Fisheries New Zealand

Tini a Tangaroa

Qualitative (Level 1) risk assessment of the impact of commercial fishing on New Zealand chondrichthyans: an update for 2017

New Zealand Aquatic Environment and Biodiversity Report No. 201.

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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. An initial qualitative (level 1) risk assessment (RA) workshop in November 2014 assessed the risk to all New Zealand chondrichthyan taxa from commercial fishing. This report details outcomes from a repeat of that RA process in 2017 which used similar methodologies and personnel, and incorporated new information available since the 2014 risk assessment. The intention was for this RA to inform management and be a forerunner to a more quantitative (level 2) RA.

The qualitative RA used a modified Scale Intensity Consequence Analysis (SICA) approach. A data compilation exercise completed prior to the workshop allowed discussion and decisions about risk to be well informed. 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 the species' biological productivity. The assessment considered risk on a national (Exclusive Economic Zone (EEZ)) scale. This process scored both intensity and consequence of the fishery to the shark taxa on a scale of one to six (where one was low, and six was high). A total of 50 taxa were assessed out of the known New Zealand fauna of 112 chondrichthyans.

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 (including rays, skates, and chimaeras) - Protected, Quota Management System (QMS) and non-QMS taxa. Basking shark remained the highest scoring protected species with an unchanged total risk score of 13.5. New data have been generated since the 2014 risk assessment, particularly for high-risk non-QMS shark species. Re-examination of all of the available data has resulted in changed evaluation of risk for a number of species. Plunket's shark, thresher shark and shovelnose dogfish (all non-QMS species) have increased 2.5 risk points or more. Plunket's shark is now considered the most at-risk shark (risk score = 22.5) due to a re-evaluation of its intensity score. Carpet shark (Non-QMS), electric ray (Non-QMS), and smooth and rough skates (both QMS) have all decreased more than 2.5 risk points due to new information on abundance or productivity. The highest risk QMS species are now rough skate, elephantfish, dark ghost shark, rig, spiny dogfish and school shark, all having a relatively high fishing intensity (scoring 6) and a moderate consequence score of 3, for a total risk score of 18. 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 five for total consequence). However, out of the 50 taxa considered in detail, the panel had low confidence in the risk scores for three of 11 QMS species, 26 of 36 non-QMS taxa and all three protected species. Some species that were evaluated in detail in 2014 were not re-evaluated in

2017, as the panel were confident risk was low, but not that it could be assessed well quantitatively.

The RA was designed to help prioritise management actions for shark taxa, noting that protected species are also given priority under the NPOA–Sharks (2013). The panel made several recommendations for high-risk or protected species regarding potential research options. These included better use of existing data, data grooming or analysis to improve inputs to assessment scores, improved taxonomy and training to underpin identification of sharks, and collection of more biological information to increase understanding of productivity (especially the ability of a taxon to withstand and to recover from fishing impacts). The RA panel also stressed that, particularly where abundance indices are lacking, the consequence scale was more relevant to risk than the total risk score which was often dominated by the level of intensity (masking differences in potential consequence). Taxa with high consequence scores have low productivity or presumed low productivity. In such cases, more information may improve the scores or our confidence in them, but in the interim a more precautionary approach to management was recommended by the panel.

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]). The term "shark" is used generally in this document to refer to all sharks, rays, skates, and chimaeras. That document recognises that sharks can play important roles in maintaining healthy ocean ecosystems, and that they commonly share biological characteristics that render 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." The IPOA-Sharks suggests that member states of the FAO that conduct fisheries either targeting sharks, or regularly catching 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 (MPI) in conjunction with a range of stakeholders produced an updated National Plan of Action for Sharks 2013 (NPOA-Sharks 2013[2]) 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[3] 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 one and six 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.

---

[1] http://www.fao.org/docrep/006/x3170e/x3170e03.htm

[2] The NPOA-Sharks was first published in 2008 and reviewed and updated for the NPOA-Sharks 2013. See: http://www.fao.org/ipoa-sharks/en/ and https://fs.fish.govt.nz/Page.aspx?pk=165

[3] Risk as defined here is consistent with other New Zealand fisheries risk assessments, e.g., Currey et al. (2012) and Richard & Abraham (2013).

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 of the NPOA-Sharks:

> Objective 1.1
> Develop and implement a **risk assessment framework** to identify the nature and extent of risks to shark populations
>
> 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, Clark et al. (2011) for seamount habitat, Clark et al. (2014) for deep-sea corals, Currey et al. (2012) for Maui's dolphins, Stoklosa et al. (2012) for aquaculture, MacDiarmid et al. (2012) for a variety of New Zealand habitats, Richard et al. (2017) for incidental seabird captures and mortality and Abraham et al. (2017) for marine mammals.

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 one 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 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 because they 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 a SICA assessment which re-evaluated a Level 1 ERA done in 2014 (Ford et al. 2015) for the effects of commercial fishing on 50 sharks, skates, rays and chimaeras encountered in the New Zealand region. The assessment incorporated new information available since 2014, and was carried out during a 3-day expert workshop from 31 October to 2 November, 2017.

2. METHODS

2.1 Scope and panel composition.

The risk assessment workshop focused on the threat from commercial fisheries on shark populations in the New Zealand 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 more data exist for commercial than recreational or customary catch
2. A review of non-fishing threats (e.g., marine industries) concluded that their impacts were a less imminent threat to shark populations than those from commercial fisheries (Francis & Lyon 2013)
3. There was a paucity of information to inform a risk assessment on non-fishing threats (Francis & Lyon 2013).

The last five years (2011–12 to 2015–16 fishing years) were chosen to focus the assessment so that it was up-to-date and relevant for the current level of fishing. However longer-term data were used where available to inform the rate at which shark species decline or recover, and hence to determine the consequence score.

There are 112 shark taxa present in the EEZ and TS (Appendix 8. 2). Ninety-two taxa were considered at the 2014 workshop, but not all were assessed due to limitations on data availability, fisheries reporting codes, and commercial catch information. These factors, and the decision not to score species with an intensity score of two or less (see 2.3 below), resulted in 50 taxa being assessed in 2017 (Appendix 8.2).

The RA 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 Clark (National Institute of Water and Atmospheric Research (NIWA))
- Clinton Duffy MSc (Department of Conservation (DOC))
- Dr Matt Dunn (NIWA)

- Dr Malcolm Francis (NIWA)
- Dr Emma Jones (NIWA)
- Richard Wells BSc (Deepwater Group and Fisheries Inshore New Zealand).

The panel was chaired by Dr Rich Ford (Fisheries New Zealand (FNZ)) and assisted by Dr Lyndsey Holland (FNZ). Stakeholders and representatives of government agencies were invited to observe the workshop to ensure transparency in the scientific process. These participants (Jack Fenaughty, Tom Clark and John Annala) could provide additional technical advice to inform the RA scoring, but not participate in the scoring itself.

The Panel operated under formal Terms of Reference (Appendix 0).

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 the directory to assess each shark taxon. For each shark species assessed by Ford et al. (2015), the directory collated new information post November 2014 (plus anything that was missed by the previous collation exercise completed under SEA2013-16) from the following sources:

- most recent Plenary chapter (May or November plenaries),
- data files, summaries and maps of reported commercial captures over the last five complete fishing years up to 30 September 2016,
- catch-effort reports by fishery group (based on fishing method, vessel length and target taxa, see Table 2 for a list) for the last five full fishing years,
- observer records by fishery group for the last five full fishing years,
- analysis of trends in observer records,
- trawl survey information on distribution and trends of various taxa,
- research papers, reports or summaries of biology, age, growth, fecundity, and general productivity.

Where taxonomic revisions have occurred since November 2014, data were combined, or extra data were collected, as appropriate.

In order to inform consequence scoring, a spreadsheet of management and biological factors (where available) was compiled for all taxa (see Appendices). This included taxon names (common, scientific, fisheries codes and different taxonomic levels), management classifications (QMS/Non-QMS/Protected, IUCN “redlist” classes, and New Zealand 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[4], litter size, gestation period and reproductive cycle length). In order to simplify the process, three larger groups of these factors (subcomponents) were identified and scored on a scale from one (being the least biologically susceptible to over-fishing) to three (being highly susceptible). These factor groups were population size in the focal area,

[4] Maximum known age is often an underestimate (as sampling and ageing the oldest individuals is difficult).

distribution class, and age at maturity and fecundity. Details of how these factors were scored are given in Table 1.

Estimated catch and total effort data for sharks were collated based on the ‘fisheries’ in Table 2 (for reporting purposes some fisheries with small numbers of captures were combined).

Maps were produced of the distribution of estimated shark catch and fishing effort for the last five years combined for commercial fisheries where more than 10 records of a particular shark taxon existed in that fishery (see 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 was based on other available information including observer records and/or expert judgement.

Where possible, a map of total catch of each shark taxon across all fisheries was produced so that the overall contribution of all relevant fisheries could be judged.

All pre-workshop figures and quantities were produced from un-groomed data. This was more cost and time effective than using groomed data. However, data errors were identified in the un-groomed results by the expert panel and such data and obvious outliers were discounted by the experts when making their RA interpretations. Therefore, the graphics presented here may contain inaccuracies and should not be used for further detailed analysis without checking the data, or reference to expert opinion.

Table 1: Consequence and intensity subcomponent 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)

	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 (1–100 per year	Quarterly (100–200 per year)	Weekly (200–300 per year)	Daily (> 300 per year)

[1] 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 is ignored.

Table 2: Classification of commercial and observer records into fishery groups (last column) based on fishing method, vessel length and target taxa. Species codes are defined in Appendix 8.6 and method codes in Appendix 8.7.

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

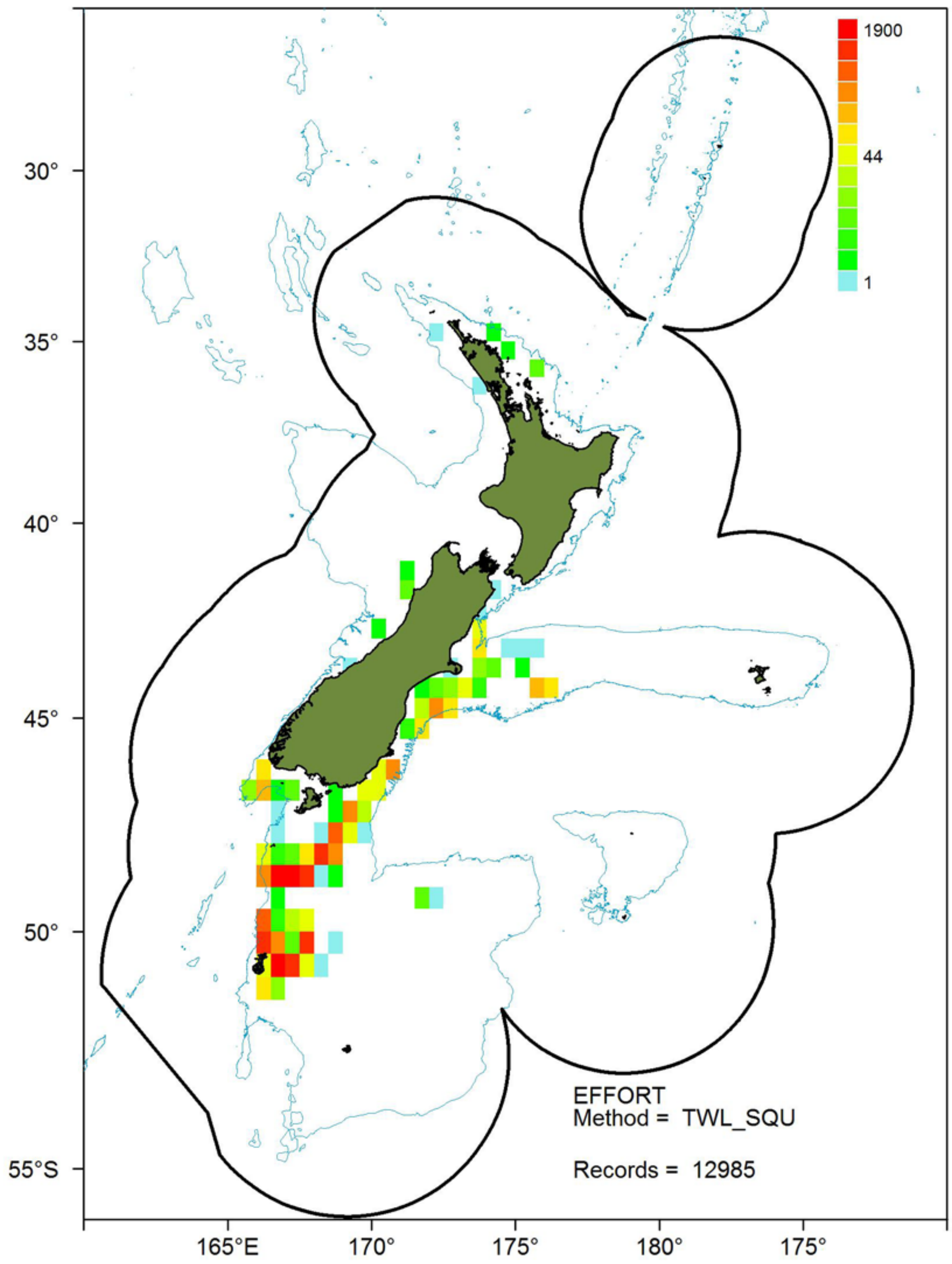

Figure 1: An example fishing effort map considered by the panel to determine intensity scores, in this case, effort (number of fishing events) from the SQU (squid) trawl fishery (last five years only). Scale bar is on a log scale, but numerals show untransformed values. For more details of how maps were produced see Francis (2015a).

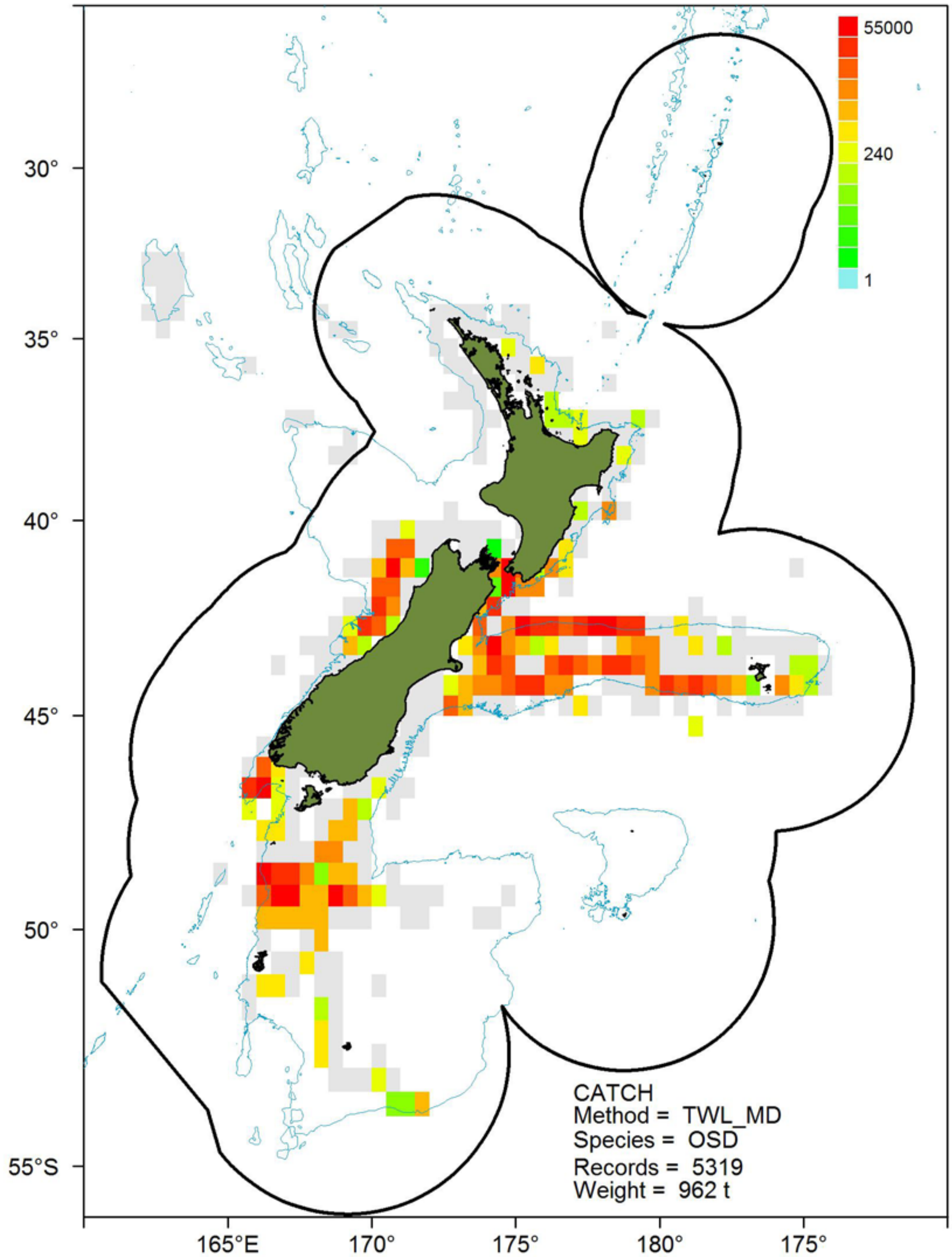

Figure 2: An example map, showing estimated catch of OSD (Other Sharks and Dogfish) from the middle-depths trawl fishery (TWL_MD in Table 2; last five years only). Scale bar is on a log scale, but numerals show untransformed values in kilograms. For more details of how maps were produced see Francis (2015a).

2.3 Assessment Methodology

A SICA methodology (Hobday et al. 2007, 2011) was chosen as the most appropriate for the risk assessment of commercial fishing threats, which are 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 data 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 scored for both temporal and spatial subcomponents on a categorical scale of increasing risk from one to six (Table 1). Spatial and temporal scale were scored in a manner consistent with Marine Stewardship Council (MSC) (2013) guidelines. 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 3, and notes were taken for each taxon to substantiate scores and to justify any deviations of the overall intensity score from the score class definition (Table 3).

The evaluation panel concluded that it was difficult to confidently assess the risk to species for which the fishing intensity occurred "rarely or in few restricted locations" (an intensity score of 2), or less. At these levels of intensity it was not possible to consistently separate consequence, which was usually poorly data-informed for these species, from intensity. In addition, this risk assessment is mainly used as a coarse filter to prioritise actions for species with the highest risks; therefore effort spent evaluating risk for relatively low-scoring taxa might have little practical benefit. Consequently, risk was not scored for species with intensity scores of two or less.

Consequence was scored in a manner consistent with MSC guidelines (MSC 2013) as shown in Table 4. Scores were based on discussion and consideration of the subcomponents of consequence (Table 4) and any abundance index/indices for the taxon under consideration.

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), and east coast South Island coastal (Beentjes et al. 2013) or deepwater (Doonan & Dunn 2011). In the absence of trawl survey indices, trends in bycatch rates were examined for deepwater taxa (Anderson 2013). Bycatch trends were treated more cautiously than abundance index trends, as they were considered less robust. Where subcomponent scores for consequence were sparse, by necessity the panel scored consequence against the definitions of the total consequence scores (Table 4). 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).

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

Table 3: Intensity overall scores and definitions, modified from Marine Stewardship Council (2013).

	Intensity overall score and description
1	Remote likelihood of catch/capture at any spatial or temporal scale (spatial (s)= 1, temporal (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 capture is moderate at broader spatial scale (s greater than or equal to 3), or high but local (t = 4 or above)
4	The amount of capture is relatively high (cf. 1–3) and occurs reasonably often at a 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 4: Consequence overall scores and descriptions, modified from Marine Stewardship Council (2013).

