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Qualitative (Level 1) Risk Assessment of the impact of commercial fishing on New Zealand Chondrichthyans.

New Zealand Aquatic Environment and Biodiversity Report No. 157.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

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New Zealand adopted a revised National Plan of Action for the Conservation and Management of Sharks (NPOA-Sharks 2013) in January 2014. Amongst other objectives, the NPOA-Sharks established a risk-based approach to prioritising management actions. This report details outcomes from a qualitative (level 1) risk assessment (RA) workshop held in November 2014, which assessed the risk to all New Zealand chondrichthyes taxa from commercial fishing. The intention was for this to inform management and be followed by a more quantitative (level 2) RA, prior to the next review of the NPOA-Sharks in 2017. The term “shark” is used generally in this document to refer to all sharks, rays, skates and chimaeras.

The qualitative RA used a modified Scale Intensity Consequence Analysis (SICA) approach. A data compilation exercise was completed prior to the workshop, and allowed discussion and decisions about risk to be informed by as much data as possible. An expert panel then scored the risk to each taxon from commercial fishing, based on fishing information from the last five years and information on its biological productivity. The assessment considered risk on a national (Exclusive Economic Zone (EEZ) -wide) scale. This process scored intensity and consequence of the fishery to the shark taxa, both on a scale of 1 to 6 (where 1 was low, and 6 was high). The rationale for the intensity and consequence scores for each taxon was documented. These intensity and consequence scores were then multiplied together to get a total risk score (with a possible maximum score of 36). Workshop participants also made recommendations about the presentation and utilisation of workshop outputs, as well as identifying key information gaps.

The results are reported here within the three management classes of sharks - Quota Management System (QMS), Non-QMS, and Protected species. Carpet shark (Non-QMS) and rough skate (QMS) attained the highest total risk scores (both scored 21). The highest scoring protected species was basking shark with a total risk score of 13.5. The panel allocated intensity scores across the full range (1–6), based on fisheries capturing taxa over time periods ranging from decadal to daily, and over a spatial distribution ranging between less than 1% to greater than 60% of their range. No consequence score greater than 4.5 was allocated (out of a maximum possible of 6) because available information did not suggest that commercial fishing is currently causing, or in the near future could cause, serious unsustainable impacts (the description of a score of 5 for total consequence). However, out of the 84 taxa considered, the panel had low confidence in the risk scores for 43 taxa and consensus was not reached for 3 taxa. Overall risk scores were relatively low compared to the maximum possible score because of the relatively low consequence scores.

The risk assessment was designed to help prioritise actions to sharks taxa, noting that protected species are also given priority under the NPOA–Sharks (2013). The panel made a number of recommendations for high-risk or protected species regarding potential research options. These included more use of existing data, grooming or analysis to improve inputs to assessment scores, better taxonomy and education to improve identification of sharks, and collection of more biological information to improve understanding of productivity (especially the ability of a taxon to recover from or sustain fishing impacts).

1. INTRODUCTION

New Zealand is a signatory to the United Nations Food and Agriculture Organisation (FAO)'s International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks[1]). That document recognises that sharks can play important roles in maintaining healthy ocean ecosystems, and that they share biological characteristics that can make them susceptible to over-fishing, such as late age at maturity and low productivity. The overarching objective of the IPOA-Sharks is "to ensure the conservation and management of sharks and their long-term sustainable use."[2] The IPOA-Sharks suggests that member states of the FAO that conduct fisheries either targeting sharks, or regularly taking sharks as incidental bycatch, should each develop a National Plan of Action for the conservation and management of Sharks (NPOA-Sharks).

The Ministry for Primary Industries (the Ministry; MPI) in conjunction with a range of stakeholders has produced an updated National Plan of Action for Sharks 2013 (NPOA-Sharks 2013[3]) to outline New Zealand's planned actions for the conservation and management of sharks, consistent with the overarching goal of the IPOA-Sharks. The purpose of the NPOA-Sharks 2013 is:

> "To maintain the biodiversity and the long-term viability of all New Zealand shark populations by recognising their role in marine ecosystems, ensuring that any utilisation of sharks is sustainable, and that New Zealand receives positive recognition internationally for its efforts in shark conservation and management."

The NPOA Sharks 2013 recognises that New Zealand waters are home to at least 113 taxa of shark, of which more than 70 have been recorded in fisheries. The term "shark", as used generally in this document, refers to all sharks, rays, skates, chimaeras and other members of the Class Chondrichthyes.

Fundamental to the NPOA-Sharks 2013 is a risk-based approach to management that directs resources to those shark populations most in need of active management. Risk in this context is defined[4] as:

> "Population-level risk, which is a function of impact and depends on the inherent biological or population-level characteristics of that population."

This risk based approach as mentioned in Goals 1 and 6 of the NPOA sharks is to (verbatim):

1. Maintain the biodiversity and long-term viability of New Zealand shark populations based on a **risk assessment framework** with assessment of stock status, measures to ensure any mortality is at appropriate levels, and protection of critical habitat.

6. Continuously improve the information available to conserve sharks and manage fisheries that impact on sharks, with prioritisation guided by the **risk assessment framework**.

The risk assessment framework (or its outcomes) are mentioned again specifically in the following objectives:

> Objective 1.1
> Develop and implement a **risk assessment framework** to identify the nature and extent of risks to shark populations

[1] http://www.fao.org/docrep/006/x3170e/x3170e03.htm
[2] http://www.fao.org/docrep/006/x3170e/x3170e03.htm
[3] http://www.fish.govt.nz/en-nz/Environmental/Sharks/default.htm
[4] Risk is defined here consistently with other New Zealand fisheries risk assessments, e.g., Currey et al. 2012 and Richard &Abraham 2013.

Objective 1.4

Mortality of all sharks from fishing is at or below a level that allows for the maintenance at, or recovery to, a favourable stock and/or conservation status giving priority to protected species and **high risk species**.

Ecological risk assessment (ERA) is increasingly being used across a range of marine threats and habitats, see Halpern et al. (2007) for a global example and MacDiarmid et al. (2012) for a local example. Approaches to assessing risks from fisheries have been developed and broadly fit into three categories (after Hobday et al. 2011):

Level 1: Qualitative expert based risk assessments which are used for "data poor" fisheries, or for scoping higher risk species for more detailed assessment.
Level 2: Semi-quantitative risk assessments, where more data are available, but not enough to complete a quantitative assessment.
Level 3: Quantitative risk assessments, where enough data are available to complete a fully quantitative assessment.

Most ERAs done to date for New Zealand fisheries have been either level 1 or 2, or a combination with parts extending towards level 3 (e.g. Sharp et al. (2009) for Antarctic benthos, Parker (2008) for South Pacific High Seas fisheries, Waugh et al. (2010), Baird & Gilbert (2010), Rowe (2010), and Richard & Abraham (2013) for incidental seabird captures and mortality, Clark et al. (2011) for seamount habitat, Currey et al. (2012) for Maui's dolphins, Stoklosa et al. (2012) for aquaculture and MacDiarmid et al. (2012) for a variety of New Zealand habitats).

A number of approaches and methods have been applied around the world to conduct Level 1 assessments. Two of the most common methods are:

- Scale Intensity Consequence Analysis (SICA) used within the broader ERAEF (Ecological Risk Assessment of the Effects of Fishing) (Hobday et al. 2007, 2011). This level 1 method was developed to screen out hazards that did not pose risk, to identify species at most risk and to identify gaps in knowledge.
- Consequence-Likelihood (CL) method developed by Fletcher (2005) for Australian fisheries, and used for New Zealand fisheries by Campbell & Gallagher (2007), Baird & Gilbert (2010), and as the basis for a recent New Zealand hoki fishery risk assessment (Boyd 2011).

There is a subtle difference in the underlying concept of risk between these methods. The SICA methodology measures the total level of impact from the activity, and the effect is the ecological consequence of the impact. The overall risk is then the sum of all the effects. This approach generally requires greater knowledge of the underlying ecology of the system being impacted, but is generally regarded as being more suitable for assessing risk from fisheries as it is more suited to activities that are predictable, ongoing, and cumulative (Smith et al. 2007, Sharp et al. 2009). The SICA approach has also been endorsed by the Marine Stewardship Council (MSC) (2010), and hence is a recognised international method. A CL approach summarises risk as a product of the expected likelihood and consequence of an event. This approach is often regarded as more suitable for rare and unpredictable events (Smith et al. 2007, Sharp et al. 2009).

In this report, we document the results of the SICA methodology, which was applied during a 5-day expert workshop (17–21 November, 2014) which developed a Level 1 ERA for the effects of commercial fishing on all sharks, skates and rays encountered in the New Zealand region.

2. METHODS

2.1 Scope and Panel Composition

The risk assessment workshop focused on commercial fisheries threats to shark populations in the New Zealand EEZ (NZ EEZ) and Territorial Sea (TS) over the past five years. The scope was limited to commercial fishing threats for three reasons:

1. More sharks are caught commercially and better data exist for commercial than recreational or customary catch
2. A review of non-fishing threats concluded these sources were a less imminent threat to shark populations than commercial fisheries related threats (Francis & Lyon 2013)
3. There was a paucity of information to inform a risk assessment on non-fishing threats (Francis and Lyon 2013).

The last five years (2008–09 to 2012–13 fishing years) were chosen so that the assessment was relevant to the present day. In addition, inshore fishing reporting was at a finer geographic scale over the last five years than previously, enabling better comparisons between shark ranges and fished areas than for earlier periods. However longer-term data were used where available to inform the rate at which shark species decline or recover, and hence the consequence score.

The NPOA-Sharks 2013 listed 113 shark taxa as present in the NZ EEZ and TS. Ninety-two taxa were originally selected for consideration by the workshop (Appendix 8.2), excluding undescribed taxa listed in the NPOA-Sharks. Only 90 of those 92 taxa had MPI reporting codes (Appendix 8.2) and data were only reported in the last five years for 64 reporting codes (Appendix 8.3). Therefore it was not anticipated that all 92 taxa would be able to be assessed in the workshop due to data limitations, but this judgment was left to the panel members at the workshop.

The expert panel comprised New Zealand experts in at least one of the three topic areas of sharks, risk assessment, or fisheries that capture sharks:

- Dr Malcolm Francis (National Institute of Water and Atmospheric Research (NIWA))
- Dr Malcolm Clark (NIWA)
- Dr Matt Dunn (Victoria University of Wellington)
- Clinton Duffy (Department of Conservation (DOC))
- Dr Paul Crozier (DOC)
- Richard Wells BSc (Deepwater Group and Fisheries Inshore New Zealand).

The panel was chaired by Dr Rich Ford (MPI). Stakeholders and representatives of government agencies were invited to observe the workshop to ensure transparency in the scientific process. At the request of the Chair these stakeholders or representatives could provide additional technical advice to inform the RA scoring.

The Panel operated under formal Terms of Reference (Appendix 8.1).

2.2 Pre- workshop preparation

Prior to the workshop all relevant data regarding New Zealand sharks, and the commercial fisheries that may impact upon them were compiled into an electronic directory. The panel used that directory to work through taxa-by-taxa. The directory included information on the fishing effort, estimated catches, distribution and biology of each taxon as specified below:

- Most recent Plenary chapter, if any (Ministry for Primary Industries 2014a, 2014b)

- Data files, summaries and maps of reported captures over last five complete fishing years (2008–09 to 2012–13):
    - Catch-effort reports by fishery
    - Observer records by method and shark taxon
    - Analysis of trends in observer records (Anderson 2013)
- NABIS[5] distribution maps and unpublished hotspot layers
- Predicted layers from demersal fish classification (Leathwick et al. 2006)
- Distribution maps of effort, estimated catch and catch per unit effort (CPUE) by taxon, data resolution (latitude/longitude, statistical area), data source (commercial, observer and Non-Fish bycatch (NFB)) and fishery (Francis 2015a)
- Trawl survey information on distribution and trends (e.g., Bagley et al. 2013 for Sub-Antarctic surveys and O'Driscoll et al. 2011 for the Chatham Rise)
- Papers or summaries of biology, age, growth, fecundity (including frequency of reproduction, as this is not always annual), and general productivity obtained through a literature search
- Australian ERAEF risk assessment database, which included biological parameters used in CSIRO ERAs

In order to inform consequence scoring, a spreadsheet of management and biological factors was compiled (where available) that covered all taxa (see Appendices 8.4–8.6). This included names of taxa (common, scientific, fisheries codes and different taxonomic levels), management classifications (QMS/Non-QMS/Protected, IUCN "redlist" classes, and Department of Conservation (DOC) threat classes), population characteristics (habitat, relative population size and distribution) and biological characteristics (reproductive mode, maximum length, length and age at maturity, maximum known age[6], litter size, gestation period and length of the reproductive cycle). In order to simplify the process three larger groups of these factors (subcomponents) were identified and scored (on a scale from 1 being the least biologically susceptible to over-fishing to 3 being highly susceptible). These factor groups were population size in the focal area, distribution class, and age at maturity and fecundity. Details of how these factors were scored are given in Table 3.

Fisheries were defined according to the classifications used in the DOC Conservation Services Programme Report, consistent with previous level 1 risk assessments, e.g. Rowe (2010). Shark estimated catch and total effort data were collated based on the 'fisheries' in Table 1 (for reporting purposes some fisheries with small numbers of captures were combined).

Maps were produced of the distribution of estimated shark catch and effort of fishing for the last five years combined for commercial fisheries where more than 10 records of a particular shark taxon existed in that fishery (e.g. Figure 1, Figure 2). This threshold was not met for all shark taxa and/or fisheries, but for most taxa there was more than one relevant fishery map. Species for which no maps of commercial catch were available were still considered in the RA, but assessment of likely or potential overlap between taxon range and fishing effort and intensity were based on other available information including observer records and/or expert judgement.

Where possible, a map of total catch of shark taxa across all fisheries was produced so that the relative contribution of each fishery to the total could be judged.

[5] www.nabis.govt.nz
[6] Maximum known age is often an underestimate (as it is hard to sample and age the oldest individuals).

Additional maps of the previous 19 years of trawl catch and effort data (TCEPR forms only, from 1989−90 to 2007−08) were produced where possible to help inform any temporal changes in the geographic spread of trawl catches (see Figure 3).

All pre-workshop figures and quantities were produced from un-groomed data. This was more cost-effective than using groomed data; but data errors were identified in the un-groomed results by the expert panel, and those data and obvious outliers were discounted by the experts when making their RA interpretations. Therefore the graphics presented here may be incorrect in some of their detail, and should not be used for further detailed analyses without checking for data inaccuracies or reference to expert opinion. The distribution maps produced from this pre-workshop preparation and further detail on their construction are available in Francis (2015a).

Table 1: Classification of commercial and observer records into fisheries (last column) based on fishing method, vessel length and target taxa. Species codes are defined in Appendix 8.2 (including alternate names).

Method	Method codes	Vessel length	Target species	Method class	Pie graph key
Bottom longline	BLL	>= 40 m	All	BLL_GT40	BLL_DW
Bottom longline	BLL	< 40 m	BCO, TRU	BLL_LT40_BCO	BLL_IN
Bottom longline	BLL	< 40 m	BNS, HPB, HAP, BAS, BYX, SKI, SPE	BLL_LT40_BNS	BLL_IN
Bottom longline	BLL	< 40 m	LIN, RIB, HAK	BLL_LT40_LIN	BLL_IN
Bottom longline	BLL	< 40 m	Other BLL targets	BLL_LT40_OTH	BLL_IN
Bottom longline	BLL	< 40 m	SCH, SPO, ELE, SPD, RSK	BLL_LT40_SCH	BLL_IN
Bottom longline	BLL	< 40 m	SNA, GUR, TRE, TAR, RSN, RRC, KIN, KAH, JDO, BRA	BLL_LT40_SNA	BLL_IN
Bottom longline	BLL	Length N/A	All	BLL_OTH	BLL_IN
Beach seine	BS	All	All	BS	BS
Trawl	BT, BPT	All	Other trawl targets	BT_OTH	TWL_DW
Dredge	D	All	All	D	D
Diving	DI	All	All	DI	DI
Drop line	DL, TL	All	All	DL	DL
Drag net	DN	All	All	DN	DN
Danish seine	DS	All	All	DS	DS
Fyke net	FN	All	All	FN	FN
Fish pot	FP	All	All	FP	FP
Hand line	HL	All	All	HL	HL
Trawl	MW, BT	All	JMA, EMA	MW_JMA	MWT
Pole and line	PL	All	All	PL	PL
Pot	CP, CRP, RLP	All	All	POT	POT
Purse seine	PS	All	Other PS targets	PS_OTH	PS
Purse seine	PS	All	SKJ, ALB	PS_SKJ	PS
Ring net	RN	All	All	RN	RN
Surface long line	SLL	>= 48 m	All	SLL_GT48	SLL
Surface long line	SLL	< 48 m	All	SLL_LT48	SLL
Surface long line	SLL	Length N/A	All	SLL_OTH	SLL
Set net	SN	All	All	SN	SN
Troll	T	All	All	T	T
Trawl	MW, BT	All	ORH, OEO, CDL, SSO, BOE, SOR, SND	TWL_DW	TWL_DW
Trawl	BT, BPT	BT, BPT	FLA, FLO, LSO, SFL, ESO, YBF, TUR, GFL, BRI, BFL	TWL_FLA	TWL_IN
Trawl	MW, BT	All	TAR, GUR, RCO, SNA, BAR, TRE, STA, JDO, ELE, WAR, SPD, SPO, LEA, SKI, SCH, QSC, MOK, RSK, HPB, HAP, PAD, BCO, KAH, CAR, BOA, THR, SPZ, KIN, BRA, WRA, WHE, TRU, SCA, MAK, BWS, ALB, SFI	TWL_IN	TWL_IN
Trawl	MW, BT	All	RAT, CDO, JAV, TRA, SCO, RBM, FRO, SDO, SBO, SSK, MDO, RBT, BNS, LDO, RBY, WWA, SPE, BYX, HAK, SWA, LIN, GSH, HOK, GSC	TWL_MD	TWL_MD
Trawl	MW, BT	All	SBW	TWL_SBW	TWL_DW
Trawl	BT	All	SCI	TWL_SCI	TWL_DW
Trawl	MW, BT	All	SQU	TWL_SQU	TWL_DW

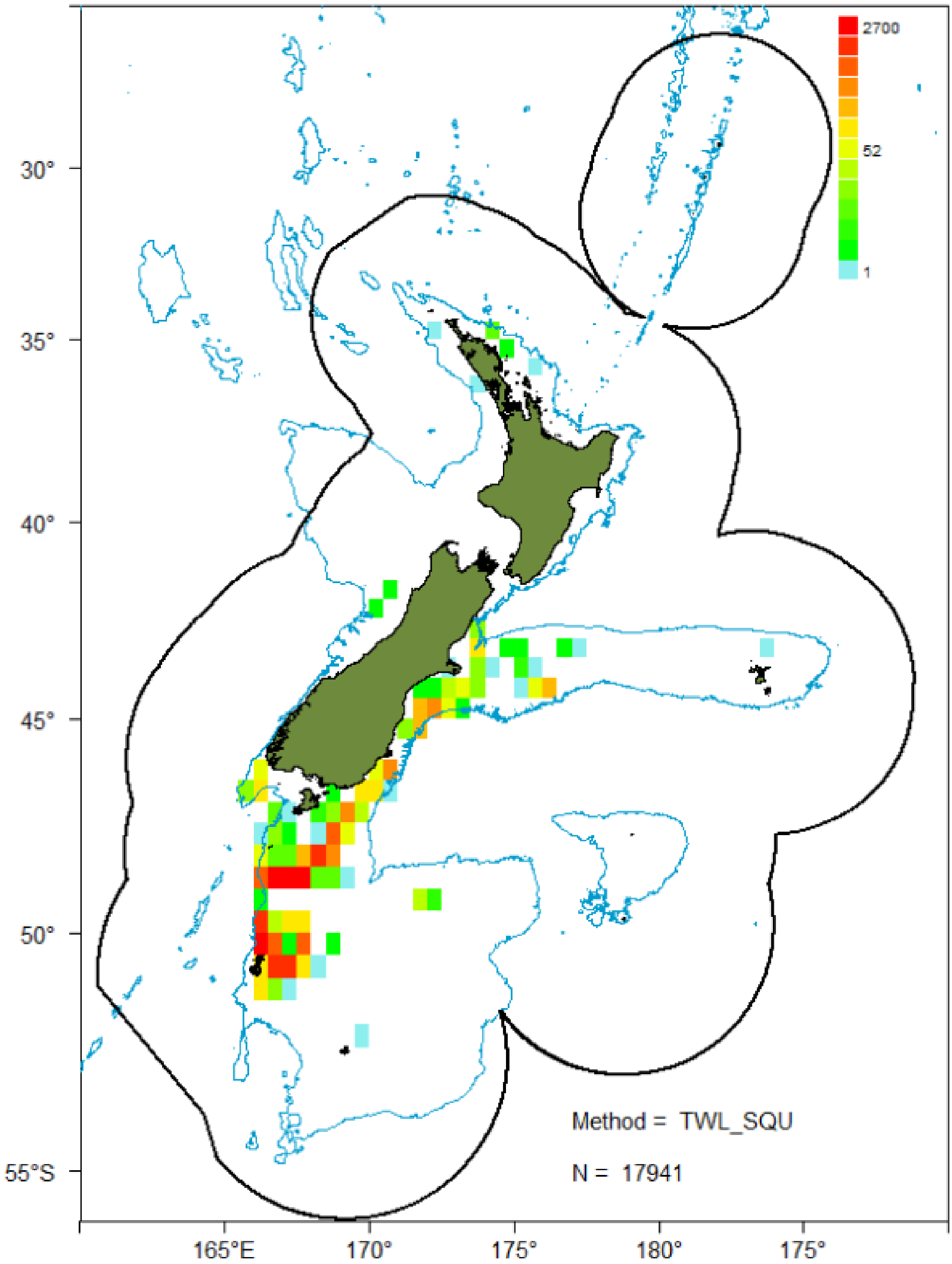


Figure 1: Effort (number of fishing events) from the SQU (squid) trawl fishery (last five years only). Scale bar is on a log scale, but numerals show untransformed values. For more details see Francis (2015a).

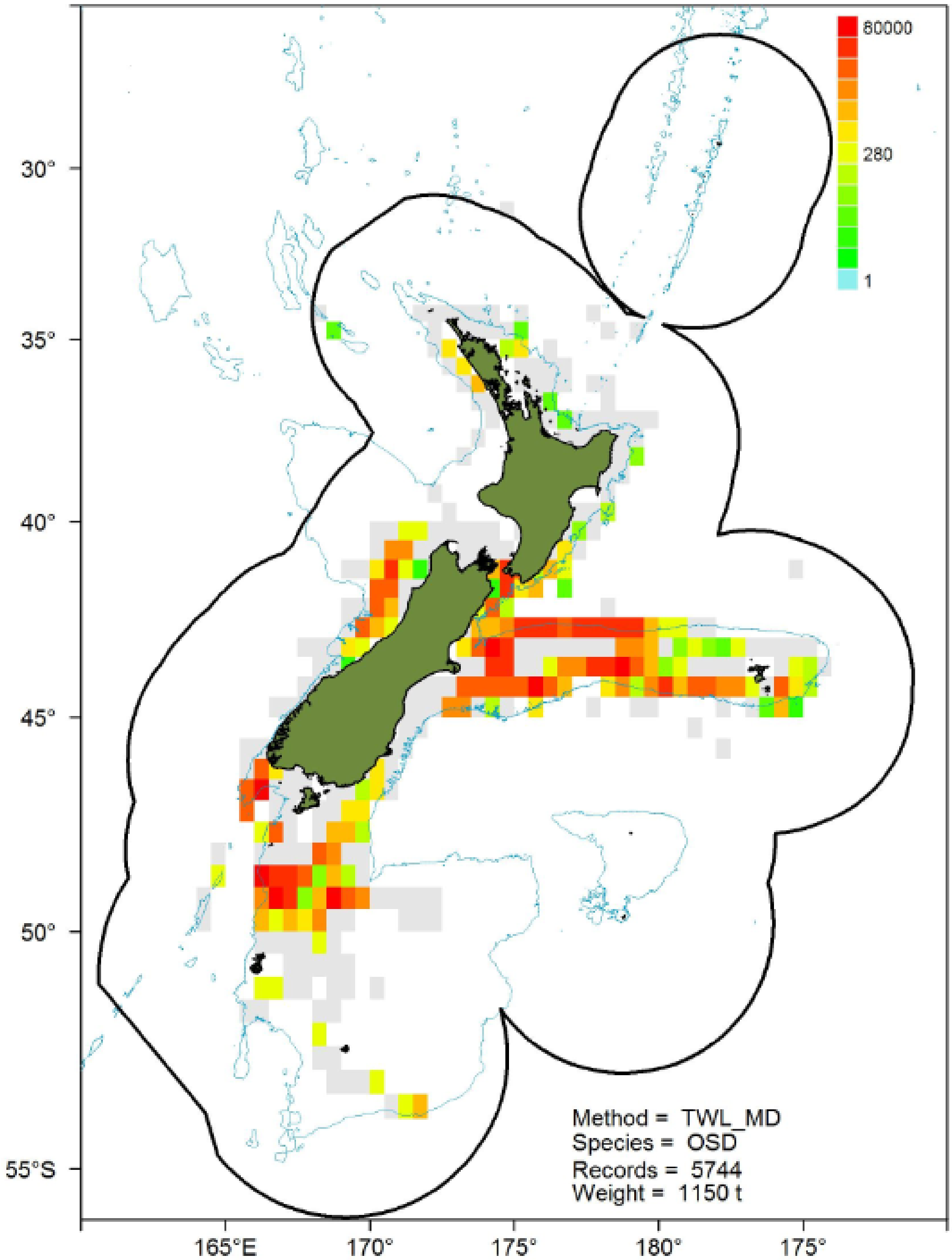


Figure 2: Estimated catch of OSD (Other Sharks and Dogfish) from the middle-depths trawl fishery (last five years only). Scale bar is on a log scale, but numerals show untransformed values in kilograms. For more details see Francis (2015a).

