aware of any age/growth data for any species from this family.
<i>Amblyraja doellojuradoi</i>	Rajidae	-	C.Rigby - Interbirth interval estimated from cogenetic species. Of <i>Amblyraja</i> with age/growth, <i>A. radiata</i> occurs the deepest (18-1400 m) and is of similar size to this species. Proxy data for k, Amat and Amax used from <i>A. radiata</i> (Campana and McPhie 2009a that used bomb radiocarbon age validation). Kyne & Simpfendorfer 2007- there is little ovarian fecundity data for the Rajidae skates. Min/max no eggs proxy from ovarian fecundity data for <i>A. radiata</i> which is of similar size but occurs a bit deeper (100 cm and 18-1400 m). McPhie & Campana 2009b estimated annual fecundity of <i>A. radiata</i> as 56 egg cases per year (no ovarian fecundity stated).
<i>Amblyraja frerichsi</i>	Rajidae	-	Ebert 2016- bycatch in the Patagonian toothfish ( <i>Dissostichus eleginoides</i> ) fishery in southern Chile. C.Rigby - Interbirth interval estimated from cogenetic species. Ebert 2016 - very similar morphologically to <i>Amblyraja georgina</i> (no ovarian fecundity data) which has age/growth data, i.e. proxy data from <i>A. georgina</i> used for Amat, Amax, k. Francis & Gallagher 2009- used caudal thorns as they had clearer bands than vertebrae, likely this slower ages are more likely than a faster estimated growth in earlier paper (Francis & Maolagáin 2005) though neither validated. Kyne & Simpfendorfer 2007- there is little ovarian fecundity data for the Rajidae skates. Min/max no eggs proxy from ovarian fecundity data for <i>Amblyraja radiata</i> which is of similar size but occurs a bit deeper (100 cm and 18-1400 m). McPhie & Campana 2009b estimated annual fecundity of <i>A. radiata</i> as 56 egg cases per year (no ovarian fecundity stated).
<i>Amblyraja hyperborea</i>	Rajidae	-	C.Rigby - Interbirth interval estimated from cogenetic species. Of <i>Amblyraja</i> with age/growth, <i>A. radiata</i> occurs the deepest (18-1400 m) and is of similar size (100 cm) to this species. Proxy data for k, Amat and Amax used from <i>A. radiata</i> (Campana and McPhie 2009a that used bomb radiocarbon age validation). Min/max no eggs proxy from ovarian fecundity data for <i>A. radiata</i> which is of similar size but occurs a bit deeper (100 cm and 18-1400 m). McPhie & Campana 2009b estimated annual fecundity of <i>A. radiata</i> as 56 egg cases per year (no ovarian fecundity stated).
<i>Dipturus acrobelus</i>	Rajidae	-	C.Rigby - Interbirth interval estimated from cogenetic species. From <i>Dipturus</i> with age/growth most similar Smax and depth range is <i>Zearaja</i> (ex <i>Dipturus</i> ) <i>nasuta</i> . Proxy Amat, Amax, k from <i>D. nasuta</i> . Kyne & Simpfendorfer 2007- there is little ovarian fecundity data for the Rajidae skates. Min/max no eggs proxy from ovarian fecundity data for <i>Dipturus trachydermus</i> which the only other large <i>Dipturus</i> species (> 100 cm) with ovarian fecundity data; <i>D. trachydermus</i> is larger and more shallow (253 cm and 93-450 m); annual fecundity of <i>D. trachydermus</i> is estimated at 40 eggs per year (Fowler et al. 2005).