	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)

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 5) 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 of the results for each species). Poor data meant data were limited, unreliable or conflicting.

Table 5: 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. Scores should not be compared with those from other risk assessments, e.g. of teleost fishes, because factors like productivity were scored relative to other chondrichthyans, and productivity is generally low compared with teleosts (Dulvy et al. 2014). At the end of the scoring process high priority research was 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 category, and then the score for each taxon (in decreasing order of risk) is explained. Where taxa had identical risk scores, they are presented in descending order of consequences, and then in alphabetical order.

For each taxon, the total reported commercial catch[5] over the last five years was summed and pie graphs of the catch by different fishing methods were produced (where the estimated catch per fishery exceeded five tonnes, and was therefore considered representative). Observer reported (observed) commercial catch[6] can exceed commercially reported catch, because fishers during the reporting period were not required to report taxa outside the top five or eight species by weight. Where observed exceeded reported commercial catch they are reported and graphed, and the source of all data is clearly stated. Each pie graph shows capture by gear type: (trawl (TWL), setnet (SN), bottom longline (BLL), surface longline (BLL), Danish seine (DS)) plus an ‘others’ category (OTH) that combined all other fisheries. The data used in these pie graphs are un-groomed and may contain errors; therefore, expert interpretation of them may be necessary.

Abundance indices were 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 and was considered qualitatively during scoring. 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.

Specific panel recommendations regarding a taxon are included under the heading of that taxon, as well as in the General Discussion section. The latter section includes general research recommendations.

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[5] Reported commercial catch includes schedule 6 releases so it may exceed the reported landings for some species.
[6] Observed commercial catch has not been scaled up from the observed portion of the fleet, so it is likely to underestimate total catch, it may also reflect observer coverage differences, e.g. more observer coverage in one fishery versus another, e.g. trawl versus setnet, may bias the proportionality of the catches between the two methods.

3. RESULTS

Fifty taxa were scored by the risk assessment panel. The taxa not scored were infrequently seen, poorly identifed, scored as part of complexes (groupings of more than one taxon) or had predicted intensity of impact of two or less. No consequence scores over 4.5 were assigned (Figure 3). However, out of the 50 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 five or six for consequence) were judged to be occurring. The frequency of each intensity score generally had a downwards trend as intensity increased (Figure 3). 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 22.5 (Figure 4), even though the theoretical maximum score is 36. Scores were well below the possible maximum mainly because no consequence scores exceeded 4.5, although where intensity was high (6) consequence never exceeded 3.5.

There were only eight taxa (seven QMS and one non-QMS) for which the data were judged to both exist and be sound for risk assessment purposes, with most taxa scoring "exist but poor" (30) or "few data" (12). Despite this, consensus was achieved on the risk scores for all taxa, either with no qualifiers (17 species) or with low confidence (33 species).

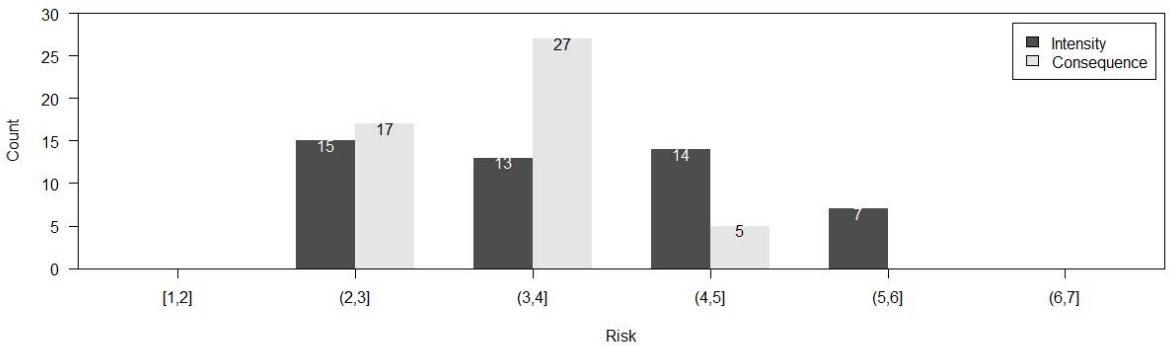


Figure 3: Frequency distribution of intensity and consequence scores.

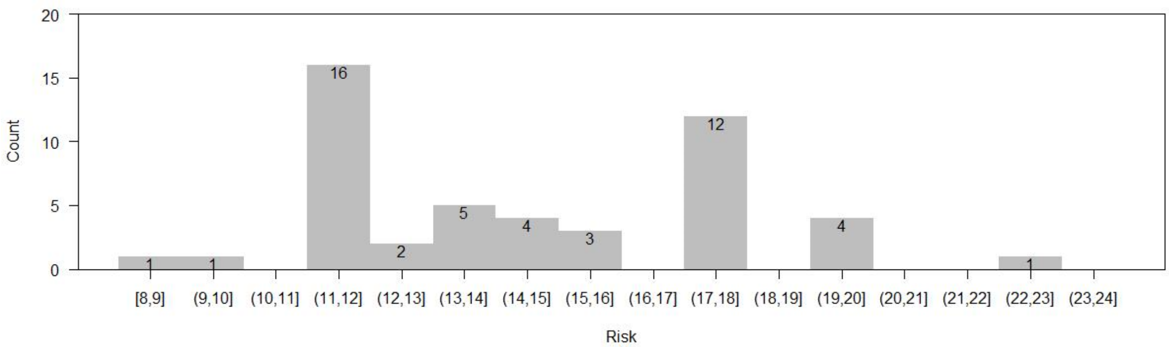


Figure 4: Frequency distribution of total risk scores.

3.1 Quota Management System (QMS) species

Eleven shark species are currently managed under the QMS (Table 6). All captures of all shark taxa were regarded as mortalities in the risk assessment process (because survival of released sharks is unknown), and this may overestimate risk of some species 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 5. The highest risk score within QMS sharks was shared by rough skate, spiny dogfish, dark ghost shark, elephantfish, rig and school shark. Smooth skate, mako shark, pale ghost shark and porbeagle shark were evaluated as having intermediate risk within this category. Blue sharks were evaluated as having the lowest risk within the QMS sharks.

Table 6: Shark species managed under the Quota Management System (QMS) in alphabetical order, and characterised by their management regime and Schedule 6 listing. HMS = Highly Migratory Species. See Appendix 8.2 for full taxonomic details. Reference to schedule 6 is within the Fisheries Act.

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

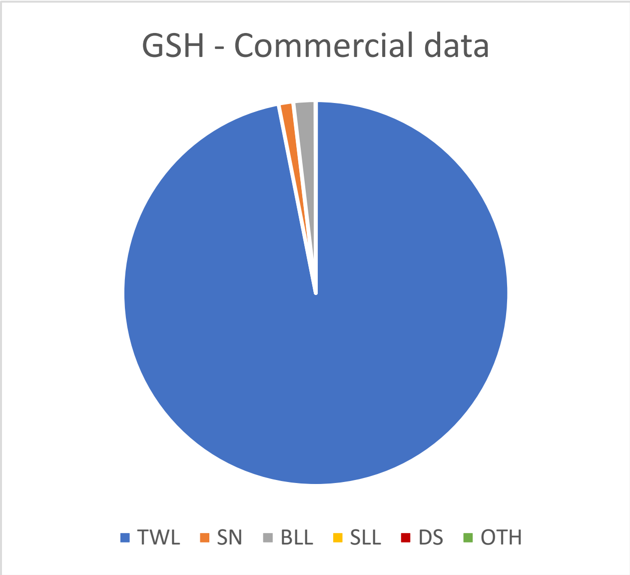
As QMS sharks are known to be either targeted by fishers or have relatively high catches (compared to most non-QMS species), it was expected that these species would score relatively highly in terms of intensity. All these sharks scored between four and six for intensity, which means the level of capture 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 three and 3.5. A score of three is defined as "Moderate and sustainable level of impact such as full exploitation rate for a target species", and 3.5 can be interpreted as halfway between three and a score of 4, which equals "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	18 - Dark ghost shark	✓✓	✓✓
6	3	18 - Elephantfish	✓✓✓	✓✓
6	3	18 - Rig	✓✓✓	✓✓
6	3	18 - Rough skate	✓✓✓	✓✓
6	3	18 - School shark	✓✓✓	✓✓
6	3	18 - Spiny dogfish	✓✓✓	✓✓
5	3.5	17.5 - Smooth skate	✓✓	✓✓
5	3	15 - Mako shark	✓✓✓	✓
5	3	15 - Pale Ghost Shark	✓✓	✓
5	3	15 - Porbeagle shark	✓✓✓	✓
4	3	12 - Blue shark	✓✓✓	✓✓

Figure 5: QMS species risk scores. For the COMPONENTS OF RISK higher numbers indicate greater intensity or consequence of impact (for more details see Table 3 and Table 4). For RISK longer bars and larger numbers indicate higher risk, and for CONFIDENCE more ticks indicate higher confidence in the data, or greater consensus (Two ticks in the consensus column indicate full consensus). Where species scored identical risk scores they are presented in descending order of consequences and then alphabetically.

Dark ghost shark (GSH) *Hydrolagus novaezealandiae*
(Intensity = 6, Consequence = 3, Risk = 18).
Reported Commercial Catch (2011–12 to 2015–16 fishing years): = 5238 t
Egg layer

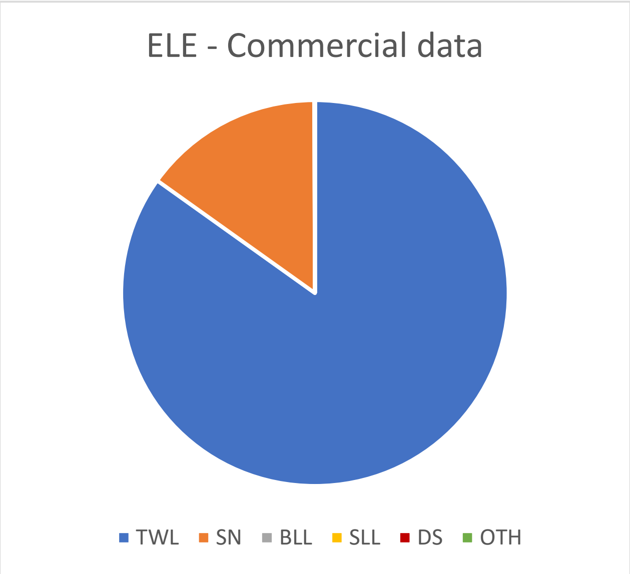


Confidence
Data were described as 'exist but poor' as no age data were available. Consensus was achieved.

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 is endemic to New Zealand (Cox & Francis 1997) but was 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 2017). The lack of a decline in any survey abundance indices over periods longer than five years suggests this population has some resilience to the effects of fishing.

Elephantfish (ELE) *Callorhinchus milii*
(Intensity = 6, Consequence = 3, Risk = 18)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 5730 t
Egg layer

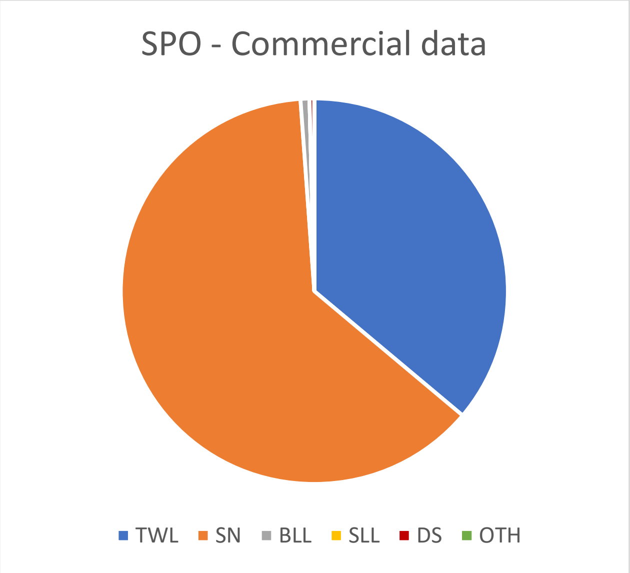


Confidence
Data were described as 'exist and sound' for the purposes of the assessment and consensus was achieved.

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

Elephantfish is 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 2010, Beentjes et al. 2013) which was also a factor in determining their consequence score.

Rig (SPO) *Mustelus lenticulatus*
(Intensity = 6, Consequence = 3, Risk = 18).
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 4801 t
Live bearer



Rationale

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

Rig is endemic (Francis 2012), but was classified as having a relatively large population within these waters. Rig is moderately productive (females are sexually mature from age 8, and produce an average of 11 pups per year – Francis & Mace 1980; Francis & ÓMaolagáin 2000). Setnet CPUE indices for rig generally varied without trend over the last five years (SPO 1E, SPO 3, SPO 7) or decreased (SPO 1W). However trawl indices have seen increases (SPO 1W, SPO 3 and SPO 7) in the last five years. 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).

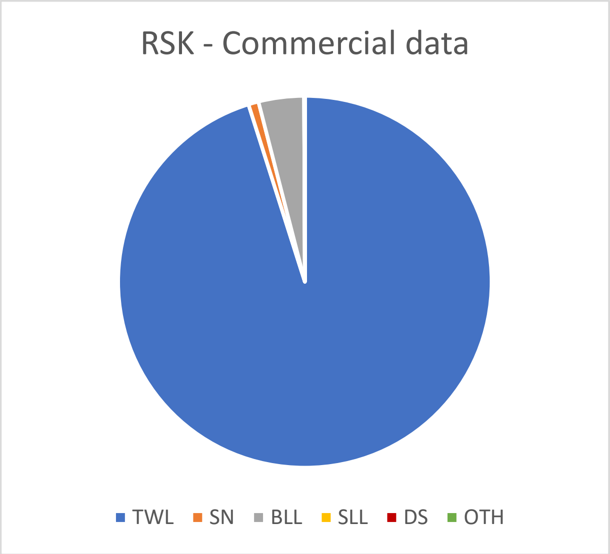
Confidence

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

Recommendation

An analysis of the sex ratio of capture in the SPO 1W setnet fishery may help to explain the observed decline in catch.

Rough skate (RSK) *Zearaja nasuta*
(Intensity = 6, Consequence = 3, Risk = 18)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 4975 t
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.

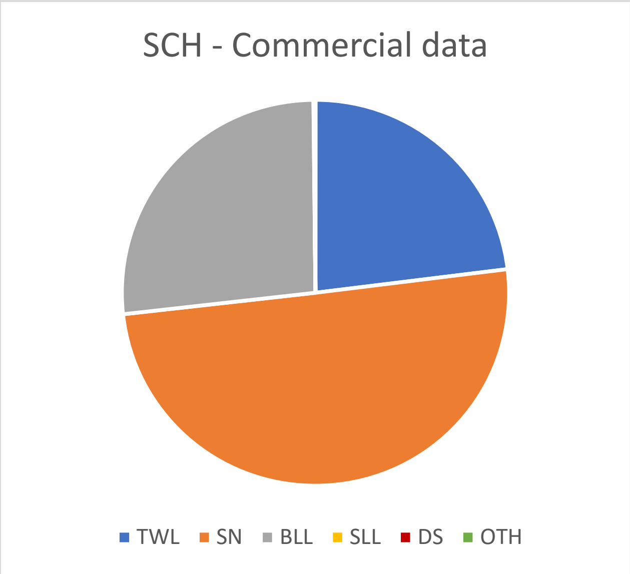
Rationale

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

Rough skate is endemic to New Zealand (Francis 2012); but was classified as having a relatively large population in New Zealand waters. Rough skate is also faster growing than the closely related smooth skate (Francis et al. 2001); therefore their consequence score (3) is marginally lower than for the smooth skate (3.5). 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 2017).

The consequence score for RSK decreased from 3.5 to three from the previous risk assessment due to greater confidence in the abundance indices as they have remained stable or are improving over a longer period. These multiple signals (although not optimised for this species) gave enough confidence to downgrade the consequence score, even given the relatively low productivity.

School shark (SCH) ***Galeorhinus galeus***
(Intensity = 6, Consequence = 3, Risk = 18)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 11 755 t
Live bearer

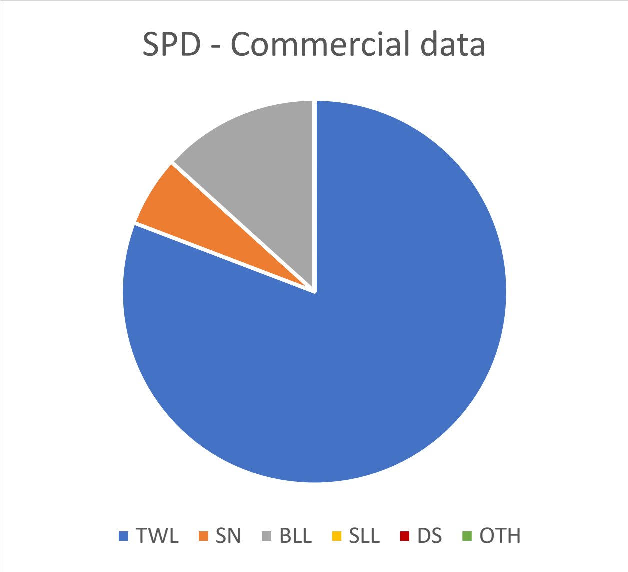


Confidence
Data were described as 'exist and sound' for the purposes of the assessment and consensus was achieved.

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 three years (Last & Stevens 2009). Abundance indices range from increasing to fluctuating without trend or decreasing (Ministry for Primary Industries 2017) so did not influence this scoring, as it was on a national scale.

Spiny dogfish (SPD) *Squalus acanthias*
(Intensity = 6, Consequence = 3, Risk = 18)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 21 301 t
Live bearer



Confidence

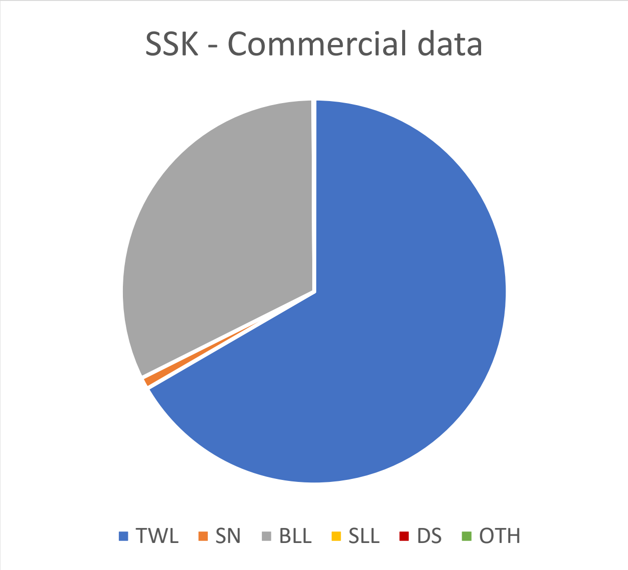
Data were described as 'exist and sound' for the purposes of the assessment and consensus was achieved.

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 six pups every two 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).

Smooth skate (SSK) *Dipturus innominatus*
(Intensity = 5, Consequence = 3.5, Risk = 17.5)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 1318 t
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.