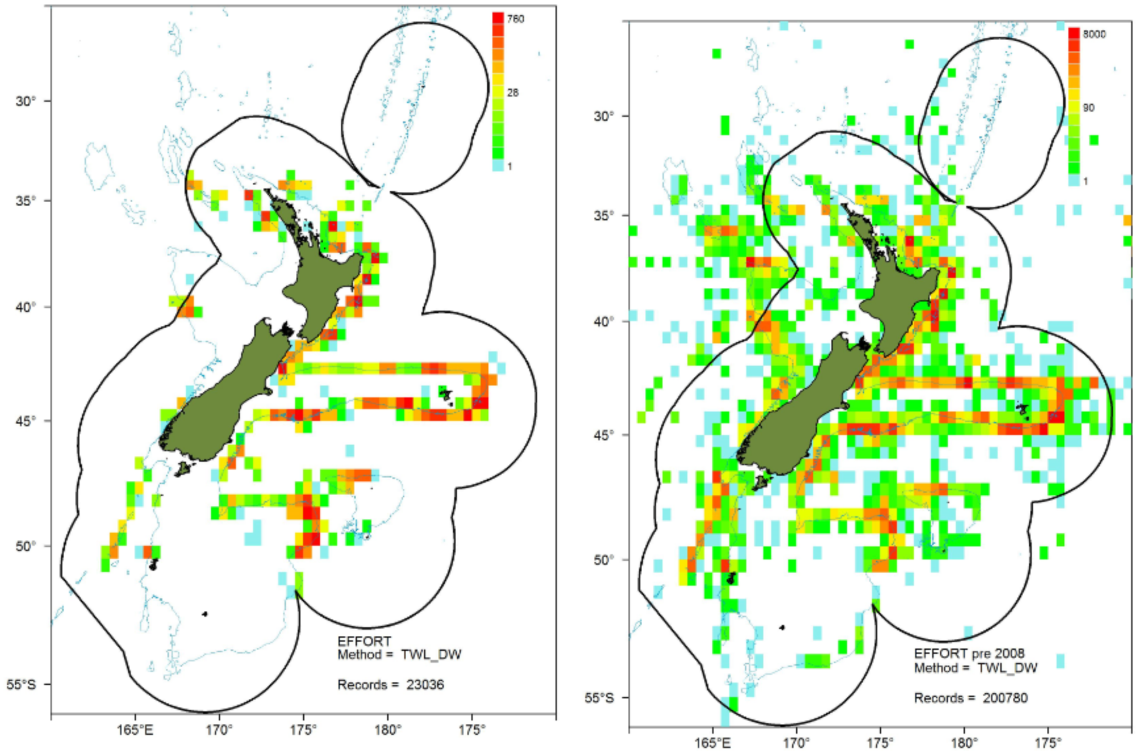


Figure 3: Deepwater fishery trawl effort (number of fishing events) from the last five years (left) and the 19 years previous (right). Scale bars are on a log scale, but numerals show untransformed values. For more details see Francis (2015a).

2.3 Assessment Methodology

A SICA methodology (Hobday et al. 2007, 2011) was chosen for the risk assessment as this was considered the most relevant for commercial fishing as it is generally predictable, ongoing, and cumulative (Smith et al. 2007, Sharp et al. 2009). It is also based on a clear description of fishing intensity parameters, and fully utilises the types of information available on shark fisheries and shark biology in New Zealand. However as this was not a preliminary screening exercise, the panel attempted to take a “realistic case” approach (as opposed to the usual “worst case” approach where the most “at-risk” subcomponents are selected). This “realistic case” approach involved examining all subcomponents for all taxa.

Fishing intensity was first scored for both temporal and spatial subcomponents (on a categorical scale of increasing risk from 1 to 6 (Table 2)). Spatial and temporal scale were scored in a manner consistent with MSC requirements (Marine Stewardship Council 2013). Spatial and temporal intensity were estimated after examining catch quantities, maps of catch and range, and assessing the temporal nature of the fishery. Overall intensity was then scored using the criteria in Table 2, and notes were taken for each taxon to substantiate scores and justify any deviations of the overall intensity score from the score class definition (Table 2).

Consequence was then scored, again in a manner consistent with MSC guidelines (Marine Stewardship Council 2013). This was based on discussion and consideration of the subcomponents of consequence (Table 3) and any abundance index/indices for that taxon. To aid consideration of the subcomponent scores two averages were calculated (Appendix 8.7). The first was for all four subcomponent scores (4-average, Table 3). The second was the average of relative population size, distribution class and the average of the two productivity scores when they exceeded zero (3-average). The 3-average score sometimes better highlighted the data available than the 4-average score, but for many taxa these scores were identical. However, the averaging of these factor scores was only used to help the panel, the key data were the actual information and metrics of the subcomponents. Abundance indices were available for some taxa from all or some of the following trawl survey series: Chatham Rise (O'Driscoll et al. 2011), Sub-Antarctic (Bagley et al. 2013), west coast South Island (Stevenson 2012) or east coast South Island coastal (Beentjes et al. 2013) or deepwater (Doonan & Dunn 2011). In the absence of trawl survey indices trends in the bycatch rates were examined for deepwater taxa (Anderson 2013). Bycatch trends were treated more cautiously than abundance indices trends, as they were considered less robust. Where subcomponent scores for consequence were minimal or not available, the panel scored consequence based on the definitions of the total consequence scores (Table 3). In these situations total consequence scores were not scored independently of total intensity, as the impact upon the taxa needed to be gauged on the basis of a level of fishing mortality; this tended to be the case mostly for taxa that had a remote likelihood of capture (a total intensity score of 1). Notes were again taken for each taxon to substantiate scores.

The overall scores for intensity (1-6) and consequence (1-6) were then multiplied together to get an overall risk score for the taxa across all commercial fisheries (potential range = 1–36).

Table 2: Intensity subcomponent and overall scores and definitions, modified from Marine Stewardship Council (2013).

	Intensity subcomponent score and description					
	1	2	3	4	5	6
Spatial (s) (overlap of commercial fishery range with NZ population range)	<1%	1–15%	16–30%	31–45%	45–60%	>60%
Temporal (t) (frequency of commercial fishery capture)	Decadal	Every few years	Annual (every 1–100 days)	Quarterly (every 100–200 days)	Weekly (every 200–300 days)	Daily (> 300 days)

Intensity overall score and description

1	Remote likelihood of catch/capture at any spatial or temporal scale (s= 1, t=1)
2	Capture occurs rarely or in few restricted locations (t less than or equal to 3, s less than or equal to 2)
3	The amount of captures are moderate at broader spatial scale (s greater than or equal to 3), or high but local (t = 4 or above)
4	The amount of captures are relatively high (cf. 1–3) and occur reasonably often at broad spatial scale (t greater than or equal to 5, s= greater than or equal to 4)
5	Captures are occasional but very high and localized or lower but widespread and frequent (s=greater than or equal to 5, t= 5 or 6)
6	Captures are locally to regionally high or continual and widespread (s and t both 6)

Table 3: Consequence subcomponent and overall scores and descriptions, modified from Marine Stewardship Council (2013).

	Consequence subcomponent score and description		
	1	2	3
Relative population size*	Large	Medium	Small
Distribution class	Worldwide	Regional	Endemic
Productivity: age at maturity	≤ 6 years	7 – 12 years	≥ 13 years
Productivity: fecundity	≥35 per litter or eggs per year (for egg layers)	8–34 per litter or eggs per year (for egg layers)	≤7 per litter or eggs per year (for egg layers)

Consequence overall score and description	
1	Impact unlikely to be detectable.
2	Minimal impact on taxa.
3	Moderate and sustainable level of impact such as full exploitation rate for a target taxa
4	Actual, or potential for, unsustainable impact (e.g. long-term decline in CPUE)
5	Serious unsustainable impacts now occurring, with relatively long time period likely to be needed to restore to an acceptable level (e.g. serious decline in spawning biomass limiting population increase).
6	Widespread and permanent/irreversible damage or loss will occur (e.g. extinction)

* Based on the number of records of each taxon in commercial, observer and research trawl databases in the NZ EEZ and in the depth ranged fished by commercial vessels. Abundance outside these geographical limits ignored.

In addition to the overall risk score, the quantity and quality of data used and the extent of expert consensus were also rated for each taxon (Table 4) according to the ERAEF methodology (Hobday et al. 2007). Where we had low confidence this was based on the absence of important information (the information lacking is specified in the confidence section for each species). Poor data meant data were limited, unreliable or conflicting.

Table 4: Data and expert judgement categories modified from Hobday et al. (2007).

Data	Expert consensus
Few data	no expert consensus
	expert consensus, but with low confidence
	expert consensus
Data exist, but are poor	no expert consensus
	expert consensus, but with low confidence
	expert consensus
Data exist and are considered sound	no expert consensus
	expert consensus, but with low confidence
	expert consensus

Throughout the process scores were revisited by the panel to test that their relativity was logical and consistent. Notably, scores were internally consistent, but should not be compared with other risk assessments, e.g. of teleost fishes, as factors such as productivity were scored relatively within chondrichthyans and this is generally low compared to teleosts (Dulvy et al. 2014). At the end of the scoring process high priority research was also identified.

All taxon-specific scores are presented below in the three separate management categories that apply to sharks: QMS species, non-QMS taxa and protected species. In each of these sections a graphic is used to show the ranking of scores within the section and the score for each taxon (in decreasing order of risk) is then explained. Where taxa scored identical risk scores they are presented so that higher consequences are reported first and then in alphabetical order.

For each taxon, the total estimated commercial catch[7] over the last five years and pie graphs of the estimated commercial catch by different fisheries over the past five years were produced (where the estimated catch per fishery exceeded 5 t, and was therefore considered likely to be representative). Each pie graph consisted of up to three fisheries with the highest catch rates, plus an ‘others’ category that combined all other fisheries. Abbreviations used in the pie graphs are shown in Table 1. The data used in these pie graphs are ungroomed, therefore they may contain errors and expert interpretation of these graphs may be necessary. Where pie graphs were considered misleading by the panel a warning is present on the pie graph.

Pie graphs were not produced for taxa having reported commercial catches over the past five years of less than 5 t (in which case the data may not be representative). Abundance indices are sometimes reported by area using the following abbreviations:

- East Coast South Island (ECSI)
- East Coast North Island (ECNI)
- West Coast South Island (WCSI)
- Chatham Rise (CR)
- Sub Antarctic (SA).

The reproductive mode (egg layer or live bearer) is also documented. Pups are usually born larger than the size at which juveniles of oviparous species hatch from eggs, suggesting that viviparous species may have higher survival after birth than oviparous species.

Where the panel made specific recommendations regarding a taxon, they were included under the heading of that taxon, as well as in the General Discussion section. General research recommendations were included in the General Discussion section.

[7] Estimated commercial catch include schedule 6 releases so for some species they may exceed the reported landings.

3. RESULTS

Eighty-five taxa were scored by the risk assessment panel. The taxa not scored were infrequently seen, poorly taxonomically described, scored as part of complexes (groupings of more than one taxa) or a combination of these factors. The full range of intensity scores were assigned by the panel, but no consequence scores over 4.5 were assigned (Figure 4). However, out of the 84 taxa considered, the panel had low confidence in the risk scores for 43 taxa and consensus was not reached for 3 taxa. This indicates that even though fisheries catch sharks frequently across a large proportion of their range, there are no taxa where serious unsustainable impacts, or widespread and permanent/irreversible damage (scores 5 or 6 for consequence) were judged as occurring. The frequency of each intensity score generally had a downwards trend as intensity increased (Figure 4). The most frequent consequence score was four (actual, or potential for, unsustainable impact). This score was often given to deepwater sharks based on either their known, or assumed, low productivity (Simpendorfer & Kyne 2009).

When the intensity and consequence scores were multiplied together to calculate risk, the maximum risk score generated was 21 (Figure 5), even though the theoretical maximum score is 36. Scores were well below the possible maximum mainly because no consequence scores exceeded 4.5, and where intensity was high (6) consequence never exceeded 3.5. Twenty of the 84 taxa scored were considered to have a remote likelihood of capture and those captures were unlikely to impact on the population (i.e. a risk score of 1).

There were only 14 taxa (9 QMS, 3 non-QMS and 2 protected species) for which the data were judged to both exist and be sound for risk assessment purposes, with most taxa scoring "exist but poor" (37) or "few data" (37). Despite this, consensus was achieved on the risk scores for 81 of the 84 taxa (either with no qualifiers (39 species) or with low confidence (43 species)).

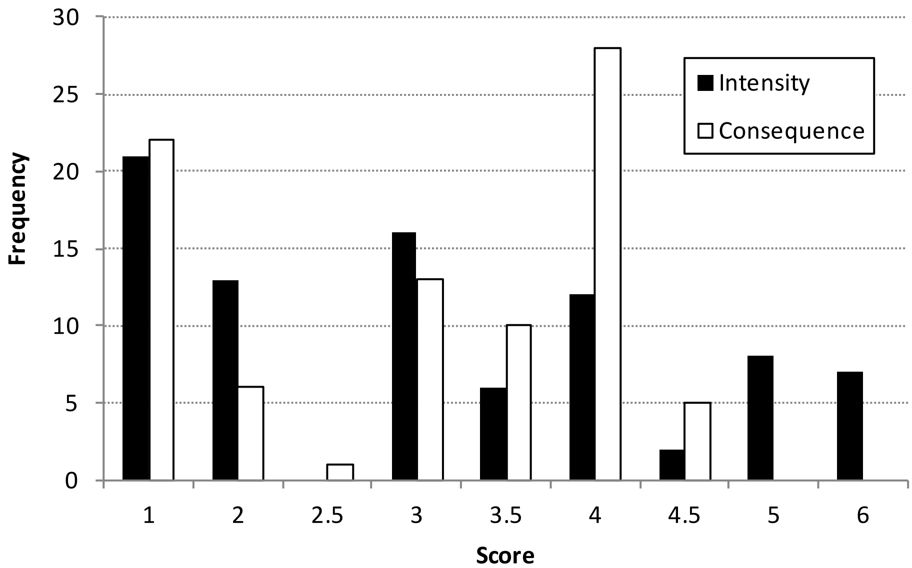


Figure 4: Frequency of intensity and consequence scores.

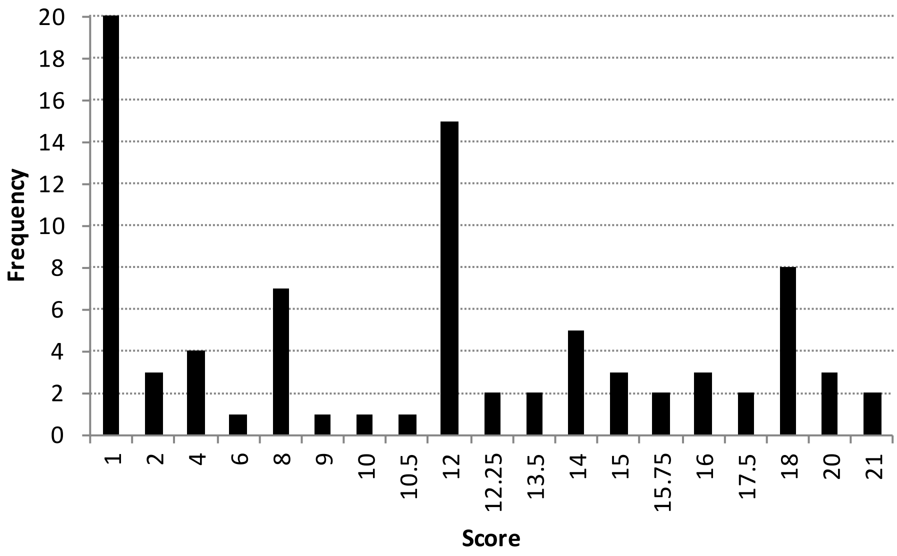


Figure 5: Frequency of risk scores.

3.1 Quota Management System (QMS) species

Eleven shark species are currently managed under the Quota Management System (QMS) (Table 5).

Species were introduced to the QMS based on a number of factors including the development of a targeted fishery, high value product, or large volumes of catch of that species. Under the QMS, catch limits aim to maintain populations at sustainable levels for each species/area (stock) based on the best available scientific information. In order to set appropriate catch limits, species are the subject of research programmes, including fishery-independent trawl surveys, scientific observer data collection and targeted work to understand the biology of the species and estimate the size and status of the stock. QMS species are subject to strict mandatory reporting requirements and may not be discarded at sea unless authorised by a government observer or the release meets the conditions of Schedule 6 of the Fisheries Act 1996. Species listed on Schedule 6 of the Fisheries Act are allowed to be returned to the water (but are still required to be reported) if the shark is alive and likely to survive on its return, however four shark species may be returned to the sea either alive or dead (Table 5). All shark captures for all shark taxa were regarded as mortalities in the risk assessment process (as survivability of released sharks is unknown); this is likely to overestimate risk to an unknown degree.

QMS shark species are reported separately to non-QMS species in this report because their inclusion in the QMS acknowledges that the intensity of fisheries on these species is high (and for certain species the catch is deliberate, i.e. they are a target species) and measures are already in place to manage this risk.

The overall risk, its component parts (intensity and consequence) and the confidence in those scores, in terms of both the quantity and quality of the data and the extent of consensus amongst the panel, are displayed in Figure 6. Rough and smooth skates were assigned the highest risk scores and the three pelagic sharks (mako, porbeagle and blue shark) and pale ghost shark the lowest.

Table 5: Shark species managed under the Quota Management System (QMS) in alphabetical order, and characterised as to their management regime and schedule 6 listing. HMS = Highly Migratory Species. See Appendix 8.2 for full taxonomic details (including alternate names).

Species	Management	Schedule 6 listing allows	
		Live returns	Dead returns
Blue shark	HMS	Yes	Yes
Dark ghost shark	Inshore/Deepwater		
Elephantfish	Inshore		
Mako shark	HMS	Yes	Yes
Pale ghost shark	Deepwater		
Porbeagle shark	HMS	Yes	Yes
Rig	Inshore	Yes	
Rough skate	Inshore	Yes	
School shark	Inshore	Yes	
Smooth skate	Inshore	Yes	
Spiny dogfish	Inshore/Deepwater	Yes	Yes

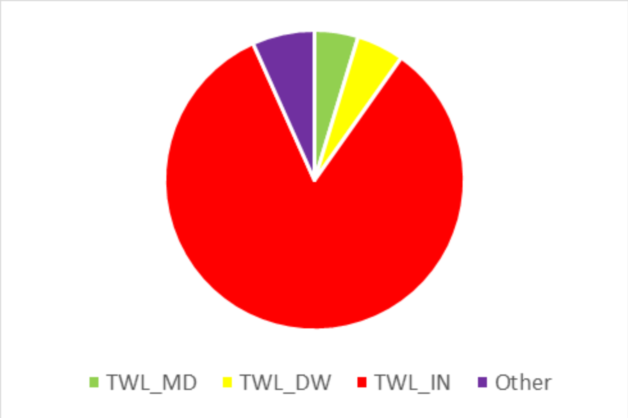
As QMS sharks are known to be either targeted by fishers or have relatively high catches (compared to most non-QMS species) it was expected that these species would score relatively highly in terms of intensity. All these sharks scored between 4 and 6 for intensity, which means that the level of captures can be described as ranging from “relatively high and occur reasonably often at broad spatial scale” to “locally to regionally high or continual and widespread”. These sharks had a narrow distribution in terms of consequence, scoring between 3 and 4. These scores equate to a description ranging from “Moderate and sustainable level of impact such as full exploitation rate for a target species” to “Actual or potential for unsustainable impact (e.g. long-term decline in CPUE)”.

QMS SPECIES RISK

COMPONENTS OF RISK		RISK	CONFIDENCE	
Intensity	Consequence		Data	Consensus
6	3.5	21 - Rough skate	✓✓	✓✓
5	4	20 - Smooth skate	✓✓	✓✓
6	3	18 - Dark ghost shark	✓✓	✓✓
6	3	18 - Elephantfish	✓✓✓	✓✓
6	3	18 - Rig	✓✓✓	✓✓
6	3	18 - School shark	✓✓✓	✓✓
6	3	18 - Spiny dogfish	✓✓✓	✓✓
5	3	15 - Mako shark	✓✓✓	✓
5	3	15 - Pale Ghost Shark	✓✓	✗
5	3	15 - Porbeagle shark	✓✓✓	✓
4	3	12 - Blue shark	✓✓✓	✓✓

Figure 6: QMS Species Risk scores. For the COMPONENTS OF RISK higher numbers indicate greater intensity or consequence of impact (for more details see Table 2 and Table 3). For RISK longer bars and larger numbers indicate higher risk, and for CONFIDENCE more ticks indicate higher confidence in the data, or greater consensus and a cross indicates a lack of consensus (Two ticks in the consensus column indicate full consensus). Where species scored identical risk scores they are presented so that higher consequences are reported first and then in alphabetical order.

Rough skate *Zearaja nasuta*
(Intensity = 6, Consequence = 3.5, Risk = 21)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 5511 tonnes
Egg layer



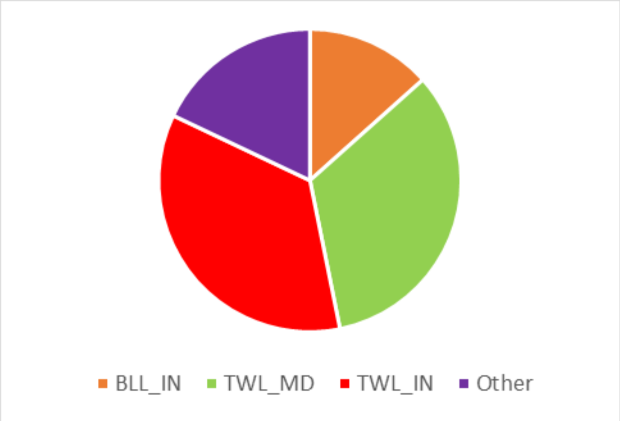
Confidence
Data were described as 'exist but poor' as no fecundity data were available and the panel believed the data included some misidentifications between rough and smooth skates, particularly on the Bounty Plateau. Consensus was achieved.

Rationale

Rough skate was estimated as vulnerable to fishing across more than 60% of their range and caught more than 300 days a year.

Rough skates are endemic to New Zealand (Francis 2012); but were classified as having a relatively large population in New Zealand waters. Rough skates are also faster growing than the closely related smooth skates (Francis et al. 2001); therefore their consequence score (3.5) is marginally lower compared to the smooth skates (4). The maximum known age of rough skates may be greater than reported (9 years) given that this is only three years older than the age from when they can reproduce (6 years). Abundance indices are available for rough skate over the last five years and these are stable or variable without trend (Ministry for Primary Industries 2014a).

Smooth skate *Dipturus innominatus*
(Intensity = 5, Consequence = 4, Risk = 20)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 1021 tonnes
Egg layer



Confidence

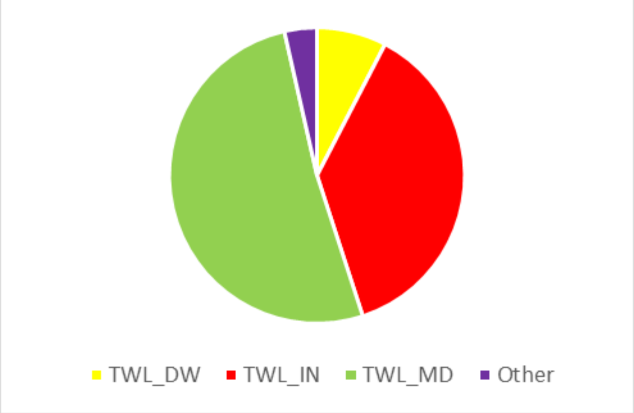
Data were described as 'exist but poor' as no fecundity data were available and the panel believed the data included some misidentifications between rough and smooth skates, particularly on the Bounty Plateau. Consensus was achieved.

Rationale

Smooth skate was estimated as vulnerable to fishing across more than 60% of their range and caught more than 300 days a year. The overall intensity was scored as a 5 because smooth skates are distributed slightly deeper than rough skates, (0–800 m compared with 0–600 m respectively, McMillan et al. 2011a), so may have limited overlap with fishing at deeper depths, especially around parts of the coast where there is little deepwater trawling (Black & Tilney 2015).

Smooth skates are endemic to New Zealand (Francis 2012); but were classified as having a relatively large population in New Zealand waters. Smooth skates are slower growing than rough skates; therefore their consequence score (4) is marginally higher compared to the rough skates (3.5). Smooth skates are also late maturing at 13 years (Francis et al. 2001) which supports the relatively high consequence score. Abundance indices were stable or variable without trend from the ECSI, WCSI and CR (Ministry for Primary Industries 2014a), and there are contrasting patterns from observer estimated catch data (Anderson 2013).

Dark ghost shark *Hydrolagus novaezealandiae*
(Intensity = 6, Consequence = 3, Risk = 18).
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): = 6899 tonnes
Egg layer

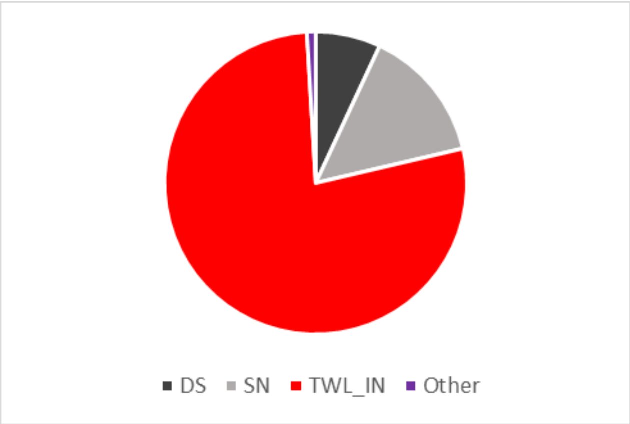


Confidence
Data were described as 'exist but poor' as no age data were available. Consensus was achieved.

Rationale
Dark ghost shark was estimated as vulnerable to fishing across more than 60% of their range and caught more than 300 days a year.

Dark ghost shark are endemic to New Zealand (Cox & Francis 1997) but were classified as having a relatively large population within these waters. Abundance indices for dark ghost shark from the CR, ECSI, WCSI and SA areas over the last five years were either stable or variable without trend (Ministry for Primary Industries 2014a). The lack of a decline in any survey abundance indices over periods longer than five years suggests that this population has some resilience to the effects of fishing.

Elephantfish *Callorhinchus milii*
(Intensity = 6, Consequence = 3, Risk = 18)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 6430 tonnes
Egg layer



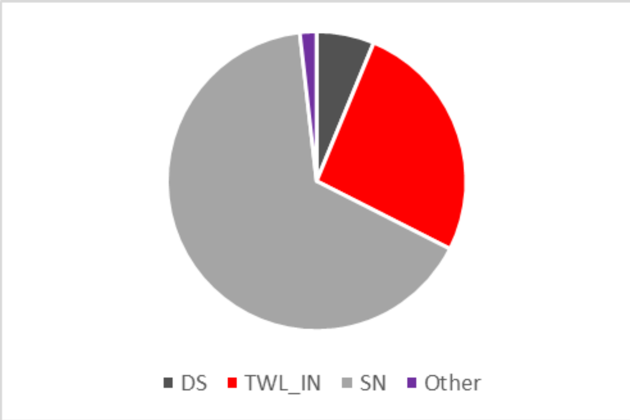
Confidence
Data were described as 'exist and sound' for the purposes of the assessment and consensus was achieved.

Rationale
Elephantfish was estimated as vulnerable to fishing across more than 60% of their range and caught more than 300 days a year.

Elephantfish are classified as having an Australasian and SW Pacific distribution (Last & Stevens 2009), and a relatively large population in New Zealand waters. Female elephantfish are known to reproduce from five years old and can live for 20 years (Francis 2012), which supports their relatively low score for consequence. In addition the abundance index was increasing for both ECSI and WCSI surveys (Stevenson & Hanchet 2007; Beentjes et al. 2013) which was also a factor in determining their consequence score.

Rig *Mustelus lenticulatus*

(Intensity = 6, Consequence = 3, Risk = 18).
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 5329 tonnes
Live bearer



Confidence

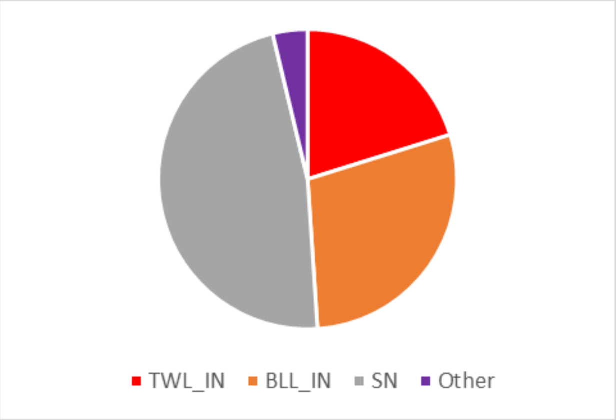
Data were described as ‘exist and sound’ for the purposes of the assessment and consensus was achieved

Rationale

Rig was estimated as vulnerable to fishing across more than 60% of their range and caught more than 300 days a year.