## PRELIMINARY ASSESSMENT

<i>Dipturus canutus</i>	Rajidae	-	C.Rigby - Interbirth interval estimated from cogeneric species. Min/max no eggs is ovarian fecundity. From Dipturus with age/growth most similar Smax is <i>Zearaja</i> (ex <i>Dipturus</i> ) <i>nasuta</i> . Proxy Amat, Amax, k from <i>Z. nasuta</i> . Smat F proxy from Smat M.
<i>Dipturus gudgeri</i>	Rajidae	-	Treloar 2008- age-at length data did not fit well to the growth curves, therefore confidence in the growth parameter is low, but is reported as it is the only growth data for this species. C.Rigby - Interbirth interval estimated from cogeneric species. Min/max no eggs is ovarian fecundity.
<i>Dipturus innominatus</i>	Rajidae	New Zealand smooth skate	Converted Francis et al. 2001 Pelvic lengths to Total length using Smat TL from Last et al. 2016 compared to Smat PL in Francis et al. 2001. C. Rigby- interbirth interval estimated from cogeneric species. Kyne & Simpfendorfer 2007- there is little ovarian fecundity data for the Rajidae skates. Min/max no eggs proxy from ovarian fecundity data for <i>Dipturus trachydermus</i> which the only other large Dipturus species (> 100 cm) with ovarian fecundity data; <i>D. trachydermus</i> is similar size but more shallow (253 cm and 93-450 m); annual fecundity of <i>D. trachydermus</i> is estimated at 40 eggs per year (Fowler et al. 2005).
<i>Dipturus trachydermus</i>	Rajidae	-	C. Rigby- interbirth interval estimated from cogeneric species. Ebert 2016- this is one of the largest species of skates, taken in both directed and indirect fisheries in Chile and Patagonia, Sbirth uncertain- smallest free swimming 60 cm. RLA- Vulnerable. Fecundity is ovarian fecundity.
<i>Dipturus wengi</i>	Rajidae	-	Seret & Last 2008- no mature males recorded so used a size one cm larger than largest immature male; morphologically similar to <i>Dipturus gudgeri</i> so used proxy data from <i>D.gudgeri</i> , that is, Amat, Amax, k. C. Rigby- interbirth interval estimated from cogeneric species. Kyne & Simpfendorfer 2007- there is little ovarian fecundity data for the Rajidae skates. Min/max no eggs proxy from ovarian fecundity data for <i>Dipturus trachydermus</i> which the only other large Dipturus species (> 100 cm) with ovarian fecundity data; <i>D. trachydermus</i> is larger and more shallow (253 cm and 93-450 m); annual fecundity of <i>D. trachydermus</i> is estimated at 40 eggs per year (Fowler et al. 2005).
<i>Rajella challengerii</i>	Rajidae	-	C. Rigby- interbirth interval estimated from cofamily species. No age and growth data or estimates of ovarian fecundity for any of the Rajella species. Phylogenetically, of the Rajidae, Rajella are the most closely related to Amblyraja (Chondrichthyan Tree of Life-website), so proxy data from that genus is used. Of Amblyraja with age/growth, <i>A. radiata</i> occurs the deepest (18-1400 m) but is larger (100 cm) than this species. Proxy data for k, Amat and Amax used from <i>A. radiata</i> (Campana and McPhie 2009a that used bomb radiocarbon age validation). Smat F- no data, used proxy data from Smat M. Min/max no eggs proxy from ovarian fecundity data for <i>Amblyraja radiata</i> which is larger but occurs to a similar depth (100 cm and 18-1400 m). McPhie & Campana 2009b estimated annual fecundity of <i>A. radiata</i> as 56 egg cases per year (no ovarian fecundity stated).
<i>Rajella eisenhardti</i>	Rajidae	-	Last et al. 2016- known only from 2 juveniles from Galapagos Islands. RLA (McCormack & Kyne 2007) - pelagic longlining occurs around Galapagos, the habitat of this species (steep rocky volcanic slopes) is unsuitable for trawling, and demersal deepwater fisheries are not presently operating within its range. C. Rigby- Smat proxy data from other Rajella species that have all similar sized Smat regardless of Smax. C. Rigby- interbirth interval estimated from cofamily species. C. Rigby- Sbirth proxy data from similar sized <i>Rajella nigerrima</i> . Of Amblyraja with age/growth, <i>A. georgina</i> has the most similar depth range (20-800 m) but is larger (100 cm) than this species. Proxy data from <i>A. georgina</i> (no ovarian fecundity data) used for Amat, Amax, k. Francis & Gallagher 2009- used caudal thorns as they had clearer bands than vertebrae, likely this slower ages are more likely than a faster estimated growth in earlier paper (Francis & Malaogain 2005) though neither validated. Min/max no eggs proxy from ovarian fecundity data for <i>Amblyraja radiata</i> which is larger and occurs deeper (100 cm and 18-1400 m). McPhie & Campana 2009b estimated annual fecundity of <i>A. radiata</i> as 56 egg cases per year (no ovarian fecundity stated).
<i>Rajella nigerrima</i>	Rajidae	-	Last et al. 2016- Biology unknown. RLA (Lamilla 2004a)- generally no fisheries in its deepwater habitat at present, but likely to be taken as bycatch if deepwater trawl fisheries develop and expand in this region (Ecuador, Peru, Chile), no adult females captured, may occur in deeper waters. C. Rigby- Smat proxy data from other Rajella species that have all similar sized Smat regardless of Smax. C. Rigby-