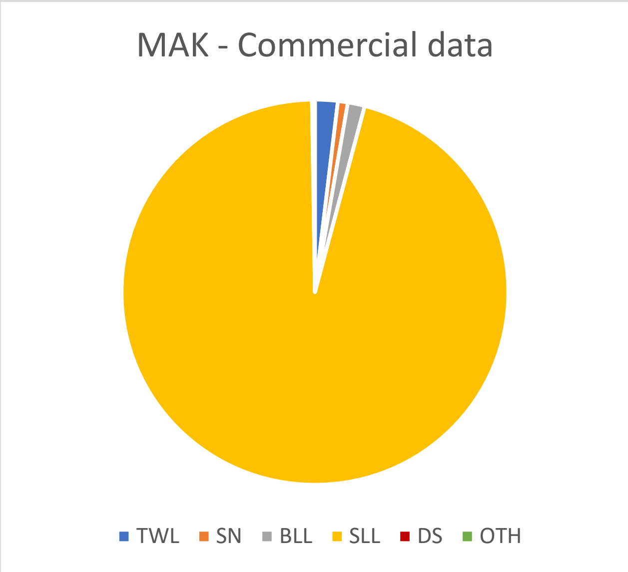
Rationale

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 five 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 a limited overlap with fishing at deeper depths, especially around parts of the coast where there is little deepwater trawling (Baird & Wood 2018).

Smooth skate is endemic to New Zealand (Francis 2012); but was classified as having a relatively large population in New Zealand waters. Smooth skate is slower growing than rough skates; therefore their consequence score (3.5) is marginally higher compared to the rough skates (3). Smooth skate is 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 2017), and there are contrasting patterns from observer estimated catch data (Anderson 2013).

The consequence score for SSK decreased from four to 3.5 from the previous risk assessment due to greater confidence in the abundance index signals that have remained stable or are improving over a longer period.

Mako (MAK) *Isurus oxyrinchus*
(Intensity = 5, Consequence = 3, Risk = 15)
Reported Commercial Catch (2011–12 to 2015–16): 841 t
Live bearer



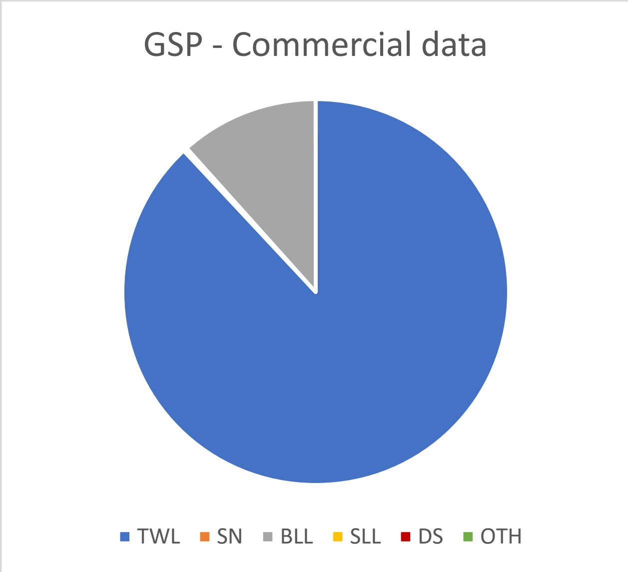
Confidence
Data were described as 'exist and sound' for the purposes of the assessment and consensus was achieved, but with low confidence. This low confidence was due to the fact that no data was available on adult stock size.

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 of 29 years; Bishop et al. 2006) and they have an average of 12 pups, but only once every three 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 nine years (particularly in northern NZ fisheries, Francis et al. (2014)).

Pale ghost shark (GSP) *Hydrolagus bemisi*
(Intensity = 5, Consequence = 3, Risk = 15)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 1215 t
Egg layer



Rationale

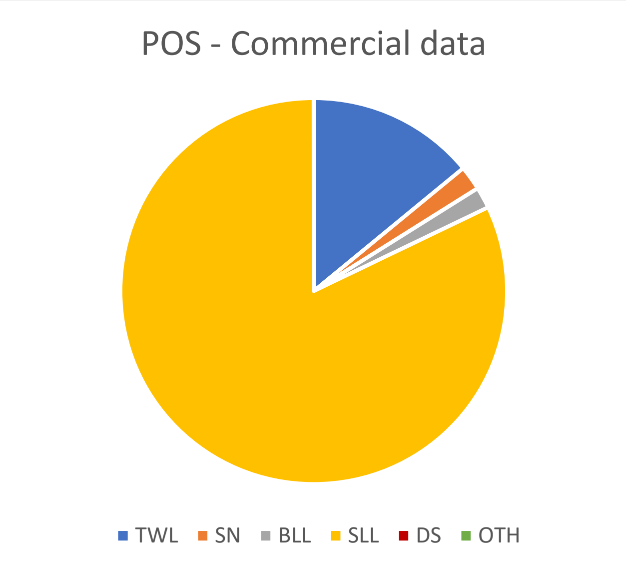
Pale ghost shark was estimated as vulnerable to fishing across 45 to 60% of their range and caught more than 300 days a year.

Pale ghost shark is 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 2017).

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.

Porbeagle shark (POS) *Lamna nasus*
(Intensity = 5, Consequence = 3, Risk = 15)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 392 t
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

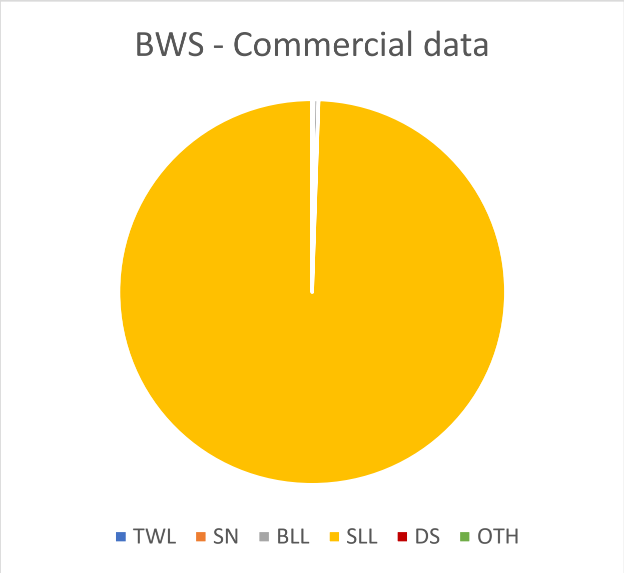
Porbeagle shark was estimated as vulnerable to fishing across 45 to 60% of their range and caught more than 300 days a year.

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 four 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 trending up suggesting an increase in abundance since 2005 (Francis et al. 2014).

Recommendation

The panel recommended that a quantitative assessment of status should be completed for this species as it is now relatively data rich. Notably, this was recently done for WCPFC, indicating that the impacts of fishing is low across the entire Southern Hemisphere range of the porbeagle shark population (Hoyle et al. 2017).

Blue shark (BWS) *Prionace glauca*
(Intensity = 4, Consequence = 3, Risk = 12)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 6196 t
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 eight 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 into 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. FNZ 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. the Chatham Rise), fisheries-independent trawl surveys provide another monitoring tool.

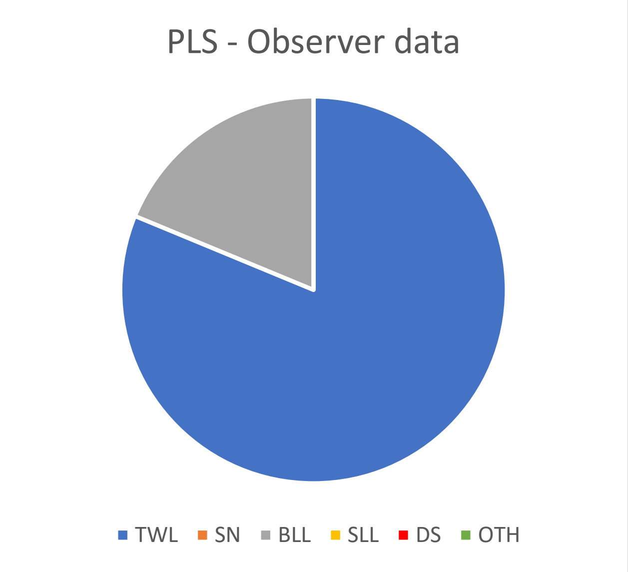
The overall risk for non-QMS shark taxa, its component parts (intensity and consequence) and the confidence in those scores, in terms of both the amount and quality of the data and the extent of consensus among the panel, are displayed in Figure 6.

NON-QMS SPECIES RISK

COMPONENTS OF RISK		RISK	CONFIDENCE	
Intensity	Consequence		Data	Consensus
5	4.5	22.5 – Plunket's shark	✓✓	✓
5	4	20 - Baxters dogfish	✓✓	✓✓
5	4	20 - Seal shark	✓✓	✓✓
5	4	20 - Shovelnose dogfish	✓✓	✓
5	4	20 - Thresher shark	✓✓	✓✓
4	4.5	18 - Leafscale gulper shark	✓✓	✓
4.5	4	18 - Longnose velvet dogfish	✓✓	✓✓
6	3	18 - Carpet Shark	✓✓	✓✓
5	3.5	17.5 - Longtail stingray	✓	✓✓
5	3.5	17.5 - Shorttail stingray	✓	✓✓
4	4	16 - Owston's dogfish	✓✓	✓
3.5	4.5	15.75 - Dawsons catshark	✓✓	✓
4.5	3.5	15.75 - Longnose spookfish	✓	✓
5	3	15 - Electric ray	✓✓	✓
3.5	4	14 - Bronze whaler	✓✓	✓
3.5	4	14 - Prickly dogfish	✓✓	✓
4	3.5	14 - Northern spiny dogfish	✓✓	✓
3.5	3.5	12.25 - Prickly deepsea skate	✓✓	✓
3.5	3.5	12.25 - Smooth deepsea skate	✓✓	✓
3	4	12 - *Brochiraja* complex	✓	✓
3	4	12 - Brown chimaera	✓	✓✓
3	4	12 - Catsharks	✓	✓
3	4	12 - Deepwater spiny skate	✓	✓
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	✓✓	✓
3	4	12 - Slender smooth hound	✓	✓
4	3	12 - Hammerhead shark	✓✓	✓
4	3	12 - Blind electric ray	✓✓	✓
4	3	12 - Broadnose sevengill shark	✓✓	✓
4	2.5	10 – Eagle ray	✓✓	✓
3	3	9 – Sharpnose sevengill shark	✓✓	✓
3	2	6 – Sixgill shark	✓ ✓	✓

Figure 6: Non-QMS Species Risk scores. For the COMPONENTS OF RISK higher numbers indicate greater intensity or consequence of impact (for more details see Table 3 and Table 4). For RISK longer bars and larger numbers indicate higher risk, and for CONFIDENCE more ticks indicate higher confidence in the data, or greater consensus (Two ticks in the consensus column indicate full consensus). Where taxa risk scores were identical they are presented so that higher consequences are reported first and then in alphabetical order. Taxa that scored less than three for consequence were not scored further, see Section 2.3 for more details. See Ford et al. (2015) for available data on shark species not listed in the table above.

Plunket's shark (PLS) *Scymnodon plunketi*
(Intensity = 5, Consequence = 4.5, Risk = 22.5)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 62 t
Live bearer



Confidence

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

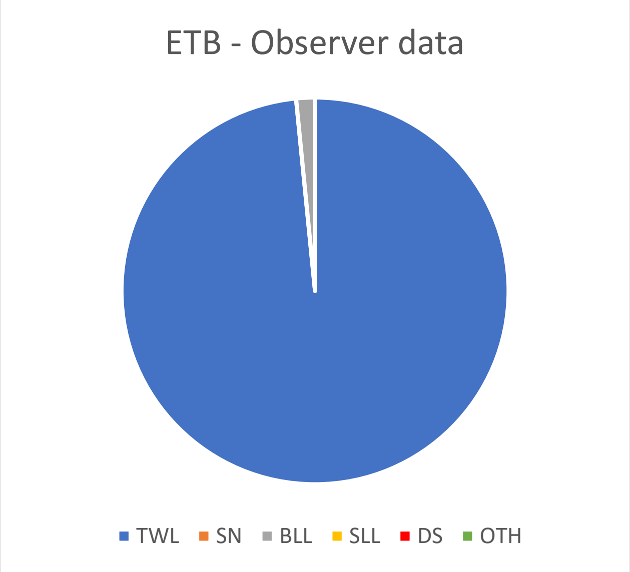
Rationale

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 five because Plunket's shark is distributed from 500 to 1200 m (McMillan et al. 2011) so have a limited overlap with fishing beyond 800 m depth, where the footprint of fishing is small (Baird & Wood 2018).

This species intensity score increased from four to five from the previous risk assessment due to the panels wish to make this equivalent to the score given for seal shark, as it was believed these occupied the same range.

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 are not known to reproduce until 48 and have a longevity of 53 years; they produce 23 to 36 pups per litter (Francis et al. 2018a). Trawl survey relative biomass indicators showed no trends in FMAs 3 – 6; however both surveys monitor this species poorly (Francis et al. 2016).

Baxter's dogfish (ETB) *Etmopterus granulosus*
(Intensity = 5, Consequence = 4, Risk = 20)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 406 t
Live bearer



Confidence

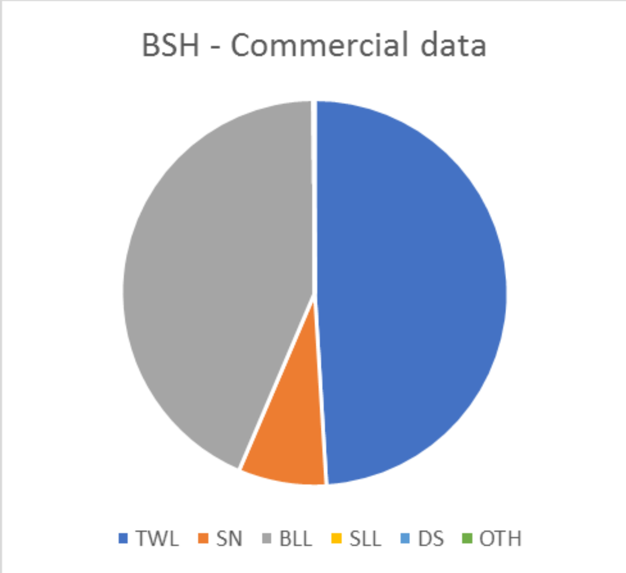
Data were described as 'exist but poor' as no reproductive frequency information or reliable abundance indices were available. Consensus was achieved

Rationale

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

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

Seal shark (BSH) *Dalatias licha*
(Intensity = 5, Consequence = 4, Risk = 20)
Reported Commercial Catch (2011–12 to 2015–16 fishing years):935 t
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.

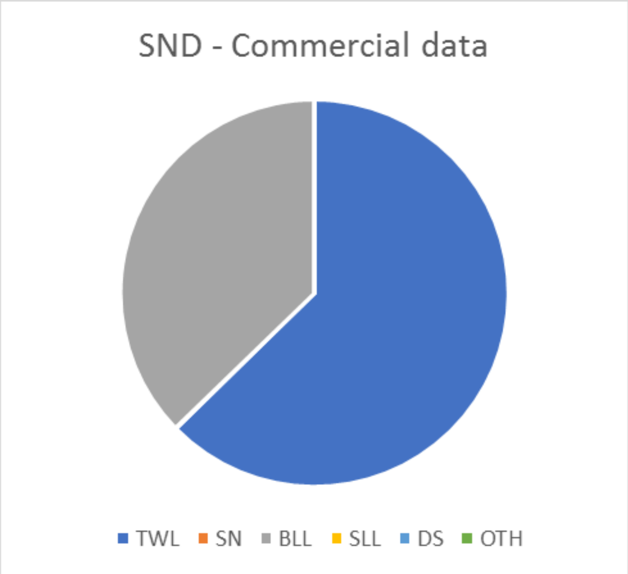
Rationale
Seal shark was estimated as vulnerable to fishing across more than 60% of its range and caught more than 300 days a year. Seal shark was scored with an overall intensity of five because it is distributed from 400 to 1000 m depth (McMillan et al. 2011) and may have a limited overlap with fishing beyond 800 m depth, where the footprint of fishing is small (Baird & Wood 2018).

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. Trawl survey indicators for FMA 3 - 6 suggest that there has been no major change over a long period of time in the abundance of juvenile seal shark; adult seal sharks are not well monitored by the surveys (Francis et al. 2016).

Recommendation

This species may benefit from having its indices analysed within different length classes.

Shovelnose dogfish (SND) *Deania calcea*
(Intensity = 5, Consequence = 4, Risk = 20)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 1087 t
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 hystricosa)*. Consensus was achieved.

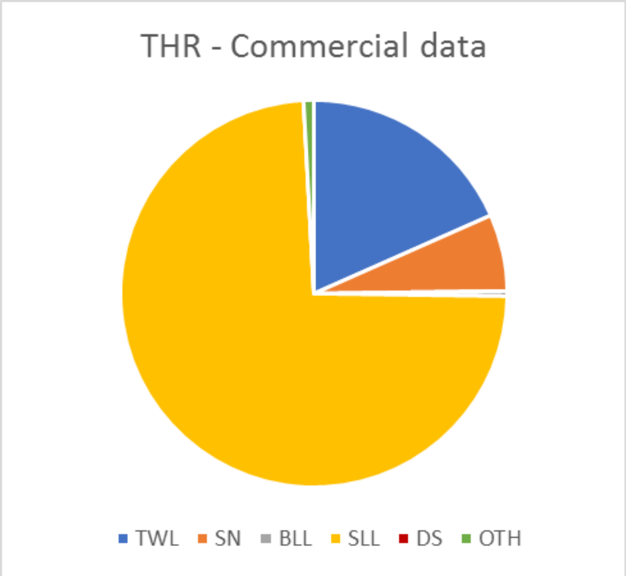
Rationale

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 five 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. 2011) and beyond 800 m the footprint of fishing is small (Baird & Wood 2018). 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 six pups per litter (Last & Stevens 2009, Parker & Francis 2012). Trawl survey indicators suggest no immediate concern for shovelnose dogfish in FMAs 3 – 6, but male median length and standardised observer CPUE show declines (Francis et al. 2016).

The consequence score for SND increased from 3.5 to four from the previous risk assessment as a reflection of the potential for unsustainable impacts due to the declines seen in some indices.

Thresher shark (THR) *Alopias vulpinus*
(Intensity = 5, Consequence = 4, Risk = 20)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 234 t
Live bearer



Confidence:
Data were described as 'exist but poor' as there are no reproductive frequency data or abundance indices. There may also be some misidentification between thresher and big eye thresher (*Alopias superciliosus*). Consensus was achieved, but with low confidence.

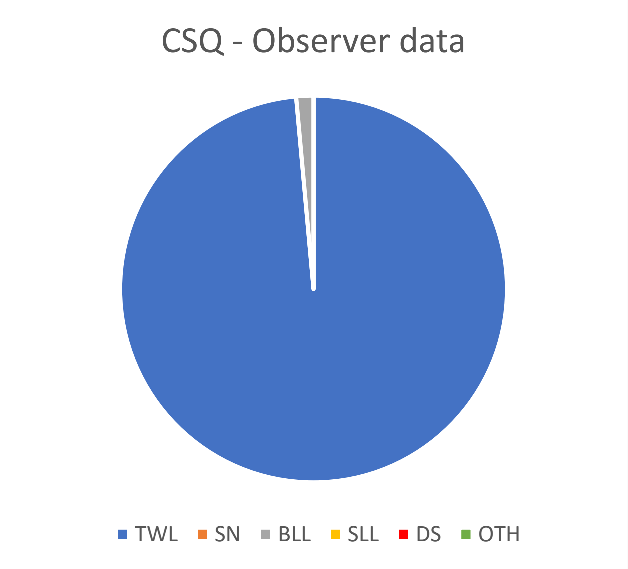
Rationale:
Thresher shark was estimated as vulnerable to fishing across 45 to 60% of their range and caught 200 to 300 days a year.

The THR intensity score increased from 3.5 to five from the previous risk assessment as the previously assumed Kermadec distribution was considered uncertain and the fishery was potentially on both adults and juveniles.

Thresher shark is globally widespread (Ebert et al. 2013) and was classified as having a relatively moderate population size in New Zealand waters. Females reproduce from 13 years old, with a maximum known age of 38 years (Natanson et al. 2015), and they have relatively low fecundity, with on average only four pups per litter (Last & Stevens 2009, Ebert et al. 2013).