Rig are endemic (Francis 2012), but were classified as having a relatively large population within these waters. Rig are moderately productive (females are sexually mature from age 8, and produce an average of 11 pups per year – Francis & Mace 1980; Francis & ÓMaolagáin 2000). CPUE indices for rig generally varied without trend over the last five years (SPO 1, SPO 2, SPO 3, SPO 8) apart from SPO 7 where an increase has been seen in the last five years (following a long period of decline) that is coincident with a managed decrease in effort and landings in this fishery (Ministry for Primary Industries, 2014a). Some, but not all, of the rig fisheries are based on mature males (which lessens the population level consequence of the fishery). Fishery area closures for trawling and set net (for example prohibitions to trawling along the west coast of the North Island (north of Taranaki) and most of the South Island east coast), should benefit rig (maps of all trawl closures can be seen in Baird et al. 2015).

School shark *Galeorhinus galeus*
(Intensity = 6, Consequence = 3, Risk = 18)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 13 447 tonnes
Live bearer



Confidence

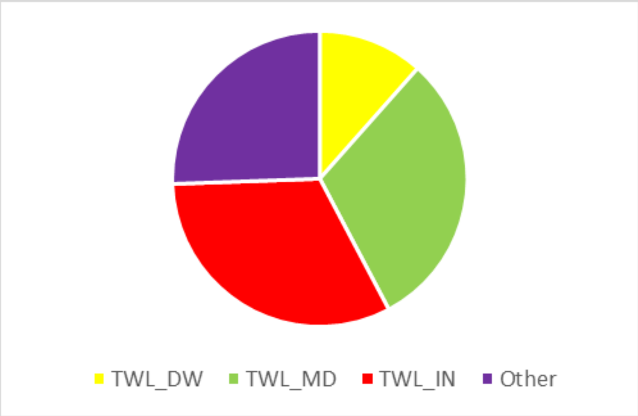
Data were described as ‘exist and sound’ for the purposes of the assessment and consensus was achieved.

Rationale

School shark was estimated as vulnerable to fishing across 45 to 60% of their range and caught more than 300 days a year.

School shark was classified as being globally widespread (Last & Stevens 2009) and having a relatively large population in New Zealand waters. Some connection with Australian stocks has been seen from tagging studies (Hurst et al. 1999, Francis 2010), which could influence the resilience of the population. School shark productivity is low to moderate as females reproduce from 14 years old with a maximum known age of 60 years and have an average of 30 pups once every 3 years (Last & Stevens 2009). Abundance indices range from increasing to fluctuating without trend or decreasing (Ministry for Primary Industries 2014a) so did not influence this scoring, as it was on a national scale.

Spiny dogfish *Squalus acanthias*
(Intensity = 6, Consequence = 3, Risk = 18)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 24 865 tonnes
Live bearer



Confidence

Data were described as 'exist and sound' for the purposes of the assessment and consensus was achieved.

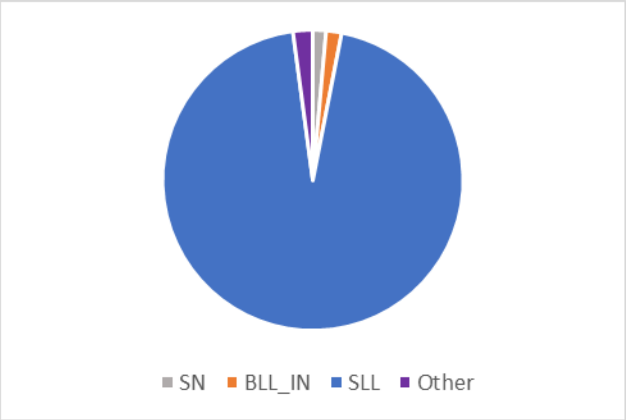
Rationale

Spiny dogfish was estimated as vulnerable to fishing across more than 60% of their range and caught more than 300 days a year.

Spiny dogfish was classified as being globally widespread (Ebert et al. 2013) and having a relatively large population in New Zealand waters. Spiny dogfish was classified as having moderate productivity with females reproducing from 10 years old and having low fecundity (only having up to 6 pups every 2 years, Hanchet 1988). Many abundance indexes are available for this species. Over the last five years all indices have been stable apart from the ECSI index which has shown an increase (Stevenson 2012; Beentjes et al. 2013; O'Driscoll et al. 2011; Bagley et al. 2013; O'Driscoll et al. 2014). The increase in numbers of spiny dogfish in the Chatham Rise survey (O'Driscoll et al. 2011) over the longer-term agrees with feedback from fishers and suggests that despite their relatively low productivity they are relatively fast growing and have some resilience to the effects of fishing. They are a Schedule 6 species so can be returned to the sea alive or dead (so this may be a factor in their resilience which is not being taken account of in this scoring, as all returns are considered mortalities).

Mako *Isurus oxyrinchus*

(Intensity = 5, Consequence = 3, Risk = 15)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 754 tonnes
Live bearer



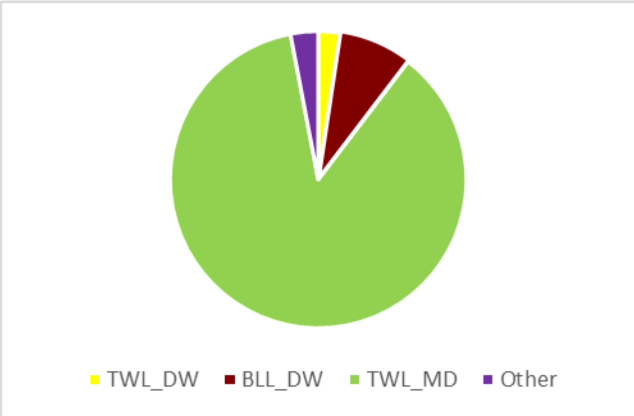
Confidence

Data were described as 'exist and sound' for the purposes of the assessment and consensus was achieved, but with low confidence. This low confidence was due to the fact that no data was available on adult stock size.

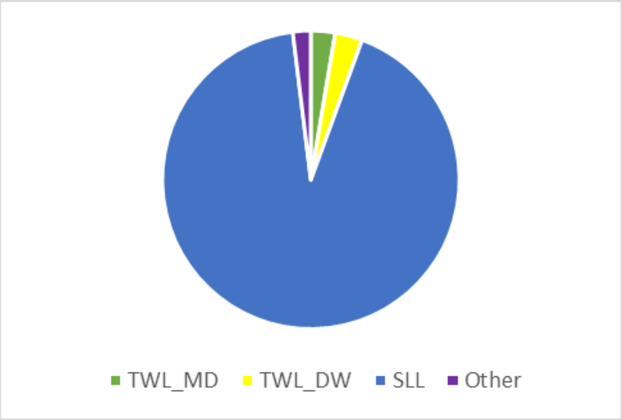
Rationale

Mako shark was estimated as vulnerable to fishing across more than 60% of their range and caught 200 to 300 days a year.

Mako shark was classified as being globally widespread (Ebert et al. 2013) and having a relatively large population in New Zealand waters. Mako sharks have relatively low productivity; females reproduce from 20 years old (with a maximum known age[6] of 29 years; Bishop et al. 2006) and they have an average of 12 pups, but only once every 3 years (Mollet et al. 2000). Two additional factors contribute to a lessening of the consequence score for mako sharks. Firstly, adult females do not appear to be caught by the New Zealand fishery (Francis 2013). Secondly, the CPUE has generally been increasing over the last 9 years (particularly in northern New Zealand fisheries, Francis et al. 2014).

Pale ghost shark *Hydrolagus bemisi* (Intensity = 5, Consequence = 3, Risk = 15) Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 1538 tonnes Egg layer	
 *Confidence* Data were described as 'exist but poor' as information on their age at maturity, maximum age or reproduction were not available. No consensus on the consequence score was achieved due to different interpretation of the abundance indices and the lack of biological data in combination with the fact that pale ghost shark is largely endemic. The consequence score assigned was therefore based on the majority view.	*Rationale* Pale ghost shark was estimated as vulnerable to fishing across 45 to 60% of their range and caught more than 300 days a year. Pale ghost sharks was considered endemic (although records do exist of their presence at Lord Howe and Norfolk ridges (Cox & Francis 1997)) and was classified as having a relatively large population. Trawl survey biomass estimates from GSP 1 (ECSI, ECNI and CR) have been declining since 2001 and increasing in GSP 5 (SA) in recent years (Ministry for Primary Industries 2014a).

Porbeagle shark *Lamna nasus*
(Intensity = 5, Consequence = 3, Risk = 15)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 773 tonnes
Live bearer



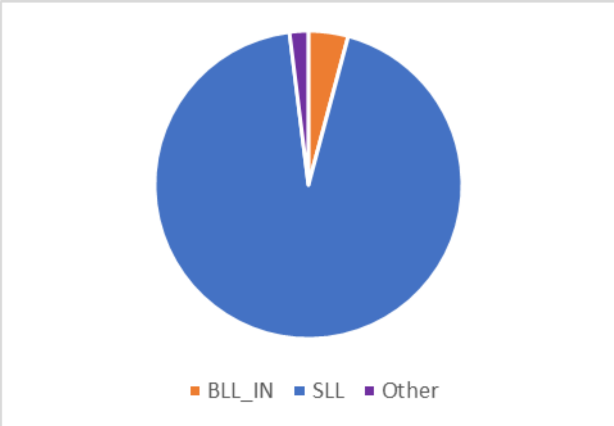
Confidence

Data were described as 'exist and sound' for the purposes of the assessment and consensus was achieved, but with low confidence. This low confidence was due to a lack of data about adult stock size.

Rationale

Porbeagle shark was estimated as vulnerable to fishing across 45 to 60% of their range and caught more than 300 days a year.

Porbeagle shark was classified as being globally widespread, and is split into two disjunct populations, one in the North Atlantic and the other in the Southern Hemisphere (Ebert et al. 2013). It has a relatively large population in New Zealand waters. Porbeagle shark have relatively low productivity; females reproduce from 17 years old (with a maximum known age of 65 years) and they have up to 4 pups per year (Last & Stevens 2009, Francis & Stevens 2000, Francis et al. 2007, Francis 2015b). Porbeagle shark is known to range more broadly in New Zealand than where it is captured by fisheries. Fishing mortality is predominantly on juveniles and adult males (Francis 2013), therefore population level impacts are likely to be limited. The indicator analysis for the New Zealand porbeagle shark fishery shows all indicators with an increasing trend, suggesting an increase in abundance since 2005 (Francis et al. 2014).

Blue shark *Prionace glauca* (Intensity = 4, Consequence = 3, Risk = 12) Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 689 tonnes Live bearer	
 *Confidence* Data were described as 'exist and sound' for the purposes of the assessment and consensus was achieved	*Rationale* Blue shark was estimated as vulnerable to fishing across 31 to 45% of their range and caught more than 300 days a year. Blue shark was classified as globally widespread (Ebert et al. 2013) and as having a relatively large population in New Zealand waters. Blue shark was classified as having a moderate to high productivity; females reproduce from 8 years old with a maximum known age of 23 years, and 35 pups can be produced on average every 1.5 years (Francis & Duffy 2005, Manning & Francis 2005, Last & Stevens 2009). An indicator analysis (which includes a standardised CPUE) suggests an increasing population size (Francis et al. 2014).

3.2 Non-QMS species and taxa

All shark taxa in New Zealand other than the eleven QMS shark species and the seven protected shark species, are considered non-QMS shark species. Non-QMS sharks make up a wide range of taxa with varying levels of interactions with fisheries.

Non-QMS taxa are not subject to the same level of regulatory requirements as QMS species, they are not subject to catch limits nor are their catches required to be balanced with Annual Catch Entitlements (ACE), although fishers are required to report all catches of non-QMS taxa on landings forms, even if the sharks are discarded at sea. There is no requirement for non-QMS taxa to be retained, and the majority of non-QMS sharks caught are discarded at sea.

Non-QMS taxa are not normally targeted in any commercial fisheries, and if caught, are usually not caught in high volumes nor retained for processing. If a non-QMS shark taxon becomes a targeted taxon and/or begins to be retained by commercial fishers, it is considered for introduction to the QMS and would then be managed under that framework.

Non-QMS shark taxa include a number of rare and difficult to identify taxa, which commercial fishers often report using generic codes, as they do not have the expertise, knowledge, or resources to accurately identify them. These generic codes, including 'OSD' – Other Sharks and Dogfish, and 'DWD' – Deep Water Dogfish, are a catch-all provided for fishers to report catches of sharks which they cannot identify to species level. MPI at-sea observers are trained and provided with resources to allow for better identification of non-QMS taxa. Data collected by observers are analysed and utilised to monitor catches of non-QMS taxa. For some taxa in some areas (e.g. Chatham Rise), fisheries-independent trawl surveys provide another monitoring tool.

The overall risk for non-QMS shark taxa, its component parts (intensity and consequence) and the confidence in those scores, in terms of both the amount and quality of the data and the extent of consensus among the panel, are displayed in Figure 7.

This category contains the most sharks (67) and shows the widest range of scores compared to QMS or protected sharks. The risk assessment for this category used the full range of scores for intensity, from 1 (remote likelihood of capture at any spatial or temporal scale) to 6 (captures are locally to regionally high or continual and widespread). The risk assessment also shows the full range of scores used for consequence, from 1 (impact unlikely to be detectable at the scale of the taxon) to 4.5 which is undescribed in Table 3, but can be interpreted as a high likelihood of actual, or potential for, unsustainable impacts. Carpet shark (as well as rough skate in the QMS section (3.1)), attained the highest risk score (21) in this assessment. The lowest possible score (1) was shared by 17 non-QMS taxa.

NON-QMS SPECIES RISK

COMPONENTS OF RISK		RISK	CONFIDENCE	
Intensity	Consequence		Data	Consensus
6	3.5	21 - Carpet Shark	✓✓	✓✓
5	4	20 - Baxters dogfish	✓✓	✓✓
5	4	20 - Seal shark	✓✓	✓
4.5	4	18 - Leafscale gulper shark	✓✓	✓✓
4	4.5	18 - Longnose velvet dogfish	✓✓	✓
4	4.5	18 - Plunkets shark	✓✓	✓
5	3.5	17.5 - Electric ray	✓	✓
5	3.5	17.5 - Shovelnose dogfish	✓✓	✓✓
4	4	16 - Blind electric ray	✓✓	✓
4	4	16 - Oval electric ray	✓✓	✓
4	4	16 - Owstons dogfish	✓✓	✓
3.5	4.5	15.75 - Dawsons catshark	✓✓	✓
4.5	3.5	15.75 Longnose spookfish	✓✓	✗
3.5	4	14 - Bronze whaler	✓✓	✗
4	3.5	14 - Longtail stingray	✓	✓✓
4	3.5	14 - Northern spiny dogfish	✓✓	✓
3.5	4	14 - Prickly dogfish	✓✓	✓
4	3.5	14 - Shorttail stingray	✓	✓✓
3.5	3.5	12.25 - Prickly deepsea skate	✓✓	✓
3.5	3.5	12.25 - Smooth deepsea skate	✓✓	✓
4	3	12 - Broadnose sevengill shark	✓✓	✓
3	4	12 - *Brochiraja* complex	✓	✓
3	4	12 - Brown chimaera	✓	✓✓
3	4	12 - Catsharks	✓	✓
3	4	12 - Deepwater spiny skate	✓	✓
4	3	12 - Hammerhead shark	✓✓	✓
3	4	12 - Longnose deepsea skate	✓	✓
3	4	12 - Longtail skate	✓	✓
3	4	12 - Lucifer dogfish	✓✓	✓
3	4	12 - Pacific spookfish	✓	✓✓
3	4	12 - Pelagic stingray	✓	✓
3	4	12 – Portugese dogfish	✓✓	✓

Figure 7: Non-QMS Species Risk scores. For the COMPONENTS OF RISK higher numbers indicate greater intensity or consequence of impact (for more details see Table 2 and Table 3). For RISK longer bars and larger numbers indicate higher risk, and for CONFIDENCE more ticks indicate higher confidence in the data, or greater consensus and a cross indicates a lack of consensus (Two ticks in the consensus column indicate full consensus). Where taxa scored identical risk scores they are presented so that higher consequences are reported first and then in alphabetical order.

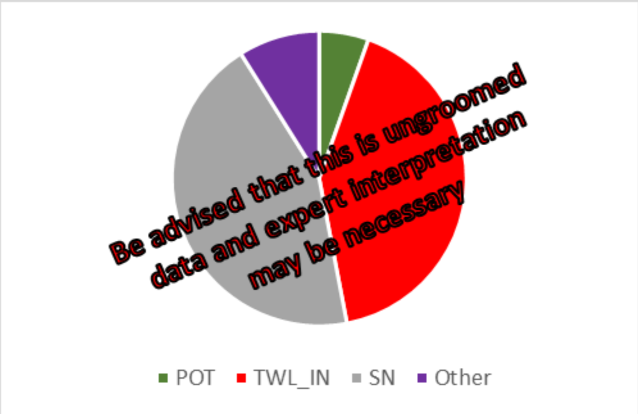
NON-QMS SPECIES RISK CONTINUED

COMPONENTS OF RISK		RISK	CONFIDENCE	
Intensity	Consequence		Data	Consensus
3	4	12 - Slender smooth hound	✓✓	✓
3.5	3	10.5 - Thresher shark	✓✓	✓
4	2.5	10 - Eagle ray	✓✓	✓
3	3	9 - Sharpnose sevengill shark	✓✓	✓
2	4	8 - Frill shark	✓✓	✓
2	4	8 - Longsnout dogfish	✓	✓✓
2	4	8 - Pointynose blue ghost shark	✓	✓
2	4	8 - Purple chimaera	✓	✓
2	4	8 - Southern mandarin dogfish	✓	✓
2	4	8 - Southern sleeper shark	✓	✓✓
3	2	6 - Sxigill shark	✓✓	✓
2	2	4 - Bigeye thresher	✓✓✓	✓
2	2	4 - Little sleeper shark	✓	✓
2	2	4 - Prickly shark	✓	✓✓
2	2	4 - Velvet dogfish	✓	✓
2	1	2 - Black ghost shark	✓	✓✓
1	2	2 - Galapagos shark	✓✓✓	✓
2	1	2 - Tiger shark	✓✓✓	✓✓
1	1	1 - Bramble shark	✓	✓✓
1	1	1 - Cookie cutter shark	✓✓	✓✓
1	1	1 - Crocodile shark	✓	✓✓
1	1	1 - Dusky shark	✓✓	✓✓
1	1	1 - False cat shark	✓	✓✓
1	1	1 - Goblin shark	✓	✓✓
1	1	1 - Harrisson's dogfish	✓	✓✓
1	1	1 - Kermadec spiny dogfish	✓	✓✓
1	1	1 - Leopard chimaera	✓	✓✓
1	1	1 - McMillan's cat shark	✓	✓
1	1	1 - Port Jackson shark	✓	✓✓
1	1	1 - Richardson's skate	✓	✓✓
1	1	1 - Sapphire skate	✓	✓✓
1	1	1 - Sherwood's dogfish	✓	✓✓
1	1	1 - Smallspine spookfish	✓✓	✓✓
1	1	1 - Whitetail dogfish	✓	✓

Figure 7 (continued): Non-QMS taxa risk scores (see the previous page for full legend details).

Carpet shark *Cephaloscyllium isabellum*

(Intensity = 6, Consequence = 3.5, Risk = 21)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 1122 tonnes
Egg layer



Confidence

Data were described as 'exist but poor' as no ageing or reproductive data or reliable abundance indices were available. Consensus was achieved.

Rationale

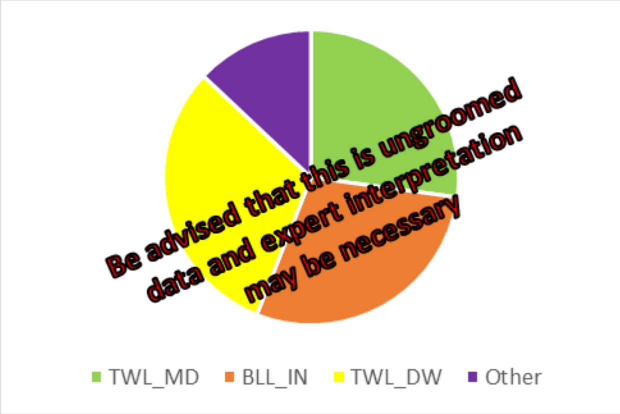
Carpet shark was estimated as vulnerable to fishing across more than 60% of its range and caught more than 300 days a year.

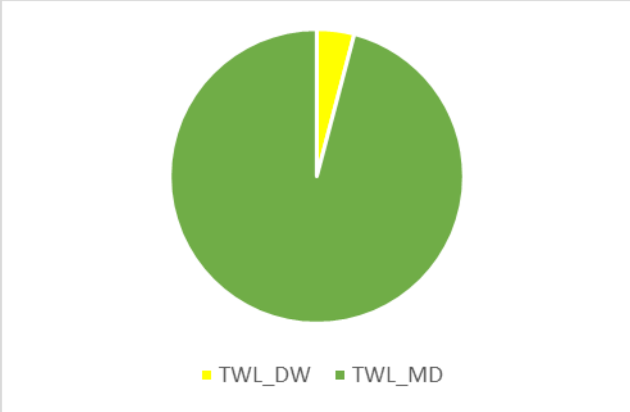
Carpet shark is endemic (Francis 2012) and was classified as having a relatively large population in New Zealand waters. Carpet shark catch has been recorded for over 20 years and no national trend is seen in the rates of their bycatch (Anderson 2013).

Recommendation

Abundance indices could probably be calculated from data from surveys or commercial catches to better inform subsequent risk assessments.

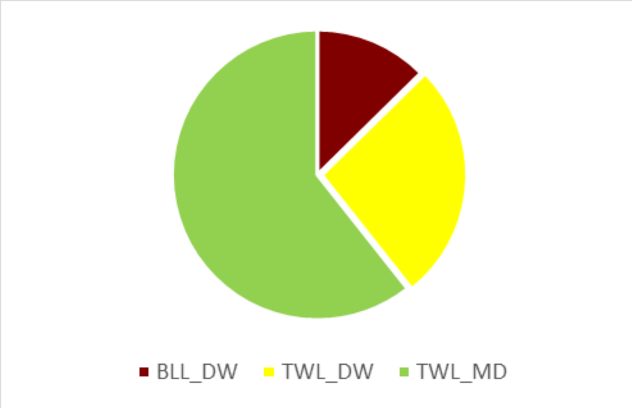
Seal shark *Dalatias licha*

(Intensity = 5, Consequence = 4, Risk = 20) Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years):1157 tonnes Live bearer	
 *Confidence* Data were described as 'exist but poor' as no ageing data, reproductive frequency information or abundance indices at the deeper end of the distribution range were available. Consensus was achieved.	*Rationale* Seal shark was estimated as vulnerable to fishing across more than 60% of its range and caught more than 300 days a year. Seal shark was scored with an overall intensity of 5 because it is distributed from 400 to 1000 m depth (McMillan et al. 2011a) and may have a limited overlap with fishing as they occur beyond 800 m depth, where the footprint of fishing is small (Black & Tilney 2015). Seal shark was classified as globally widespread (Ebert et al. 2013) and as having a relatively large population in New Zealand waters. Seal shark have an average of 12 pups per litter (Last & Stevens 2009). Identification of seal shark has been poor, so past seal shark records may contain more than one species. Seal sharks feed on, among other things, other sharks (Navarro et al., 2014), therefore they occupy a high trophic level which contributes to the relatively high consequence score. No strong trends are seen from either the CR or SA abundance indices (O'Driscoll et al. 2011; Bagley et al. 2013).

Leafscale gulper shark *Centrophorus squamosus* (Intensity = 4.5, Consequence = 4, Risk = 18) Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 8 tonnes Live bearer	
 *Confidence* Data were described as 'exist but poor' as the location of pregnant females and reproductive frequency are both unknown. Consensus was achieved.	*Rationale* Leafscale gulper shark was estimated as vulnerable to fishing across more than 60% of its range and caught more than 300 days a year. This species scored an overall intensity of 5 because leafscale gulper shark are distributed from 500 to 1500 m (McMillan et al. 2011a) and may have a limited overlap with fishing beyond 800 m depth, where the footprint of fishing is small (Black & Tilney 2015). Leafscale gulper shark was classified as globally widespread (Ebert et al. 2013) and having a moderately sized population in New Zealand waters. Leafscale gulper shark was classified as having a relatively low productivity as females reproduce from 21 years old (with a maximum known age of 42) and they have an average of 6 pups per litter (Last & Stevens 2009, Parker & Francis 2012). Abundance indices are either flat or increasing from the Sub-Antarctic or Chatham Rise (O'Driscoll et al. 2011; Bagley et al. 2013). Orange roughy and oreo fisheries are reduced from their previous extent (Black & Tilney 2015) so the impact of this fishery on leafscale gulper shark is also likely to have reduced compared to when these fisheries were more widespread.

Longnose velvet dogfish *Centroselachus crepidater* (Intensity = 4, Consequence = 4.5, Risk = 18) (No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail) Live bearer
Rationale Longnose velvet dogfish was estimated as vulnerable to fishing across 45 to 60% of its range and caught more than 300 days a year. This species scored an overall intensity of 4 because it is distributed from 500 to 1500 m (McMillan et al. 2011a) and has a limited overlap with fishing beyond 800 m depth where the footprint of fishing is small (Black & Tilney 2015). Longnose velvet dogfish was classified as being globally widespread (Ebert et al. 2013) and having a large population in New Zealand waters. Longnose velvet dogfish have an average of 6 pups per litter (Last & Stevens 2009) which classifies them as low productivity. Abundance indices are either declining, from the Mid-East Coast Survey, (Doonan & Dunn 2011) or flat, from the Chatham Rise and Sub-Antarctic surveys (O'Driscoll et al. 2011; Bagley et al. 2013). Orange roughy and oreo fisheries are reduced from their previous extent (Black & Tilney 2015) so the impact of this fishery on longnose velvet dogfish is also likely to be reduced compared to when these fisheries were more widespread. *Confidence* Data were described as 'exist but poor' as ageing information was not available. Consensus was achieved, but with low confidence.

Baxter's lantern dogfish *Etmopterus baxteri*
(Intensity = 5, Consequence = 4, Risk = 20)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 28 tonnes
Live bearer



Confidence

Data were described as 'exist but poor' as no reproductive frequency information or reliable abundance indices were available. Consensus was achieved

Rationale

Baxter's lantern dogfish was estimated as vulnerable to fishing across 45 to 60% of its range and caught more than 300 days a year.

Baxter's lantern dogfish was classified as globally widespread (Ebert et al. 2013) and having a relatively large population in New Zealand waters. Baxter's lantern dogfish females reproduce relatively late (from 30 years old with a maximum known age of 57) and have moderate fecundity with an average of 9 pups at a time (Ebert et al. 2013). Baxter's lantern dogfish has a high overlap with the orange roughy and oreo fisheries and reported catches of this species are likely to include other species e.g. blue-eye lantern shark.