## PRELIMINARY ASSESSMENT

			interbirth interval estimated from cofamily species. Of Amblyraja with age/growth, <i>A. gerogina</i> has the most similar depth range (20-800 m) but is larger (100 cm) than this species. Proxy data from <i>A. georgina</i> (no ovarian fecundity data) used for Amat, Amax, k. Francis & Gallagher 2009- used caudal thorns as they had clearer bands than vertebrae, likely this slower ages are more likely than a faster estimated growth in earlier paper (Francis & Malaogain 2005) though neither validated. Min/max no eggs proxy from ovarian fecundity data for <i>Amblyraja radiata</i> which is larger and occurs deeper (100 cm and 18-1400 m). McPhie & Campana 2009b estimated annual fecundity of <i>A. radiata</i> as 56 egg cases per year (no ovarian fecundity stated).
<i>Rajella sadowskii</i>	Rajidae	-	Last et al. 2016- Biology unknown. RLA (Lamilla 2004b)-taken as bycatch of artisanal longline fisheries for Patagonian toothfish <i>Disostichus eleginoides</i> , however, specific catch data are not available. C. Rigby- interbirth interval estimated from cofamily species. Smat F- no data, used proxy data from Smat M. Nothing known of its biology. C. Rigby - Sbirth proxy data from similar sized <i>Rajella caudaspinosa</i> . Of Amblyraja with age/growth, <i>A. radiata</i> occurs the deepest (18-1400 m) but is larger (100 cm) than this species. Proxy data for k, Amat and Amax used from <i>A. radiata</i> (Campana and McPhie 2009a that used bomb radiocarbon age validation). Min/max no eggs proxy from ovarian fecundity data for <i>A. radiata</i> which is larger but occurs to a similar depth (100 cm and 18-1400 m). McPhie & Campana 2009b estimated annual fecundity of <i>A. radiata</i> as 56 egg cases per year (no ovarian fecundity stated).
<i>Zearaja chilensis</i>	Rajidae	Yellownose skate	There are a range of parameters for this species endemic to Chile, use Licandeo 2006 as it was from more open water than other estimates based on fjord and channel populations. C. Rigby- interbirth interval estimated from cogeneric species. C. Rigby - Min/max no eggs is ovarian fecundity.
<i>Zearaja nasuta</i>	Rajidae	New Zealand rough skate	Converted Francis et al. 2001 Pelvic lengths to Total length using Smat TL from Last et al. 2016 compared to Smat PL in Francis et al. 2001. C. Rigby- interbirth interval estimated from cogeneric species. Ford et al. 2015- this was one of the highest risk species because it is intensively fished across 60% of its range year-round. Min/max no eggs is proxy ovarian fecundity from cogeneric <i>Zearaja nasuta</i> (only other large <i>Zearaja</i> with fecundity data).
<i>Harriotta haeckeli</i>	Rhinochimaeridae	Smallspine spookfish	Of other Rhinochimaerids, <i>R. pacifica</i> only species with age/growth data, although it is larger (130 cm) than <i>H. haeckeli</i> and does not occur as deep (1290 m). Amat, Amax, k and Interbirth interval proxy from <i>R. pacifica</i> (Finucci et al. 2016b, Bell 2012). Used proxy min/max no. eggs that is ovarian fecundity for <i>H. raleighana</i> (Finucci et. al 2016b). Sbirth proxy data from only other Harriotta species- <i>H. raleighana</i> .
<i>Harriotta raleighana</i>	Rhinochimaeridae	Pacific longnose chimaera	Most lengths reported in the literature are without the caudal filament; lengths are still comparable to TL. Sbirth- converted Ebert 2014 PCL to TL, based on Ebert 2014 PCL to TL Smax. Interbirth interval estimated based on cogeneric species. Min/max no. eggs is ovarian fecundity. Of other Rhinochimaerids, <i>R. pacifica</i> only species with age/growth data that is similar size (130 cm) but does not occur as deep (1290 m). Amat, Amax and k proxy from <i>R. pacifica</i> (Finucci et al. 2016b, Bell 2012).
<i>Rhinochimaera africana</i>	Rhinochimaeridae	-	Most lengths reported in the literature are without the caudal filament; lengths are still comparable to TL. Smat- converted Ebert 2016 BDL to TL, based on Ebert 2016 BDL to TL for Smax. RLA (Dagit 2016) - used for meat when landed in Taiwan; this species used to be confused with <i>Rhinochimaera pacifica</i> . Amat, k, Amax from cogeneric <i>R. pacifica</i> (Bell 2012 and Finucci et al. 2016b interpretation of Bell 2012 growth curves). Min/max no eggs, interbirth interval and Sbirth estimated based on cogeneric species (Finucci et al. 2016b).
<i>Rhinochimaera pacifica</i>	Rhinochimaeridae	Pacific spookfish	Finucci et al. 2016b- Interbirth interval estimated from cogeneric species.
<i>Apristurus ampliceps</i>	Scyllorhinidae	-	C. Rigby - Interbirth interval and Sbirth estimated from cogeneric species. Min/max no eggs (ovarian fecundity) proxy from <i>A. kampae</i> , the most similar size and depth (65 cm and 117-1888 m) of <i>Apristurus</i> species with ovarian fecundity.