The consequence score for THR increased from three to four from the previous risk assessment as we now understand the productivity of THR is lower than was previously understood.

Leafscale gulper shark (CSQ) *Centrophorus squamosus*
(Intensity = 4.5, Consequence = 4, Risk = 18)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 8 t
Live bearer



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 five because leafscale gulper shark are distributed from 500 to 1500 m (McMillan et al. 2011) and may have a limited overlap with fishing beyond 800 m depth, where the footprint of fishing is small (Baird & Wood 2018).

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 six pups per litter (Last & Stevens 2009, Parker & Francis 2012). Trawl survey relative biomass indices showed no trends in FMAs 3–6; however Chatham Rise surveys monitor this species poorly (Francis et al. 2016).

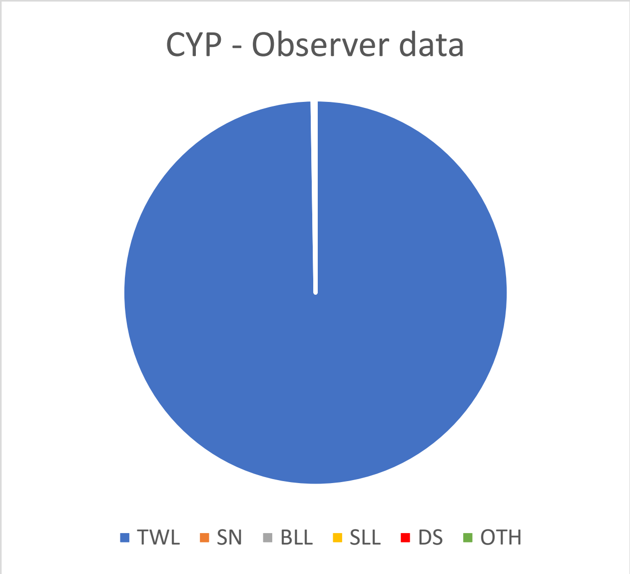
Confidence

Data were described as 'exist but poor' as the location of pregnant females and reproductive frequency are both unknown. Consensus was achieved.

Recommendation

This species may benefit from having its indices analysed within different length classes.

Longnose velvet dogfish (CYP) ***Centroselachus crepidater***
(Intensity = 4, Consequence = 4.5, Risk = 18)
Observed (2011–12 to 2015–16 fishing years): 74 t
Live bearer



Confidence

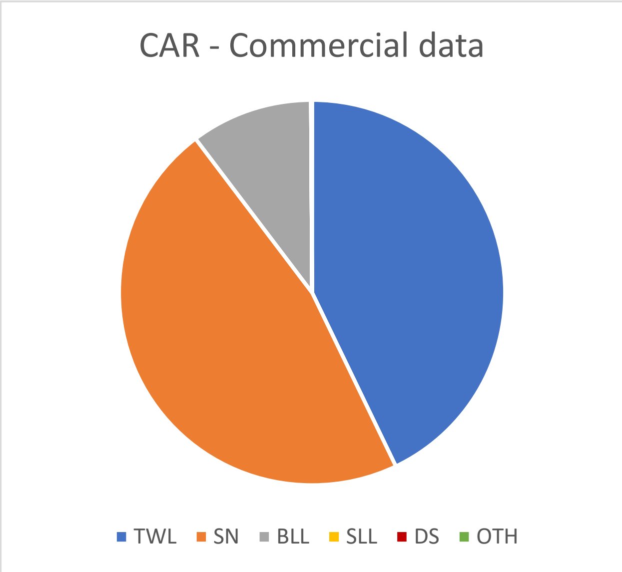
Data were described as 'exist and sound'. Consensus was achieved.

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 four because it is distributed from 500 to 1500 m (McMillan et al. 2011) and has a limited overlap with fishing beyond 800 m depth where the footprint of fishing is small (Baird & Wood 2018).

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 reproduce from 15 years, have a longevity of 26 years (Francis et al. 2018a) and an average of six pups per litter (Last & Stevens 2009) which classifies them as low productivity. Abundance indices from trawl surveys in FMAs 3–6 show no trends, however the Chatham Rise survey monitors this species poorly (Francis et al. 2016).

Carpet shark (CAR) *Cephaloscyllium isabellum*
(Intensity = 6, Consequence = 3, Risk = 18)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 1137 t
Egg layer



Confidence

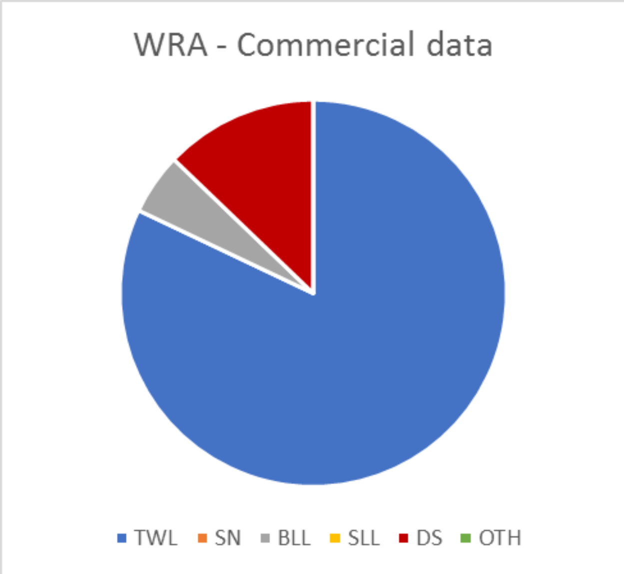
Data were described as 'exist but poor' as no ageing or reproductive data or reliable abundance indices were available. Consensus was achieved.

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 sharks reproduce from nine years and have a maximum longevity of 15 years, their eggs have a development period of 12 to 14 months (Francis et al. 2018b). Carpet shark indices from both CPUE and trawl surveys are either flat or positive, with only the most uncertain indicator (for FMA 5) showing a decline (Francis et al. 2016).

Longtail stingray (WRA) *Bathytoshia lata*
(Intensity = 5, Consequence = 3.5, Risk = 17.5)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 40 t
Live bearer



Confidence

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

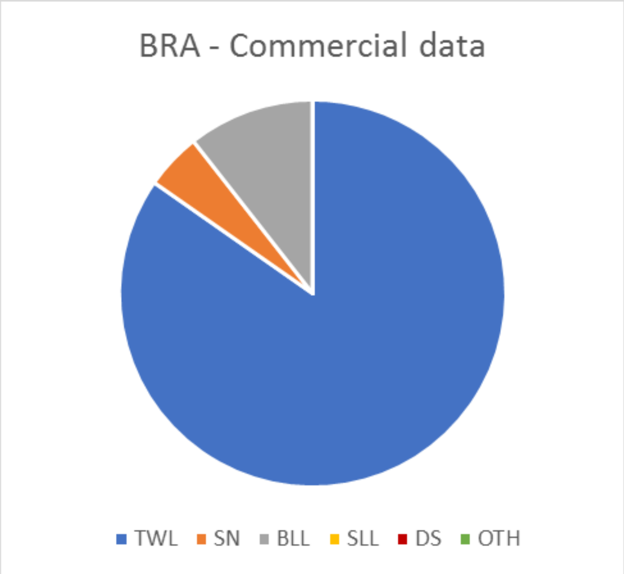
Rationale

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 five as they are found in New Zealand at depths of less than 100 m (McMillan et al. 2011) where many commercial fisheries closures exist (Baird et al. 2015).

The WRA intensity score increased from four to five from the previous risk assessment as increased spatial overlap of the fishery on the distribution was observed, presumably due to better reporting.

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

Shorttail stingray (BRA) *Bathytoshia brevicaudata*
(Intensity = 5, Consequence = 3.5, Risk = 17.5)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 85 t
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.

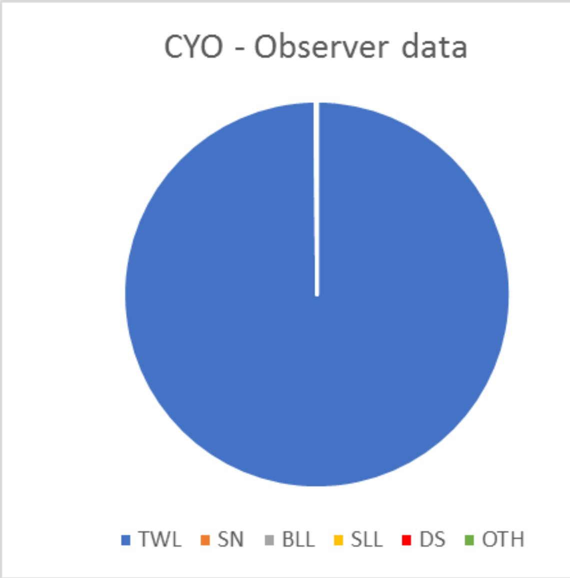
Rationale

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 five 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).

The BRA intensity score increased from four to five from the previous risk assessment as increased spatial overlap of the fishery on the distribution was observed, presumably due to better reporting.

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

Owston's dogfish (CYO) ***Centroscymnus owstonii***
(Intensity = 4, Consequence = 4, Risk = 16)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 27 t
Live bearer



Confidence

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

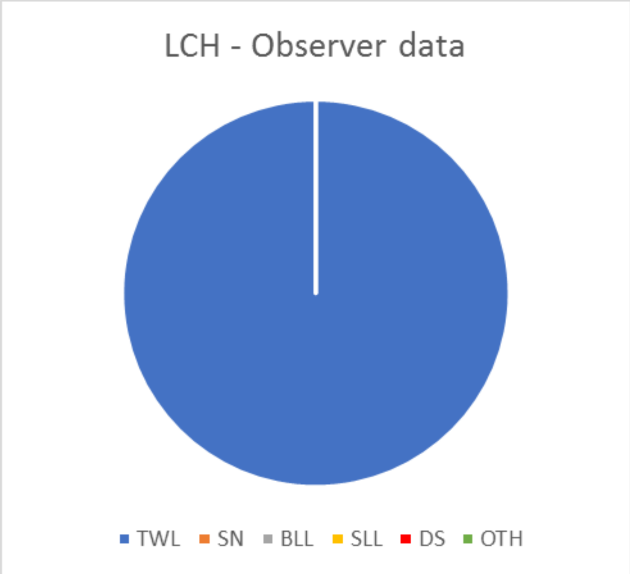
Rationale

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 four 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. 2011) and beyond 800 m the footprint of fishing is small (Baird & Wood 2018).

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). Preliminary results from 12 spine band counts suggest a maximum age of 29 years for Owston's dogfish (Irvine 2004). The Mid-East coast deepwater survey generates a reliable abundance index and shows no change over time (Doonan & Dunn 2011).

Dawson's cat shark (DCS) *Bythaelurus dawsoni* (Intensity = 3.5, Consequence = 4.5, Risk = 15.75) Observed Commercial Catch (2011–12 to 2015–16 fishing years): 2.7 t Egg layer	
No graph shown as less than 5t reported. *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.	*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 is endemic and was classified as having a relatively small population in New Zealand waters (Francis 2006).

Longnose spookfish (LCH) *Harriotta raleighana*
(Intensity = 4.5, Consequence = 3.5, Risk = 15.75)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 164 t
Egg layer



Confidence

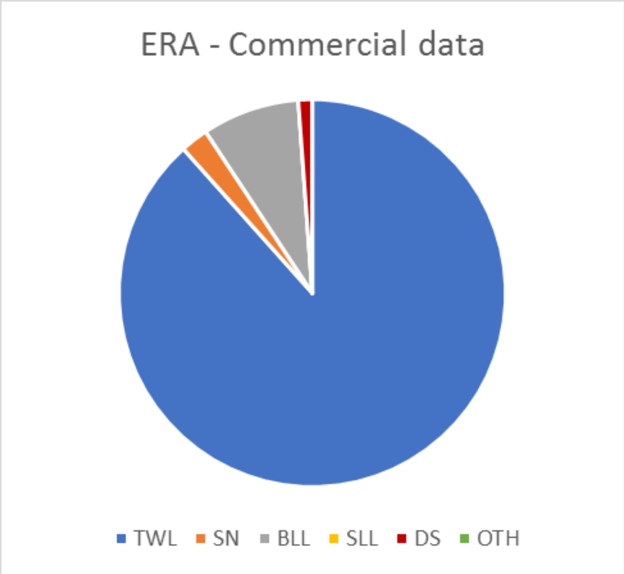
Data were described as 'exist but poor' as no ageing or reproductive information exist. Consensus was achieved with low confidence.

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. 2011) and beyond 800 m the footprint of fishing is small (Baird & Wood 2018).

Longnose spookfish is globally widespread (Ebert et al. 2013) and was classified as having a relatively large population in New Zealand waters. The Chatham Rise trawl survey indicated an up/down biomass trajectory in FMAs 3 and 4, and relative biomass in the 2010s was similar to that in the early 1990s. There was no trend in the Sub-Antarctic survey (FMAs 5 and 6) (Francis et al. 2016).

Electric ray (ERA) ***Tetronarce nobiliana***
(Intensity = 5, Consequence = 3, Risk = 15)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 86 t
Live bearer



Confidence

Data were descried as 'exists but poor' as no 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.

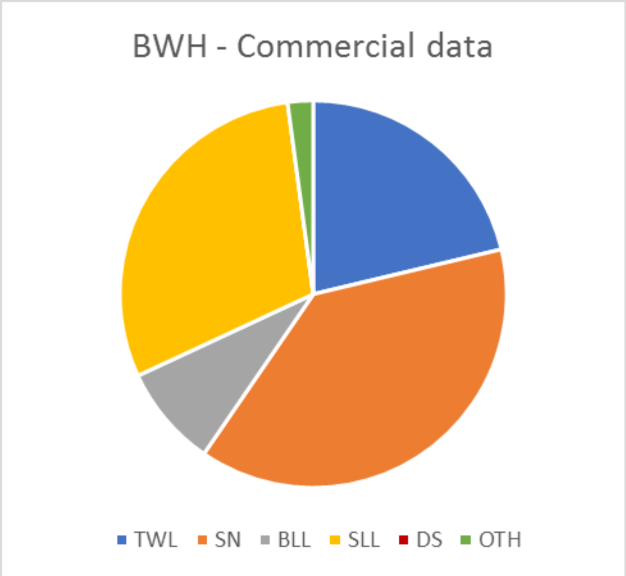
Rationale

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 scored an overall intensity of five 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 has a global distribution (Last & Yearsley 2016) and was classified as having a relatively large population in New Zealand waters. Female maturity is uncertain but suggested from 2.0 to 4.4 years and longevity for females is 10 years. Litter size as high as 60 has been reported in the Atlantic (Francis et al. 2018b), therefore this ray was considered highly productive.

The consequence score for ERA decreased from 3.5 to 3.0 from the previous risk assessment as this species is no longer considered endemic (previously it was as *Torpedo fairchildi*) and productivity is now known and relatively high.

Bronze whaler (BWH) ***Carcharhinus brachyurus***
(Intensity = 3.5, Consequence = 4, Risk = 14)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 6 t
Live bearer

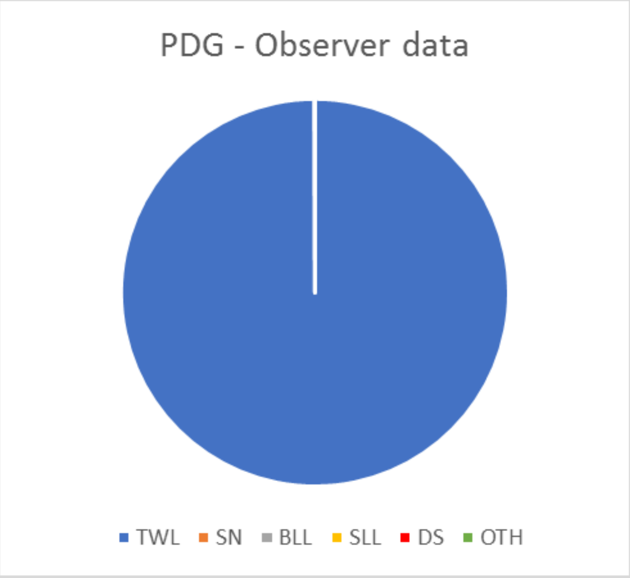


Confidence
Data were described as ‘exist but poor’ as no abundance indices exist. Consensus was achieved with low confidence.

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 16 years old (with a maximum known age of 31) and they have an average of 15 pups every two years (Last & Stevens 2009, Ebert et al. 2013, Drew et al. 2017).

Prickly dogfish (PDG) *Oxynotus bruniensis*
(Intensity = 3.5, Consequence = 3.5, Risk = 12.25)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 16 t
Live bearer

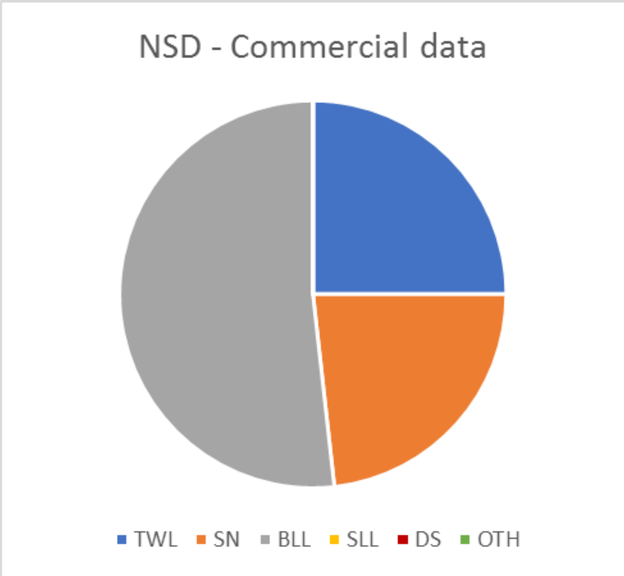


Confidence
Data were described as ‘exist but poor’ as no ageing or reproductive frequency information exist. Consensus was achieved, but with low confidence.

Rationale
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 is distributed through New Zealand and southern and eastern Australia (Last & Stevens 2009) and was classified as having a moderate population size in New Zealand waters. Prickly dogfish can produce 7–8 pups at one time (Last & Stevens 2009, Finucci et al. 2016). The Chatham Rise abundance index shows no clear trend over the five years up to 2010 (O’Driscoll et al. 2011).