Plunket's shark *Scymnodon plunketi*
(Intensity = 4, Consequence = 4.5, Risk = 18)
Live bearer
(No pie graph is shown here as less than 10 tonne of estimated catch was reported in the 2008-09 to 2012-13 fishing years – see Section 2.3 for more detail)

Rationale

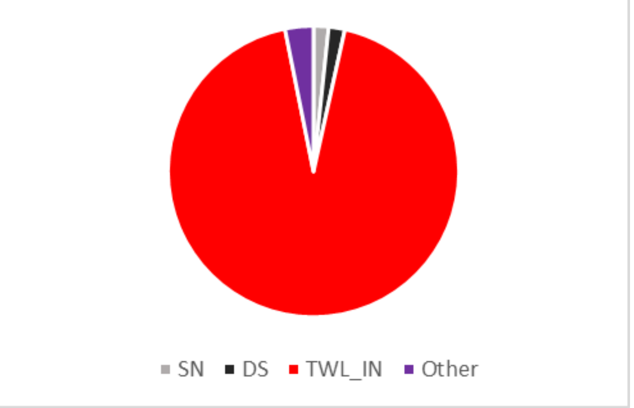
Plunket's shark was estimated as vulnerable to fishing across more than 60% of its range and caught more than 300 days a year. This species scored an overall intensity of 4 because Plunket's shark is distributed from 500 to 1200 m (McMillan et al. 2011a) so have a limited overlap with fishing beyond 800 m depth, where the footprint of fishing is small (Black & Tilney 2015).

Plunket's shark was classified as widespread in the Southern Hemisphere (Last & Stevens 2009) and having a relatively large population in New Zealand waters. Plunket's shark have up to 36 pups per litter (Last & Stevens 2009).

Confidence

Data were described as 'exist but poor' as no ageing information, reproductive frequency or reliable abundance indices were available and there may be some taxonomic confusion or misidentification between Plunket's shark and other dogfish (particularly Scymnodon macracanthus). Consensus was achieved, but with low confidence.

Electric ray *Torpedo fairchildi*
(Intensity = 5, Consequence = 3.5, Risk = 17.5)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 90 tonnes
Live bearer



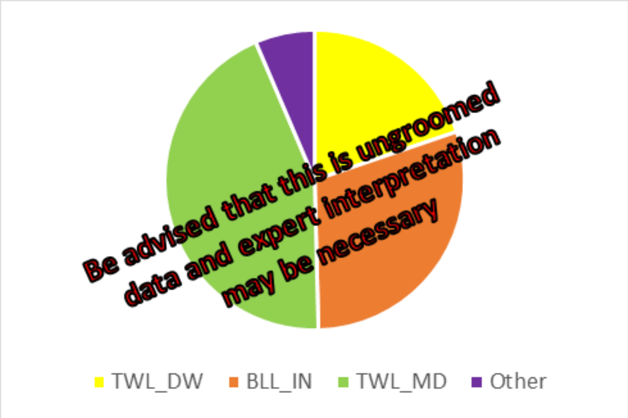
Confidence

Data were described as 'few' as no ageing, reproductive frequency data or abundance indices exist. Electric rays are also mainly caught in inshore trawl where there is poor observer coverage and poor reporting of species that make up a minority of the catch. Consensus was achieved, but with low confidence.

Rationale

Electric ray was estimated as vulnerable to fishing across more than 60% of its range and caught more than 300 days a year. This species thus scored an overall intensity of 5 because electric ray have the potential for a high number of releases and some inshore habitat exists that is closed to trawling, particularly on the west coast of the North Island and the east coast of the South Island (see Baird et al. 2015 for a full list of closures).

Electric ray is endemic (McMillan et al. 2011a) but was classified as having a relatively large population in New Zealand waters.

Shovelnose dogfish *Deania calcea* (Intensity = 5, Consequence = 3.5, Risk = 17.5) Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 713 tonnes Live bearer	
 *Confidence* Data were described as ‘exist but poor’ as reproductive frequencies are unknown, abundance indices do not cover the entire depth range for this species and they may be easily confused with the rough longnose dogfish (*Deania histricosa).* Consensus was achieved.	*Rationale* Shovelnose dogfish was estimated as vulnerable to fishing across approximately 60% of their range and caught more than 300 days a year. However, they scored an overall intensity of 5 because they are likely to have a limited overlap with fishing with depth (they are found from 400 to 1500 m in New Zealand waters (McMillan et al. 2011a) and beyond 800 m the footprint of fishing is small (Black & Tilney 2015). Pregnant females are also infrequently caught. Shovelnose dogfish was classified as globally widespread (Ebert et al. 2013) and having a relatively large population in New Zealand waters. Shovelnose dogfish was also classified as having a relatively low productivity as females reproduce from 16 years old (with a maximum known age of 21) and they have an average of 6 pups per litter (Last & Stevens 2009, Parker & Francis 2012).

Blind electric ray *Typhlonarke aysoni*
(Intensity = 4, Consequence = 4, Risk = 16)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

Blind electric ray was estimated as vulnerable to fishing across more than 60% of its range and caught between 200 and 300 days a year. However, this scored an overall intensity of 4 because although they have a limited distribution in New Zealand waters (McMillan et al. 2011a) they are relatively small and likely to go under fishing gear or through meshes.

Blind electric ray is endemic (Cox & Francis 1997) and was classified as having a moderate population size in New Zealand waters. Blind electric rays have a maximum of 11 pups per litter (Waite 1909).

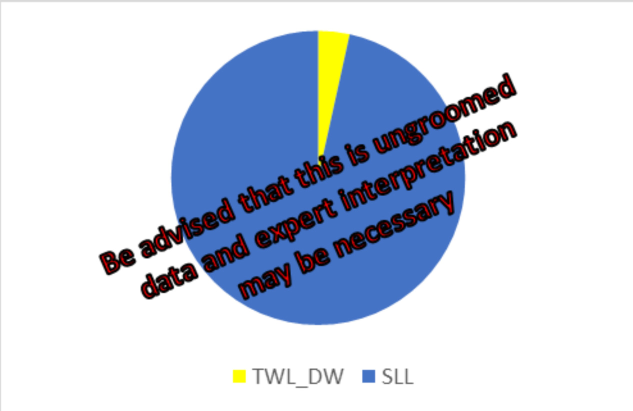
Confidence

Data were described as 'exist but poor' as few size data exist, and no ageing or reproductive frequency data, or abundance indices exist. In addition, there is some taxonomic uncertainty that suggests that the oval electric ray and blind electric ray may be the same species. Consensus was achieved, but with low confidence.

Oval electric ray *Typhlonarke tarakea*
(Intensity = 4, Consequence = 4, Risk = 16)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

There was considerable uncertainty that oval electric ray was a separate species to blind electric rays. There was also little information about oval electric rays, therefore they were scored identically to blind electric rays (directly above).

Owston's dogfish *Centroscymnus owstonii*
(Intensity = 4, Consequence = 4, Risk = 16)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 8 tonnes
Live bearer



Confidence

Data were described as 'exist but poor' as no ageing or reproductive frequency information exist. Consensus was achieved, but with low confidence.

Rationale

Owston's dogfish was estimated as vulnerable to fishing across 31 to 45% of their range and caught between 200 and 300 days a year. This species scored an overall intensity of 4 as they have a limited overlap with fishing, as they are found in New Zealand at depths of 500 to 1500 m (McMillan et al. 2011a) and beyond 800 m the footprint of fishing is small (Black & Tilney 2015).

Owston's dogfish was classified as globally widespread (Ebert et al. 2013) and having a relatively large population in New Zealand waters. Owston's dogfish have an average of 10 pups per litter (Last & Stevens 2009). The Mid-East coast deepwater survey generates a reliable abundance index and shows no change over time (Doonan & Dunn 2011).

Dawson's cat shark *Bythaelurus dawsoni*
(Intensity = 3.5, Consequence = 4.5, Risk = 15.75)
Egg layer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

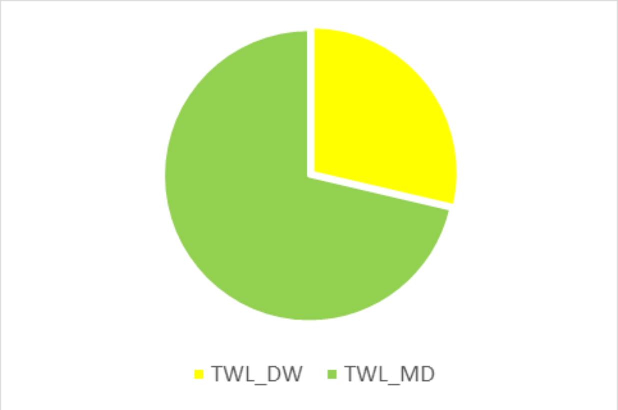
Dawson's cat shark was estimated as vulnerable to fishing across more than 60% of their range and caught between 200 and 300 days a year. However, this scored an overall intensity of 3.5 as although Dawson's cat shark are known from 250 to 800 m depths in south eastern New Zealand (Francis 2006); the fisheries in this area are mostly seasonal and Dawson's catshark is small (Francis 2006) therefore catchability is assumed to be low.

Dawson's cat shark are endemic and were classified as having a relatively small population in New Zealand waters (Francis 2006).

Confidence

Data were described as 'exist but poor' as no ageing, reproductive data or reliable abundance indices exist. Consensus was achieved, but with low confidence.

Longnose spookfish *Harriotta raleighana*
(Intensity = 4.5, Consequence = 3.5, Risk = 15.75)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 82 tonnes
Egg layer



Confidence

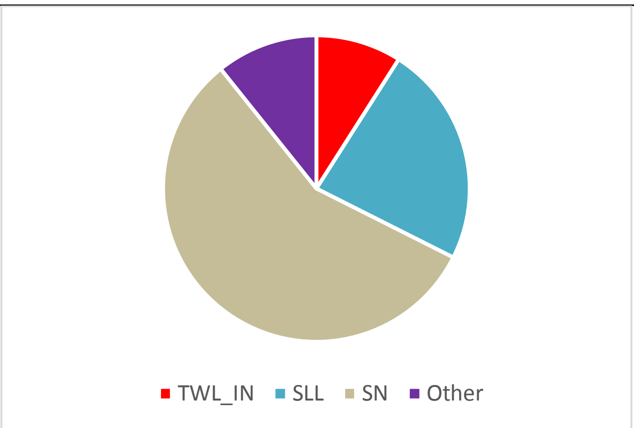
Data were described as 'exist but poor' as no ageing or reproductive information exist. Consensus was not achieved for this species due to disagreement over the spatial intensity and overall intensity scores, therefore the scores portray the majority view.

Rationale

Longnose spookfish was estimated as vulnerable to fishing across more than 60% of their range and caught more than 300 days a year. However, this scored an overall intensity of 4.5 as they have a limited overlap with fishing, as they are found in New Zealand at depths of 400 to 1300 m (McMillan et al. 2011a) and beyond 800 m the footprint of fishing is small (Black & Tilney 2015).

Longnose spookfish are globally widespread (Ebert et al. 2013) and classified as having a relatively large population in New Zealand waters. The abundance index for the Sub-Antarctic is well estimated and shows no clear trend (Bagley et al. 2013).

Bronze whaler *Carcharhinus brachyurus*
(Intensity = 3.5, Consequence = 4, Risk = 14)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 44 tonnes
Live bearer



Confidence

Data were described as 'exist but poor' as no abundance indices exist. Consensus was not achieved for this species due to disagreement over the vulnerability to fishing gear and the effect of this upon intensity and/or consequence, therefore the reported score reflects the panels' majority view.

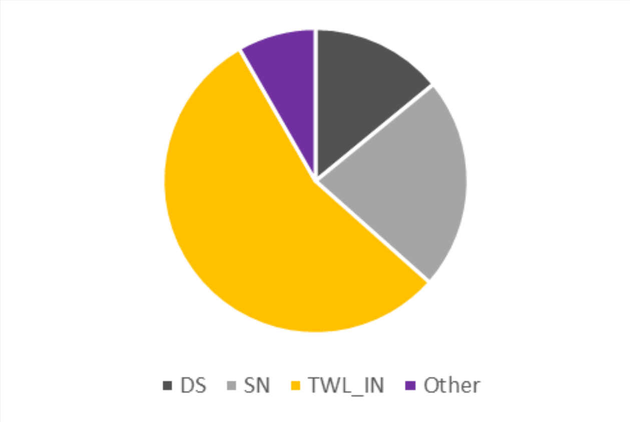
Rationale

Bronze whaler was estimated as vulnerable to fishing across more than 60% of their range and caught between 200 and 300 days a year. This species scored an overall intensity of 3.5 as adults are known to be present in large numbers coastally, but are rarely caught.

Bronze whaler was classified as globally widespread (Ebert et al. 2013) and having a relatively large population in New Zealand waters. Bronze whaler were classified as having a relatively low productivity as the females reproduce from 20 years old (with a maximum known age of 30) and they have an average of 15 pups every 2 years (Last & Stevens 2009, Ebert et al. 2013).

Longtail stingray *Dasyatis thetidis*

(Intensity = 4, Consequence = 3.5, Risk = 14)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 33 tonnes
Live bearer



Confidence

Data were described as 'few' as no ageing, reproductive information or abundance indices exist. Consensus was achieved.

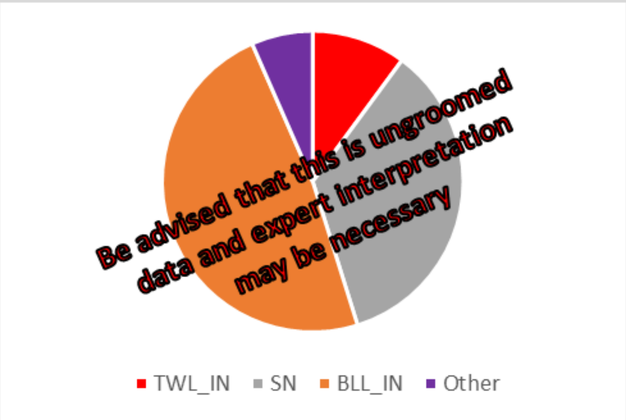
Rationale

Longtail stingray was estimated as vulnerable to fishing across more than 60% of their range and caught more than 300 days a year. However, this species scored an overall intensity of 4 as they are found in New Zealand at depths of less than 100 m (McMillan et al. 2011a) where many commercial fisheries closures exist (Baird et al. 2015).

Longtail stingray is widespread in the Southern Hemisphere (Last & Stevens 2009) and was classified as having a moderate population size in New Zealand waters.

Northern spiny dogfish *Squalus griffini*

(Intensity = 4, Consequence = 3.5, Risk = 14)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 367 tonnes
Live bearer



Confidence

Data were described as 'exist but poor' as no ageing and few reproductive information exist. In addition there may be some identification issues between spiny dogfish and northern spiny dogfish such that records of northern spiny dogfish may include spiny dogfish. Consensus was achieved, but with low confidence.

Rationale

Northern spiny dogfish was estimated as vulnerable to fishing across 45 to 60% of their range and caught more than 300 days a year. However, this scored an overall intensity of 4 as they have a limited overlap with fishing in the Kermadec area, and overlapping fisheries on the west coast of the New Zealand are largely seasonal.

Northern spiny dogfish is known from New Zealand, Norfolk Island and on the Louisville Seamount Chain (Duffy & Last 2007a) and was classified as having a relatively large population in New Zealand waters. Abundance indices are not robust but are either highly variable or relatively stable (O'Driscoll et al. 2011, Stevenson 2012).

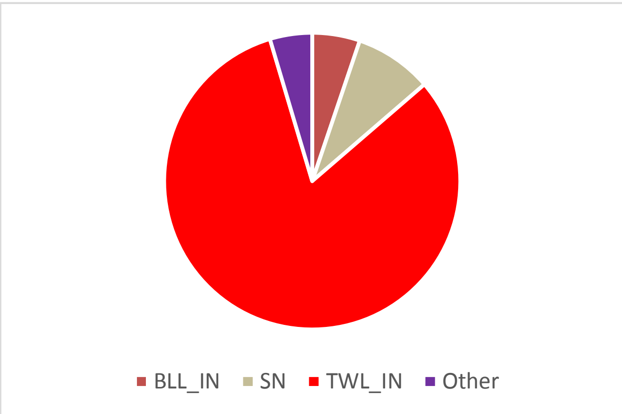
Prickly dogfish *Oxynotus bruniensis*
(Intensity = 3.5, Consequence = 4, Risk = 14)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale
Prickly dogfish was estimated as vulnerable to fishing across 45 to 60% of their range and caught between 200 and 300 days a year. However, this scored an overall intensity of 3.5 as they are known from rocky ground and the Kermadecs where they have a limited overlap with fishing.

Prickly dogfish are distributed through New Zealand and southern and eastern Australia (Last & Stevens 2009) and classified as having a moderate population size in New Zealand waters. Prickly dogfish can produce at least 7 pups at one time (Last & Stevens 2009, M. Francis unpubl. data). The Chatham Rise abundance index shows no clear trend over the last five years (O'Driscoll et al. 2011).

Confidence
Data were described as 'exist but poor' as no ageing or reproductive frequency information exist. Consensus was achieved, but with low confidence.

Shorttail stingray *Dasyatis brevicaudata*
(Intensity = 4, Consequence = 3.5, Risk = 14)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 39 tonnes
Live bearer



Confidence
Data were described as 'few' as few length measures and no ageing, reproductive frequency information or abundance indices exist. In addition shorttail stingray are likely to be under-reported in inshore fisheries. Consensus was achieved.

Rationale
Shorttail stingray was estimated as vulnerable to fishing across more than 60% of their range and caught more than 300 days a year. However, this scored an overall intensity of 4 as they are distributed shallower than 200 m (McMillan et al. 2011) but with a preference for the shallower depths, therefore they overlap with the many inshore commercial fisheries closures (Baird et al. 2015).

Shorttail stingray is widespread in the Southern Hemisphere (Last & Stevens 2009) and was classified as having a relatively large population in New Zealand waters.

Prickly deepsea skate *Brochiraja spinifera*
(Intensity = 3.5, Consequence = 3.5, Risk = 12.25)
Egg layer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

Prickly deepsea skate was estimated as vulnerable to fishing across 45 to 60% of their range and caught between 200 and 300 days a year. However, this species scored an overall intensity of 3.5 as they are distributed from 200 to 1200 m (McMillan et al. 2011a) so have a limited overlap with fishing beyond 800 m depth, where the footprint of fishing is small (Black & Tilney 2015).

Prickly deepsea skate is endemic (Last & McEachran 2006) and was classified as having a relatively small population in New Zealand waters. Abundance indices (with the exclusion of the implausible first point from the Chatham Rise index) show no clear trend (O'Driscoll et al. 2011, Bagley et al. 2013).

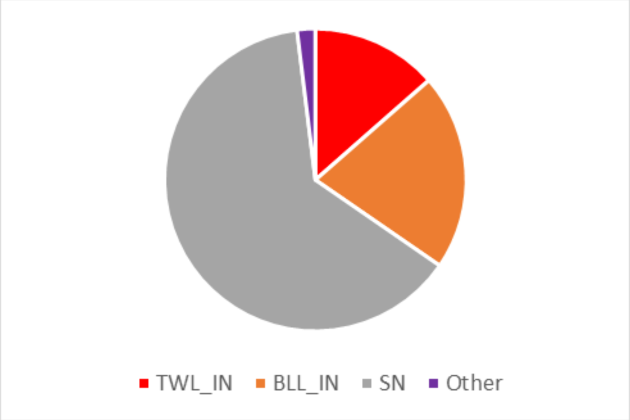
Confidence

Data were described as 'exist but poor' as few length measures exist and no reproductive or ageing information exist. In addition identification is problematic between smooth, prickly and sapphire skates. Consensus was achieved, but with low confidence.

Smooth deepsea skate *Brochiraja asperula*
(Intensity = 3.5, Consequence = 3.5, Risk = 12.25)
Egg layer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

There was considerable uncertainty that smooth deepsea skates were accurately distinguished from prickly deepsea skates by fishers and observers, or that the data from these two species were discrete. Therefore smooth deepsea skates were scored identically to prickly deepsea skates (directly above).

Broadnose sevengill shark ***Notorynchus cepedianus***
(Intensity = 4, Consequence = 3, Risk = 12)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 51 tonnes
Live bearer



Confidence

Data were described as 'exist but poor' as no abundance indices were available and inshore reporting of this species is likely to be poor. Consensus was achieved, but with low confidence.

Rationale

Broadnose sevengill shark was estimated as vulnerable to fishing across more than 60% of their range and caught more than 300 days a year. However, this species scored an overall intensity of 4 as although they are distributed as deep as 200 m (McMillan et al. 2011) they are often found in harbours and shallow inshore areas where many commercial fisheries closures are present (Baird et al. 2015).

Broadnose sevengill shark was classified as globally widespread (Ebert et al. 2013) and having a moderate population size in New Zealand waters. Broadnose sevengill shark was classified as having high fecundity, but a late age at maturity. Broadnose sevengill shark females reproduce from 16 years old, but can live until 50 and they produce an average of 85 pups every 2 years (Last & Stevens 2009, Ebert et al. 2013).

Brochiraja complex (3 species)

(Intensity = 3, Consequence = 4, Risk = 12)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale
The spatial and temporal intensity of fishing on *Brochiraja* complex was unable to be scored. But the overall intensity of fishing was characterised as a 3 (the amount of captures are moderate at a broader scale or high but local). These species have depth ranges spanning 300 to 1200 m (Last & McEachran 2006) therefore there is likely to be some limited overlap with fishing beyond 800 m depth, where the footprint of fishing is small (Black & Tilney 2015).

The *Brochiraja* complex includes at least three current species for which identifications are uncertain (*Brochiraja microspinifera, B. leviveneta,* and *B. albilabiata*) and may possibly include *B. aenigma* which is known to occur just outside the New Zealand EEZ. The three species are endemic to New Zealand, and the Challenger Plateau just outside the EEZ (Last & McEachran 2006). The three known species population sizes in New Zealand waters were classified as moderate to small.

Confidence
Data were described as 'few' as there are few length data, no ageing data or abundance indices exist and taxonomy is uncertain. Consensus was achieved, but with low confidence.

Brown chimaera *Chimaera carophila*

Live bearer
(Intensity = 3, Consequence = 4, Risk = 12)
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale
Brown chimaera was estimated as vulnerable to fishing across 31 to 45% of their range and caught between 100 and 200 days a year. This scored an overall intensity of 3 as this species has a depth range of 800 to over 1500 m (McMillan et al. 2011a) therefore there is limited overlap with fishing beyond 800 m depth, where the footprint of fishing is small (Black & Tilney 2015).

Brown chimaera are endemic (Kemper et al. 2014) and their population size was classified as relatively small.

Confidence
Data were described as 'few' as there are few length data, no ageing data and no abundance indices. Consensus was achieved.

Catsharks *Apristurus* spp.
(Intensity = 3, Consequence = 4, Risk = 12)
Egg layer
(No pie graph is shown here as less than5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)\

Rationale
Catsharks were estimated as vulnerable to fishing across more than 60% of their range and caught between 200 and 300 days a year. This species group scored an overall intensity of 3 as the species have a depth range deeper than 600 m and different species are likely to have different depth ranges within the catsharks (McMillan et al. 2011a). Some catsharks are likely to have limited overlap with fishing beyond 800 m depth, where the footprint of fishing is small (Black & Tilney 2015).

Catsharks include at least seven current species where taxonomy and identifications are uncertain (roughskin catshark Apristurus ampliceps, pale catshark A. exsanguis, fleshynose catshark A. melanoasper, catshark A. pinguis and freckled catshark A. sinensis and two other unidentified or undescribed species). All of these species were categorised as having relatively small population sizes in New Zealand waters. Pale catshark is endemic, fleshynose catshark has a globally widespread distribution, roughskin catshark occurs in Australasia, and catshark and freckled catshark have Western Pacific distributions (Last & Stevens 2009, Ebert et al. 2013).

Confidence
Data were described as 'few' as there are no ageing data, reproductive data or abundance indices and taxonomy is uncertain (hence the genus was scored rather than the separate species). Consensus was achieved, but with low confidence.

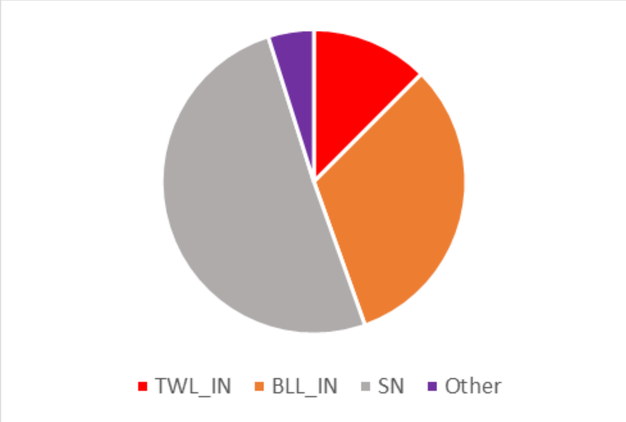
Deepwater spiny skate *Amblyraja hyperborean*
(Intensity = 3, Consequence = 4, Risk = 12)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale
Deepwater spiny skate is estimated as vulnerable to fishing between 45 to 60% of their range and caught between 200 and 300 days a year. This species scored an overall intensity of 3 as it has a depth range of 500 to 1500 m (McMillan et al. 2011a) and is therefore likely to have limited overlap with fishing beyond 800 m depth, where the footprint of fishing is small (Black & Tilney 2015).

Deepwater spiny skate is classified as globally widespread (Ebert et al. 2013) and having a moderate population size in New Zealand waters

Confidence
Data were described as 'few' as there are no ageing data, reproductive data or credible abundance indices. In addition observer identifications of deepwater spiny skates beyond depths where trawl surveys have found them suggest possible misidentifications. Consensus was achieved, but with low confidence.

Hammerhead shark *Sphyrna zygaena*
(Intensity = 4, Consequence = 3, Risk = 12)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 31 tonnes
Live bearer



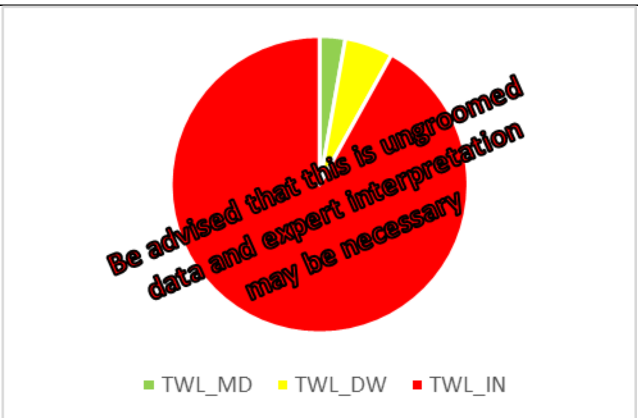
Confidence
Data were described as 'exist but poor' as there are no ageing, reproductive frequency data or indicators of abundance. Consensus was achieved, but with low confidence.

Rationale

Hammerhead shark was estimated as vulnerable to fishing across 31 to 45% of their range and caught between 200 and 300 days a year. This species scored an overall intensity of 4 as adult females are rarely caught and coastal setnet closures are likely to benefit juveniles.

Hammerhead shark is globally widespread (Ebert et al. 2013) and was classified as having a relatively large population in New Zealand waters. Hammerhead sharks have a maximum known age of 21 years and an average litter size of 35 pups (Last & Stevens 2009, Coelho et al. 2011).

Longnose deepsea skate *Bathyraja shuntovi*
(Intensity = 3, Consequence = 4, Risk = 12)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 9 tonnes
Live bearer



Confidence:
Data were described as 'few' as there are no ageing, reproductive data or indicators of abundance and identification of this species in observer or commercial data may be problematic. Consensus was achieved, but with low confidence.