## PRELIMINARY ASSESSMENT

<i>Apristurus australis</i>	Scyliorhinidae	-	C. Rigby - Interbirth interval and Sbirth estimated from cogeneric species. Min/max no eggs (ovarian fecundity) proxy from <i>A. brunneus</i> , the most similar size and depth (69 cm and 24-1341 m) of <i>Apristurus</i> species with ovarian fecundity.
<i>Apristurus brunneus</i>	Scyliorhinidae	-	C. Rigby - Interbirth interval estimated from cogeneric species. Min/max no eggs is ovarian fecundity.
<i>Apristurus exsanguis</i>	Scyliorhinidae	-	C. Rigby - Interbirth interval and Sbirth estimated from cogeneric species. Min/max no eggs (ovarian fecundity) proxy from <i>Apristurus saldanha</i> , the most similar size and depth (89 cm and 344-1009 m) of <i>Apristurus</i> species with ovarian fecundity.
<i>Apristurus kampae</i>	Scyliorhinidae	Longnose catshark	C. Rigby - Interbirth interval estimated from cogeneric species. Min/max no eggs is ovarian fecundity
<i>Apristurus melanoasper</i>	Scyliorhinidae	-	C. Rigby - Interbirth interval and Sbirth estimated from cogeneric species. Min/max no eggs (ovarian fecundity) proxy from <i>Apristurus kampae</i> , the most similar size and depth (65 cm and 117-1888 m) of <i>Apristurus</i> species with ovarian fecundity.
<i>Apristurus nasutus</i>	Scyliorhinidae	Largenose catshark	C. Rigby - Interbirth interval and Sbirth estimated from cogeneric species. RLA (Huveneers et al. 2004)-females never observed (so Smat F not known and used proxy data from Smat M); off Northern and Central Chile the species is taken as bycatch in the deep sea shrimp <i>Heterocarpus reedi</i> fishery. Min/max no eggs (ovarian fecundity) proxy from <i>Apristurus saldanha</i> , the most similar size and depth (89 cm and 344-1009 m) of <i>Apristurus</i> species with ovarian fecundity.
<i>Apristurus pinguis</i>	Scyliorhinidae	-	C. Rigby - Interbirth interval and Sbirth estimated from cogeneric species. Min/max no eggs (ovarian fecundity) proxy from <i>Apristurus kampae</i> , the most similar size and depth (65 cm and 117-1888 m) of <i>Apristurus</i> species with ovarian fecundity.
<i>Apristurus sinensis</i>	Scyliorhinidae	South China catshark	C. Rigby - Interbirth interval and Sbirth estimated from cogeneric species. Min/max no eggs (ovarian fecundity) proxy from <i>Apristurus brunneus</i> , the most similar size and depth (69 cm and 24-1341 m) of <i>Apristurus</i> species with ovarian fecundity.
<i>Bythaelurus canescens</i>	Scyliorhinidae	-	C. Rigby - Interbirth interval and Sbirth estimated from cogeneric species. Min/max no eggs (ovarian fecundity) proxy data from other oviparous <i>Bythaelurus</i> with ovarian fecundity data.
<i>Bythaelurus dawsoni</i>	Scyliorhinidae	-	C. Rigby - Interbirth interval estimated from cogeneric species. Min/max no eggs is ovarian fecundity.
<i>Cephaloscyllium isabellum</i>	Scyliorhinidae	Draughtsboard shark	C. Rigby - Interbirth interval estimated from cogeneric species. RLA (Francis 2003a)- was previously (1988-1991) retained for liver, since then probably discarded. Ebert et al. 2013- bycatch in deepwater trawl fisheries, survives discard well. Ford et al. 2015 - this species was one of the highest risk species as 60 % of its range is fished intensively year-round. Only <i>Cephaloscyllium</i> species aged is <i>C. albipinnum</i> - vertebrae, not validated. Proxy data used for Amat, Amax from <i>C. albipinnum</i> (110 cm and 125-555 m). Min/max no eggs (ovarian fecundity) proxy data from <i>C. albipinnum</i> .
<i>Figaro boardmani</i>	Scyliorhinidae	-	C. Rigby - Interbirth interval and Sbirth estimated from sawtail catshark ( <i>Galeus</i> spp.) species. Min/max no eggs is ovarian fecundity.
<i>Parmaturus macmillani</i>	Scyliorhinidae	McMillan's cat shark	FAO 2013- From NZ and three specimens off South Africa. C. Rigby - Smat M, interbirth interval and Sbirth estimated from cogeneric species. Min/max no eggs (ovarian fecundity) proxy from <i>Parmaturus xaniurus</i> which is slightly larger and slightly deeper (61 cm and 91-1251 m).
<i>Centroscymnus coelolepis</i>	Somniosidae	Portuguese dogfish	Kyne & Simpfendorfer 2007 -Interbirth interval estimated. Figueiredo et al. 2013 used k from Moura 2011- requested report to get growth curve to estimate Amat and possibly Amax but no response (cannot find anywhere else in literature). Figueiredo et al. 2013- estimated max age as equivalent to <i>Centrophorus squamosus</i> (Clarke et al. 2002). Amat - proxy data from other cofamily species