Northern spiny dogfish (NSD) *Squalus griffini*
(Intensity = 4, Consequence = 3.5, Risk = 14)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 396 t
Live bearer



Confidence

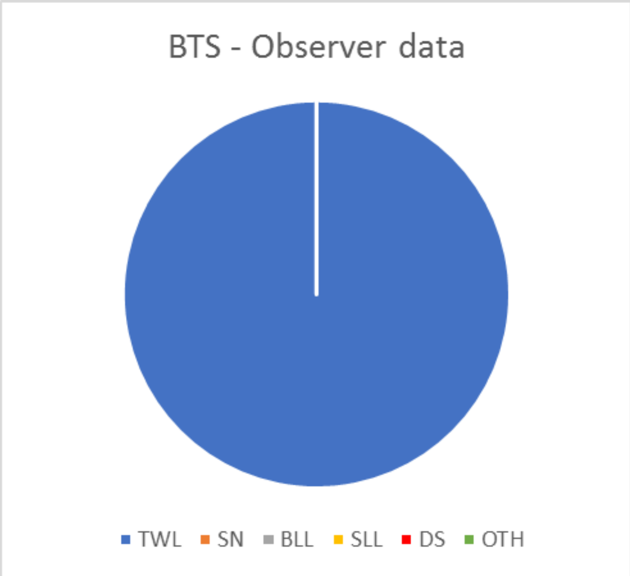
Data were described as 'exist but poor' as no ageing and few reproductive information exist. In addition there may be some identification issues between spiny dogfish and northern spiny dogfish such that records of northern spiny dogfish may include spiny dogfish. Consensus was achieved, but with low 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 four 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 deepsea skate (BTS) ***Brochiraja spinifera***
(Intensity = 3.5, Consequence = 3.5, Risk = 12.25)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 9 t
Egg layer



Confidence

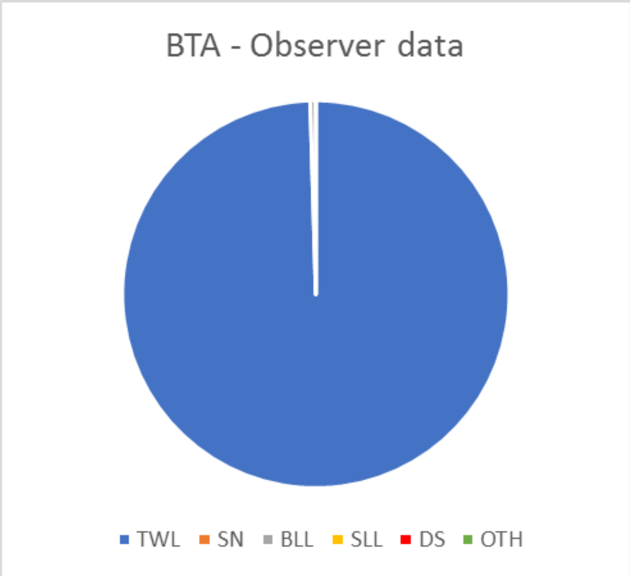
Data were described as 'exist but poor' as few length measures exist and no reproductive or ageing information exist. In addition identification is problematic between smooth, prickly and sapphire skates. Consensus was achieved, but with low confidence.

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 scored an overall intensity of 3.5 as they are distributed from 200 to 1200 m (McMillan et al. 2011) so have a limited overlap with fishing beyond 800 m depth, where the footprint of fishing is small (Baird & Wood 2018).

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).

Smooth deepsea skate (BTA) ***Brochiraja asperula***
(Intensity = 3.5, Consequence = 3.5, Risk = 12.25)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 7 t
Egg layer



Confidence

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).

Brochiraja complex (5 species, *Brochiraja microspinifera, B. leviveneta, B. albilabiata, B. heuresa,* and *B. vittacauda*)

(Intensity = 3, Consequence = 4, Risk = 12)
Observed Commercial Catch (2011–12 to 2015–16 fishing years, *B. leviveneta* only): <0.1 t
Egg layer

No graph shown as less than 5t reported

Confidence

Data were described as ‘few’ as there are few length data, no ageing data or abundance indices exist and fisher and observer identification is uncertain. Consensus was achieved, but with low confidence.

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 three (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, Stewart & Last 2015), therefore it is likely there is limited overlap with fishing beyond 800m depth, where the footprint of fishing is small (Baird & Wood 2018).

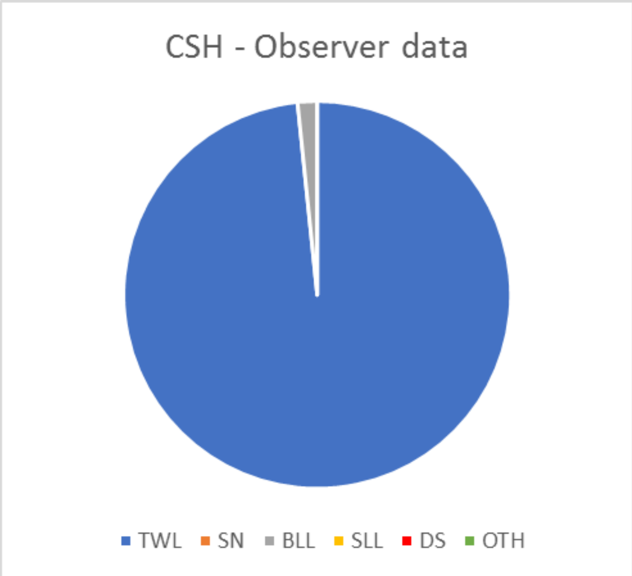
The *Brochiraja* complex includes at least five species as listed above and may also include *B. aenigma* which is known to occur just outside the New Zealand EEZ. The five species are endemic to New Zealand, and the Challenger Plateau just outside the EEZ (Last & McEachran 2006). The population sizes in New Zealand waters were classified as small.

<table>
<tr><td colspan="2">Brown chimaera (CHP) Chimaera carophila
(Intensity = 3, Consequence = 4, Risk = 12)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 1 t
Egg layer</td></tr>
<tr><td>No graph shown as less than 5t reported

Confidence
Data were described as ‘few’ as there are few length data, no ageing data and no abundance indices. Consensus was achieved.</td><td>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 three as this species has a depth range of 800 to over 1500 m (McMillan et al. 2011) therefore there is limited overlap with fishing beyond 800 m depth, where the footprint of fishing is small (Baird & Wood 2018).

Brown chimaera is endemic (Kemper et al. 2014) and their population size was classified as relatively small.</td></tr>
</table>

Catsharks (CSH) *Apristurus* spp.
(Intensity = 3, Consequence = 4, Risk = 12)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 8 t
Egg layer

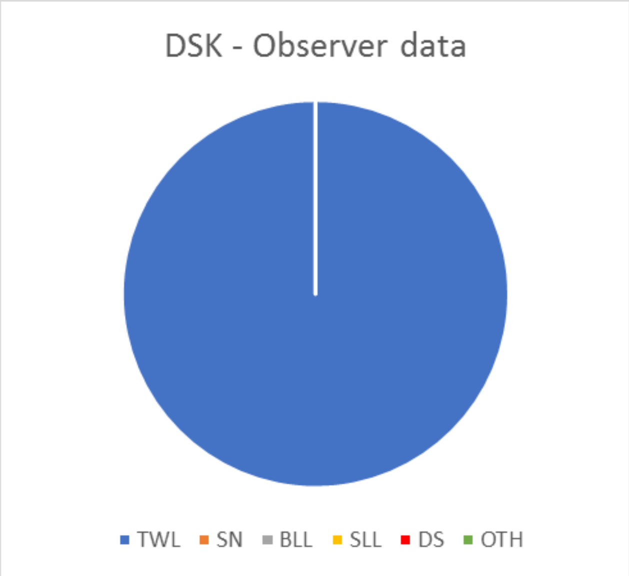


Confidence
Data were described as 'few' as there are no ageing data, reproductive data or abundance indices and species identification is uncertain (hence the genus was scored rather than the separate species). Consensus was achieved, but with low confidence.

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 three 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. 2011). Some catsharks are likely to have limited overlap with fishing beyond 800 m depth, where the footprint of fishing is small (Baird & Wood 2018).

Catsharks include at least seven current species and although taxonomy has improved recently, field identifications are uncertain. All species were categorised as having relatively small population sizes in New Zealand waters. Pale and Garrick's catsharks are endemic, with the remainder being more widespread (Last & Stevens 2009, Ebert et al. 2013, Nakaya et al. 2015).

Deepwater spiny skate (DSK) ***Amblyraja hyperborea***
(Intensity = 3, Consequence = 4, Risk = 12)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 11 t
Egg layer



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.

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 three as it has a depth range of 500 to 1500 m (McMillan et al. 2011) and is therefore likely to have limited overlap with fishing beyond 800 m depth, where the footprint of fishing is small (Baird & Wood 2018).

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

<table>
<tr><td colspan="2">Longnose deepsea skate (PSK) Bathyraja shuntovi
(Intensity = 3, Consequence = 4, Risk = 12)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 4 t
Egg layer</td></tr>
<tr><td>No graph shown as less than 5 t reported

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.</td><td>Rationale:

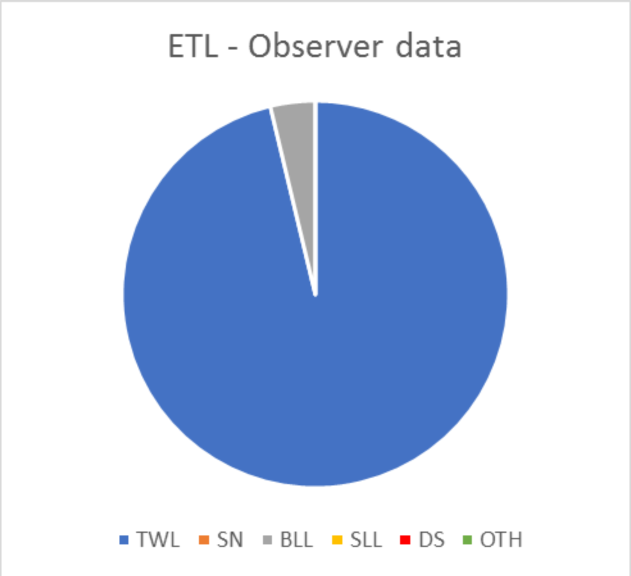
Longnose deepsea skate was estimated as vulnerable to fishing across 31 to 45% of their range and caught between 200 and 300 days a year. This species scored an overall intensity of three as they are likely to have limited overlap with fishing as they are found from 500 to over 1500 m in New Zealand waters (McMillan et al. 2011) and beyond 800 m the footprint of fishing is small (Baird & Wood 2018).

Longnose deepsea skate is endemic (McMillan et al. 2011) and was classified as having a relatively small population in New Zealand waters.</td></tr>
</table>

Longtail skate (LSK) ***Arhynchobatis asperrimus***
(Intensity = 3, Consequence = 4, Risk = 12)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 3 t
Egg layer

No graph shown as less than 5 t reported *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.	*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 three because research trawl data suggest a narrower distribution of catch; this suggests misidentification by observers. Longtail skate is endemic (McMillan et al. 2011) and was classified as having a moderate population size in New Zealand waters.

Lucifer dogfish (ETL) ***Etmopterus lucifer***
(Intensity = 3, Consequence = 4, Risk = 12)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 85 t
Live bearer



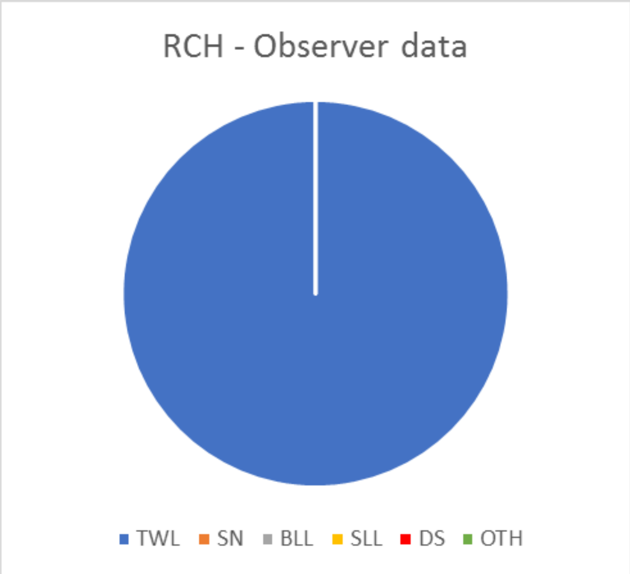
Confidence:
Data were described as 'exist but poor' as reproductive frequency is not known, and productivity results are sparse. Consensus was achieved, but with low confidence.

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 three as they are small (maximum total length 45 cm, McMillan et al. 2011) and are therefore likely to pass under or through fishing gear.

Lucifer dogfish is widespread in the western Pacific (Ebert et al. 2013) and was 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 six pups on average per litter (from only two specimens - Galland (2015)). Abundance indices are stable or increasing up to 2010 (O'Driscoll et al. 2011, Bagley et al. 2013, Doonan & Dunn 2011).

Pacific spookfish (RCH) *Rhinochimaera pacifica*
(Intensity = 3, Consequence = 4, Risk = 12)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 40 t
Egg layer



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.

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 three 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. 2011) and beyond 800 m the footprint of fishing is small (Baird & Wood 2018).

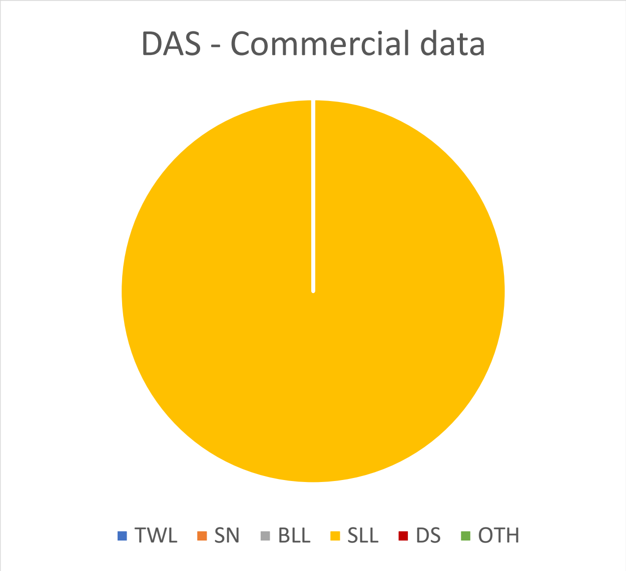
Pacific spookfish is widespread in the Pacific and Indian oceans (Last & Stevens 2009) and was classified as having a relatively large population in New Zealand waters.

Pelagic stingray (DAS) ***Pteroplatytrygon violacea***

(Intensity = 3, Consequence = 4, Risk = 12)

Reported Commercial Catch (2011–12 to 2015–16 fishing years): 12 t

Live bearer



Confidence

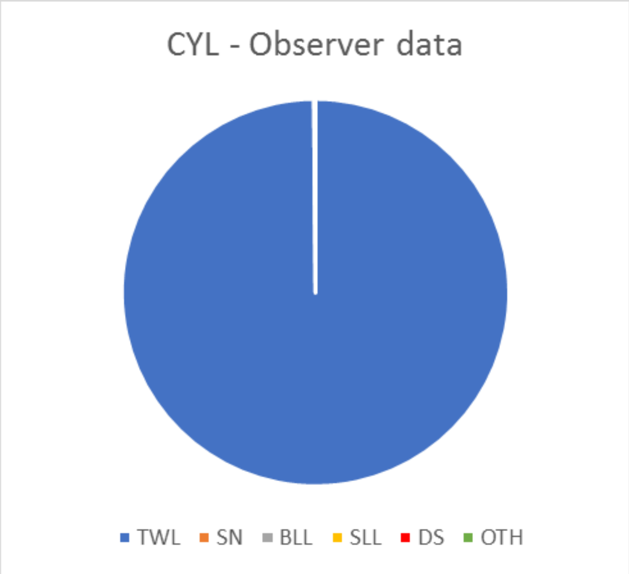
Data were described as ‘few’ as there are no ageing data, reproductive frequency data or abundance indices. Consensus was achieved, but with low confidence.

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 three as they are oceanic (Last & Stevens 2009) and probably only exposed to fishing seasonally.

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

Portuguese dogfish (CYL) ***Centroscymnus coelolepis***
(Intensity = 3, Consequence = 4, Risk = 12)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 21 t
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.

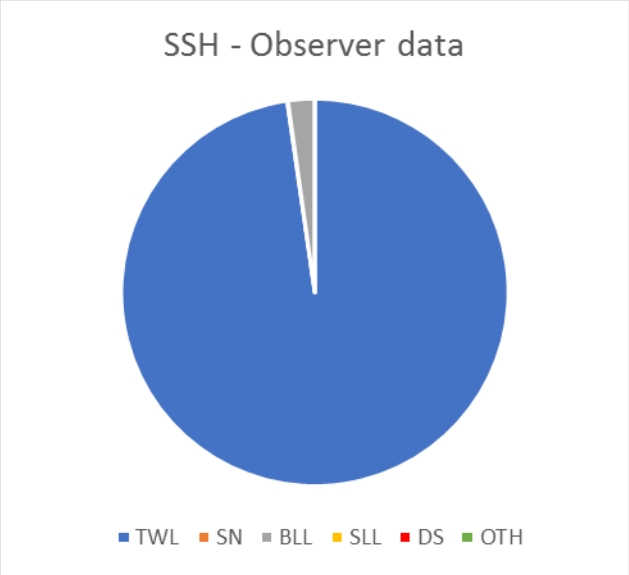
Rationale

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 three 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. 2011) and beyond 800 m the footprint of fishing is small (Baird & Wood 2018).

Portuguese dogfish is globally widespread (Ebert et al. 2013) and was 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 (SSH) *Gollum attenuatus*

(Intensity = 3, Consequence = 4, Risk = 12)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 69 t
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 three as they are likely to have limited overlap with fishing as the areas they are found in (McMillan et al. 2011) are only fished some of the year.

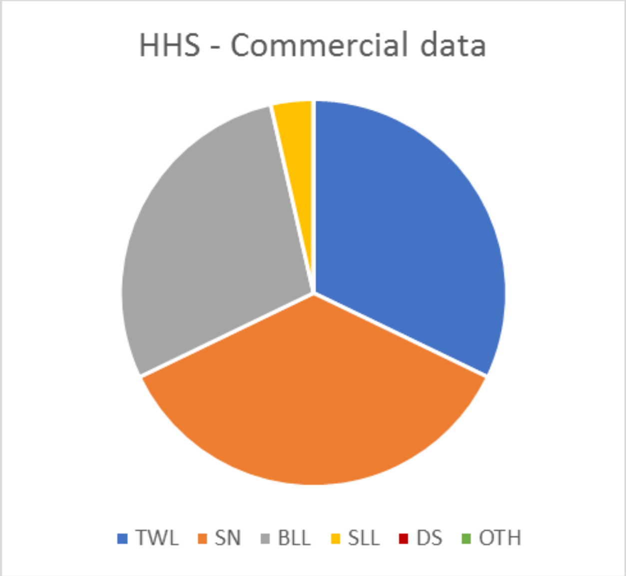
Slender smooth hound is distributed through the south-west Pacific (New Zealand and surrounding ridges) (Ebert et al. 2013) and was classified as having a relatively moderate population size in New Zealand waters. This species was classified as having a low productivity with an average litter size of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

Hammerhead shark (HHS) ***Sphyrna zygaena***

(Intensity = 4, Consequence = 3, Risk = 12)

Commercially Estimated Total Commercial Catch (2011–12 to 2015–16 fishing years): 5 t

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 four 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. Female hammerhead sharks can reproduce from 22 years and have a maximum known age of 25 years - from ageing of small animals (Clarke et al. 2015), but longevity is probably under-estimated because 25 years would only provide three years of reproduction. Average litter size is 35 pups (Last & Stevens 2009, Coelho et al. 2011).

Blind electric ray (TAY) ***Typhlonarke aysoni***
(Intensity = 4, Consequence = 3, Risk = 12)
Observer Estimated Total Commercial Catch (2011–12 to 2015–16 fishing years): 0.2 t
Live bearer

No graph shown as less than 5t reported

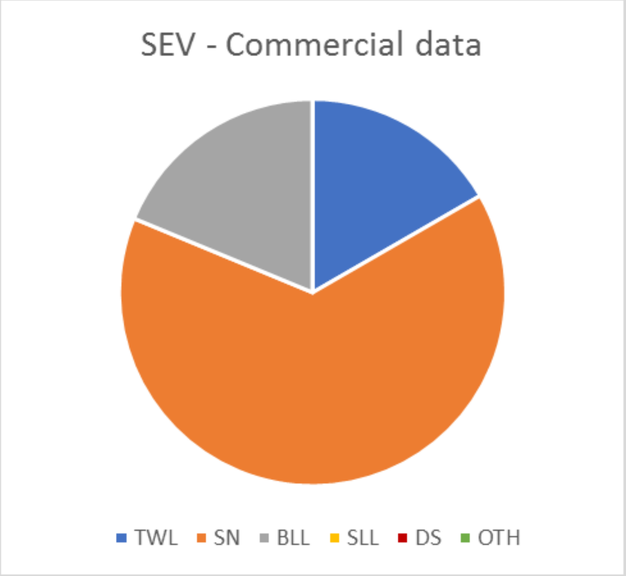
Confidence
Data were described as 'exist but poor' as few size data exist, and no ageing or reproductive frequency data, or abundance indices exist. In addition, there is some taxonomic uncertainty that suggests that the oval electric ray and blind electric ray may be the same species. Consensus was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

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 four because although they have a limited distribution in New Zealand waters (McMillan et al. 2011) 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 reproduce from two years, have an estimated longevity of 13 years and litters of fewer than 10 embryos (Francis et al. 2018b).