Rationale:

Longnose deepsea skate was estimated as vulnerable to fishing across 31 to 45% of their range and caught between 200 and 300 days a year. This species scored an overall intensity of 3 as they are likely to have limited overlap with fishing as they are found from 500 to over 1500 m in New Zealand waters (McMillan et al. 2011a) and beyond 800 m the footprint of fishing is small (Black & Tilney 2015).

Longnose deepsea skate are endemic (McMillan et al. 2011a) and were classified as having a relatively small population in New Zealand waters.

Longtail skate *Arhynchobatis asperrimus*
(Intensity = 3, Consequence = 4, Risk = 12)
Egg layer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

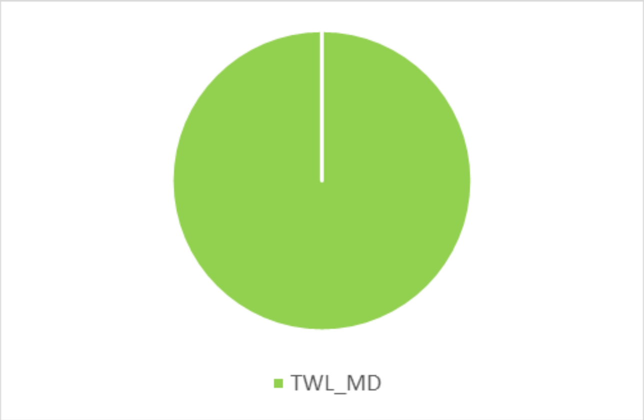
Longtail skate was estimated as vulnerable to fishing across 45 to 60% of their range and caught between 200 and 300 days a year. This species scored an overall intensity of 3 because research trawl data suggest a narrower distribution of catch; this suggests misidentification by observers.

Longtail skate is endemic (McMillan et al. 2011a) and was classified as having a moderate population size in New Zealand waters.

Confidence

Data were described as ‘few’ as there are no ageing data, reproductive data or credible abundance indices. In addition observer identifications are questionable, and these may be reported under other skates. Consensus was achieved, but with low confidence.

Lucifer dogfish *Etmopterus lucifer*
(Intensity = 3, Consequence = 4, Risk = 12)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 8 tonnes
Live bearer



Confidence:

Data were described as ‘exist but poor’ as reproductive frequency is not known, and productivity results are sparse. Consensus was achieved, but with low confidence.

Rationale:

Lucifer dogfish was estimated as vulnerable to fishing across more than 60% of their range and caught more than 300 days a year. This species scored an overall intensity of 3 as they are small (maximum total length 45 cm, McMillan et al. 2011a) and are therefore likely to pass under or through fishing gear.

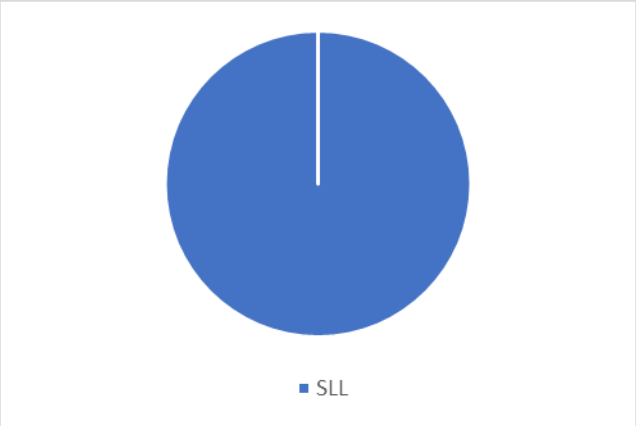
Lucifer dogfish are widespread in the western Pacific (Ebert et al. 2013) and classified as having a relatively large population in New Zealand waters. Females reproduce from 12 years old (with a maximum known age of 18) and have a relatively low productivity with 6 pups on average per litter (from only two specimens - Galland (2015)). Abundance indices are stable or increasing over the last five years (O’Driscoll et al. 2011, Bagley et al. 2013, Doonan & Dunn 2011).

Pacific spookfish *Rhinochimaera pacifica*
(Intensity = 3, Consequence = 4, Risk = 12)
Egg layer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale
Pacific spookfish was estimated as vulnerable to fishing across 31 to 45% of their range and caught 100 to 200 days a year. This species scored an overall intensity of 3 as they are likely to have limited overlap with fishing, as they are found from 600 to over 1500 m in New Zealand waters (McMillan et al. 2011a) and beyond 800 m the footprint of fishing is small (Black & Tilney 2015).
Pacific spookfish are widespread in the Pacific and Indian oceans (Last & Stevens 2009) and classified as having a relatively large population in New Zealand waters.

Confidence
Data were described as 'few' as there are no ageing data, reproductive data or credible abundance indices. In addition there are unrealistically few commercial catch data compared with research trawl data, which suggests misreporting. Consensus was achieved.

Pelagic stingray *Pteroplatytrygon violacea*
(Intensity = 3, Consequence = 4, Risk = 12)
Total Commercial Catch (2008–09 to 2012–13 fishing years): 14 tonnes
Live bearer



Rationale

Pelagic stingray was estimated as vulnerable to fishing across 31 to 45% of their range and caught between 100 and 200 days a year. This species scored an overall intensity of 3 as they are oceanic (Last & Stevens 2009) and probably only exposed to fishing seasonally.

Pelagic stingray are globally widespread (Ebert et al. 2013) and classified as having a relatively large population in New Zealand waters.

Confidence
Data were described as 'few' as there are no ageing data, reproductive frequency data or abundance indices. Consensus was achieved, but with low confidence.

Portuguese dogfish *Centroscymnus coelolepis*

(Intensity = 3, Consequence = 4, Risk = 12)
Total Commercial Catch (2008–09 to 2012–13 fishing years): 7 tonnes
Live bearer

Confidence

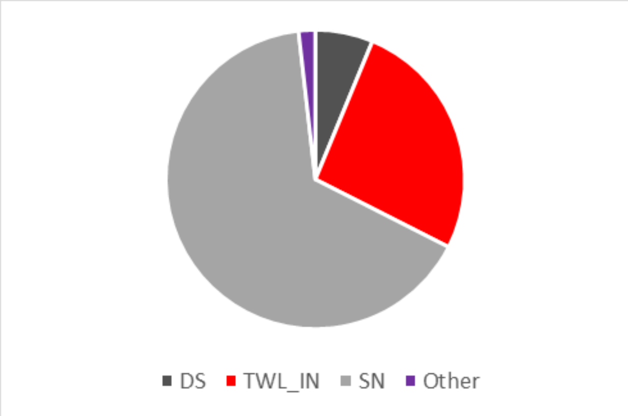
Data were described as ‘exist but poor’ as there are no ageing data, reproductive frequency data or abundance indices. In addition, the panel believed they may be incorrectly reported as deep water dogfish (DWD). Consensus was achieved, but with low confidence.

Rationale

Portuguese dogfish was estimated as vulnerable to fishing across 16 to 30% of their range and caught 100 to 200 days a year. This species scored an overall intensity of 3 as they are likely to have limited overlap with fishing (they are found in waters deeper than 500 m in New Zealand waters and to 3700 m elsewhere (McMillan et al. 2011a) and beyond 800 m the footprint of fishing is small (Black & Tilney 2015).

Portuguese dogfish are globally widespread (Ebert et al. 2013) but classified as having a relatively small population in New Zealand waters. This species has an average litter size of twelve (Ebert et al. 2013).

Slender smooth hound *Gollum attenuatus*
(Intensity = 3, Consequence = 4, Risk = 12)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 119 tonnes
Live bearer

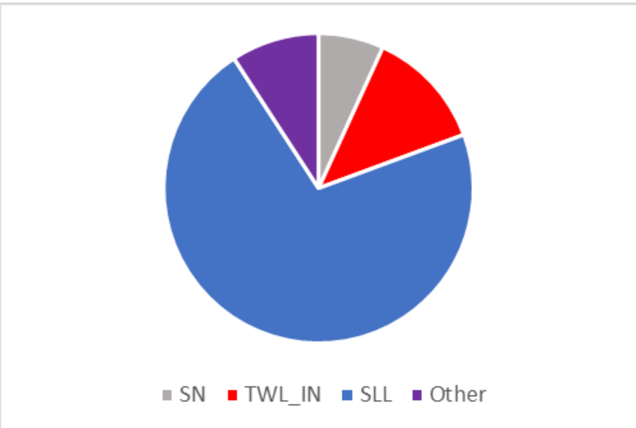


Confidence:
Data were described as 'exist but poor' as there are no ageing data, reproductive frequency data or abundance indices, the discrepancy between observer and research trawl record locations also suggests mis-identification by observers. Consensus was achieved, but with low confidence.

Rationale:
Slender smooth hound was estimated as vulnerable to fishing across more than 60% of their range and caught 100 to 200 days a year. This species scored an overall intensity of 3 as they are likely to have limited overlap with fishing as the areas they are found in (McMillan et al. 2011a) are only fished some of the year.

Slender smooth hound are distributed through the south-west Pacific (New Zealand and surrounding ridges) (Ebert et al. 2013) and classified as having a relatively moderate population size in New Zealand waters. This species was classified as having a low productivity with an average litter size of two (Yano 1993).

Thresher shark *Alopias vulpinus*
(Intensity = 3.5, Consequence = 3, Risk = 10.5)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 193 tonnes
Live bearer

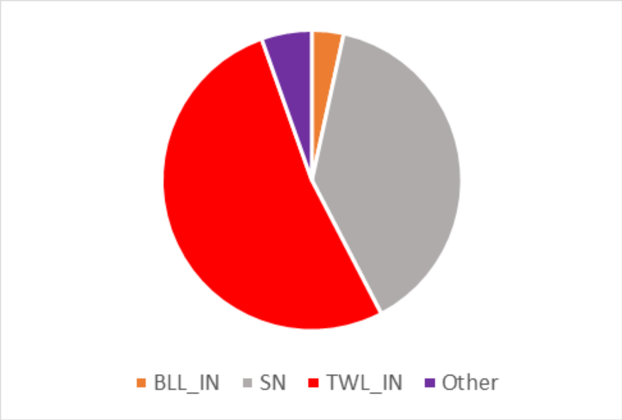


Confidence:
Data were described as 'exist but poor' as there are no reproductive frequency data or abundance indices. Consensus was achieved, but with low confidence.

Rationale:
Thresher shark was estimated as vulnerable to fishing across 45 to 60% of their range and caught 200 to 300 days a year. This species scored an overall intensity of 3.5 as they are known, but not fished, from the Kermadec Islands and spatial separation within this species appears likely with adults distributed offshore and juveniles inshore.

Thresher shark are globally widespread (Ebert et al. 2013) and classified as having a relatively moderate population size in New Zealand waters. Females reproduce relatively early (from 6 years old), with a maximum known age of 24 years, and they have relatively low fecundity, with on average only four pups per litter (Last & Stevens 2009, Ebert et al. 2013).

Eagle ray *Myliobatis tenuicaudatus*
(Intensity = 4, Consequence = 2.5, Risk = 10)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 249 tonnes
Live bearer



Confidence:
Data were described as 'exist but poor' as there are no ageing or reproductive data or abundance indices. Consensus was achieved, but with low confidence.

Rationale:
Eagle ray was estimated as vulnerable to fishing across more than 60% of their range and caught more than 300 days a year. This species scored an overall intensity of 4 as they are distributed from 0 to 200 m (McMillan et al. 2011a) so have limited overlap with fishing coastally due to setnet and harbour closures (Baird et al. 2015).

Eagle ray are distributed through New Zealand, Australia and Norfolk Island (Last & Stevens 2009) and classified as having a relatively large population in New Zealand waters.

Sharpnose sevengill shark *Heptranchias perlo*
(Intensity = 3, Consequence = 3, Risk = 9)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale
Sharpnose sevengill shark was estimated as vulnerable to fishing across more than 60% of their range and caught 100 to 200 days a year. This species scored an overall intensity of 3 due to the panel's judgement that the distribution is probably broader than shown in McMillan et al. (2011a).

Sharpnose sevengill shark are globally widespread (Ebert et al. 2013) but classified as having a relatively small population in New Zealand waters. This species was classified as having a moderate fecundity with an average litter size of 13 (Last & Stevens 2009; Ebert et al. 2013).

Confidence
Data were described as 'exist but poor' as there are no ageing data, reproductive frequency data or abundance indices and have a questionable known distribution. Consensus was achieved, but with low confidence.

Frill shark *Chlamydoselachus anguineus*
(Intensity = 2, Consequence = 4, Risk = 8)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

Frill shark was estimated as vulnerable to fishing across 31 to 45% of their range and caught 1 to 100 days a year. This species scored an overall intensity of 2 as they have limited overlap with fishing as they are distributed from 700 to 1500 m (McMillan et al. 2011a) and beyond 800 m the fishing footprint is small (Black & Tilney 2015).

Frill shark are globally widespread (Ebert et al. 2013) but classified as having a relatively small population in New Zealand waters. This species was classified as having a relatively low fecundity with an average litter size of 7 every 1.5 years (Last & Stevens 2009, Ebert et al. 2013).

Confidence

Data were described as ‘exist but poor’ as there are no ageing data or abundance indices. Consensus was achieved, but with low confidence.

Longsnout dogfish *Deania quadrispinosa*
(Intensity = 2, Consequence = 4, Risk = 8)
Egg layer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

The spatial and temporal intensity of fishing on longsnout dogfish was unable to be scored. This species scored an overall intensity of 2, which is described as “minimal impact on taxa”.

Longsnout dogfish are globally widespread (Ebert et al. 2013) but classified as having a relatively small population in New Zealand waters. This species was classified as having a moderate fecundity with an average litter size of 10 (Last & Stevens 2009; Ebert et al. 2013).

Confidence

Data were described as ‘few’ as there are no ageing, reproductive frequency data or abundance indices, in addition this species may be misreported as shovelnose dogfish (SND). Consensus was achieved.

Pointynose blue ghost shark *Hydrolagus trolli*

(Intensity = 2, Consequence = 4, Risk = 8)

Egg layer

(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

Pointynose blue ghost shark was estimated as vulnerable to fishing across 16 to 30% of their range and caught 1 to 100 days a year. This species scored an overall intensity of 2 as they have limited overlap with fishing as they are distributed from 600 to 1700 m (McMillan et al. 2011a), but were considered rare beyond 1200 m by the panel; beyond 800 m the fishing footprint is small (Black & Tilney 2015).

Pointynose blue ghost shark are distributed throughout the south-west Pacific (Last & Stevens 2009) and classified as having a relatively small population in New Zealand waters.

Confidence

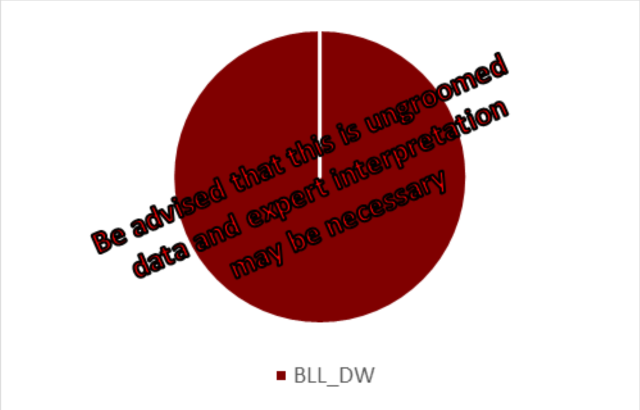
Data were described as 'few' as there are no ageing, reproductive data or abundance indices. Consensus was achieved, but with low confidence.

Purple chimaera *Chimaera lignaria*

(Intensity = 2, Consequence =4, Risk = 8)

Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 57 tonnes

Egg layer



Confidence:

Data were described as 'few' as there are no ageing, reproductive data or abundance indices. Consensus was achieved, but with low confidence.

Rationale:

Purple chimaera was estimated as vulnerable to fishing across 16 to 30% of their range and caught 1 to 100 days a year. This species scored an overall intensity of 2 as they have limited overlap with fishing as they are distributed from 400 to 1800 m, but mainly deeper than 800 m (Last & Stevens 2009), where the fishing footprint is small (Black & Tilney 2015).

Purple chimaera are distributed throughout New Zealand and around Tasmania (Last & Stevens 2009) and classified as having a relatively small population in New Zealand waters.

Recommendation

A number of records of purple chimaera from bottom longline fisheries in the Bounty Islands were considered anomalous and these data should be reviewed before they can be confidently used.

Southern mandarin dogfish *Cirrhigaleus australis* (Intensity = 2, Consequence = 4, Risk = 8) Live bearer (No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)
Rationale The spatial and temporal intensity of fishing on southern mandarin dogfish was unable to be scored. This species scored an overall intensity of 2, which is described as "minimal impact on taxa", as this species is considered to inhabit rocky ground that is not well suited to fishing. Southern mandarin dogfish are distributed throughout New Zealand and south-eastern Australia (Last & Stevens 2009) and classified as having a relatively small population in New Zealand waters. This species has a moderate fecundity with on average 10 pups per litter (Cox & Francis 1997) *Confidence* Data were described as 'few' as there are no ageing, reproductive frequency data or abundance indices. Consensus was achieved, but with low confidence.

Southern sleeper shark *Somniosus antarcticus* (Intensity = 2, Consequence = 4, Risk = 8) Live bearer (No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)
Rationale The spatial and temporal intensity of fishing on southern sleeper shark was unable to be scored. The species scored an overall intensity of 2, which is described as "minimal impact on taxa" on the basis of its low estimated catch. Southern sleeper shark are widespread in the Southern Hemisphere (Last & Stevens 2009) and classified as having a relatively small population in New Zealand waters. This species has a moderate fecundity with the only recorded litter containing 10 pups (Ebert et al. 2013). *Confidence* Data were described as 'few' as there are no ageing, reproductive frequency data or abundance indices. Consensus was achieved, but with low confidence.

Sixgill shark *Hexanchus griseus*
(Intensity = 3, Consequence = 2, Risk = 6)
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)
Live bearer

Rationale

The spatial and temporal intensity of fishing on sixgill shark was unable to be scored. This species scored an overall intensity of 3, which is described as "The amount of captures are moderate at broader spatial scale, or high but local" on the basis of its estimated catch.

Sixgill shark are globally widespread (Ebert et al. 2013) but classified as having a relatively small population in New Zealand waters. This species has a high fecundity with an average litter size of 77 pups (Last & Stevens 2009; Ebert et al. 2013).

Confidence

Data were described as 'exist but poor' as there are no ageing, reproductive frequency data or credible abundance indices. Consensus was achieved, but with low confidence, as the panel thought that catch of this species may be under-reported, particularly in the ling longline fishery.

Bigeye thresher *Alopias superciliosus*
(Intensity = 2, Consequence = 2, Risk = 4)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

The spatial and temporal intensity of fishing on bigeye thresher was unable to be scored. This species scored an overall intensity of 2, which is described as "capture occurs rarely or in few restricted locations" on the basis of its low estimated catch.

Bigeye thresher are globally widespread (Ebert et al. 2013) but classified as having a relatively small population in New Zealand waters. Females reproduce relatively early (age 13), with a maximum known age of 20 years (Ebert et al. 2013) and a low productivity, with an average litter size of 2 (Last & Stevens 2009).

Confidence

Data were described as 'exist and sound'. Consensus was achieved, but with low confidence, due to the low observer coverage in longline fisheries where higher catch of this species has been recorded overseas and lack of distribution information.

Little sleeper shark *Somniosus longus*
(Intensity = 2, Consequence = 2, Risk = 4)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

The spatial and temporal intensity of fishing on little sleeper shark was unable to be scored. This species scored an overall intensity of 2, which is described as "capture occurs rarely or in few restricted locations" on the basis of its low estimated catch.

Little sleeper shark are widespread in the Pacific Ocean (Ebert et al. 2013) and classified as having a relatively small population in New Zealand waters.

Confidence

Data were described as 'few' as no ageing, reproduction data or abundance indices for this species exist. This species could also be confused by observers with southern sleeper shark (*S. antarcticus*). Consensus was achieved, but with low confidence.

Prickly shark *Echinorhinus cookei*
(Intensity = 2, Consequence = 2, Risk = 4)
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)
Live bearer

Rationale

The spatial and temporal intensity of fishing on prickly shark was unable to be scored. This species scored an overall intensity of 2, which is described as "capture occurs rarely or in few restricted locations" on the basis of its low estimated catch.

Prickly shark are widespread in the Pacific Ocean (Last & Stevens 2009) and classified as having a relatively small population in New Zealand waters. This species appears highly productive as one pregnant female has been examined and had a litter size of 114 pups (Last & Stevens 2009). This species is mainly known from canyons and tagging data suggest high site fidelity (Dawson & Starr 2009), therefore they may be susceptible to localised depletion.

Confidence

Data were described as 'few' as there are no ageing, reproductive frequency data or abundance indices for this species. Consensus was achieved.

Velvet dogfish *Zameus squamulosus*
(Intensity = 2, Consequence = 2, Risk = 4)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

The spatial and temporal intensity of fishing on velvet dogfish was unable to be scored. This species scored an overall intensity of 2, which is described as “capture occurs rarely or in few restricted locations” on the basis of its low estimated catch.

Velvet dogfish are globally widespread (Ebert et al. 2013) but were classified as having a relatively small population in New Zealand waters. This species has a relatively low productivity with an average of 7 pups per litter (Ebert et al. 2013).

Confidence

Data were described as ‘few’ as there are no age or reproductive frequency data, nor abundance indices for this species. In addition Plunket’s shark may be misidentified as velvet dogfish. Consensus was achieved, but with low confidence.

Black ghost shark *Hydrolagus homonycteris*
(Intensity = 2, Consequence = 1, Risk = 2)
Egg layer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

The spatial and temporal intensity of fishing on black ghost shark was unable to be scored. This species scored an overall intensity of 2, which is described as “capture occurs rarely or in few restricted locations”, This is partially as this species is thought to have limited overlap with fishing as it is known from 450 to 1100 m and beyond 800 m the footprint of fishing is small (Black & Tilney 2015).

Black ghost shark are distributed through New Zealand and south-west Australia (Last & Stevens 2009) and classified as having a relatively moderate population size in New Zealand waters.

Confidence

Data were described as ‘few’ as there are no ageing, reproductive data or abundance indices for this species. There were only seven observer records of this species in the last five years, and identification of this species may be inaccurate. Consensus was achieved.

Galapagos shark *Carcharhinus galapagensis*
(Intensity = 1, Consequence = 2, Risk = 2)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

The spatial and temporal intensity of fishing on Galapagos shark was unable to be scored. This species scored an overall intensity of 2, which is described as “capture occurs rarely or in few restricted locations”, this is because this species shows only one capture in the last five years and a large part of the population in New Zealand waters is thought to exist in the Kermadec Islands Marine Reserve (M. Francis, unpubl. data).

Galapagos shark are globally distributed in tropical and subtropical waters (Ebert et al. 2013) and classified as having a relatively moderate population size in New Zealand waters. This species has a moderate productivity with a females reproducing from 8 years old (Ebert et al. 2013) and an average of 9 pups per litter (Last & Stevens 2009).

Confidence

Data were described as ‘exist and sound’, although no abundance indices exist. Consensus was achieved, but with low confidence.

Tiger shark *Galeocerdo cuvier*
(Intensity = 2, Consequence = 1, Risk = 2)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

The spatial and temporal intensity of fishing on tiger shark was unable to be scored. This species scored an overall intensity of 2, which is described as “capture occurs rarely or in few restricted locations”, this is because it is only present in New Zealand waters when it migrates from tropical areas over summer (Cox & Francis 1997) and is infrequently captured by offshore surface long-lines.

Tiger shark are globally distributed (Ebert et al. 2013) and classified as having a relatively small population in New Zealand waters. This species has a moderate productivity with females reproducing from 10 years old (maximum known age of at least 22 years) and an average of 33 pups per litter every two years (Last & Stevens 2009, Ebert et al. 2013).

Confidence

Data were described as ‘exist and sound’, although no abundance indices exist. Consensus was achieved.

Bramble shark *Echinorhinus brucus*

(Intensity = 1, Consequence = 1, Risk = 1)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale
The spatial and temporal intensity of fishing on bramble shark was unable to be scored. This species scored an overall intensity of 1, which is described as a "remote likelihood of capture" as it is rarely caught in New Zealand waters.

Bramble sharks are globally widespread (Ebert et al. 2013), and classified as having a moderate size in New Zealand waters. Bramble sharks have a moderate productivity with an average fecundity of 20 pups per litter (Ebert et al. 2013).

Confidence
Data were described as 'few' as there was no ageing, reproductive frequency data or abundance indices. Consensus was achieved, but with low confidence.

Cookie cutter shark *Isistius brasiliensis*

(Intensity = 1, Consequence = 1, Risk = 1)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale
Cookie cutter shark was estimated as vulnerable to fishing across 1 to 15% of their range and caught every few years. This species has an overall intensity of 1 which is described as a "remote likelihood of capture". Cookie cutter shark is considered to have a low catchability due to its small size (maximum total length 50 cm) and pelagic and midwater habitat (Last & Stevens 2009).

Cookie cutter shark are globally widespread (Ebert et al. 2013) but are classified as having a small population in New Zealand waters. This species has a moderate fecundity with an average of 8 pups per litter (Ebert et al. 2013).

Confidence
Data were described as 'exist but poor' as there was no ageing data or abundance indices. Consensus was achieved, but with low confidence.

Crocodile shark *Pseudocarcharias kamoharai*
(Intensity = 1, Consequence = 1, Risk = 1)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale
The spatial and temporal intensity of fishing on the crocodile shark was unable to be scored. This species scored an overall intensity of 1 which is described as "a remote likelihood of capture", as there has only been one reported capture of this species in New Zealand waters.

Crocodile shark are globally widespread (Ebert et al. 2013), but classified as having a relatively small population in New Zealand waters. This species also has a low productivity with an average of 4 pups produced per litter (Last & Stevens, 2009).

Confidence
Data were described as 'few' as there was no ageing data or abundance indices. Consensus was achieved.

Dusky shark *Carcharhinus obscurus*
(Intensity = 1, Consequence = 1, Risk = 1)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale
The spatial and temporal intensity of fishing on the dusky shark was unable to be scored. This species scored an overall intensity of 1, which is described as a "remote likelihood of capture", this is because this species shows only three suspected captures in the last five years, and has not been observed breeding in New Zealand waters.

Dusky shark is globally widespread (Ebert et al. 2013), but classified as having a small population in New Zealand waters. Females reproduce from 21 years old (with a maximum known age of 34) and dusky shark have a moderate level of productivity having 10 pups on average per litter (Last & Stevens, 2009; Ebert et al. 2013).

Confidence
Data were described as 'exist but poor' as there was no information on abundance, and there may also be some taxonomic confusion or misidentification between the dusky shark and the Galapagos shark. Consensus was achieved.

False cat shark *Pseudotriakis microdon*
(Intensity = 1, Consequence = 1, Risk = 1)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale
The spatial and temporal intensity of fishing on the false cat shark was unable to be scored. This species scored an overall intensity of 1, as a “remote likelihood of capture”, this is because this species shows only two observed captures in the last 5 years in New Zealand waters.

False cat shark are globally widespread (Ebert et al. 2013), but classified as having a relatively small population in New Zealand waters. This species was classified as having a low productivity with an average litter size of two pups (Last & Stevens, 2009).

Confidence
Data were described as ‘few’ as there was no ageing data or abundance indices. Consensus was achieved.