## PRELIMINARY ASSESSMENT

			<i>Centroselachus crepidator</i> with age/growth data (Irvine et al. 2006a) which is also has a deep depth range of 200-2080 m and is of similar but slightly smaller Smax (103 cm) to <i>C. coelolepis</i> .
<i>Centroscymnus owstoni</i>	Somniosidae	Roughskin dogfish	Kyne & Simpfendorfer 2007 - Interbirth interval estimated. Irvine 2004-only estimated Amax not Amat (and no growth curve to estimate it from). Intrinsic rate of growth $r$ from Forrest and Walters 2009. Amat and $k$ - proxy data from other cofamily species <i>Centroselachus crepidator</i> with age/growth data (Irvine et al. 2006a) which is has a deeper max depth of 200-2080 m and is of similar but slightly smaller Smax (103 cm) to <i>C. owstoni</i> .
<i>Centroselachus crepidater</i>	Somniosidae	-	Irvine et al. 2006a - Interbirth interval estimated. Simpfendorfer and Kyne 2009- r2M1.25b is intrinsic rebound potential incorporating density dependence.
<i>Scymnodalatias albicauda</i>	Somniosidae	Whitetail dogfish	Ebert et al. 2013- very rarely caught by deepwater trawls and tuna longlines. Kyne & Simpfendorfer 2007 - Interbirth interval estimated. Amat, Amax and $k$ - proxy data from other cofamily species <i>Centroselachus crepidator</i> with age/growth data (Irvine et al. 2006a) which is has a much deeper max depth of 200-2080 m and is of similar but slightly smaller Smax (103 cm) to <i>S. albicauda</i> . Smat M not known so used proxy of Smat F.
<i>Scymnodon plunketi</i>	Somniosidae	-	Weigmann 2016-Proscymnodon became Scymnodon; <i>Scymnodon plunketi</i> is probably a junior synonym of <i>Scymnodon macracanthus</i> . C. Rigby- however <i>Scymnodon plunketi</i> is still the valid species according to Catalog of Fishes (website). Presumed to be used as byproduct for fishmeal and squalene. Kyne & Simpfendorfer 2007 - Interbirth interval estimated. Irvine 2004- could not model growth as no juveniles collected. $k$ - proxy data from other cofamily species <i>Centroselachus crepidator</i> which is has a deeper max depth of 200-2080 m and is of smaller Smax (103 cm) than <i>S. plunketi</i> . Simpfendorfer and Kyne 2009- r2M1.25b is instrinsic rebound potential incorporating density dependence.
<i>Scymnodon ringens</i>	Somniosidae	Knifetooth dogfish	Ebert et al. 2013- bycatch of bottom trawls, line gear and fixed nets; dried salted for food and fishmeal. Age data proxy data from cogenetic <i>Scymnodon plunketi</i> . $k$ proxy data from other cofamily species <i>Centroselachus crepidator</i> which is has a deeper max depth of 200-2080 m and is slightly smaller (103 cm) than <i>S. ringens</i> . Kyne & Simpfendorfer 2007 - Interbirth interval estimated. Min/max no eggs, Sbirth proxy data from <i>S. plunketi</i> . C. Rigby- Smat estimated from relative Smat of <i>S. plunketi</i> .
<i>Somniosus antarcticus</i>	Somniosidae	-	Kyne & Simpfendorfer 2007 - Interbirth interval estimated. Only Somniosus species with age/growth data is <i>S. microcephalus</i> . Used proxy Amat F and Amax F from <i>S. microcephalus</i> which was based on bomb and radiocarbon dating of eye lens but that is dubious (Nielsen et al. 2016); no growth curve. No Male Amat or Amax so used proxy data from Female <i>S. microcephalus</i> (Nielsen et al. 2016).
<i>Somniosus longus</i>	Somniosidae	-	Min/max no eggs is proxy data from <i>Somniosus rostrata</i> of which this species has been debated to be a synonym (RLA-Francis and Tanaka 2009). Kyne & Simpfendorfer 2007 - Interbirth interval estimated. Not appropriate to use proxy age/growth data from <i>S. microcephalus</i> as that species is much larger (at 640-730 cm) than <i>S. longus</i> .
<i>Zameus squamulosus</i>	Somniosidae	-	Last & Stevens 2009- in eastern Atlantic used dried and salted for human consumption and for fishmeal. Amat, Amax and $k$ - proxy data from other cofamily species <i>Centroselachus crepidator</i> with age/growth data (Irvine et al. 2006a) which is has a deeper max depth of 200-2080 m and is slightly larger Smax (103 cm) than <i>Z. squamulosus</i> . Kyne & Simpfendorfer 2007 - Interbirth interval estimated.
<i>Cirrhigaleus australis</i>	Squalidae	-	C. Rigby- interbirth interval estimated from Squalus species. Smat, Amat, Amax and $k$ proxy data from <i>S. montalbani</i> , the other deepwater Squalid with age/growth data of most similar size and depth range (111 cm and 154-1370 m). Sbirth estimated from cogenetic <i>C. asper</i> of similar Smax (118 cm).