The consequence score for TAY decreased from four to three from the previous risk assessment as the new age and reproduction information shows higher productivity than was assumed.

Broadnose sevengill shark (SEV) ***Notorynchus cepedianus***
(Intensity = 4, Consequence = 3, Risk = 12)
Reported Commercial Catch (2011–12 to 2015–16 fishing years): 12 t
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 four 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).

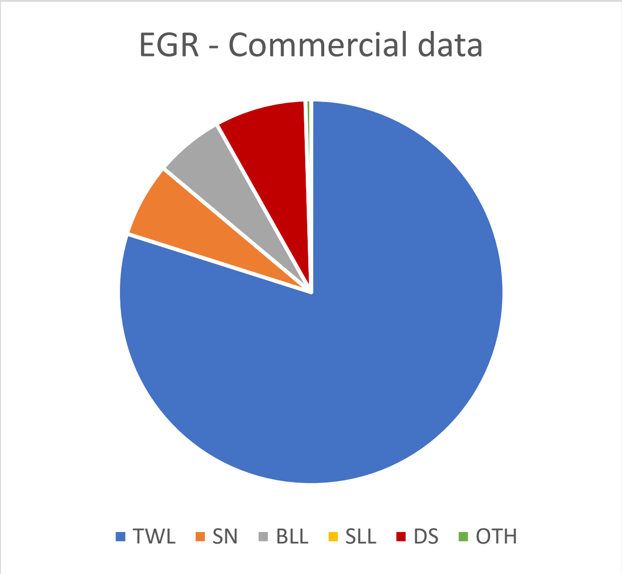
Broadnose sevengill shark is classified as globally widespread (Ebert et al. 2013) and having a moderate population size in New Zealand waters. Broadnose sevengill shark was classified as having high fecundity, but a late age at maturity. Broadnose sevengill shark females reproduce from 16 years old,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

Eagle ray (EGR) *Myliobatis tenuicaudatus*

(Intensity = 4, Consequence = 2.5, Risk = 10)

Reported Commercial Catch (2011–12 to 2015–16 fishing years): 209 t

Live bearer



Confidence:

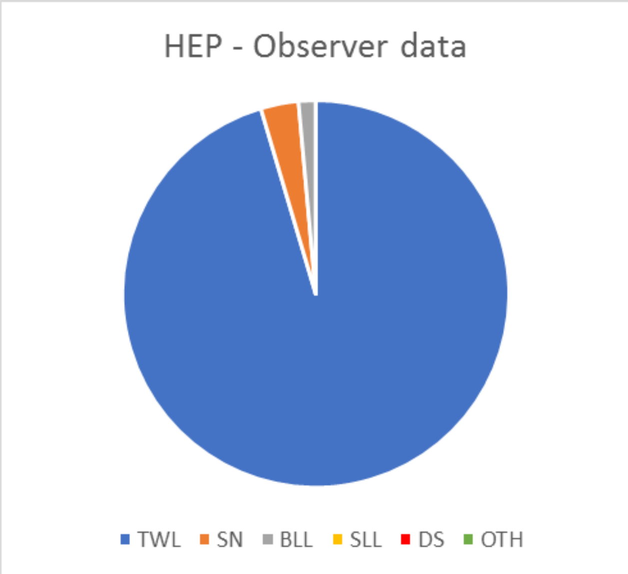
Data were described as ‘exist but poor’ as there are no ageing or reproductive data or abundance indices. Consensus was achieved, but with low confidence.

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 four as they are distributed from 0 to 200 m (McMillan et al. 2011) so have limited overlap with fishing coastally due to setnet and harbour closures (Baird et al. 2015).

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

Sharpnose sevengill shark (HEP) *Heptranchias perlo*
(Intensity = 3, Consequence = 3, Risk = 9)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 5 t
Live bearer



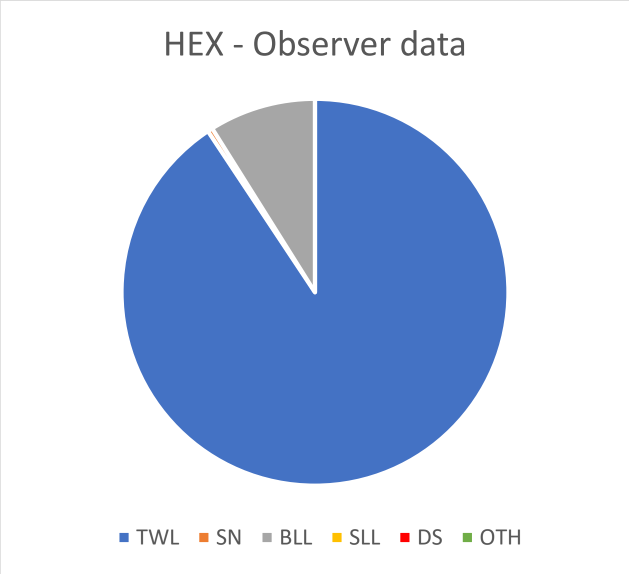
Confidence:
Data were described as ‘exist but poor’ as there are no ageing data, reproductive frequency data or abundance indices and have a questionable known distribution. Consensus was achieved, but with low confidence.

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 three due to the panel’s judgement that the distribution is probably broader than shown in McMillan et al. (2011).

Sharpnose sevengill shark is globally widespread (Ebert et al. 2013) and was 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).

Sixgill shark (HEX) *Hexanchus griseus*

(Intensity = 3, Consequence = 2, Risk = 6)
Observed Commercial Catch (2011–12 to 2015–16 fishing years): 19 t
Live bearer



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 catch of this species may be under-reported, particularly in the ling longline fishery.

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 is globally widespread (Ebert et al. 2013) and was 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).

3.3 Protected species

Seven species of shark are afforded absolute protection under the Wildlife Act 1953[7] (Table 7). 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 off northeastern North Island 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 7: Shark species protected under Schedule 7a of the Wildlife Act 1953 including IUCN threat status, and status according to the revised New Zealand Threat Classification System (Duffy et al. 2018). Since the last Risk Assessment, the IUCN status of whale sharks was changed from vulnerable to endangered (in 2016), and in New Zealand the conservation status of basking sharks and great whites were changed from Gradual Decline to Threatened: Nationally Vulnerable, manta rays from Migrant to Data Deficient, smalltooth sandtigers from Sparse to Nationally Uncommon, and spinetail devil rays from Not Threatened to Data Deficient (Duffy et al. 2018).

Common name	Scientific Name	NZ threat class	IUCN Threat Ranking
Basking shark	*Cetorhinus maximus*	Threatened: Nationally Vulnerable	Vulnerable A2ad+3d
Smalltooth sandtiger shark	*Odontaspis ferox*	Nationally Uncommon	Vulnerable A2bd
Oceanic whitetip shark	*Carcharhinus longimanus*	Migrant	Vulnerable A2ad+3d+4ad
Whale shark	*Rhincodon typus*	Migrant	Endangered* A2bd+4bd
Great white shark	*Carcharodon carcharias*	Threatened: Nationally Vulnerable	Vulnerable A2cd+3cd
Manta ray	*Manta birostris*	Data Deficient	Vulnerable A2abd+3bd+4abd
Spinetail devil ray	*Mobula japanica*	Data Deficient	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 to adhere to New Zealand's 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

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

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 great white shark, and the factors influencing this (Francis & Sutton 2013, Francis 2017a, 2017b). 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 survival (Jones & Francis 2012, Francis 2014, Francis & Jones 2017). This work has led to recommendations for improvement of animal release in order to reduce fisheries impacts.

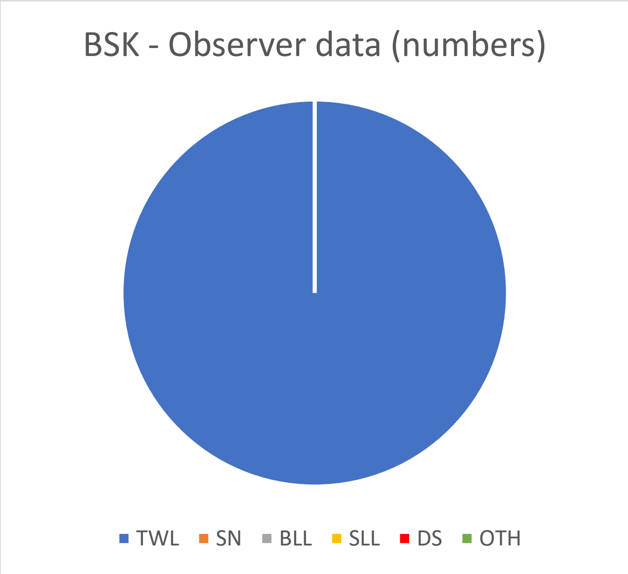
The overall risk for protected shark species, its component parts (intensity and consequence) and the confidence in those scores, in terms of both the amount and quality of the data and the extent of consensus amongst the panel, are displayed in Figure . Basking shark and spinetail devil ray attained the highest risk scores. Scores for protected sharks showed lower risk scores than many QMS or non-QMS sharks. Protected sharks scored an intensity of 3. Consequence scores ranged from 4.5 (undescribed in Table 4) which can be interpreted as “a high likelihood of actual, or potential for, unsustainable impacts”, to four “Actual, or potential for, unsustainable impact (e.g. long-term decline in CPUE)”.

PROTECTED SPECIES RISK

COMPONENTS OF RISK		RISK	CONFIDENCE	
Intensity	Consequence		Data	Consensus
3	4.5	13.5 – Basking shark	✓✓	✓
3	4.5	13.5 – Spinetail devil ray	✓	✓
3	4	12 – Great white shark	✓✓	✓

Figure 7: Protected Species Risk scores. For the COMPONENTS OF RISK higher numbers indicate greater intensity or consequence of impact (for more details see Table 3 and Table 4). 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 taxa are in alphabetical order. Taxa that scored less than three for consequence were not scored further, see Section 2.3 for more details. See Ford et al. (2015) for available data on shark species not listed in the table above.

Basking shark (BSK) *Cetorhinus maximus*
(Intensity = 3, Consequence = 4.5, Risk = 13.5)
Total Commercially Estimated Commercial Catch (2011–12 to 2015–16 fishing years): 90 t
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.

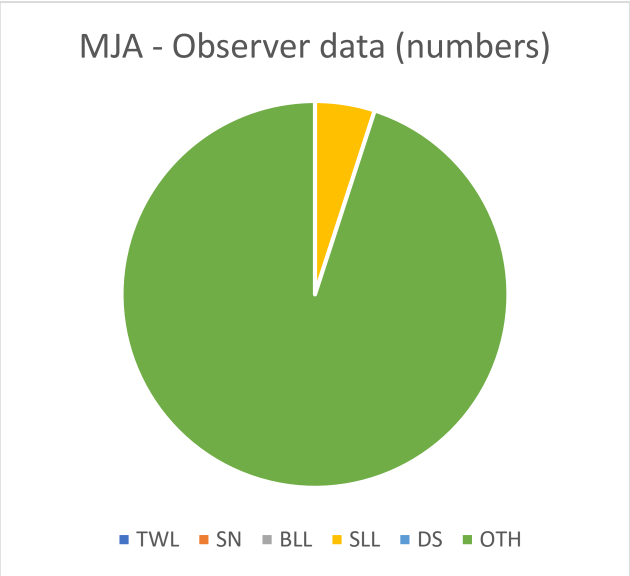
Basking shark is globally widespread (Ebert et al. 2013) but was classified as having a relatively small population in New Zealand waters. Basking shark is potentially a migrant in NZ waters but movement and connectivity information is lacking and high and localised catches can occur (Francis & Lyon 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 than males in New Zealand (Francis & Smith 2010). Longer-term data show catch rates were larger in 1986 to 1991, but the reason for the decline in catch rates is unknown (Francis & Sutton 2013).

Spinetail devil ray (MJA) ***Mobula japanica***

(Intensity = 3, Consequence = 4.5, Risk = 13.5)

Total Commercially Estimated Commercial Catch (2011–12 to 2015–16 fishing years): 54 t

Live bearer



Confidence

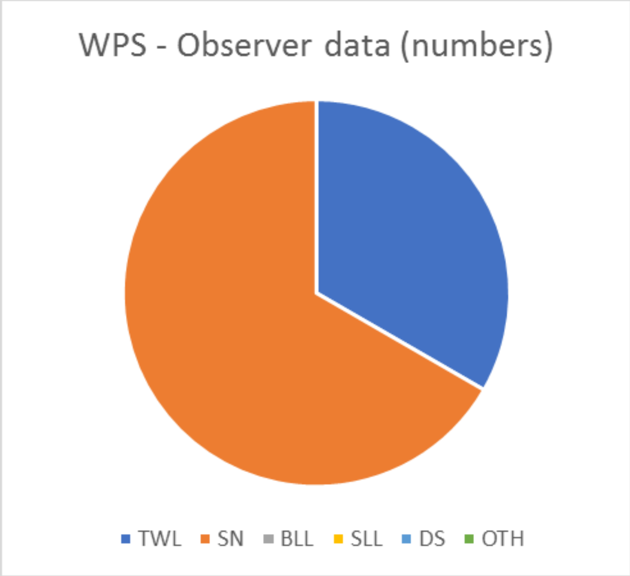
Data were described as ‘few’ as no reproductive frequency or abundance indices exist. Consensus was achieved, but with low confidence due to the lack of data.

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). The mortality rate of MJA following tagging and release from purse seine catches is currently 35% from 14 individuals (M. Francis pers. comm.). 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 one year to produce one juvenile, and they live to at least 14 years (Francis & Lyon 2012, Cuevas-Zimbrón et al. 2013). Spinetail devil ray apparently 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 (WPS) *Carcharodon carcharias*
(Intensity = 3, Consequence = 4.5, Risk = 13.5)
Total Commercially Estimated Commercial Catch (2011–12 to 2015–16 fishing years): 33 t
Live bearer



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.

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. Very few mature females are observed in New Zealand, although they are known to breed in New Zealand waters (C. Duffy and M. Francis pers. comm.).

Great white shark is globally widespread (Ebert et al. 2013) but was 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 eight pups are produced at a time (Francis 1996). The great white shark population on the east coast of Australia is stable, and genetic evidence shows 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.

4. DISCUSSION

This risk assessment was qualitative by design, and therefore involved some subjective decision-making. However, every effort was made to use as much data as possible to guide discussion, and have the most appropriate people on the panel to make expert judgements and to be as comparable as possible in terms of personnel and methodology to 2014. 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 and scoring. Consensus was reached for all taxa. The non-scoring of taxa with an intensity score of two "Minimal impact on taxa" or less was the only methodological adjustment made from the 2014 risk assessment, but this was deemed likely to prevent misleading scores and not impact on the use of the final risk assessment for informing management directives.

New data were available for thirteen of the fifty taxa considered, much of which were generated through MPI funded projects commissioned after the last risk assessment (Francis et al. 2016, 2018a, 2018b). These data, in combination with information from continuation of catch and effort monitoring and abundance indices, led to changes in intensity scores for three taxa and consequence scores for a further six taxa, which resulted in five increases and three decreases in total risk scores. The largest change in total risk was for thresher shark which increased from a score of 10.5 to 20 due to a re-interpretation of fisheries overlap and new information showing lower productivity. Plunket's shark now shows the highest total risk (22.5), increasing from 20 due to a reinterpretation of fishing intensity. Longtail and shorttail stingray both increased in total risk scores from 14 to 17.5 due to a reinterpretation of fisheries overlap. Shovelnose dogfish increased in risk from 17.5 to 20 due to some abundance indices now showing declines. Conversely, total risk scores for blind electric ray, electric ray and carpet sharks all decreased (16 to 12, 17.5 to 15 and 21 to 18 respectively) due to information showing that they have higher productivity than previously assumed.

The data that were compiled for the RA workshop (see Section 2.2 and Francis 2015a for an example) were un-groomed and some errors were identified by the panel. In addition some reporting changes have occurred between risk assessments. Such data imperfections were not, however, considered by the panel to materially impact the quality of the assessment.

No consequence scores exceeded 4.5, as no evidence existed of "serious unsustainable impacts now occurring" (the definition of a score of five for consequence). However, out of the 50 taxa considered, the panel had low confidence in the risk scores for 33 taxa. The RA panel stressed that, particularly where abundance indices are lacking, the consequence scale was more relevant to risk than the total risk score. Taxa with high consequence scores have low productivity or presumed low productivity. In such cases, more information may improve the scores or our confidence in them, but in the interim a more precautionary approach to management was recommended by the panel. The species with the highest consequence scores (all scoring 4.5 and for all of which the panel had low confidence) were (with management categories and total risk score in brackets):

- Plunket's shark (non-QMS, 22.5)
- Dawson's cat shark (non-QMS, 15.75)
- basking shark (Protected, 13.5)

- spinetail devil ray (Protected, 13.5)

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 contemporary relative risk among New Zealand sharks.

These caveats should not hinder the use of the RA results in prioritising management actions. Nevertheless, the increasing amount of abundance and productivity data for more species mean that quantitative (Level 2) RA techniques, such as a Productivity-Susceptibility Analysis (Hobday et al. 2011) should be able to be applied to sharks in the medium term to provide improved assessments of the risks of fisheries to them.

This assessment of risk may or may not disagree with other RA or analyses of stock status for the same species across different ranges. For example porbeagle shark risk status has been assessed both here and for the southern hemisphere population/s (Hoyle et al. 2017). Direct comparability can be limited by a number of factors including differing methodologies, different range coverage of a species between assessments and spatially differing fishing intensities. Therefore, detailed knowledge of risk assessment methodologies and inputs is required before findings may be usefully compared.

5. RISK ASSESSMENT RECOMMENDATIONS

A stated objective of the NPOA-Sharks is to prioritise management of, or research into, shark species based on 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 (in order of occurrence in the report):

1. For **rig,** an analysis of the sex ratio of capture in the SPO 1W setnet fishery may help to explain the decline in catch seen there.
2. For **porbeagle,** a quantitative assessment of status should be completed for this species as it is now relatively data rich. Notably, this has now been completed indicating that the impacts of fishing is low across the entire Southern Hemisphere range of the porbeagle shark population (Hoyle et al. 2017).
3. **Leafscale gulper** and **seal shark** may benefit from having their abundance indices analysed within different length classes.
4. Recreational catch may be a significant proportion of the **big eye thresher**[8] catch and this should be considered in any assessment of risk for this species.

The panel also made general recommendations regarding either future RAs or further research. These are listed below, grouped by timeframe (not in order of importance):

In the short-term for high risk or protected[9] species (where this has not already been done)[10]:

- 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.

- Biological studies should be extended to improve estimates of population parameters for high-risk shark species where these are lacking.

- 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, 2016), or (b) using new platforms for data collection (e.g. using spotter planes for large pelagic species; Taylor & Doonan 2014).