Goblin shark *Mitsukurina owstoni*
(Intensity = 1, Consequence = 1, Risk = 1)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale
The spatial and temporal intensity of fishing on goblin shark was unable to be scored. This species scored an overall intensity of 1, which is described as “a remote likelihood of capture”, this is because there have been no reported captures of this species in the last five years. The goblin shark is also likely to have limited overlap with fishing as goblin shark is found on steep slopes and is highly mesopelagic (Ebert et al. 2013).

Goblin shark are globally widespread (Ebert et al. 2013), but classified as having a small population in New Zealand waters.

Confidence:
Data were described as ‘few’ as there was no information on ageing, reproductive frequency and abundance indices for this species. Consensus was achieved.

Harrisson's dogfish *Centrophorus harrissoni*
(Intensity = 1, Consequence = 1, Risk = 1)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale
The spatial and temporal intensity of fishing on Harrisson's dogfish was unable to be scored. This species scored an overall intensity of 1 which is described as "a remote likelihood of capture" as there have only been three reported captures in New Zealand waters over the last five years (C. Duffy pers comm.).

Harrisson's dogfish is regionally distributed in Australasia (Last & Stevens, 2009), and is classified as having a relatively small population in New Zealand waters. Females reproduce from 25 years old and this species has a low productivity as they have on average two pups per litter (Last & Stevens, 2009; Ebert et al. 2013).

Confidence
Data were described as 'few' as there was no information on maximum known age, reproductive frequency, and abundance indices for this species. Consensus was achieved.

Kermadec spiny dogfish *Squalus raoulensis* (Intensity = 1, Consequence = 1, Risk = 1) Live bearer (No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)
Rationale The spatial and temporal intensity of fishing on Kermadec spiny dogfish was unable to be scored. Kermadec spiny dogfish scored an overall intensity of 1 which is described as a "remote likelihood of capture". This is because there has only been one reported capture of Kermadec spiny dogfish in the last five years and they have limited overlap with fishing in the Kermadec Islands Marine Reserve. Kermadec spiny dogfish is endemic, and is confined primarily to the North Kermadec Ridge (Duffy & Last 2007b). This species was classified as having a small population in New Zealand waters. *Confidence* Data were described as 'few' as there was no ageing, reproductive frequency data or abundance indices for this species. Consensus was achieved.

Leopard chimaera *Chimaera panthera* (Intensity = 1, Consequence = 1, Risk = 1) Egg layer (No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)
Rationale: The spatial and temporal intensity of fishing on leopard chimaera was unable to be scored. Leopard chimaera scored an overall intensity of 1 which is described as "a remote likelihood of capture" as there have been no reported captures of this species in New Zealand waters over the last five years. Leopard chimaera occurs around northern New Zealand and on the ridges north of North Island (Didier 1998, McMillan et al. 2011b) and was classified as having a small population in New Zealand waters. *Confidence:* Data were described as 'few' as there was no ageing, reproductive data or abundance indices for this species. Consensus was achieved.

McMillan's cat shark *Parmaturus macmillani*

(Intensity = 1, Consequence = 1, Risk = 1)
Egg layer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale:
The spatial and temporal intensity of fishing on McMillan's cat shark was unable to be scored. McMillan's cat shark scored an overall intensity of 1 as there have been fewer than 10 reported captures of this species (C. Duffy pers comm.). McMillan's cat shark is also likely to have limited overlap with fishing as it is usually found beyond 800 m depth (locally distributed at 1000 metres; McMillan et al. 2011b), where the footprint of trawling is small (Black & Tilney 2015). This species was also considered to have low catchability due to its small size (maximum size = 53 cm; McMillan et al. 2011b).

This species has been reported from the southern Indian Ocean, but that identification needs confirmation. Otherwise the species is only known from the New Zealand region (Ebert et al. 2013) and was classified as having a relatively small population in New Zealand waters.

Confidence:
Data were described as 'few' as there was no information available on productivity or abundance. Consensus was achieved, but with low confidence.

Port Jackson shark *Heterodontus portusjacksoni*

(Intensity = 1, Consequence = 1, Risk = 1)
Egg layer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail

Rationale:
The spatial and temporal intensity of fishing on Port Jackson shark was unable to be scored. This species scored an overall intensity of 1, which is described as a "remote likelihood of capture".

Port Jackson shark is known only from Australia, plus a single specimen caught in Cook Strait, New Zealand (now held in the Museum of New Zealand collection) (Last & Stevens, 2009) and was classified as having a relatively small population in New Zealand waters. Females reproduce from 13 years old (with a maximum known age of 35) they have a moderate level of productivity with an average of 13 eggs laid per year (Last & Stevens, 2009).

Confidence:
Data were described as 'few' as there was no information available on reproduction frequency, and abundance indices. Consensus was achieved.

Richardson's skate *Bathyraja richardsoni*
(Intensity = 1, Consequence = 1, Risk = 1)
Egg layer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale:
The spatial and temporal intensity of fishing on Richardson's skate was unable to be scored. Richardson's skate scored an overall intensity of 1 as they are likely to have limited overlap with fishing (found as deep as 2990 m; Last & Stevens 2009), well beyond 800 m depth, where the footprint of fishing is small (Black & Tilney 2015).

This species is patchily distributed, being found around New Zealand, off southern Tasmania and possibly in the North Atlantic Ocean (Last & Stevens, 2009), and was classified as having a relatively small population in New Zealand waters.

Confidence:
Data were described as 'few' as there was no ageing, reproductive frequency and no abundance indices, and there may also be some taxonomic confusion or misidentification of this species by observers. Consensus was achieved.

Sapphire skate *Notoraja sapphira*
(Intensity = 1, Consequence = 1, Risk = 1)
Egg layer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale:
The spatial and temporal intensity of fishing on sapphire skate was unable to be scored. Sapphire skate scored an overall intensity of 1 as there is no record of sapphire skates being caught in New Zealand waters.

This species is known only from the Norfolk Ridge (Séret & Last, 2009), and was classified as having a relatively small population in New Zealand waters.

Confidence:
Data were described as 'few' as there was no ageing, reproductive or abundance indices. Consensus was achieved.

Sherwood's dogfish *Scymnodalatias sherwoodi*
(Intensity = 1, Consequence = 1, Risk = 1)
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale:
The spatial and temporal intensity of fishing on Sherwood's dogfish was unable to be scored. Sherwood's dogfish scored an overall intensity of 1, which is described as a "remote likelihood of capture" as there have been only three specimens recorded in New Zealand waters (C. Duffy pers comm.).

This species occurs off southern New Zealand and Australia (Last & Stevens, 2009), and was classified as having a relatively small population in New Zealand waters.

Confidence:
Data were described as 'few' as the species distribution and productivity is unknown, therefore a conservative approach was taken. Consensus was achieved.

Smallspine spookfish *Harriotta haeckeli*
(Intensity = 1, Consequence = 1, Risk = 1)
Egg layer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale:
Smallspine spookfish was estimated as vulnerable to fishing in less than 1% of their range and caught once every ten years. Smallspine spookfish scored an overall intensity of 1 which is described as a "remote likelihood of capture".

Smallspine spookfish are globally widespread but only patchily distributed (Ebert et al. 2013) and have a relatively small population in New Zealand waters.

Confidence:
Data were described as 'exist but poor' as there was no information available on ageing, reproduction frequency or abundance indices. Consensus was achieved.

Whitetail dogfish *Scymnodalatias albicauda*
(Intensity = 1, Consequence = 1, Risk = 1)
Live bearer
(No pie graph is shown here as less than 5tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale:
The spatial and temporal intensity of fishing on Whitetail dogfish was unable to be scored. This species scored an overall intensity of 1 which is described as a "remote likelihood of capture" as whitetail dogfish have limited overlap with fishing, as they are epipelagic to benthopelagic over depths from 240 to 1550 m and may migrate vertically (Last & Stevens 2009, Ebert et al. 2013), so they are not vulnerable to bottom trawling and are rarely caught on surface longlines.

Whitetail dogfish are distributed in the Sub-Antarctic (Last & Stevens, 2009) and classified as having a relatively small population in New Zealand waters. This species has a high fecundity with a maximum litter size of 59 pups (Last & Stevens 2009).

Confidence:
Data were described as 'few' as there were minimal length estimates, no reproductive frequency data or abundance indices. Consensus was achieved, but with low confidence.

3.3 Protected species

Seven species of shark are afforded absolute protection under the Wildlife Act 1953[8] (Table 6). Spatial distribution is highly variable among these species, some occupying wide ranges, though at low densities, while others display more restricted distributions; a number of species are also known to be migratory. Susceptibility to interaction with commercial fisheries is dependent on the temporal and spatial distribution of these species in relation to fisheries as well as the species vulnerability to the gear used. For example, spinetail devil ray interactions are mainly with purse seine fisheries whereas basking and white shark interactions have been observed in a much broader range of fisheries, both demersal and pelagic, ranging from the North Island to the sub-Antarctic islands.

Table 6: Shark species protected under Schedule 7a of the Wildlife Act 1953 including IUCN threat status (these species have not yet been assessed against the revised New Zealand Threat Classification System 2008 therefore IUCN Redlist classifications are used).

Common name	Scientific Name	Family	IUCN Threat Ranking
Basking shark	*Cetorhinus maximus*	Cetorhinidae	Vulnerable
Smalltooth sandtiger shark	*Odontaspis ferox*	Odontaspididae	Vulnerable (decreasing population)
Oceanic whitetip shark	*Carcharhinus longimanus*	Carcharhinidae	Vulnerable
Whale shark	*Rhincodon typus*	Rhincodontidae	Vulnerable (decreasing population)
White shark	*Carcharodon carcharias*	Lamnidae	Vulnerable
Manta ray	*Manta birostris*	Mobulidae	Vulnerable
Spinetail devil ray	*Mobula japanica*	Mobulidae	Near Threatened

Shark species have been added to Schedule 7a of the Wildlife Act for a variety of reasons including their susceptibility to anthropogenic impacts and obligations under international agreements. Protection under the Wildlife Act means that the animals (alive or dead), and any part of them, cannot be intentionally harmed, held or traded. While incidental mortality of protected species occurs during the course of fishing, there are compulsory reporting requirements for fishers regarding incidental captures. The management intent is to minimise these incidental captures. Protected shark species fall within the mandate of the Conservation Services Programme (CSP) administered by the Department of Conservation. Through the CSP, DOC has an ability to levy commercial quota holders for relevant research to understand the nature and extent of interactions and techniques to mitigate them.

Under the CSP, research has been undertaken by Francis & Lyon (2012, 2014) to review the population and bycatch information for the nine protected fish (including sharks) species, while more in-depth work has been undertaken to look at changing bycatch rates of basking shark and the factors which may be affecting this (Francis & Sutton 2013). Research into the bycatch of spinetail devil rays has revealed that post-release survival is probably low and crew handling and release techniques can influence this survival (Jones & Francis 2012, Francis 2014). This work has led to recommendations for improvement of animal release in order to reduce fisheries impacts.

The overall risk for protected shark species, its component parts (intensity and consequence) and the confidence in these scores, in terms of both the amount and quality of the data and the extent of consensus amongst the panel, are displayed in Figure 8. Basking shark and spinetail devil ray attained

[8] Some of these species are also protected under the Fisheries Act 1996, see the NPOA-Sharks (2013) for details.

the highest risk scores, and the lowest possible scores were allocated to whale sharks, oceanic whitetip sharks and manta rays.

Scores for protected sharks showed lower risk scores than many QMS or non-QMS sharks. Intensity scores for protected sharks ranged from 3, described as "the amount of captures are moderate at broader spatial scale or high but local" to 1, described as "remote likelihood of catch/capture at any spatial or temporal scale". Consequence scores ranged from 4.5 (undescribed in Table 3) which can be interpreted as a high likelihood of actual, or potential for, unsustainable impacts, to 1 which can be described as "impact unlikely to be detectable at any scale". The minimal risk scores (1) seen for whale sharks, oceanic whitetip sharks and manta rays are on the basis that either no captures have ever been recorded of these species, or none in the last 5 years.

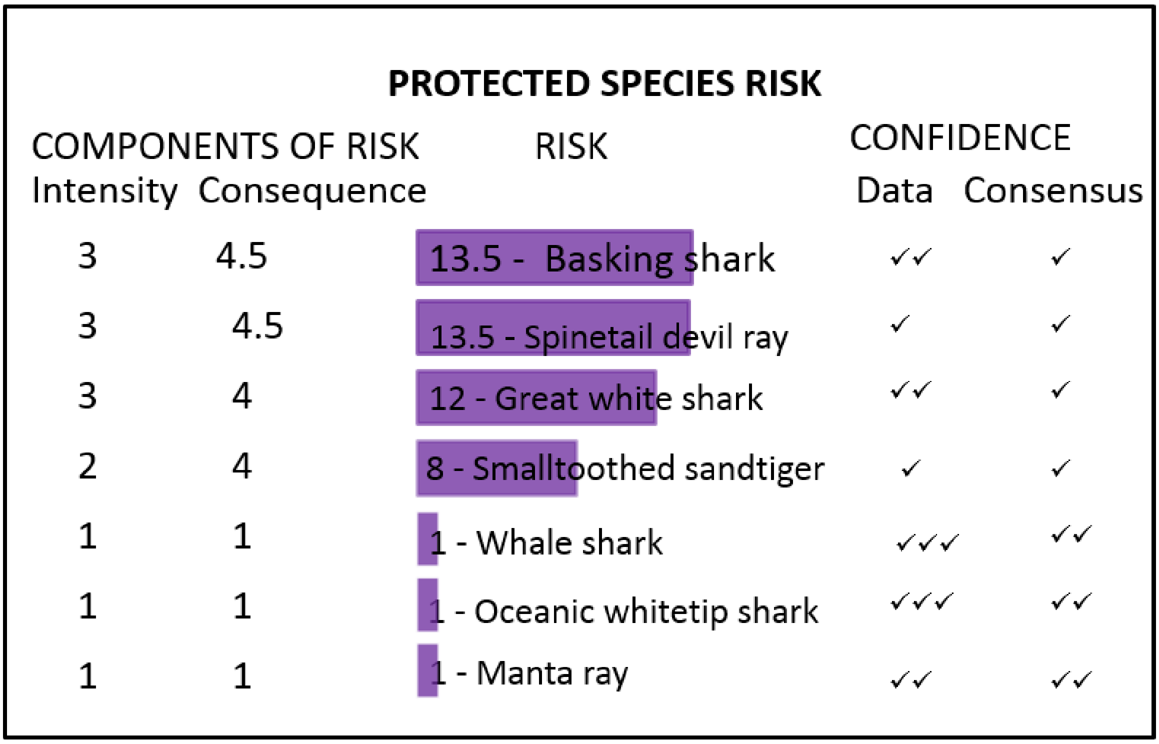
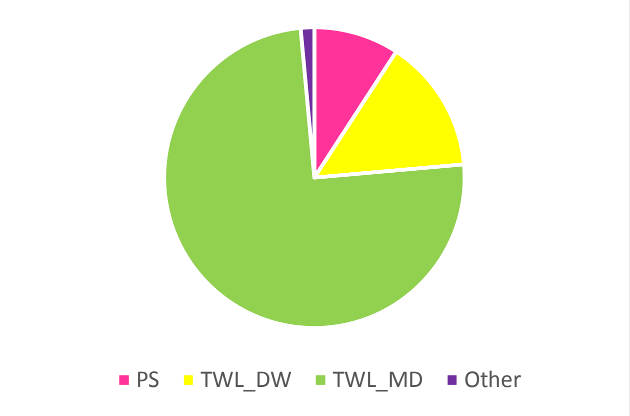


Figure 8: Protected Species Risk scores. For the COMPONENTS OF RISK higher numbers indicate greater intensity or consequence of impact (for more details see Table 2 and Table 3). For RISK longer bars and larger numbers indicate higher risk, and for CONFIDENCE more ticks indicate higher confidence in the data, or greater consensus and a cross indicates a lack of consensus (Two ticks in the consensus column indicate full consensus). Where species scored identical risk scores they are presented so that higher consequences are reported first and then in alphabetical order.

Basking shark *Cetorhinus maximus*
(Intensity = 3, Consequence = 4.5, Risk = 13.5)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 15 tonnes
Live bearer



Confidence

Data were described as 'exist but poor' as no ageing, reproductive frequency or abundance indices exist. Consensus was achieved, but with low confidence

Rationale

Basking shark was estimated as vulnerable to fishing across 45 to 60% of their range and caught between 1 and 100 days a year.

Basking shark is globally widespread (Ebert et al. 2013) but was classified as having a relatively small population in New Zealand waters. Basking shark is potentially a migrant in NZ waters but movement and connectivity information is lacking and high and localised catches can occur (Francis & Lyon 2012). Given their length (up to 10 m) and the small size of the only known litter (6 pups) this species is likely to have a low productivity (Francis & Duffy 2002). Fewer females have been caught in New Zealand than males (Francis & Smith 2010). Longer-term data show that catch rates were larger in the period 1986 to 1991, but the reason for the decline in catch rates is unknown (Francis & Sutton 2012).

Spinetail devil ray *Mobula japanica*
(Intensity = 3, Consequence = 4.5, Risk = 13.5)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 6 tonnes
Live bearer

Confidence

Data were described as ‘few’ as no reproductive frequency or abundance indices exist. Consensus was achieved, but with low confidence due to the lack of data.

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Rationale

Spinetail devil ray was estimated as vulnerable to fishing across 31 to 45% of their range and caught between 100 and 200 days a year (the skipjack tuna fishery that catches them only operates over the warmer months and catches are highly variable year to year). Fish spotter plane pilots anecdotally suggest that the spinetail devil ray can be highly abundant in some years.

Spinetail devil ray is globally widespread (Couturier et al. 2012) and their population size was classified as moderate in New Zealand waters. Spinetail devil ray have very low fecundity taking on average 1 year to produce one juvenile, and they live to at least 14 years (Francis & Lyon 2012, Cuevas-Zimbrón et al. 2013). Spinetail devil ray mostly come down from the tropics/subtropics in January to March and are caught by purse-seiners (Francis & Lyon 2012) out to a depth of 500 m; but beyond 500 m depth we have no knowledge of their distribution. Some captured spinetail devil ray are pregnant (Francis & Lyon 2012), so this increases the consequence score.

Great white shark *Carcharodon carcharias*

(Intensity = 3, Consequence = 4.5, Risk = 13.5)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 22 individuals
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

Great white shark was estimated as vulnerable to fishing across 16 to 30% of their range and caught between 100 and 200 days a year. There is however a known absence of reporting of captures of juveniles in inshore fisheries (where they are found in summer-autumn). Larger individuals are likely to have low vulnerability to capture and very few mature females are observed in New Zealand (C. Duffy and M. Francis pers. comm.).

Great white shark are globally widespread (Ebert et al. 2013) but classified as having a relatively small population in New Zealand waters. Productivity is relatively low with females reproducing from 14 years old (Francis & Lyon 2012), although this is considered likely to be an underestimate (M. Francis pers. comm.) with a maximum known age of 70 (Hamady et al. 2014). On average 8 pups are produced at a time (Francis 1996). The great white shark population on the east coast of Australia is stable, and genetic evidence suggests that these sharks mix with the New Zealand population (Malcolm et al. 2001, Blower et al. 2012). There is little fishing elsewhere in the population's south-west Pacific range (M. Francis, pers. comm.) and inshore set-net bans (e.g. west coast North Island for marine mammal protection) are likely to help this species.

Confidence

Data were described as 'exist but poor' as the frequency of reproduction is unknown and no abundance indices exist. Consensus was achieved, but with low confidence.

Smalltooth sandtiger shark *Odontaspis ferox*

(Intensity = 4, Consequence = 2, Risk = 8)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): less than 1 tonne.
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more details.

Rationale

Smalltooth sandtiger shark was estimated as vulnerable to fishing across 1 to 15% of their range and caught between 100 and 200 days a year. This species aggregates on seamounts which makes them susceptible to fisheries that target seamounts.

Smalltooth sandtiger shark are globally widespread (Ebert et al. 2013) but classified as having a relatively small population in New Zealand waters. Productivity is not proven, but reproduction is likely to be the same as in the closely-related grey nurse shark (*Carcharias taurus*) which has a litter size of two (Francis & Lyon 2012). Smalltooth sandtiger shark has declined in Australia, potentially due to fisheries (Francis & Lyon 2012). The lack of fishing around the Kermadec Islands and within Benthic Protection Areas (Helson et al. 2010) is likely to provide some protection to this shark from fisheries.

Confidence

Data were described as 'few' as no ageing, reproductive frequency data, reliable ranges or abundance indices exist. In addition identification errors are likely and misidentifications are suspected from the data presented (as the species has not been reliably identified south of approximately the South Taranaki Bight). Consensus was achieved, but with low confidence due to the lack of data.

Whale shark *Rhincodon typus*
(Intensity = 1, Consequence = 1, Risk = 1)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 0 individuals
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

Whale shark was estimated as vulnerable to fishing across less than 1% of their range and caught less than one every few years (none were caught in the past five years). A single individual was caught off the Canterbury coast in the late 1970s (Francis & Lyon 2012). Whale sharks are highly migratory (Francis & Lyon 2012) but the provenance of those in New Zealand waters is unknown and are they believed to be at the edge of their range.

Whale shark are globally widespread (Ebert et al. 2013) but classified as having a relatively small population in New Zealand waters. Only one litter has been sized and this had over 300 embryos, which suggests high productivity (Francis & Lyon 2012).

Confidence

Data were described as 'few' as no ageing, reproductive frequency data or abundance indices exist. However, given the current low likelihood of catch consensus was achieved.

Oceanic whitetip shark *Carcharhinus longimanus*
(Intensity = 1, Consequence = 1, Risk = 1)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 0 individuals
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

Oceanic whitetip shark was estimated as vulnerable to fishing across less than 1% of their range and caught less than once every few years (none were caught in the past five years).

Oceanic whitetip shark is globally widespread (Ebert et al. 2013) but was classified as having a relatively small population in New Zealand waters. This species was classified as having a relatively low fecundity (average 6 pups per litter) and mature relatively early (females reproduce from 6 years old, with a maximum known age of 12 years; Francis & Lyon 2014). These sharks have a mainly tropical distribution and their populations are largely declining elsewhere (Francis & Lyon 2014).

Confidence

Data were described as 'exist and sound' for the purposes of the assessment and consensus was achieved.

Manta ray Manta birostris
(Intensity = 1, Consequence = 1, Risk = 1)
Estimated Total Commercial Catch (2008–09 to 2012–13 fishing years): 0 individuals
Live bearer
(No pie graph is shown here as less than 5 tonne of estimated catch was reported in the 2008–09 to 2012–13 fishing years – see Section 2.3 for more detail)

Rationale

Manta ray was estimated as vulnerable to fishing across less than 1% of their range and caught less than once every few years (none have ever been recorded caught in New Zealand). This species occurs off the north-east coast of North Island during summer-autumn (Duffy & Abbott 2003), and has not been observed in fisheries in New Zealand, which, if they were present, they would be expected to be vulnerable to.

Manta ray are globally widespread (Ebert et al. 2013) and classified as having a relatively large population in New Zealand waters. Manta rays have a litter size of 1 and maximum known age of greater than 20 years (Couturier et al. 2012). The distribution of the New Zealand population of Manta rays after they leave North Island waters is unknown.

Confidence

Data were described as 'exist but poor' as no age at maturity data exist, maximum known age is uncertain, as is reproductive frequency, and no abundance indices exist. Consensus was achieved (given the lack of captures).

4. DISCUSSION

This risk assessment was qualitative by design, and therefore involved some subjective decision-making. However, every effort was made to have the most appropriate people on the panel to make expert judgements and to be as consistent as possible when such judgements were necessary. Consistency of decision making was ensured by applying the same scoring to similar data conditions across all species. Scoring was structured so that similar species were scored consecutively, and periodic checks occurred when categories of sharks had been completed to ensure consistency of decision making. Several times this process resulted in revised justifications and/or species scores.

Consensus was reached for 81 of 84 taxa. In instances where consensus was not reached, this was not due to flawed data, but differing interpretations over vulnerability to fishing gear (bronze whalers), intensity of fishing (longnose spookfish) or the consequence score given to the combination of endemicity, abundance indices and a lack of biological data (pale ghost shark).

The data that were compiled for the RA workshop (see Francis 2015) were un-groomed and some errors were identified by the panel. These data imperfections were not however considered by the panel to materially impact the quality of the assessment.

The total risk scores across all species were skewed, with many more low than high scores (Figure 5). This is largely due to the fact that no consequence scores exceeded 4.5, as no evidence existed of "serious unsustainable impacts now occurring…" (the definition of a score of 5 for consequence). However, out of the 84 taxa considered, the panel had low confidence in the risk scores for 43 taxa and consensus was not reached for 3 taxa. The RA panel stressed that the consequence scale was more relevant to risk than the overall intensity score, as high consequence taxa were those whose biology makes them susceptible to risk, e.g. low productivity. This statement is qualified by the fact that when data to inform consequence scoring were sparse, consequence was necessarily influenced by the level of catch (a measure of intensity). Thirty-three consequence scores of 4 or above (described as 'Actual or potential for unsustainable impact (e.g. long-term decline in CPUE)') were attained. The species with the highest consequence scores (all scoring 4.5) were (with their management categories in brackets):

- longnose velvet dogfish (non-QMS)
- plunket's shark (non-QMS)
- dawson's cat shark (non-QMS)
- basking shark (Protected), and
- spinetail devil ray (Protected)

These species all have low or potentially low productivity and consensus was achieved but with low confidence, suggesting that further information could influence either these scores, or our confidence in them.

Two caveats apply to the outputs of the risk assessment, over and above the limits placed upon them by its scope (Section 2.2):

1. The risk scores only apply to the population or the known part of the population within New Zealand, therefore they are not well-suited to populations that extend beyond the EEZ and Territorial Sea, e.g. mako shark and great white shark.
2. The risk scores only apply to the last five years, and therefore are not indicative of current absolute stock size, sustainability, or status in relation to reference points. They should only be used for gauging relative risk among New Zealand sharks.

These caveats should not hinder the use of the RA results in prioritising management actions. Nevertheless, quantitative (Level 2) RA techniques will be applied to sharks in the medium term to provide improved assessments of the risks of fisheries to them.

5. RISK ASSESSMENT RECOMMENDATIONS

The stated objective of the NPOA-Sharks is to prioritise management of, or research into, shark species based on the estimated risk levels. It was outside the scope of the panel to suggest management measures, however some useful species-specific research recommendations were made and these are repeated here:

1. Abundance indices could probably be calculated for **carpet shark** from data from surveys or commercial catches to better inform subsequent risk assessments
2. A number of records of **purple chimaera** from bottom longline fisheries in the Bounty Islands were considered anomalous and these data should be reviewed before they can be confidently used

The panel also made general recommendations regarding either future RAs or further research. These are listed below, grouped by time-frame (not in order of importance):
In the short-term for high risk or protected[9] species:

- Catch rates and biological information already collected from trawl surveys should be reviewed to determine if better estimates of biological parameters are available or if abundance indices can be generated for species where they do not already exist.

- Overlap between fisheries activity and shark distribution range should be examined at a finer scale to refine estimates of intensity within sub-regions rather than the EEZ as a whole.

- Catch of generic codes (e.g. other sharks and dogfish (OSD) and deepwater dogfish (DWD)) or hard to identify taxa (e.g. Plunket's shark) could be apportioned to relevant taxa in order to explore the sensitivity of risk scores to unidentified catch.

- The accuracy of identifications used in the RA could be tested, either on the basis of historical observer photographs or by specifying that identifications of certain high-risk or rare species require photographs so that identifications can be verified.