## PRELIMINARY ASSESSMENT

<i>Cirrhigaleus barbifer</i>	Squalidae	Mandarin dogfish	C. Rigby- interbirth interval estimated from <i>Squalus</i> species. Amat, Amax and k proxy data from <i>S. megalops</i> , the other deepwater Squalid with age/growth data of most similar depth range (63.5 cm and 0-732 m). Sbirth estimated from cogenetic <i>C. asper</i> of similar Smax (118 cm).
<i>Squalus acanthias</i>	Squalidae	Picked dogfish	Parameters vary regionally, used parameters from NZ ((Hanchet 1998, Hanchet 1986 (unpubl. thesis in Orlov et al. 2011), Hanchet & Ingerson 1997). Amat and AmaxF calculated from Hanchet 1986 -k and SmatF. r2m 1.25b for NW Atlantic from Smith et al. 1998.
<i>Squalus cholorculus</i>	Squalidae	-	Of other Squalids with age/growth data, <i>S.mitsukurii</i> most similar in Smax, Smat and depth range (95 cm, 69 cm and 4-954 m). Amat, Amax, k proxy data from <i>S. mitsukurii</i> .
<i>Squalus griffini</i>	Squalidae	-	C. Rigby- interbirth interval estimated from cogenetic species. Of other Squalids with age/growth data, <i>S.montalbani</i> most similar in Smax, Smat and depth range (111 cm, 79 cm and 154-1370 m). Amat, Amax, k proxy data from <i>S. montalbani</i> .
<i>Squalus megalops</i>	Squalidae	Shortnose spurdog	Simpfendorfer and Kyne 2009- r2M1.25b is intrinsic rebound potential incorporating density dependence. Used age/growth from Watson & Smale 1999 as that is for a temperate population (from South Africa).
<i>Squalus mitsukurii</i>	Squalidae	Shortspine spurdog	Cortes 2000 data is data from South East Pacific so used that for Smax and Sbirth. No data on Smat F in SEP, so Smat M used as proxy data. For Amat, Amax used range of values across regions and studies. C. Rigby -k values used median of range of k values tabled in Cotton et al. 2011. Simpfindorfer and Kyne 2009- r2M1.25b is intrinsic rebound potential incorporating density dependence (Hancock Seamount-Pacific Ocean).
<i>Squalus montalbani</i>	Squalidae	-	C. Rigby- interbirth interval estimated from cogenetic species.
<i>Tetronarce nobiliana</i>	Torpedinidae	-	No data on Smat F so Smat M used as proxy data. Litter size of 60 seems large, but this is also a very large ray, RLA (Notobartolo di Sciara et al. 2009) refers to McEachran & de Carvalho 2002 and an older Whitehead et al. 1984 book that cannot get. Simpfindorfer and Kyne 2007 does not refer to the RLA -as it is 2009. No age/growth from any deepwater torpedo rays but data from shelf species, deepest occurring of them with age/growth being <i>Torpedo marmorata</i> (2-370 m), although it is smaller (63 cm). Proxy Amat, Amax, k from <i>T. marmorata</i> .