- Taxonomic confusion and misidentification was problematic for a number of species assessed, and sharks recorded under generic codes (e.g. other sharks and dogfish OSD and deepwater dogfish DWD), were unable to be assessed in the workshop. Therefore

[8] Big eye thresher was not a species scored in this risk assessment (see Ford et al. 2015 for a previous assessment of risk for this species) but this recommendation was forthcoming, so is captured here.
[9] The NPOA-Sharks 2013 places special emphasis on protected species.
[10] All of these recommendations have been acted upon since 2015, but given changes to scores and the passing of time these may need to be revisited.

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.

Prior to a 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 mapped; these could potentially (and 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.

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

- The last Sub-Antarctic survey in late 2016 (O'Driscoll et al. In Prep) completed fewer sampling stations due to weather issues. This resulted in highly changed or uncertain estimates of abundance for some species, compared to previous survey data. Therefore these latest estimates should not be utilised independently and the data re-examined as additional data become available.

- Recreational catches of a number of shark species where recreational catch is thought to be significant by comparison to commercial catch, e.g. thresher, big eye thresher, would be a useful additional to future risk assessments.

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8. APPENDICES

8.1 Terms of Reference

Ministry for Primary Industries/Department of Conservation Terms of Reference for 2017 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 112 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'.* A qualitative data-informed risk assessment workshop was completed in late 2014 and the results of this published as Ford et al. 2015. This assessed the risk to 85 taxa of sharks from the previous five years of commercial fishing. There is now a need to integrate new information into our assessment of risk for sharks prior to the revision of the NPOA – Sharks scheduled for 2018.

2. Terms of Reference

Purpose

The purpose of the workshop is to update 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, Fisheries New Zealand);
- A facilitation group of Fisheries New Zealand 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, Dr. Malcolm Clarke, Dr. Matt Dunn and Dr. Emma Jones (NIWA), Clinton Duffy (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;
- representing the facts as they perceive them from their expert perspective, as opposed representing the views of their employers or institutions;
- 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:

- 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 structure will be discussed within the workshop and finalised following workshop completion.

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

3. Approach

The aim of the workshop will be to update expert-based (but data informed where possible) 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.

4. Reference

Ford, R., A. Galland, M. Clark, P. Crozier, C. A. Duffy, M. Dunn, M. Francis and R. Wells (2015). Qualitative (Level 1) Risk Assessment of the impact of commercial fishing on New Zealand Chondrichthyans. New Zealand Aquatic Environment and Biodiversity Report. **No. 157:** 111.

8.2 List of shark species

List of 112 New Zealand chondrichthyans, with species assessed in the 2017 RA shown in bold font. Species are listed in alphabetical order by scientific name within taxonomic group (chimaera, shark or batoid) and family. The seven *Apristurus* species were grouped into a genus-level taxon (*Apristurus* spp.) for analysis; and five *Brochiraja* species (all except *B. asperula* and *B. spinifera*) were grouped into a genus-level taxon (*Brochiraja* spp.) for analysis. Compiled by Malcolm Francis (NIWA), Andrew Stewart (Te Papa), Clinton Duffy (DOC) and Peter McMillan (NIWA). Code refers to the FNZ research code. QMS, Quota Management System species. IUCN Redlist classifications: DD, Data Deficient; LC, Least Concern; NT, Near Threatened; VU = Vulnerable; EN, Endangered; see http://www.iucnredlist.org/initiatives/mammals/description/glossary for more information. NZ threat classes: AR:NU, At risk: Naturally Uncommon; DD, Data Deficient; MI, Migrant; NOT, Not Threatened; NU, Naturally Uncommon; T:NE Threatened: Nationally Endangered; T:NV Threatened: Nationally Vulnerable; VA, Vagrant. NZ qualifiers: CD, Conservation Dependent; DP, Data Poor; Inc, increasing; SO, Secure Overseas; S?O, Uncertain whether Secure Overseas; TO, Threatened Overseas; T?O, Uncertain whether Threatened Overseas; blank cells indicate a species has not been classified, see https://www.doc.govt.nz/Documents/science-and-technical/nztcs23entire.pdf for more information.

Group	Family	Species	Common name	Code	Manage-ment class	IUCN redlist class	NZ threat class	NZ qualifier
Chimaera	Callorhinchidae	***Callorhinchus milii* Bory de St Vincent, 1823**	**Elephantfish**	ELE	QMS	LC	NOT	CD, Inc
Chimaera	Rhinochimaeridae	*Harriotta haeckeli* Karrer, 1972	Smallspine spookfish	HHA	Non-QMS	LC	NOT	
Chimaera	Rhinochimaeridae	***Harriotta raleighana* Goode & Bean, 1895**	**Longnose spookfish**	LCH	Non-QMS	LC	NOT	
Chimaera	Rhinochimaeridae	***Rhinochimaera pacifica* (Mitsukuri, 1895)**	**Pacific spookfish**	RCH	Non-QMS	LC	NOT	DP
Chimaera	Chimaeridae	***Chimaera carophila* Kemper, Ebert, Naylor & Didier 2014**	**Brown chimaera, longspine chimaera**	CHP	Non-QMS		NOT	
Chimaera	Chimaeridae	*Chimaera lignaria* Didier, 2002	Purple chimaera, giant chimaera	CHG	Non-QMS	LC	NOT	
Chimaera	Chimaeridae	*Chimaera panthera* Didier, 1998	Leopard chimaera	CPN	Non-QMS	DD	NOT	DP
Chimaera	Chimaeridae	***Hydrolagus bemisi* Didier, 2002**	**Pale ghost shark**	GSP	QMS	LC	NOT	CD
Chimaera	Chimaeridae	*Hydrolagus homonycteris* Didier 2008	Black ghost shark	HYB	Non-QMS	LC	NOT	SO
Chimaera	Chimaeridae	***Hydrolagus novaezealandiae* (Fowler, 1911)**	**Dark ghost shark**	GSH	QMS	LC	NOT	
Chimaera	Chimaeridae	*Hydrolagus trolli* Didier and Seret, 2002	Pointynose blue ghost shark	HYP	Non-QMS	LC	NOT	SO

Group	Family	Species	Common name	Code	Manage-ment class	IUCN redlist class	NZ threat class	NZ qualifier
Chimaera	Chimaeridae	*Hydrolagus* cf *affinis* (de Brito Capello 1868)	Giant black ghost shark	HGB	Non-QMS		DD	CD
Shark	Chlamydoselachidae	*Chlamydoselachus anguineus* Garman, 1884	Frill shark	FRS	Non-QMS	LC	AR:NU	DP,SO
Shark	Hexanchidae	***Heptranchias perlo* (Bonnaterre, 1788)**	**Sharpnose sevengill shark**	HEP	Non-target	NT	NU	DP,SO
Shark	Hexanchidae	***Hexanchus griseus* (Bonnaterre, 1788)**	**Sixgill shark**	HEX	Non-QMS	NT	NOT	DP,SO
Shark	Hexanchidae	***Notorynchus cepedianus* (Peron, 1807)**	**Broadnose sevengill shark**	SEV	Non-QMS	DD	NOT	DP,SO
Shark	Echinorhinidae	*Echinorhinus brucus* (Bonnaterre, 1788)	Bramble shark	BRS	Non-QMS	DD	AR:NU	DP,SO
Shark	Echinorhinidae	*Echinorhinus cookei* Pietschmann, 1928	Prickly shark	ECO	Non-QMS	NT	AR:NU	DP,SO
Shark	Squalidae	*Cirrhigaleus australis* White, Last & Stevens, 2007	Southern mandarin dogfish	MSH	Non-QMS	DD	AR:NU	DP,TO
Shark	Squalidae	***Squalus acanthias* Linnaeus, 1758**	**Spiny dogfish**	SPD	QMS	VU	NOT	SO
Shark	Squalidae	***Squalus griffini* Phillipps, 1931**	**Northern spiny dogfish**	NSD	Non-QMS	LC	NOT	SO
Shark	Squalidae	*Squalus raoulensis* Duffy & Last, 2007	Kermadec spiny dogfish		Non-QMS	LC	DD	
Shark	Squalidae	*Squalus* sp.	Shortspine dogfish		Non-QMS		DD	
Shark	Centrophoridae	*Centrophorus harrissoni* McCulloch, 1915	Harrisson's dogfish		Non-QMS	EN	DD	TO
Shark	Centrophoridae	***Centrophorus squamosus* (Bonnaterre, 1788)**	**Leafscale gulper shark**	CSQ	Non-QMS	VU	NOT	SO
Shark	Centrophoridae	***Deania calcea* (Lowe, 1839)**	**Shovelnose dogfish**	SND	Non-QMS	LC	NOT	
Shark	Centrophoridae	*Deania hystricosa* (Garman, 1906)	Rough longnose dogfish	SNR	Non-QMS	DD	DD	
Shark	Centrophoridae	*Deania quadrispinosa* (McCulloch, 1915)	Longsnout dogfish	DEQ	Non-QMS	NT	DD	SO
Shark	Etmopteridae	*Centroscyllium kamoharai* Abe 1966	Fragile dogfish		Non-QMS	DD	DD	
Shark	Etmopteridae	***Etmopterus granulosus* (Günther, 1880)**	**Baxter’s dogfish**	ETB	Non-QMS	LC	NOT	SO
Shark	Etmopteridae	***Etmopterus lucifer* Jordan & Snyder, 1902**	**Lucifer dogfish**	ETL	Non-QMS	LC	NOT	DP, SO

Group	Family	Species	Common name	Code	Manage-ment class	IUCN redlist class	NZ threat class	NZ qualifier
Shark	Etmopteridae	*Etmopterus molleri* (Whitley, 1939)	Moller's lantern shark	EMO	Non-QMS	DD	DD	S?O
Shark	Etmopteridae	*Etmopterus pusillus* (Lowe, 1839)	Smooth lantern shark	ETP	Non-QMS	LC	NU	DP, SO
Shark	Etmopteridae	*Etmopterus unicolor* (Engelhardt 1912)	Bristled lantern shark	ETU	Non-QMS	DD	NOT	SO
Shark	Etmopteridae	*Etmopterus viator* Straube 2011	Blue-eye lantern shark	EVI	Non-QMS		DD	
Shark	Somniosidae	***Centroscymnus coelolepis* Bocage & Capello, 1864**	**Portuguese dogfish**	CYL	Non-QMS	NT	NOT	DP
Shark	Somniosidae	*Centroscymnus ?macracanthus* Regan 1906	Roughskin dogfish	SCM	Non-QMS			
Shark	Somniosidae	***Centroscymnus owstonii* Garman, 1906**	**Owston's dogfish**	CYO	Non-QMS	LC	NOT	
Shark	Somniosidae	***Centroselachus crepidater* (Bocage & Capello, 1864)**	**Longnose velvet dogfish**	CYP	Non-QMS	LC	NOT	SO
Shark	Somniosidae	*Scymnodalatias albicauda* Taniuchi & Garrick, 1986	Whitetail dogfish	SLB	Non-QMS	DD	DD	S?O
Shark	Somniosidae	*Scymnodalatias sherwoodi* (Archey, 1921)	Sherwood's dogfish	SHE	Non-QMS	DD	DD	S?O
Shark	Somniosidae	***Scymnodon plunketi* (Waite, 1910)**	**Plunket's shark**	PLS	Non-QMS	NT	NOT	T?O
Shark	Somniosidae	*Scymnodon ringens* Bocage & Capello, 1864	Knifetooth dogfish	SRI	Non-QMS	DD	DD	S?O
Shark	Somniosidae	*Somniosus antarcticus* Whitley, 1939	Southern sleeper shark	SOP	Non-QMS	DD	NOT	DP,S?O
Shark	Somniosidae	*Somniosus longus* (Tanaka, 1912)	Little sleeper shark	SOM	Non-QMS	DD	DD	S?O
Shark	Somniosidae	*Zameus squamulosus* (Günther, 1877)	Velvet dogfish	ZAS	Non-QMS	DD	DD	S?O
Shark	Oxynotidae	***Oxynotus bruniensis* (Ogilby, 1893)**	**Prickly dogfish**	PDG	Non-QMS	DD	NOT	DP,SO
Shark	Dalatiidae	***Dalatias licha* (Bonnaterre, 1788)**	**Seal shark**	BSH	Non-QMS	NT	NOT	SO
Shark	Dalatiidae	*Euprotomicrus bispinatus* (Quoy & Gaimard, 1824)	Pygmy shark	EBI	Non-QMS	LC	NOT	SO
Shark	Dalatiidae	*Isistius brasiliensis* (Quoy & Gaimard, 1824)	Cookie cutter shark	IBR	Non-QMS	LC	NOT	SO

Group	Family	Species	Common name	Code	Manage-ment class	IUCN redlist class	NZ threat class	NZ qualifier
Shark	Heterodontidae	*Heterodontus portusjacksoni* (Meyer, 1793)	Port Jackson shark	PJS	Non-QMS	LC	VA	SO
Shark	Rhincodontidae	*Rhincodon typus* Smith, 1828	Whale shark	WSH	Protected	EN	MI	SO
Shark	Odontaspidae	*Odontaspis ferox* (Risso, 1810)	Deepwater (smalltooth) sand tiger shark	ODO	Protected	VU	NU	TO
Shark	Pseudocarchariidae	*Pseudocarcharias kamoharai* (Matsubara, 1936)	Crocodile shark.	CRC	Non-QMS	NT	DD	SO
Shark	Mitsukurinidae	*Mitsukurina owstoni* Jordan, 1898	Goblin shark	GOB	Non-QMS	LC	AR:NU	DP,SO
Shark	Alopiidae	*Alopias superciliosus* Lowe 1841	Bigeye thresher	BET	Non-QMS	VU	NOT	TO
Shark	Alopiidae	***Alopias vulpinus* (Bonnaterre, 1788)**	**Thresher shark**	THR	Non-QMS	VU	NOT	DP, TO
Shark	Cetorhinidae	***Cetorhinus maximus* (Gunnerus, 1765)**	**Basking shark**	BSK	Protected	VU	T:NV	
Shark	Lamnidae	***Carcharodon carcharias* (Linnaeus, 1758)**	**White shark, white pointer**	WPS	Protected	VU	NE	DP, TO
Shark	Lamnidae	***Isurus oxyrinchus* Rafinesque, 1810**	**Mako shark, shortfin mako**	MAK	QMS	VU	NOT	S?O
Shark	Lamnidae	***Lamna nasus* (Bonnaterre, 1788)**	**Porbeagle shark**	POS	QMS	VU	NOT	TO
Shark	Pentanchidae	***Apristurus albisoma* Nakaya & Seret 1999**	**Grey roundfin catshark**		Non-QMS	LC	DD	
Shark	Pentanchidae	***Apristurus ampliceps* Sasahara, Sato & Nakaya 2008**	**Roughskin cat shark**	AAM	Non-QMS	LC	DD	
Shark	Pentanchidae	***Apristurus exsanguis* Sato, Nakaya and Stewart 1999**	**Pale catshark**	AEX	Non-QMS	LC	DD	
Shark	Pentanchidae	***Apristurus garricki* Sato, Stewart & Nakaya 2013**	**Garrick's catshark**	AGK	Non-QMS		DD	
Shark	Pentanchidae	***Apristurus melanoasper* Iglésias, Nakaya & Stehmann 2004**	**Fleshynose cat shark**	AML	Non-QMS	LC	DD	
Shark	Pentanchidae	***Apristurus pinguis* Deng, Xiong & Zhan 1983**	**Bulldog catshark**	APN	Non-QMS	LC	DD	
Shark	Pentanchidae	***Apristurus* cf *sinensis* Chu & Hu 1981**	**Freckled cat shark**	ASI	Non-QMS		DD	
Shark	Scyliorhinidae	***Bythaelurus dawsoni* (Springer, 1971)**	**Dawson's cat shark**	DCS	Non-QMS	DD	NOT	DP
Shark	Scyliorhinidae	***Cephaloscyllium isabellum* (Bonnaterre, 1788)**	**Carpet shark**	CAR	Non-QMS	LC	NOT	
Shark	Scyliorhinidae	*Cephaloscyllium* cf *variegatum* Last & White 2008	Swellshark		Non-QMS		DD	

Group	Family	Species	Common name	Code	Management class	IUCN redlist class	NZ threat class	NZ qualifier
Shark	Pentanchidae	*Parmaturus macmillani* Hardy, 1985	McMillan's cat shark	PCS	Non-QMS	DD	DD	S?O
Shark	Pentanchidae	*Parmaturus* sp.	Rough-backed cat shark		Non-QMS		DD	
Shark	Pseudotriakidae	***Gollum attenuatus* (Garrick, 1954)**	**Slender smooth hound**	SSH	Non-QMS	LC	NOT	SO
Shark	Pseudotriakidae	*Pseudotriakis microdon* de Brito Capello, 1868	False cat shark	PMI	Non-QMS	LC	DD	SO
Shark	Triakidae	***Galeorhinus galeus* (Linnaeus, 1758)**	**School shark**	SCH	QMS	VU	NOT	CD,TO
Shark	Triakidae	***Mustelus lenticulatus* Phillipps, 1932**	**Rig**	SPO	QMS	LC	NOT	CD
Shark	Triakidae	*Mustelus* sp.	Kermadec Rig		Non-QMS		NOT	
Shark	Carcharhinidae	***Carcharhinus brachyurus* (Günther, 1870)**	**Bronze whaler**	BWH	Non-QMS	NT	NOT	CD, DP, SO
Shark	Carcharhinidae	*Carcharhinus galapagensis* (Snodgrass & Heller, 1905)	Galapagos shark	CGA	Non-QMS	NT	NOT	CD, SO
Shark	Carcharhinidae	*Carcharhinus longimanus* (Poey, 1861)	Oceanic whitetip shark	OWS	Protected	VU	MI	SO
Shark	Carcharhinidae	*Carcharhinus obscurus* (Le Sueur, 1818)	Dusky shark	DSH	Non-QMS	VU	MI	SO
Shark	Carcharhinidae	*Carcharhinus plumbeus* (Nardo 1827)	Sandbar shark		Non-QMS	VU	DD	
Shark	Carcharhinidae	*Galeocerdo cuvier* (Peron & LeSueur, 1822)	Tiger shark	TIS	Non-QMS	NT	MI	SO
Shark	Carcharhinidae	***Prionace glauca* (Linnaeus, 1758)**	**Blue shark**	BWS	QMS	NT	NOT	SO
Shark	Carcharhinidae	*Triaenodon obesus* (Rüppell 1837)	Whitetip reef shark	TRB	Non-QMS	NT	VA	
Shark	Sphyrnidae	***Sphyrna zygaena* (Linnaeus, 1758)**	**Hammerhead shark, smooth hammerhead**	HHS	Non-target	VU	NOT	SO
Batoid	Narkidae	***Typhlonarke aysoni* (Hamilton, 1902)**	**Blind electric ray**	TAY	Non-QMS	DD	NOT	DP
Batoid	Torpedinidae	***Tetronarce nobiliana* (Bonaparte, 1835)**	**Electric ray**	ERA	Non-QMS	DD	DD	
Batoid	Torpedinidae	*Tetronarce* cf *tokionis* (Tanaka 1908)	Slender electric ray		Non-QMS		DD	
Batoid	Arhynchobatidae	***Arhynchobatis asperrimus* Waite, 1909**	**Longtail skate**	LSK	Non-QMS	DD	DD	