Prior to the quantitative risk assessment, or in the longer-term:

- Distribution maps should be updated. For some species additional records exist that may change the distribution patterns, and they should be collated and plotted; these could potentially also more usefully be displayed showing relative abundance.

- It is recommended that the data input to any subsequent RA process should be checked or groomed prior to its use.

- Biological studies should be commissioned to get better estimates of population parameters for high-risk shark species where these are lacking. This is a common problem internationally (Dulvy et al. 2014).

- Indicators of abundance should be developed for species where they are currently lacking. This could be achieved either by (a) collecting more information using existing platforms (e.g. collecting data from more or a different range of species on trawl surveys), or investigating new indicators (e.g. range contraction over time; Francis et al. 2014), or (b) using new platforms for data collection (e.g. using spotter planes for large pelagic species; Taylor & Doonan 2014).

[9] The NPOA-Sharks 2013 places special emphasis on protected species.

- Taxonomic confusion and misidentification was problematic for a number of species assessed, and sharks recorded under generic codes, e.g. (e.g. other sharks and dogfish (OSD) and deepwater dogfish (DWD)), were not able to be assessed in the workshop. Therefore any taxonomic work or observer education to aid better identification of sharks, particularly targeted at high risk species, would aid in future consideration of risk.

- The likely number of pups produced per female within their lifetime should be considered as a useful additional metric.

6. ACKNOWLEDGMENTS

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8. APPENDICES

8.1 Terms of Reference (dated 7/11/2014).

Department of Conservation
Te Papa Atawhai

Ministry for Primary Industries
Manatū Ahu Matua

Ministry for Primary Industries/Department of Conservation Terms of Reference for 2014 Level 1 (Qualitative) Risk Assessment of New Zealand Chondrichthyans (hereafter referred to as sharks)

1. Background

New Zealand fisheries waters are home to at least 113 species of shark, of which more than 70 have been recorded in fisheries. The term "shark", as used generally in this document, refers to all sharks, rays, skates, chimaeras and other members of the Class Chondrichthyes. Some of these species support significant commercial fisheries, are prized as recreational game fishing species, and/or are of special significance to Maori. Some are also recognised as regionally or globally threatened or endangered. Some shark species reside exclusively in our waters, while others also occur on the high seas and in other fisheries jurisdictions.

A National Plan of Action for the Conservation and Management of Sharks (NPOA-Sharks) was collaboratively produced in 2013 in accordance with New Zealand's obligations under the United Nations Food and Agriculture Organisation's International Plan of Action for the Conservation and Management of Sharks.

The purpose of the NPOA-Sharks 2013 is:

> *To maintain the biodiversity and the long-term viability of all New Zealand shark populations by recognising their role in marine ecosystems, ensuring that any utilisation of sharks is sustainable, and that New Zealand receives positive recognition internationally for its efforts in shark conservation and management.*

The NPOA-Sharks 2013 identifies goals and five-year objectives in the following key areas:

- Biodiversity and long-term viability of shark populations;
- Utilisation, waste reduction and the elimination of shark finning;
- Domestic engagement and partnerships;
- Non-fishing threats;
- International engagement;
- Research and information.

Fundamental to the NPOA-Sharks 2013 is a risk-based approach to management; therefore a risk assessment is specified under Objective 1.1 to '*Develop and implement a risk assessment framework to identify the nature and extent of risks to shark populations*'. The risk assessment framework in the NPOA Sharks 2013 is as written below:

> *In order to most appropriately prioritise research, management, and compliance, it is necessary to understand the impact of both extractive and, where possible, non-extractive users on*

populations as well as the resilience of populations to those impacts. A risk assessment framework will be developed and implemented for all shark species, including QMS, non-QMS, and protected species. The risk assessment will take account of any available information including species' characteristics, conservation status, and biology. Risk assessment will form the basis of management action, allowing a focus on high risk species. Given the reliance of other objectives on the completion of the risk assessment, the aim is to complete this by December 2014. This objective contributes to IPOA Aims 2 and 3[10].

2. Terms of Reference

Purpose

The purpose of the workshop is to generate risk assessment scores for as many New Zealand shark species as possible in order to inform prioritisation of subsequent management and research actions.

Scope

The focus of the workshop is risk assessment, not risk management. As a result, discussion of risk management, management measures and advocacy for particular positions or conclusions are out of scope.

Participants

Attendance at the workshop is by invitation only. The workshop participants are (preferred participants are identified by name):

- A technical workshop Chair (Dr. Rich Ford, MPI);
- A facilitation group of MPI and/or DOC staff that will assist the chair;
- A panel comprising domestic experts in sharks and their fisheries to conduct the risk assessment scoring (Dr. Malcolm Francis and Dr. Malcolm Clarke (NIWA), Dr. Matt Dunn (Victoria University), Clinton Duffy and Dr. Paul Crozier (DOC) and Richard Wells (Deepwater Group and Fisheries Inshore New Zealand))
- Invited stakeholders and representatives of government agencies to observe (to ensure transparency in the scientific process) and, at the request of the Chair, provide technical advice to inform the risk assessment scoring.

Protocols

All workshop participants will commit to:

- participating in the discussion in an objective and unbiased manner;
- resolving issues;
- following up on agreements and tasks;
- adopting a constructive approach;
- facilitating an atmosphere of honesty, openness and trust;
- having respect for the role of the Chair; and
- listening to the views of others, and treating them with respect.

The workshop will be run formally with an approach pre-circulated, notes taken and a formal report generated. Participants who do not adhere to the standards of participation may be requested by the Chair to leave a particular part of the workshop or, in more serious instances, will be excluded from the remainder of the workshop.

Chairperson

The roles of the technical workshop Chair include that of a facilitator, and the Chair is responsible for:

10 IPOA(2) Assess threats to shark populations, determine and protect critical habitats and implement harvesting strategies consistent with the principles of biological sustainability and rational long-term use
IPOA(3) Identify and provide special attention, in particular, to vulnerable or threatened shark stocks

- setting the rules of engagement consistent with the workshop's purpose and scope;
- promoting full participation by all members;
- facilitating a constructive discussion per the workshop's protocols;
- focusing the workshop on relevant issues;
- working with the panel members to achieve the workshop's objectives consistent with the workshop's approach; and
- helping the workshop to make progress against the list of species to be scored.

The Chair is responsible for working towards an agreed view of the workshop participants, but where that proves not to be possible then the Chair is responsible for making the final decision. Minority views will be clearly represented in those cases.

Conflicts of Interest

Panel members will be asked to declare any "actual, perceived or likely conflicts of interest" before involvement in the workshop, and any new conflicts that arise during the process should be declared immediately. These will be clearly documented in the notes of the workshop. Management of conflicts of interest will be determined by the Chair. Panel members' employers are already known but examples of additional conflicts of interest that should be notified to the Chair could include holding quota for shark species or public advocacy for shark conservation (outside of roles for listed employers).

Documents and record-keeping

Documents circulated to participants are done so in confidence. Participants may not distribute these to others unless with the expressed agreement of the Chair in writing. Participants who use workshop papers inappropriately may be excluded from this and/or subsequent workshops. The overall responsibility for record-keeping rests with the Chair and any facilitation staff, including:

- Recording the risk assessment scoring, including rationale
- In cases designated by the Chair, recording the extent to which consensus was achieved, and recording any residual disagreement.

The findings of the risk assessment workshop will be documented in a report, whose drafting and compilation will be overseen by the Chair, with feedback and agreement sought from all participants. Individual panel members' risk scores may be recorded as part of the workshop, but will be released so that scores cannot be attributed to individual panel members in the final report. This final report will include all relevant tables, details of relevant discussions, conclusions and an Appendix detailing how the data used were compiled.

Until that report is released publicly, findings from the workshop should be considered draft and remain confidential.

3. Approach

A qualitative (level 1) risk assessment workshop will be held in the boardroom of Credit Consultants, Level 4, 135 Victoria Street, Wellington from the hours of 9am to 5pm November 17–21, 2014.

The aim of the workshop will be to generate risk assessment scores using a Scale Intensity Consequence Analysis (SICA) approach for as many New Zealand shark species as possible in order to inform prioritisation of subsequent management and research actions. A subsequent semi-quantitative (level 2) risk assessment is scheduled for completion prior to the end of 2015, and is likely to take more of a spatially-explicit, exposure-effects approach. We are still clarifying a few details of the approach and will send out more information on this next week.

8.2 List of shark species

The 92 described shark species for consideration by the risk assessment workshop. This is the NPOA Sharks list (113 species) minus undescribed species. Code refers to the MPI research code. Those not assessed by the risk assessment are written in grey. Notably brown chimaera and deepwater spiny skate are not listed here but were also considered in the risk assessment.

Code	Group	Common name/code	Species	Additional names
ELE	Chimaera	Elephantfish	*Callorhinchus milii* Bory de St Vincent, 1823	*Callorhynchus milii*
HHA	Chimaera	Smallspine spookfish	*Harriotta haeckeli* Karrer, 1972	
LCH	Chimaera	Longnose spookfish	*Harriotta raleighana* Goode & Bean, 1895	
RCH	Chimaera	Pacific spookfish	*Rhinochimaera pacifica* (Mitsukuri, 1895)	
CHG	Chimaera	Purple chimaera, giant chimaera (CHG, sp. D)	*Chimaera lignaria* Didier, 2002	
CPN	Chimaera	Leopard chimaera (= sp. A2 black chimaera)	*Chimaera panthera* Didier, 1998	
GSP	Chimaera	Pale ghost shark	*Hydrolagus bemisi* Didier, 2002	
HYB	Chimaera	Black ghost shark (HYB, sp. A)	*Hydrolagus homonycteris* Didier 2008	
GSH	Chimaera	Dark ghost shark	*Hydrolagus novaezealandiae* (Fowler, 1910)	
HYP	Chimaera	Pointynose blue ghost shark (HYP, sp. C)	*Hydrolagus trolli* Didier and Seret, 2002	
FRS	Shark	Frill shark	*Chlamydoselachus anguineus* Garman, 1884	
HEP	Shark	Sharpnose sevengill shark	*Heptranchias perlo* (Bonnaterre, 1788)	
HEX	Shark	Sixgill shark	*Hexanchus griseus* (Bonnaterre, 1788)	
SEV	Shark	Broadnose sevengill shark	*Notorynchus cepedianus* (Peron, 1807)	*Notorhynchus cepedianus*
BRS	Shark	Bramble shark	*Echinorhinus brucus* (Bonnaterre, 1788)	
ECO	Shark	Prickly shark	*Echinorhinus cookei* Pietschmann, 1928	
MSH	Shark	Southern mandarin dogfish	*Cirrhigaleus australis* White, Last & Stevens, 2007	*Cirrhigaleus barbifer* (NZ & Aust)
SPD	Shark	Spiny dogfish	*Squalus acanthias* Linnaeus, 1758	
NSD	Shark	Northern spiny dogfish	*Squalus griffini* Phillipps, 1931	*Squalus mitsukurii* (NZ)
SQA	Shark	Kermadec spiny dogfish	*Squalus raoulensis* Duffy & Last, 2007	
	Shark	Harrisson's dogfish	*Centrophorus harrissoni* McCulloch, 1915	

Code	Group	Common name/code	Species	Additional names
CSQ	Shark	Leafscale gulper shark	*Centrophorus squamosus* (Bonnaterre, 1788)	
SND	Shark	Shovelnose dogfish	*Deania calcea* (Lowe, 1839)	*Deania calceum*
SNR	Shark	Rough longnose dogfish	*Deania histricosa* (Garman, 1906)	
DEQ	Shark	Longsnout dogfish	*Deania quadrispinosa* (McCulloch, 1915)	
ETB	Shark	Baxter's lantern dogfish	*Etmopterus baxteri* (NZ & Aust)	*Etmopterus granulosus* (Günther, 1880
ETL	Shark	Lucifer dogfish	*Etmopterus lucifer* Jordan & Snyder, 1902	
EMO	Shark	Moller's lantern shark	*Etmopterus molleri* (Whitley, 1939)	
ETP	Shark	Smooth lantern shark	*Etmopterus pusillus* (Lowe, 1839)	
EVI	Shark	Blue-eye lantern shark	*Etmopterus viator* Straube 2012	
CYL	Shark	Portuguese dogfish	*Centroscymnus coelolepis* Bocage & Capello, 1864	
CYO	Shark	Owston's dogfish	*Centroscymnus owstonii* Garman, 1906	*Centroscymnus owstoni*
CYP	Shark	Longnose velvet dogfish	*Centroselachus crepidater* (Bocage & Capello, 1864)	*Centroscymnus crepidater*
PLS	Shark	Plunket's shark	*Proscymnodon plunketi* (Waite, 1909)	*Centroscymnus plunketi*
SLB	Shark	Whitetail dogfish	*Scymnodalatias albicauda* Taniuchi & Garrick, 1986	*albicauda*
SHE	Shark	Sherwood's dogfish	*Scymnodalatias sherwoodi* (Archey, 1921)	*sherwoodi*
SOP	Shark	Southern sleeper shark	*Somniosus antarcticus* Whitley, 1939	*Somniosus pacificus* (NZ, Aust)
SOM	Shark	Little sleeper shark	*Somniosus longus* (Tanaka, 1912)	*Somniosus rostratus* (NZ)
ZAS	Shark	Velvet dogfish	*Zameus squamulosus* (Günther, 1877)	*Scymnodon squamulosus*
PDG	Shark	Prickly dogfish	*Oxynotus bruniensis* (Ogilby, 1893)	
BSH	Shark	Seal shark, black shark	*Dalatias licha* (Bonnaterre, 1788)	
EBI	Shark	Pygmy shark	*Euprotomicrus bispinatus* (Quoy & Gaimard, 1824)	
IBR	Shark	Cookie cutter shark	*Isistius brasiliensis* (Quoy & Gaimard, 1824)	
PJS	Shark	Port Jackson shark	*Heterodontus portusjacksoni* (Meyer, 1793)	
WSH	Shark	Whale shark	*Rhincodon typus* (Smith, 1828)	
ODO	Shark	Smalltooth sand tiger shark	*Odontaspis ferox* (Risso, 1810)	*Odontaspis herbsti*
CRC	Shark	Crocodile shark	*Pseudocarcharias kamoharai* (Matsubara, 1936)	

Code	Group	Common name/code	Species	Additional names
GOB	Shark	Goblin shark	*Mitsukurina owstoni* Jordan, 1898	
BET	Shark	Bigeye thresher	*Alopias superciliosus* (Lowe, 1839)	
THR	Shark	Thresher shark	*Alopias vulpinus* (Bonnaterre, 1788)	
BSK	Shark	Basking shark	*Cetorhinus maximus* (Gunnerus, 1765)	
WPS	Shark	Great white shark, white pointer	*Carcharodon carcharias* (Linnaeus, 1758)	
MAK	Shark	Mako, shortfin mako	*Isurus oxyrinchus* Rafinesque, 1810	
POS	Shark	Porbeagle	*Lamna nasus* (Bonnaterre, 1788)	
APR	Shark	Roughskin cat shark*[1]	*Apristurus ampliceps* Sasahara, Sato & Nakaya 2008	
APR	Shark	Pale catshark*[1]	*Apristurus exsanguis* Sato, Nakaya and Stewart 1999	
APR	Shark	Fleshynose cat shark*[1]	*Apristurus melanoasper* Iglésias, Nakaya & Stehmann 2004	
APR	Shark	Cat shark*[1]	*Apristurus pinguis* Deng, Xiong & Zhan 1983	
APR	Shark	Freckled cat shark*[1]	*Apristurus sinensis* Chu & Hu 1981	
DCS	Shark	Dawson's cat shark*[1]	*Bythaelurus dawsoni* (Springer, 1971)	*Halaelurus dawsoni*
CAR	Shark	Carpet shark	*Cephaloscyllium isabellum* (Bonnaterre, 1788)	
	Shark	Shorttail cat shark	*Parmaturus bigus* Seret & Last, 2007	
PCS	Shark	McMillan’s cat shark	*Parmaturus macmillani* Hardy, 1985	
SSH	Shark	Slender smooth hound	*Gollum attenuatus* (Garrick, 1954)	
PMI	Shark	False cat shark	*Pseudotriakis microdon* Capello, 1868	
SCH	Shark	School shark, tope	*Galeorhinus galeus* (Linnaeus, 1758)	
SPO	Shark	Rig	*Mustelus lenticulatus* Phillipps, 1932	
BWH	Shark	Bronze whaler	*Carcharhinus brachyurus* (Günther, 1870)	
CGA	Shark	Galapagos shark	*Carcharhinus galapagensis* (Snodgrass & Heller, 1905)	
OWS	Shark	Oceanic whitetip shark	*Carcharhinus longimanus* (Poey, 1861)	
DSH	Shark	Dusky shark	*Carcharhinus obscurus* (Le Sueur, 1818)	
TIS	Shark	Tiger shark	*Galeocerdo cuvier* (Peron & Le Sueur, 1822)	
BWS	Shark	Blue shark	*Prionace glauca* (Linnaeus, 1758)	

Code	Group	Common name/code	Species	Additional names
HHS	Shark	Hammerhead shark, smooth hammerhead	*Sphyrna zygaena* (Linnaeus, 1758)	
TAY	Batoid	Blind electric ray, numbfish	*Typhlonarke aysoni* (Hamilton, 1902)	
TTA	Batoid	Oval electric ray	*Typhlonarke tarakea* Phillipps, 1929	
ERA	Batoid	Electric ray	*Torpedo fairchildi* Hutton, 1872	
LSK	Batoid	Longtail skate, softnose skate	*Arhynchobatis asperrimus* Waite, 1909	
RIS	Batoid	Richardson's skate	*Bathyraja richardsoni* (Garrick, 1961)	
PSK	Batoid	Longnose deepsea skate	*Bathyraja shuntovi* Dolganov, 1985	
	Batoid	White-lipped ray*	*Brochiraja albilabiata* Last & McEachran, 2006	
BTA	Batoid	Smooth deepsea skate	*Brochiraja asperula* (Garrick & Paul, 1974)	*Pavoraja asperula*
BTS	Batoid	Prickly deepsea skate	*Brochiraja spinifera* (Garrick & Paul, 1974)	*Pavoraja spinifera*
BTH	Batoid	Sapphire skate	*Notoraja sapphira* Seret & Last 2009	
SSK	Batoid	Smooth skate	*Dipturus innominatus* (Garrick & Paul, 1974)	*Raja innominata*
RSK	Batoid	Rough skate	*Zearaja nasuta* (Banks in Müller & Henle, 1841)	*Raja nasuta, Raja nasutus*
BRA	Batoid	Shorttail stingray	*Dasyatis brevicaudata* (Hutton, 1875)	
WRA	Batoid	Longtail stingray	*Dasyatis thetidis* Ogilby in Waite, 1899	
DAS	Batoid	Pelagic stingray	*Pteroplatytrygon violacea* (Bonaparte, 1832)	*Dasyatis violacea, Dasyatis guileri*
EGR	Batoid	Eagle ray	*Myliobatis tenuicaudatus* Hector, 1877	
RMB	Batoid	Manta ray	*Manta birostris* (Donndorff, 1798)	
MJA	Batoid	Spinetail devil ray	*Mobula japanica* (Müller & Henle, 1841)	

*[1] Considered under the complex Catsharks or *Apristurus spp.* (APR)

8.3 List of shark reporting codes where commercial catch information is available.

Ranked in order of decreasing catch over the last five years of complete records. Species = MPI reporting codes.

Rank	Species	Preferred common name	Scientific name
1	SCH	School shark	*Galeorhinus galeus*
2	SPO	Rig	*Mustelus lenticulatus*
3	RSK	Rough skate	*Zearaja nasuta*
4	SPD	Spiny dogfish	*Squalus acanthias*
5	ELE	Elephant fish	*Callorhinchus milii*
6	CAR	Carpet shark	*Cephaloscyllium isabellum*
7	GSH	Dark ghost shark	*Hydrolagus novaezealandiae*
8	SSK	Smooth skate	*Dipturus innominatus*
9	OSD	Sharks & Dogfish not otherwise specified in Sch3, Part2 Reporting Regs 2001	Selachii (Order)
10	BWS	Blue shark	*Prionace glauca*
11	BSH	Seal shark	*Dalatias licha*
12	GSP	Pale ghost shark	*Hydrolagus bemisi*
13	MAK	Mako shark	*Isurus oxyrinchus*
14	EGR	Eagle ray	*Myliobatis tenuicaudatus*
15	SND	Shovelnose dogfish	*Deania calcea*
16	ERA	Electric ray	*Torpedo fairchildi*
17	POS	Porbeagle shark	*Lamna nasus*
18	NSD	Northern spiny dogfish	*Squalus griffini*
19	DWD	Deepwater dogfish (Unspecified)	N/A
20	THR	Thresher shark	*Alopias vulpinus*
21	HHS	Hammerhead shark	*Sphyrna zygaena*
22	SEV	Broadnose sevengill shark	*Notorynchus cepedianus*
23	BWH	Bronze whaler shark	*Carcharhinus brachyurus*
24	BRA	Short-tailed black ray	*Dasyatis brevicaudata*
25	LCH	Long-nosed chimaera	*Harriotta raleighana*
26	WRA	Whiptail ray	*Dasyatis thetidis*
27	DAS	Pelagic stingray	*Pteroplatytrygon violacea*
28	RAY	Rays	Torpedinidae, Narkidae, Dasyatidae, Myliobatidae, Mobulidae (Families)
29	CYO	Owston's dogfish	*Centroscymnus owstoni*
30	STR	Stingray (Unspecified)	NULL
31	CHI	Chimaera spp.	*Chimaera* spp.
32	PSK	Longnosed deepsea skate	*Bathyraja shuntovi*
33	ETB	Baxter's lantern dogfish	*Etmopterus baxteri*
34	CHG	Purple chimaera	*Chimaera lignaria*
35	SSH	Slender smooth hound	*Gollum attenuatus*
36	OSK	Skate, Other	Rajidae (Family)
37	ETL	Lucifer dogfish	*Etmopterus lucifer*
38	CSQ	Leafscale gulper shark	*Centrophorus squamosus*
39	HYD	Hydrolagus spp.	*Hydrolagus* spp.

Rank	Species	Preferred common name	Scientific name
40	ECO	Prickly shark	*Echinorhinus cookei*
41	BSK	Basking shark	*Cetorhinus maximus*
42	CYP	Longnose velvet dogfish	*Centroselachus crepidater*
43	CHP	Brown chimaera	*Chimaera carophila*
44	MJA	Spine-tailed devil ray	*Mobula japanica*
45	HEX	Sixgill shark	*Hexanchus griseus*
46	SHE	Sherwood's dogfish	*Scymnodalatias sherwoodi*
47	TIS	Tiger shark	*Galeocerdo cuvier*
48	BET	Bigeye thresher	*Alopias superciliosus*
49	DSK	Deepwater spiny skate	*Amblyraja hyperborea*
50	PDG	Prickly dogfish	*Oxynotus bruniensis*
51	PLS	Plunket's shark	*Scymnodon plunketi*
52	APR	*Apristurus* spp.	*Apristurus* spp.
53	SOP	Southern sleeper shark	*Somniosus antarcticus*
54	CSH	Cat shark	Other than *Apristurus* spp.
55	DSH	Dusky shark	*Carcharhinus obscurus*
56	BER	Blind electric rays	*Typhlonarke* spp.
57	HEP	Sharpnose sevengill shark	*Heptranchias perlo*
58	CYL	Portuguese dogfish	*Centroscymnus coelolepis*
59	DCS	Dawson’s cat shark	*Bythaelurus dawsoni*
60	EMO	Moller’s lantern shark	*Etmopterus molleri*
61	HYB	Black ghost shark	*Hydrolagus homonycteris*
62	RCH	Widenosed chimaera	*Rhinochimaera pacifica*
63	TTA	Oval electric ray	*Typhlonarke tarakea*
64	TAY	Blind electric ray	*Typhlonarke aysoni*

8.4 The management class, IUCN red list classification, DOC threat class and the DOC qualifier for a subset of the NPOA-Sharks (2013) list.

Compiled by Malcolm Francis (NIWA), Andrew Stewart (Te Papa), Clinton Duffy (DOC) and Peter McMillan (NIWA)

Code = the MPI reporting code, within management class (QMS = Quota Management System species), and this column includes the date that the species entered that category (where applicable). IUCN redlist classifications: DD = Data Deficient, EN = Endangered, LC = Least Concern, NT = Near Threatened, VU = Vulnerable, see http://www.iucnredlist.org/initiatives/mammals/description/glossary for more information. DOC threat classes: DD = Data Deficient, GD = Gradual Decline, MI = Migrant, NOT = Not Threatened, RR = Range Restricted, SP = Sparse, VA = Vagrant. DoC qualifiers: CD = Conservation Dependent, DP = Data Poor, RC = Recovering, SO = Secure Overseas, TO= Threatened Overseas, see http://www.doc.govt.nz/Documents/science-and-technical/sap244.pdf for more information.

Common name	Species	Code	Management class	IUCN redlist class	DOC threat class	DOC qualifier
Basking shark	*Cetorhinus maximus* (Gunnerus, 1765)	BSK	Protected (2010)	VU	GD	TO
Baxter's lantern dogfish	*Etmopterus baxteri*[11]	ETB	Non-QMS	LC	NOT	SO
Bigeye thresher	*Alopias superciliosus* (Lowe, 1839)	BET	Non-QMS	VU	NOT	TO
Black ghost shark*	*Hydrolagus homonycteris (*Didier 2008)	HYB	Non-QMS	DD	NOT	SO
Blind electric ray	*Typhlonarke aysoni* (Hamilton, 1902)	TAY	Non-QMS	DD	NOT	DP
Blue shark	*Prionace glauca* (Linnaeus, 1758)		QMS (2004)	NT	NOT	SO
Bramble shark	*Echinorhinus brucus* (Bonnaterre, 1788)	BRS	Non-QMS	DD	SP	DP,SO
Broadnose sevengill shark	*Notorynchus cepedianus* (Peron, 1807)	SEV	Non-QMS	DD	NOT	DP,SO
Bronze whaler	*Carcharhinus brachyurus* (Günther, 1870)	BWH	Non-QMS	NT	NOT	SO
Carpet shark	*Cephaloscyllium isabellum* (Bonnaterre, 1788)	CAR	Non-QMS	LC	NOT	
Cookie cutter shark	*Isistius brasiliensis* (Quoy & Gaimard, 1824)	IBR	Non-QMS	LC	NOT	SO
Crocodile shark	*Pseudocarcharias kamoharai* (Matsubara, 1936)	CRC	Non-QMS	NT	DD	SO
Dark ghost shark	*Hydrolagus novaezealandiae* (Fowler, 1910)	GSH	QMS (1998)	LC	NOT	
Dawson's cat shark	*Bythaelurus dawsoni* (Springer, 1971)	DCS	Non-QMS	DD	NOT	
Deepwater spiny skate	*Amblyraja hyperborea* (Collette, 1879)	DSK	Non-QMS		NOT	

[11] See Appendix 8.2 for alternate name and authority.