<i>Tetronarce tremens</i>	Torpedinidae	-	Last et al. 2016- possibly wide ranging in the Pacific, but distribution not well defined; synonyms include <i>T. peruana</i> , <i>T. semipelagica</i> , <i>T. microdiscus</i> - there is no age/growth data for these species. No data on Smat F so Smat M used as proxy data. C. Rigby- interbirth interval estimated from cogenetic species. No age/growth from any deepwater torpedo rays but data from shelf species, deepest occurring of them with age/growth being <i>Torpedo marmorata</i> (2-370 m), a which has a bit smaller (63 cm). Proxy Amat, Amax, k, litter size, Sbirth from <i>T. marmorata</i> . Litter size and Sbirth of a smaller torpedo ray ( <i>T. torpedo</i> Smax 60 cm) is litters of up to 21 pups, Sbirth 9 cm, so proxy litter size and Sbirth seem satisfactory.
<i>Typhlonarke aysoni</i>	Torpedinidae	Blind electric ray	Last et al. 2016- <i>Typhlonarke tarakea</i> is probably based on a poorly preserved specimen of <i>Typhlonarke aysoni</i> ; and (C Rigby's words) consequently the new Rays of the World book does not recognise <i>T. tarakea</i> as a species. No data on Smat F so Smat M used as proxy data. C. Rigby- interbirth interval estimated from cofamily species. No minimum litter size stated, so used proxy of maximum litter size. No age/growth from any deepwater torpedo rays but data from shelf species, deepest occurring of them with age/growth being <i>Torpedo marmorata</i> (2-370 m), which is of a bit larger Smax of 63 cm. Proxy Amat, Amax, k from <i>T. marmorata</i> . There is another small shelf <i>Torpedo</i> ray ( <i>T. torpedo</i> Smax 41cm) with estimated age/growth, however it is a shallow shelf (0-70 m) and therefore considered it more appropriate to use proxy data from the deeper occurring <i>T. marmorata</i> .
<i>Galeorhinus galeus</i>	Triakidae	Tope shark	Parameters vary regionally - mostly used those from Australia. Walker 1999- reproductive frequency varies from one to three years. Amat, k from Francis and Mulligan (1998) as that is from NZ. Amax from Moulton et al. 1992 (Aust), as NZ study stated Amax likely

PRELIMINARY ASSESSMENT

			underestimated and Moulton et al. 1992 AmaxM from a tag return and vertebral reads said to be inaccurate for older sharks, AmatM used as proxy for AmatF.
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PRELIMINARY ASSESSMENT

## PRELIMINARY ASSESSMENT

PRELIMINARY ASSESSMENT