Group	Family	Species	Common name	Code	Manage-ment class	IUCN redlist class	NZ threat class	NZ qualifier
Batoid	Arhynchobatidae	*Bathyraja pacifica* Last, Stewart & Seret 2016	Pacific blonde skate		Non-QMS		NOT	DP
Batoid	Arhynchobatidae	*Bathyraja richardsoni* (Garrick, 1961)	Richardson's skate	RIS	Non-QMS	LC	NOT	DP
Batoid	Arhynchobatidae	***Bathyraja shuntovi* Dolganov, 1985**	**Longnose deepsea skate**	PSK	Non-QMS	DD	NOT	DP
Batoid	Arhynchobatidae	***Brochiraja albilabiata* Last & McEachran, 2006**	**Whitemouth skate**		Non-QMS	DD	NOT	
Batoid	Arhynchobatidae	***Brochiraja asperula* (Garrick & Paul, 1974)**	**Smooth deepsea skate**	BTA	Non-QMS	DD	DD	
Batoid	Arhynchobatidae	***Brochiraja heuresa* Last & Seret 2012**	**Eureka skate**		Non-QMS		DD	
Batoid	Arhynchobatidae	***Brochiraja leviveneta* Last & McEachran, 2006**	**Blue skate**	BRL	Non-QMS	DD	DD	
Batoid	Arhynchobatidae	***Brochiraja microspinifera* Last & McEachran, 2006**	**Dwarf skate**	BMI	Non-QMS	DD	DD	
Batoid	Arhynchobatidae	***Brochiraja spinifera* (Garrick & Paul, 1974)**	**Prickly deepsea skate**	BTS	Non-QMS	DD	DD	
Batoid	Arhynchobatidae	***Brochiraja vittacauda* Last & Seret 2012**	**Ribbontail skate**		Non-QMS			
Batoid	Arhynchobatidae	*Notoraja alisae* Seret & Last 2012	Velcro skate	NAL	Non-QMS		DD	
Batoid	Arhynchobatidae	*Notoraja sapphira* Seret & Last 2009	Sapphire skate		Non-QMS	DD	DD	
Batoid	Rajidae	***Amblyraja hyperborea* (Collett, 1879)**	**Deepwater spiny skate**	DSK	Non-QMS	LC	NOT	
Batoid	Rajidae	***Dipturus innominatus* (Garrick & Paul, 1974)**	**Smooth skate**	SSK	QMS	NT	NOT	CD
Batoid	Rajidae	***Zearaja nasuta* (Müller & Henle, 1841)**	**Rough skate**	RSK	QMS	LC	NOT	CD
Batoid	Dasyatidae	***Bathytoshia brevicaudata* (Hutton, 1875)**	**Shorttail stingray**	BRA	Non-QMS	LC	NOT	SO
Batoid	Dasyatidae	***Bathytoshia lata* (Garman 1880)**	**Longtail stingray**	WRA	Non-QMS	LC	NOT	SO
Batoid	Dasyatidae	***Pteroplatytrygon violacea* (Bonaparte, 1832)**	**Pelagic stingray**	DAS	Non-QMS	LC	NOT	SO
Batoid	Myliobatidae	***Myliobatis tenuicaudatus* Hector, 1877**	**Eagle ray**	EGR	Non-QMS	LC	NOT	DP, SO
Batoid	Mobulidae	*Manta birostris* (Walbaum, 1792)	Manta ray	RMB	Protected	VU	DD	TO

Group	Family	Species	Common name	Code	Manage-ment class	IUCN redlist class	NZ threat class	NZ qualifier
Batoid	Mobulidae	***Mobula japanica* (Müller & Henle 1841)**	**Spinetail devilray**	MJA	Protected	NT	DD	SO

Notes:

1. Baxter's dogfish, *Etmopterus granulosus* (Günther, 1880) was previously known as *E. baxteri* Garrick, 1957.
2. The electric ray, *Torpedo fairchildi* Hutton, 1872, has been reclassified and synonymised into *Tetronarce nobiliana* (Bonaparte, 1835), a globally widespread species.
3. The longtail stingray, previously *Dasyatis thetidis* (Ogilby in Waite, 1899) is now *Bathytoshia lata* (Garman, 1880). The shorttail stingray, previously *Dasyatis brevicaudata* (Hutton, 1875) is now *Bathytoshia brevicaudata* (Hutton, 1875).
4. The oval electric ray, *Typhlonarke tarakea* Phillipps, 1929, is now thought to be a synonym of the blind electric ray, *T. aysoni* (Hamilton, 1902), and was not considered independently during this RA.

8.3 Information on habitat, relative population size, distribution and reproductive mode of the shark species assessed in the present study (listed in alphabetical order by common name). Species in the *Brochiraja* skate complex and *Apristurus* catshark complex are listed separately. Data for other New Zealand species that were not assessed here were reported by Ford et al. (2015).

Common name	Habitat	Relative population size in EEZ	Distribution	Distribution class	Reproductive mode
Basking shark	Demersal - shelf	Small	Worldwide	Globally widespread	Live bearer
Baxter's dogfish	Demersal - upper slope	Large	Southern Hemisphere	Globally widespread	Live bearer
Blind electric ray	Demersal - upper slope	Moderate	Endemic	Endemic	Live bearer
Blue shark	Pelagic	Large	Worldwide	Globally widespread	Live bearer
Blue skate	Demersal - upper slope	Small	Endemic	Endemic	Egg layer
Broadnose sevengill shark	Demersal - shelf	Moderate	Worldwide	Globally widespread	Live bearer
Bronze whaler	Demersal - shelf	Moderate	Worldwide	Globally widespread	Live bearer
Brown chimaera, longspine chimaera	Demersal - mid slope	Small	Endemic	Endemic	Egg layer
Bulldog catshark	Demersal - mid slope	Small	Western Pacific	Globally widespread	Egg layer
Carpet shark	Demersal - shelf	Large	Endemic	Endemic	Egg layer
Dark ghost shark	Demersal - upper slope	Large	Endemic	Endemic	Egg layer
Dawson's cat shark	Demersal - upper slope	Small	Endemic	Endemic	Egg layer
Deepwater spiny skate	Demersal - mid slope	Moderate	Atlantic and Pacific	Globally widespread	Egg layer
Dwarf skate	Demersal - upper slope	Small	Endemic	Endemic	Egg layer
Eagle ray	Demersal - shelf	Large	Australasia	Regional	Live bearer
Electric ray	Demersal - shelf	Large	Worldwide	Globally widespread	Live bearer
Elephantfish	Demersal - shelf	Large	Australasia	Regional	Egg layer
Eureka skate	Demersal - upper slope	Small	Endemic	Endemic	Egg layer
Fleshynose cat shark	Demersal - mid slope	Small	North Atlantic, SW Pacific, Indian Ocean	Endemic	Egg layer
Freckled cat shark	Demersal - mid slope	Small	West Pacific	Widespread	Egg layer
Garrick's catshark	Demersal - mid slope	Small	Endemic	Endemic	Egg layer
Great white shark, white pointer	Demersal - shelf	Small	Worldwide	Globally widespread	Live bearer

Common name	Habitat	Relative population size in EEZ	Distribution	Distribution class	Reproductive mode
Grey roundfin catshark	Demersal - mid slope	Small	SW Pacific	Regional	Egg layer
Hammerhead shark, smooth hammerhead	Demersal - shelf	Large	Worldwide	Globally widespread	Live bearer
Leafscale gulper shark	Demersal - upper slope	Moderate	East Atlantic to west Pacific	Globally widespread	Live bearer
Longnose deepsea skate	Demersal - mid slope	Small	Endemic	Endemic	Egg layer
Longnose spookfish	Demersal - upper slope	Large	Worldwide	Globally widespread	Egg layer
Longnose velvet dogfish	Demersal - upper slope	Large	Worldwide	Globally widespread	Live bearer
Longtail skate	Demersal - upper slope	Moderate	Endemic	Endemic	Egg layer
Longtail stingray	Demersal - shelf	Moderate	Worldwide	Globally widespread	Live bearer
Lucifer dogfish	Demersal - upper slope	Large	Western Pacific	Globally widespread	Live bearer
Mako shark, shortfin mako	Pelagic	Large	Worldwide	Globally widespread	Live bearer
Northern spiny dogfish	Demersal - shelf	Large	Endemic	Endemic	Live bearer
Owston’s dogfish	Demersal - upper slope	Large	Worldwide	Globally widespread	Live bearer
Pacific spookfish	Demersal - mid slope	Large	Pacific	Globally widespread	Egg layer
Pale catshark	Demersal - mid slope	Small	Endemic	Endemic	Egg layer
Pale ghost shark	Demersal - upper slope	Large	Australasia	Regional	Egg layer
Pelagic stingray	Pelagic	Large	Worldwide	Globally widespread	Live bearer
Plunket’s shark	Demersal - upper slope	Large	Southern Hemisphere	Globally widespread	Live bearer
Porbeagle shark	Pelagic	Large	Atlantic, South Pacific and Indian	Globally widespread	Live bearer
Portuguese dogfish	Demersal - mid slope	Small	Worldwide	Globally widespread	Live bearer
Prickly deepsea skate	Demersal - upper slope	Small	Endemic	Endemic	Egg layer
Prickly dogfish	Demersal - upper slope	Moderate	Australasia	Regional	Live bearer
Ribbontail skate	Demersal - upper slope	Small	Endemic	Endemic	Egg layer
Rig	Demersal - shelf	Large	Endemic	Endemic	Live bearer
Rough skate	Demersal - shelf	Large	Endemic	Endemic	Egg layer

Common name	Habitat	Relative population size in EEZ	Distribution	Distribution class	Reproductive mode
Roughskin cat shark	Demersal - mid slope	Small	Australasia	Regional	Egg layer
School shark, tope	Demersal - shelf	Large	Atlantic and Pacific	Globally widespread	Live bearer
Seal shark, black shark	Demersal - upper slope	Large	Atlantic and Pacific	Globally widespread	Live bearer
Sharpnose sevengill shark	Demersal - upper slope	Small	Worldwide	Globally widespread	Live bearer
Shorttail stingray	Demersal - shelf	Large	Southern Hemisphere	Globally widespread	Live bearer
Shovelnose dogfish	Demersal - upper slope	Large	East Atlantic to Pacific	Globally widespread	Live bearer
Sixgill shark	Demersal - upper slope	Small	Worldwide	Globally widespread	Live bearer
Slender smooth hound	Demersal - upper slope	Moderate	South-west Pacific	Regional	Live bearer
Smooth deepsea skate	Demersal - upper slope	Small	Endemic	Endemic	Egg layer
Smooth skate	Demersal - upper slope	Large	Endemic	Endemic	Egg layer
Spinetail devil ray	Pelagic	Moderate	Worldwide	Globally widespread	Live bearer
Spiny dogfish	Demersal - shelf	Large	Worldwide	Globally widespread	Live bearer
Thresher shark	Pelagic	Moderate	Worldwide	Globally widespread	Live bearer
Whitemouth skate	Demersal - upper slope	Small	Endemic	Endemic	Egg layer

8.4 Shark length and age data and reproductive statistics for 48 of the species assessed in the present study (listed in alphabetical order by common name). Species-specific data were not available for the *Brochiraja* skate complex, or the *Apristurus* catshark complex.

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. Data for other New Zealand species that were not assessed here were reported by Ford et al. (2015).

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 dogfish	22	90	55	63	20	30	57	9	
Blind electric ray	10	40			1.6	1.7	13	< 10	
Blue shark	40	383	230	216	8	8	23	35	1(1.5)
Broadnose sevengill shark	45	300	150	220	5	16	50	85	1(2)
Bronze whaler	65	295	224	270	16	16	31	15	1(2)
Brown chimaera, longspine chimaera		103	80	85					
Carpet shark	16	103	60	76	5.5	9.2			
Dark ghost shark	11	80	53	63					
Dawson's cat shark	11	42	35	35					
Deepwater spiny skate	16	110	94						
Eagle ray	25	200	65	80					
Electric ray		120							
Elephantfish	11	110	52	71	3	5	20		

Common name	L_0	L_{max}	Male L_{50}	Female L_{50}	Male A_{50}	Female A_{50}	A_{max}	Litter average	Gestation (cycle)
Great white shark, white pointer	135	600	360	475	10	14	70	8	
Hammerhead shark, smooth hammerhead	55	370	250	265	15	22	25	35	
Leafscale gulper shark	40	164	99	119	15	21	42	6	
Longnose deepsea skate		140							
Longnose spookfish	13	120							
Longnose velvet dogfish	33	105	60	80				6	
Longtail skate	10	75							
Longtail stingray	60	400							
Lucifer dogfish	15	47	34	41	10.4	13	17		
Mako, shortfin mako	75	394	200	306	8	20	29	12	1.5(3)
Northern spiny dogfish	25	110	70	90				8	
Owston’s dogfish	30	120	70	100				10	
Pacific spookfish	12	140	105	125	16	41			
Pale ghost shark		90	60	70					
Pelagic stingray	18	130	37	47					
Plunket’s shark	34	170	110	130	33	49		25	
Porbeagle	78	285	170	204	10	17	65	3.8	0.7(1)
Portuguese dogfish	30	122	85	100				12	
Prickly deepsea skate		80							
Prickly dogfish	24	91	54	64				8	
Rig	28	151	85	100	6	8	20	11	1(1)
Rough skate	13	79	52	59	4	6	9		
School shark, tope	30	175	130	138	15	14	60	30	1(3)
Seal shark, black shark	35	182	108.8	120				12	
Sharpnose sevengill shark	25	139	75	100				13	

Common name	L_0	L_{max}	Male L_{50}	Female L_{50}	Male A_{50}	Female A_{50}	A_{max}	Litter average	Gestation (cycle)
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	
Smooth deepsea skate		57							
Smooth skate	13	158	93	112	8	13	28		
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	

8.5 The classification of productivity and averages of subcomponents for the 50 species or species complexes assessed in the present study (listed in alphabetical order by common name).

Classification (on a scale of 1–3) of age at maturity, fecundity, average productivity and the average of three (distribution class, population size in the EEZ and the average productivity) and four subcomponents (average of age at maturity, 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. Data for other New Zealand species that were not assessed here were reported by Ford et al. (2015).

Common name/code	Relative EEZ population size	Distribution class	Productivity age at mat	Productivity fecundity	Avg. productivity	Avg. 3-score	Avg. 4-score
Basking shark	3	1		3	3	2.33	2.33
Baxter’s dogfish	1	1	3	2	2.5	1.50	1.75
Blind electric ray	2	3	1	2	1.5	2.17	2.00
Blue shark	1	1	2	1	1.5	1.17	1.25
Broadnose sevengill shark	2	1	3	1	2	1.67	1.75
Brochiraja complex	3	3				3.00	3.00
Bronze whaler	2	1	3	3	3	2.00	2.25
Brown chimaera, longspine chimaera	3	3				3.00	3.00
Carpet shark	1	3	1		1	1.67	1.67
Catsharks (*Apristurus* species)	3	1				2.00	2.00
Dark ghost shark	1	3				2.00	2.00
Dawson's cat shark	3	3				3.00	3.00
Deepwater spiny skate	2	1				1.50	1.50
Eagle ray	1	2				1.50	1.50
Electric ray	1	3				2.00	2.00
Elephantfish	1	2	1		1	1.33	1.33
Great white shark, white pointer	3	1	3	2	2.5	2.17	2.25
Hammerhead shark, smooth hammerhead	1	1		1	1	1.00	1.00
Leafscale gulper shark	2	1	3	3	3	2.00	2.25
Longnose deepsea skate	3	3				3.00	3.00
Longnose spookfish	1	1				1.00	1.00
Longnose velvet dogfish	1	1		3	3	1.67	1.67

Common name/code	Relative EEZ population size	Distribution class	Productivity age at mat	Productivity fecundity	Avg. productivity	Avg. 3-score	Avg. 4-score
Longtail skate	2	3				2.50	2.50
Longtail stingray	2	1				1.50	1.50
Lucifer dogfish	1	1	3		3	1.67	1.67
Mako, shortfin mako	1	1	3	3	3	1.67	2.00
Northern spiny dogfish	1	3		2	2	2.00	2.00
Owston’s dogfish	1	1		2	2	1.33	1.33
Pacific spookfish	1	1	3		3	1.67	1.67
Pale ghost shark	1	2				1.50	1.50
Pelagic stingray	1	1				1.00	1.00
Plunket’s shark	1	1	3	2	2.5	1.50	1.75
Porbeagle	1	1	3	3	3	1.67	2.00
Portuguese dogfish	3	1		2	2	2.00	2.00
Prickly deepsea skate	3	3				3.00	3.00
Prickly dogfish	2	2		3	3	2.33	2.33
Rig	1	3	2	2	2	2.00	2.00
Rough skate	1	3	1		1	1.67	1.67
School shark, tope	1	1	3	2	2.5	1.50	1.75
Seal shark, black shark	1	1		2	2	1.33	1.33
Sharpnose sevengill shark	3	1		2	2	2.00	2.00
Shorttail stingray	1	1		2	2	1.33	1.33
Shovelnose dogfish	1	1	3	3	3	1.67	2.00
Sixgill shark	3	1		1	1	1.67	1.67
Slender smooth hound	2	2		3	3	2.33	2.33
Smooth deepsea skate	3	3				3.00	3.00
Smooth skate	1	3	3		3	2.33	2.33
Spinetail devil ray	2	1		3	3	2.00	2.00
Spiny dogfish	1	1	2	3	2.5	1.50	1.75
Thresher shark	2	1	1	3	2	1.67	1.75

8.6 Species codes

Species code	Species		Species code	Species		Species code	Species
ALB	Albacore tuna		JDO	John dory		SDO	Silver dory
BAR	Barracouta		JMA	Jack mackerel		SFI	Starfish
BAS	Bass groper		KAH	Kahawai		SFL	Sand flounder
BCO	Blue cod		KIN	Kingfish		SKI	Gemfish
BFL	Black flounder		LDO	Lookdown dory		SKJ	Skipjack tuna
BNS	Bluenose		LEA	Leatherjacket		SNA	Snapper
BOA	Sowfish		LIN	Ling		SND	Shovelnose spiny dogfish
BOE	Black oreo		LSO	Lemon sole		SOR	Spiky oreo
BRA	Short-tailed black ray		MAK	Mako shark		SPD	Spiny dogfish
BRI	Brill		MDO	Mirror dory		SPE	Sea perch
BWS	Blue shark		MOK	Moki		SPO	Rig
BYX	Alfonsino		OEO	Oreos		SPZ	Spotted stargazer
CAR	Carpet shark		ORH	Orange roughy		SQU	Arrow squid
CDL	Cardinalfish		PAD	Paddle crab		SSK	Smooth skate
CDO	Capro dory		QSC	Queen scallop		SSO	Smooth oreo
ELE	Elephant fish		RAT	Rattails		STA	Giant stargazer
EMA	Blue mackerel		RBM	Rays bream		SWA	Silver warehou
ESO	N.Z. sole		RBT	Redbait		TAR	Tarakihi
FLA	Flats		RBY	Rubyfish		THR	Thresher shark
FLO	Flounder		RCO	Red cod		TRA	Roughies
FRO	Frostfish		RIB	Ribaldo		TRE	Trevally
GFL	Greenback flounder		RRC	Red scorpion fish		TRU	Trumpeter
GSC	Giant spider crab		RSK	Rough skate		TUR	Turbot
GSH	Ghost shark		RSN	Red snapper		WAR	Common warehou
GUR	Gurnard		SBO	Southern boarfish		WHE	Whelks
HAK	Hake		SBW	Southern blue whiting		WRA	Longtailed stingray
HAP	Hapuku		SCA	Scallop		WWA	White warehou
HOK	Hoki		SCH	School shark		YBF	Yellowbelly flounder
HPB	Hapuku & bass		SCI	Scampi			
JAV	Javelin fish		SCO	Swollenhead conger			

8.7 Method codes

Method code	Method
BLL	Bottom longline
BPT	Bottom pair trawl
BS	Beach seine
BT	Bottom trawl
CP	Cod pot
CRP	Crab pot
D	Dredge
DI	Diving
DL	Dahn line
DN	Drift net
DS	Danish seine
FN	Fyke net
FP	Fish trap
HL	Hand line
MW	Midwater trawl
PL	Pole and line
PS	Purse seine
RLP	Rock lobster pot
RN	Ring net
SLL	Surface long line
SN	Set net
T	Troll
TL	Trot line