Common name	Species	Code	Management class	IUCN redlist class	DOC threat class	DOC qualifier
Dusky shark	*Carcharhinus obscurus* (Le Sueur, 1818)	DSH	Non-QMS	VU	MI	SO
Eagle ray	*Myliobatis tenuicaudatus* (Hector, 1877)	EGR	Non-QMS	LC	NOT	SO
Electric ray	*Torpedo fairchildi* (Hutton, 1872)	ERA	Non-QMS	DD	NOT	
Elephantfish	*Callorhinchus milii* (Bory de St Vincent, 1823)	ELE	QMS (1986)	LC	NOT	CD,RC
False cat shark	*Pseudotriakis microdon* (Capello, 1868)	PMI	Non-QMS	DD	DD	SO
Frill shark	*Chlamydoselachus anguineus* (Garman, 1884)	FRS	Non-QMS	NT	SP	DP,SO
Galapagos shark	*Carcharhinus galapagensis* (Snodgrass & Heller, 1905)	CGA	Non-QMS	NT	RR	SO
Goblin shark	*Mitsukurina owstoni* (Jordan, 1898)	GOB	Non-QMS	LC	SP	DP,SO
Great white shark, white pointer	*Carcharodon carcharias* (Linnaeus, 1758)	WPS	Protected (2007)	VU	GD	TO
Hammerhead shark, smooth hammerhead	*Sphyrna zygaena* (Linnaeus, 1758)	HHS	Non-target	VU	NOT	SO
Harrisson's dogfish	*Centrophorus harrissoni* (McCulloch, 1915)		Non-QMS	EN	DD	TO
Kermadec spiny dogfish	*Squalus raoulensis (*Duffy & Last, 2007)	SQA	Non-QMS	LC	DD	
Leafscale gulper shark	*Centrophorus squamosus* (Bonnaterre, 1788)	CSQ	Non-QMS	VU	NOT	
Leopard chimaera*	*Chimaera panthera* (Didier, 1998)	CPN	Non-QMS	DD	NOT	
Little sleeper shark	*Somniosus longus* (Tanaka, 1912)	SOM	Non-QMS	DD	DD	SO
Longnose deepsea skate	*Bathyraja shuntovi* (Dolganov, 1985)	PSK	Non-QMS	DD	NOT	
Longnose spookfish	*Harriotta raleighana* (Goode & Bean, 1895)	LCH	Non-QMS	LC	NOT	SO
Longnose velvet dogfish	*Centroselachus crepidater* (Bocage & Capello, 1864)	CYP	Non-QMS	LC	NOT	
Longsnout dogfish	*Deania quadrispinosa* (McCulloch, 1915)	DEQ	Non-QMS	NT	DD	SO
Longtail skate	*Arhynchobatis asperrimus* (Waite, 1909)	LSK	Non-QMS	DD	NOT	
Longtail stingray	*Dasyatis thetidis* (Ogilby in Waite, 1899)	WRA	Non-QMS	DD	NOT	SO
Lucifer dogfish	*Etmopterus lucifer* (Jordan & Snyder, 1902)	ETL	Non-QMS	LC	NOT	SO
Mako, shortfin mako	*Isurus oxyrinchus* (Rafinesque, 1810)	MAK	QMS (2004)	VU	NOT	SO
Manta ray	*Manta birostris* (Donndorff, 1798)	RMB	Protected (2010)	VU	MI	SO
McMillan’s cat shark	*Parmaturus macmillani* (Hardy, 1985)	PCS	Non-QMS	DD	DD	SO

Common name	Species	Code	Management class	IUCN redlist class	DOC threat class	DOC qualifier
Northern spiny dogfish	*Squalus griffini* (Phillipps, 1931)	NSD	Non-QMS	LC	NOT	SO
Oceanic whitetip shark	*Carcharhinus longimanus* (Poey, 1861)	OWS	Protected (2013)	VU	MI	SO
Oval electric ray	*Typhlonarke tarakea* (Phillipps, 1929)	TTA	Non-QMS	DD	NOT	DP
Owston's dogfish	*Centroscymnus owstonii* (Garman, 1906)	CYO	Non-QMS	LC	NOT	
Pacific spookfish	*Rhinochimaera pacifica* (Mitsukuri, 1895)	RCH	Non-QMS	LC	NOT	SO
Pale ghost shark	*Hydrolagus bemisi* (Didier, 2002)	GSP	QMS (1999)	LC	NOT	
Pelagic stingray	*Pteroplatytrygon violacea* (Bonaparte, 1832)	DAS	Non-QMS	LC	NOT	SO
Plunket's shark	*Scymnodon plunketi* (Waite, 1909)	PLS	Non-QMS	NT	NOT	
Pointynose blue ghost shark*	*Hydrolagus trolli* (Didier and Seret, 2002)	HYP	Non-QMS	DD	NOT	SO
Porbeagle	*Lamna nasus* (Bonnaterre, 1788)	POS	QMS (2004)	VU	NOT	TO
Port Jackson shark	*Heterodontus portusjacksoni* (Meyer, 1793)	PJS	Non-QMS	LC	VA	SO
Portuguese dogfish	*Centroscymnus coelolepis* (Bocage & Capello, 1864)	CYL	Non-QMS	NT	NOT	
Prickly deepsea skate	*Brochiraja spinifera* (Garrick & Paul, 1974)	BTS	Non-QMS	DD	DD	
Prickly dogfish	*Oxynotus bruniensis* (Ogilby, 1893)	PDG	Non-QMS	DD	NOT	DP,SO
Prickly shark	*Echinorhinus cookei* (Pietschmann, 1928)	ECO	Non-QMS	NT	SP	DP,SO
Purple chimaera, giant chimaera*	*Chimaera lignaria* (Didier, 2002)	CHG	Non-QMS	DD	NOT	SO
Pygmy shark	*Euprotomicrus bispinatus* (Quoy & Gaimard, 1824)	EBI	Non-QMS	LC	NOT	SO
Richardson's skate	*Bathyraja richardsoni* (Garrick, 1961)	RIS	Non-QMS	LC	DD	SO
Rig	*Mustelus lenticulatus* (Phillipps, 1932)	SPO	QMS (1986)	LC	NOT	CD
Rough skate	*Zearaja nasuta* (Banks in Müller & Henle, 1841)	RSK	QMS (2003)	LC	NOT	
Sapphire skate	*Notoraja sapphira (*Seret & Last 2009)	BTH	Non-QMS	DD	DD	
School shark, tope	*Galeorhinus galeus* (Linnaeus, 1758)	SCH	QMS (1986)	VU	NOT	CD,TO
Seal shark, black shark	*Dalatias licha* (Bonnaterre, 1788)	BSH	Non-QMS	NT	NOT	SO
Sharpnose sevengill shark	*Heptranchias perlo* (Bonnaterre, 1788)	HEP	Non-target	NT	SP	DP,SO
Sherwood's dogfish	*Scymnodalatias sherwoodi* (Archey, 1921)	SHE	Non-QMS	DD	SP	
Shorttail stingray	*Dasyatis brevicaudata* (Hutton, 1875)	BRA	Non-QMS	LC	NOT	SO
Shovelnose dogfish	*Deania calcea* (Lowe, 1839)	SND	Non-QMS	LC	NOT	SO

Common name	Species	Code	Management class	IUCN redlist class	DOC threat class	DOC qualifier
Sixgill shark	*Hexanchus griseus* (Bonnaterre, 1788)	HEX	Non-QMS	NT	SP	DP,SO
Slender smooth hound	*Gollum attenuatus* (Garrick, 1954)	SSH	Non-QMS	LC	NOT	SO
Smallspine spookfish	*Harriotta haeckeli* (Karrer, 1972)	HHA	Non-QMS	DD	NOT	DP,SO
Smalltooth sand tiger shark	*Odontaspis ferox* (Risso, 1810)	ODO	Protected (2010)	VU	SP	TO
Smooth deepsea skate	*Brochiraja asperula* (Garrick & Paul, 1974)	BTA	Non-QMS	DD	DD	
Smooth skate	*Dipturus innominatus* (Garrick & Paul, 1974)	SSK	QMS (2003)	NT	NOT	CD
Southern mandarin dogfish	*Cirrhigaleus australis* (White, Last & Stevens, 2007)	MSH	Non-QMS	DD	SP	DP,TO
Southern sleeper shark	*Somniosus antarcticus* (Whitley, 1939)	SOP	Non-QMS	DD	SP	DP,SO
Spinetail devil ray	*Mobula japanica* (Müller & Henle, 1841)	MJA	Protected (2010)	NT	NOT	SO
Spiny dogfish	*Squalus acanthias* (Linnaeus, 1758)	SPD	QMS (2004)	LC	NOT	SO
Thresher shark	*Alopias vulpinus* (Bonnaterre, 1788)	THR	Non-QMS	VU	NOT	TO
Tiger shark	*Galeocerdo cuvier* (Peron & Le Sueur, 1822)	TIS	Non-QMS	NT	MI	SO
Velvet dogfish	*Zameus squamulosus* (Günther, 1877)	ZAS	Non-QMS	DD	SP	DP,SO
Whale shark	*Rhincodon typus* (Smith, 1828)	WSH	Protected (2010)	VU	MI	SO
Whitetail dogfish	*Scymnodalatias albicauda* (Taniuchi & Garrick, 1986)	SLB	Non-QMS	DD	SP	DP,SO

8.5 Information on habitat, relative population size, distribution and reproductive mode of a number of shark species found in New Zealand waters.

Common name	Habitat	Relative population size in EEZ	Distribution	Distribution class	Reproductive mode
Basking shark	Demersal Shelf	Small	Worldwide	Globally widespread	Live bearers
Baxter’s lantern dogfish	Demersal Upper slope	Large	Southern Hemisphere	Globally widespread	Live bearers
Bigeye thresher	Pelagic	Small	Worldwide	Globally widespread	Live bearers
Black ghost shark	Demersal Mid slope	Moderate	Australasia	Regional	Egg laying
Blind electric ray	Demersal Upper slope	Moderate	Endemic	Endemic	Live bearers
Blue shark	Pelagic	Large	Worldwide	Globally widespread	Live bearers
Bramble shark	Demersal Upper slope	Small	Worldwide	Globally widespread	Live bearers
Broadnose sevengill shark	Demersal Shelf	Moderate	Worldwide	Globally widespread	Live bearers
Bronze whaler	Demersal Shelf	Moderate	Worldwide	Globally widespread	Live bearers
Carpet shark	Demersal Shelf	Large	Endemic	Endemic	Egg laying
Cookie cutter shark	Pelagic	Small	Worldwide	Globally widespread	Live bearers
Crocodile shark.	Pelagic	Small	Worldwide	Globally widespread	Live bearers
Dark ghost shark	Demersal Upper slope	Large	Endemic	Endemic	Egg laying
Dawson's cat shark	Demersal Upper slope	Small	Endemic	Endemic	Egg laying
Deepwater spiny skate	Demersal Mid slope	Moderate	Atlantic and Pacific	Globally widespread	Egg laying
Dusky shark	Demersal Shelf	Small	Worldwide	Globally widespread	Live bearers
Eagle ray	Demersal Shelf	Large	Australasia	Regional	Live bearers
Electric ray	Demersal Shelf	Large	Endemic	Endemic	Live bearers
Elephantfish	Demersal Shelf	Large	Australasia	Regional	Egg laying
False cat shark	Demersal Upper slope	Small	Worldwide	Globally widespread	Live bearers
Frill shark	Demersal Upper slope	Small	Worldwide	Globally widespread	Live bearers

Common name	Habitat	Relative population size in EEZ	Distribution	Distribution class	Reproductive mode
Galapagos shark	Demersal Shelf	Moderate	Worldwide	Globally widespread	Live bearers
Goblin shark	Demersal Upper slope	Small	Worldwide	Globally widespread	Live bearers
Great white shark, white pointer	Demersal Shelf	Small	Worldwide	Globally widespread	Live bearers
Hammerhead shark, smooth hammerhead	Demersal Shelf	Large	Worldwide	Globally widespread	Live bearers
Harrisson's dogfish	Demersal Upper slope	Small	Australasia	Regional	Live bearers
Kermadec spiny dogfish	Demersal Upper slope	Small	Endemic	Endemic	Live bearers
Leafscale gulper shark	Demersal Upper slope	Moderate	East Atlantic to west Pacific	Globally widespread	Live bearers
Leopard chimaera	Demersal Upper slope	Small	Australasia	Regional	Egg laying
Little sleeper shark	Demersal Upper slope	Small	Pacific	Globally widespread	Live bearers
Longnose deepsea skate	Demersal Mid slope	Small	Endemic	Endemic	Egg laying
Longnose spookfish	Demersal Upper slope	Large	Worldwide	Globally widespread	Egg laying
Longnose velvet dogfish	Demersal Upper slope	Large	Worldwide	Globally widespread	Live bearers
Longsnout dogfish	Demersal Upper slope	Small	South Africa to New Zealand	Globally widespread	Live bearers
Longtail skate	Demersal Upper slope	Moderate	Endemic	Endemic	Egg laying
Longtail stingray	Demersal Shelf	Moderate	South Africa to New Zealand	Globally widespread	Live bearers
Lucifer dogfish	Demersal Upper slope	Large	Western Pacific	Globally widespread	Live bearers
Mako, shortfin mako	Pelagic	Large	Worldwide	Globally widespread	Live bearers
Manta ray	Pelagic	Small	Worldwide	Globally widespread	Live bearers
McMillan’s cat shark	Demersal Mid slope	Small	New Zealand and southern Indian	Globally widespread	Egg laying
Northern spiny dogfish	Demersal Shelf	Large	Endemic	Endemic	Live bearers
Oceanic whitetip shark	Pelagic	Small	Worldwide	Globally widespread	Live bearers
Oval electric ray	Demersal Upper slope	Moderate	Endemic	Endemic	Live bearers
Owston’s dogfish	Demersal Upper slope	Large	Worldwide	Globally widespread	Live bearers
Pacific spookfish	Demersal Mid slope	Large	Pacific	Globally widespread	Egg laying

Appendix 8.5 Shark habitat, population size and distribution

Common name	Habitat	Relative population size in EEZ	Distribution	Distribution class	Reproductive mode
Pale ghost shark	Demersal Upper slope	Large	Australasia	Regional	Egg laying
Pelagic stingray	Pelagic	Large	Worldwide	Globally widespread	Live bearers
Plunket's shark	Demersal Upper slope	Large	Southern Hemisphere	Globally widespread	Live bearers
Pointynose blue ghost shark	Demersal Mid slope	Small	South-west Pacific	Regional	Egg laying
Porbeagle	Pelagic	Large	Atlantic, South Pacific and Indian	Globally widespread	Live bearers
Port Jackson shark	Demersal Shelf	Small	Australasia	Regional	Egg laying
Portuguese dogfish	Demersal Mid slope	Small	Worldwide	Globally widespread	Live bearers
Prickly deepsea skate	Demersal Upper slope	Small	Endemic	Endemic	Egg laying
Prickly dogfish	Demersal Upper slope	Moderate	Australasia	Regional	Live bearers
Prickly shark	Demersal Shelf	Small	Pacific	Globally widespread	Live bearers
Purple chimaera, giant chimaera	Demersal Mid slope	Small	Australasia	Regional	Egg laying
Pygmy shark	Pelagic	Small	Worldwide	Globally widespread	Live bearers
Richardson's skate	Demersal Mid slope	Small	Atlantic and Pacific	Globally widespread	Egg laying
Rig	Demersal Shelf	Large	Endemic	Endemic	Live bearers
Rough skate	Demersal Shelf	Large	Endemic	Endemic	Egg laying
Sapphire skate	Demersal Upper slope	Small	South-west Pacific	Regional	Egg laying
School shark, tope	Demersal Shelf	Large	Atlantic and Pacific	Globally widespread	Live bearers
Seal shark, black shark	Demersal Upper slope	Large	Atlantic and Pacific	Globally widespread	Live bearers
Sharpnose sevengill shark	Demersal Upper slope	Small	Worldwide	Globally widespread	Live bearers
Sherwood's dogfish	Demersal Upper slope	Small	Australasia	Regional	Live bearers
Shorttail stingray	Demersal Shelf	Large	South Africa to New Zealand	Globally widespread	Live bearers
Shovelnose dogfish	Demersal Upper slope	Large	East Atlantic to Pacific	Globally widespread	Live bearers
Sixgill shark	Demersal Upper slope	Small	Worldwide	Globally widespread	Live bearers
Slender smooth hound	Demersal Upper slope	Moderate	South-west Pacific	Regional	Live bearers
Smallspine spookfish	Demersal Mid slope	Small	Worldwide	Globally widespread	Egg laying
Smalltooth sand tiger shark	Demersal Upper slope	Small	Worldwide	Globally widespread	Live bearers

Common name	Habitat	Relative population size in EEZ	Distribution	Distribution class	Reproductive mode
Smooth deepsea skate	Demersal Upper slope	Small	Endemic	Endemic	Egg laying
Smooth skate	Demersal Upper slope	Large	Endemic	Endemic	Egg laying
Southern mandarin dogfish	Demersal Upper slope	Small	Australasia	Regional	Live bearers
Southern sleeper shark	Demersal Upper slope	Small	Subantarctic	Globally widespread	Live bearers
Spinetail devil ray	Pelagic	Moderate	Worldwide	Globally widespread	Live bearers
Spiny dogfish	Demersal Shelf	Large	Worldwide	Globally widespread	Live bearers
Thresher shark	Pelagic	Moderate	Worldwide	Globally widespread	Live bearers
Tiger shark	Demersal Shelf	Small	Worldwide	Globally widespread	Live bearers
Velvet dogfish	Demersal Upper slope	Small	Worldwide	Globally widespread	Live bearers
Whale shark	Pelagic	Small	Worldwide	Globally widespread	Live bearers
Whitetail dogfish	Demersal Upper slope	Small	Subantarctic	Globally widespread	Live bearers

8.6 Shark length and age data and reproductive statistics.

The length (in centimetres) at birth (L_0), maximum length (L_{max}), average length at maturity for the females and males (L_{50}), average age (in years) at maturity for the males and females (A_{50}), maximum known age (A_{max}; longevity), litter average size, gestation (years of pregnancy) and cycle (frequency of pregnancy in years). See species specific text for references.

Common name	L_0	L_{max}	Male L_{50}	Female L_{50}	Male A_{50}	Female A_{50}	A_{max}	Litter average	Gestation (cycle)
Basking shark	175	1000	750	800				6	
Baxter's lantern dogfish	22	90	55	63	20	30	57	9	
Bigeye thresher	120	484	275	335	10	13	20	2	
Black ghost shark		101	80	88					
Blind electric ray	10	40						11	
Blue shark	40	383	230	216	8	8	23	35	1(1.5)
Bramble shark	50	307	150	210				20	
Broadnose sevengill shark	45	300	150	220	5	16	50	85	1(2)
Bronze whaler	65	295	235	245	16	20	30	15	1(2)
Carpet shark	16	103	60	80					
Cookie cutter shark	14	50	38	40				8	
Crocodile shark.	43	122	73	95				4	
Dark ghost shark	11	80	53	63					
Dawson's cat shark	11	42	35	35					
Deepwater spiny skate	16	110	94						
Dusky shark	95	365	272	303		21	34	10	1(2.5)
Eagle ray	25	200	65	80					
Electric ray		120							
Elephantfish	11	110	52	71	3	5	20		
False cat shark	78	296	260	265				2	

Appendix 8.6 Shark length and age and reproductive data.

Common name	L_0	L_{max}	Male L_{50}	Female L_{50}	Male A_{50}	Female A_{50}	A_{max}	Litter average	Gestation (cycle)
Frill shark	50	196	117	135				7	1.5
Galapagos shark	70	300	218	237	7	8		9	
Goblin shark	85	550							
Great white shark, white pointer	135	600	360	475	10	14	70	8	
Hammerhead shark, smooth hammerhead	55	370	250	265			21	35	
Harrisson's dogfish	35	114	83	98	25	25		2	
Kermadec spiny dogfish		73	67						
Leafscale gulper shark	40	164	99	119	15	21	42	6	
Leopard chimaera									
Little sleeper shark	25	143	71	85					
Longnose deepsea skate		140							
Longnose spookfish	13	120							
Longnose velvet dogfish	33	105	60	80				6	
Longsnout dogfish	24	118	80	85				10	
Longtail skate	10	75							
Longtail stingray	60	400							
Lucifer dogfish	15	47	30	34					
Mako, shortfin mako	75	394	200	306	8	20	29	12	1.5(3)
Manta ray	136	790	380	413			20	1	
McMillan’s cat shark		53							
Northern spiny dogfish	25	110	70	90				8	
Oceanic whitetip shark	63	350	185	190	6	6	12	6	1
Oval electric ray		40							
Owston’s dogfish	30	120	70	100				10	
Pacific spookfish	12	130	100	125					

Appendix 8.6 Shark length and age and reproductive data.

Common name	L_0	L_{max}	Male L_{50}	Female L_{50}	Male A_{50}	Female A_{50}	A_{max}	Litter average	Gestation (cycle)
Pale ghost shark		90	60	70					
Pelagic stingray	18	130	37	47					
Plunket's shark	34	170	110	130				25	
Pointynose blue ghost shark		110	96						
Porbeagle	78	285	170	204	10	17	65	3.8	0.7(1)
Port Jackson shark	23	165	75	88	9	13	35	13	
Portuguese dogfish	30	122	85	100				12	
Prickly deepsea skate		80							
Prickly dogfish	24	91	60	72				7	
Prickly shark	45	450	185	275				114	
Purple chimaera, giant chimaera		128	70	80					
Pygmy shark	8	27	17	23				8	
Richardson's skate	22	175							
Rig	28	151	85	100	6	8	20	11	1(1)
Rough skate	13	79	52	59	4	6	9		
Sapphire skate		41							
School shark, tope	30	175	130	138	15	14	60	30	1(3)
Seal shark, black shark	35	182	100	120				12	
Sharpnose sevengill shark	25	139	75	100				13	
Sherwood's dogfish		85							
Shorttail stingray	50	430						8	
Shovelnose dogfish	30	122	78	106	9	16	23	6	
Sixgill shark	70	482	315	420				77	
Slender smooth hound	38	110	70	70				2	
Smallspine spookfish		65							
Smalltooth sand tiger shark	100	450	225	325				2	

Appendix 8.6 Shark length and age and reproductive data.

Common name	L_0	L_{max}	Male L_{50}	Female L_{50}	Male A_{50}	Female A_{50}	A_{max}	Litter average	Gestation (cycle)
Smooth deepsea skate		57							
Smooth skate	13	158	93	112	8	13	28		
Southern mandarin dogfish		123						10	
Southern sleeper shark	40	600	400	435				10	
Spinetail devil ray	90	310	202	236				1	1
Spiny dogfish	24	112	58	73	6	10	26	6	2(2)
Thresher shark	135	575	340	375	5	6	24	4	
Tiger shark	65	600	300	330	8	10	22	33	1(2)
Velvet dogfish	20	84	47	59				7	
Whale shark	45	1200	600	800				300	
Whitetail dogfish		111		70				59	

8.7 The classification of productivity and averages of subcomponents for the NPOA sharks list.

Classification (on a scale of 1–3) of age at maturity, productivity fecundity, average productivity and the average of three (distribution class, population size in the EEZ and the average productivity) and four subcomponents (average of productivity age at maturity, productivity fecundity, distribution class and the population size in the EEZ). 1 = least at risk and 3 = most at risk. Blank cells indicate a lack of information. Avg. = Average.

Common name	Productivity age at mat	Productivity fecundity	Avg. productivity	Avg. of 3 subcomponents	Avg. 4 subcomponents
Basking shark		3	3	2.33	2.33
Baxter’s lantern dogfish	3	2	2.5	1.5	1.75
Bigeye thresher	3	3	3	2.33	2.5
Black ghost shark				2	2
Blind electric ray		2	2	2.33	2.33
Blue shark	2	1	1.5	1.16	1.25
Bramble shark		2	2	2	2
Broadnose sevengill shark	3	1	2	1.66	1.75
Bronze whaler	3	3	3	2	2.25
Carpet shark				2	2
Cookie cutter shark		2	2	2	2
Crocodile shark.		3	3	2.33	2.33
Dark ghost shark				2	2
Dawson's cat shark				3	3
Deepwater spiny skate				1.5	1.5
Dusky shark	3	3	3	2.33	2.5
Eagle ray				1.5	1.5
Electric ray				2	2
Elephantfish	1		1	1.33	1.33
False cat shark		3	3	2.33	2.33
Frill shark		3	3	2.33	2.33

Appendix 8.7 Classification of productivity and averages of subcomponents.

Common name	Productivity age at mat	Productivity fecundity	Avg. productivity	Avg. of 3 subcomponents	Avg. 4 subcomponents
Galapagos shark	2	2	2	1.66	1.75
Goblin shark				2	2
Great white shark, white pointer	3	2	2.5	2.16	2.25
Hammerhead shark, smooth hammerhead		1	1	1	1
Harrisson's dogfish	3	3	3	2.66	2.75
Kermadec spiny dogfish				3	3
Leafscale gulper shark	3	3	3	2	2.25
Leopard chimaera				2.5	2.5
Little sleeper shark				2	2
Longnose deepsea skate				3	3
Longnose spookfish				1	1
Longnose velvet dogfish		3	3	1.66	1.66
Longsnout dogfish		2	2	2	2
Longtail skate				2.5	2.5
Longtail stingray				1.5	1.5
Lucifer dogfish				1	1
Mako, shortfin mako	3	3	3	1.66	2
Manta ray		3	3	2.33	2.33
McMillan’s cat shark				2	2
Northern spiny dogfish		2	2	2	2
Oceanic whitetip shark	1	3	2	2	2
Oval electric ray				2.5	2.5
Owston’s dogfish		2	2	1.33	1.33
Pacific spookfish				1	1
Pale ghost shark				1.5	1.5
Pelagic stingray				1	1
Plunket’s shark		2	2	1.33	1.33

Appendix 8.7 Classification of productivity and averages of subcomponents.

Common name	Productivity age at mat	Productivity fecundity	Avg. productivity	Avg. of 3 subcomponents	Avg. 4 subcomponents
Pointynose blue ghost shark				2.5	2.5
Porbeagle	3	3	3	1.66	2
Port Jackson shark	3	2	2.5	2.5	2.5
Portuguese dogfish		2	2	2	2
Prickly deepsea skate				3	3
Prickly dogfish		3	3	2.33	2.33
Prickly shark		1	1	1.66	1.66
Purple chimaera, giant chimaera				2.5	2.5
Pygmy shark		2	2	2	2
Richardson's skate				2	2
Rig	2	2	2	2	2
Rough skate	1		1	1.66	1.66
Sapphire skate				2.5	2.5
School shark, tope	3	2	2.5	1.5	1.75
Seal shark, black shark		2	2	1.33	1.33
Sharpnose sevengill shark		2	2	2	2
Sherwood's dogfish				2.5	2.5
Shorttail stingray		2	2	1.33	1.33
Shovelnose dogfish	3	3	3	1.66	2
Sixgill shark		1	1	1.66	1.66
Slender smooth hound		3	3	2.33	2.33
Smallspine spookfish				2	2
Smalltooth sand tiger shark		3	3	2.33	2.33
Smooth deepsea skate				3	3
Smooth skate	3		3	2.33	2.33
Southern mandarin dogfish		2	2	2.33	2.33
Southern sleeper shark		2	2	2	2
Spinetail devil ray		3	3	2	2

Appendix 8.7 Classification of productivity and averages of subcomponents.

Common name	Productivity age at mat	Productivity fecundity	Avg. productivity	Avg. of 3 subcomponents	Avg. 4 subcomponents
Spiny dogfish	2	3	2.5	1.5	1.75
Thresher shark	1	3	2	1.66	1.75
Tiger shark	2	2	2	2	2
Velvet dogfish		3	3	2.33	2.33
Whale shark		1	1	1.66	1.66
Whitetail dogfish		1	1	1.66	1.66