

# Conservation Services Programme

## Protected fish medium term research plan

December 2018

Conservation Services Programme

Department of Conservation

## 1. Purpose

The Conservation Services Programme (CSP) undertakes research to understand and address the effects of commercial fishing on protected species, in New Zealand fisheries waters (for further details see the [CSP Strategic Statement 2018](#)). Protected fish species are those listed under Schedule 7a of the Wildlife Act 1953 and detailed in Table 1.

This CSP protected fish medium term research plan (CSP fish plan) outlines a rolling five-year research programme to deliver on the protected fish population, mitigation and interaction research component of CSP. It has been developed as part of the work of the CSP Research Advisory Group ([CSP RAG](#)), and will be used in the development of CSP Annual Plans and any other relevant delivery mechanisms. This iteration of the plan represents an update following key developments including updated risk assessments and Threat Classification.

Protected fish research that falls outside the scope and mandate of CSP, for example recreational fishing bycatch, is not included in this plan.

## 2. Guiding objectives and risk framework

This plan is guided by the relevant objectives of CSP and relevant elements the National Plan of Action for the Conservation and Management of Sharks 2013 ([NPOA-Sharks](#)). These are summarised in Table 2. The NPOA sharks is scheduled for review in 2019, following that the CSP fish plan will re-updated to reflect any changes to guidance.

The risk referred to in the guiding objectives is the risk of commercial fisheries to New Zealand protected fish populations. One objective of the NPOA-Sharks is to undertake a quantitative risk assessment in order to understand the impact of commercial fisheries on shark species. While this quantitative risk assessment has yet to be progressed, a 'level 1' qualitative risk assessment has been conducted (Ford et.al 2015) and subsequently revised (Ford et. al. 2018). In both instances the risk assessment was conducted by an expert panel comprising representatives from DOC, MPI the fishing industry and NIWA. Ninety-two shark taxa were considered in the first iteration of the risk assessment, including all protected fish sharks and rays, however paucity of data prevented all taxa from being assessed. Therefore, in the second iteration of the risk assessment only 50 taxa were assessed, those with sufficient data available and those with intensity scores of >2 in the original assessment (Ford et. al. 2018).

While assessment criteria for all shark species were the same, protected sharks and rays were considered separately as they are afforded special status under the Wildlife Act. The objective of the risk assessment was to provide a scoring which will inform species priority relative to others. It also provides a broad gaps analysis for each species.

In 2016 the Department also reviewed the New Zealand Threat Classification for all elasmobranchs (Duffy et. al. 2016).

The prioritisation in this plan combines the results of the Threat Classification, the updated level 1 risk assessment, findings of Francis and Lyon (2012; 2014) and any other relevant information.

### 3. Data requirements

In general, there is a paucity of data relating to the biology, population size and population structure of protected fishes in New Zealand. Francis and Lyon (2012; 2014) summarise the state of knowledge for all nine protected fishes (Table 3) and give direction as to where priority research should be focused. This has largely echoed the outputs of the Level 1 Risk Assessments detailed in Table 4 (Ford et. al., 2015, 2018).

Recent international work has been undertaken to identify research needs for manta and devil rays (Stewart et. al. 2018) and white sharks (Huvneers et. al. in press).

This plan describes a research approach to fill knowledge gaps in order to better understand protected fish species susceptibility to impacts from commercial fisheries and therefore inform and prioritise management actions to avoid, remedy or mitigate these impacts:

- A core prerequisite for any research on protected fish is accurate identification of bycaught animals. Historically a number of shark species have been reported to generic taxonomic levels by both observers and fishers. This was due to a lack of suitable identification guides, a lack of formal descriptions for several cryptic species and limited effort targeted at identifying animals due to conflicting observer priorities. In some cases, the ability for fishers to report captures has been hampered by a lack of species-specific codes, for example, a reporting code for oceanic white-tip shark was not available prior to its protection.
- In order to accurately assess risk of fishing as a function of overlap with commercial fisheries detailed knowledge of species' distributions is required. For migratory species these distributions should contain seasonal dimensions. For many more commonly caught fish taxa this can be achieved through catch data. However, for the seven protected shark species this data is too sparse and should be supplemented with tracking studies where possible.
- Sharks can be characterised as having relatively slow growth rates, late sexual maturation and low fecundity. These factors place them at increased risk of impact from commercial fishing bycatch. Understanding the reproductive characteristics of protected sharks in New Zealand allows understanding of the resilience of populations to such fishing impacts.
- Very little information is available on growth rates or fecundity for either spotted black grouper or giant grouper, however it is generally believed to be low based on the characteristics of other similarly sized grouper species (Francis and Lyon 2012). Therefore, caution should be applied when estimating risk from commercial fisheries interactions.
- The degree of post-release mortality in commercial fisheries is not well understood for fish species. Some fishery/ species interactions have higher incidence of live release than others, for example white pointer sharks bycaught in setnets and spine tailed devil rays bycaught in purse seine. While animals are assessed as being alive at time of

release the level of subsequent mortality is poorly understood. Sharks are susceptible to toxic poisoning due to stress and studies by Francis and Jones (2014) have shown that post-release mortality of spine-tail devil rays, assessed by observers as in good condition on release, can be high (75% based on a very limited sample). Francis (2017c) undertook an analysis of white shark captures and proposed methodologies for undertaking post release survival studies. This methodology should be applied to other protected fish species in order to refine assessments of mortality.

- Other sources of information, particularly around estimation of capture rates in fisheries, is also of great importance in accurately estimating risk. This information is generally best obtained via vessel observation programmes.

#### 4. Current risk and uncertainty

All protected fishes, with the exception of spine-tailed devil ray and spotted black grouper<sup>1</sup> are listed as vulnerable under the IUCN Redlist classification system (Table 1). While a formalised quantitative risk assessment for shark species has not yet been completed, the results of the Level 1 risk assessments (Table 4) give guidance and a preliminary matrix of fisheries and protected fish species can be constructed based on known interactions with fisheries. This can be used to prioritise data gathering to better understand interactions including bycatch rates and where to target mitigation. Two matrices are presented in Tables 5 and 6, to aid prioritisation. Data needs are species specific and dependant on our understanding of the nature of interactions and the population dynamics and distribution of the species.

Interactions of some protected fishes with commercial fisheries in New Zealand may be infrequent; whale shark and giant grouper are tropical species which do not occur in New Zealand waters in high numbers. Therefore, these species would be lower priority candidates for research (Francis and Lyon 2012). This was reflected by Ford et. al (2015) in the relative rankings of protected shark species according to risk from anthropogenic impact, primarily fisheries bycatch (Table 4). Basking shark and spine tailed devil rays are the most frequently reported bycatch species followed by white pointer sharks.

Observed interactions with spine-tailed devil rays are largely limited to skipjack purse seine fisheries, and over a relatively short season. As this fishery aims for live capture of fish, many of the animals are recorded as caught and released alive (Francis and Lyon 2012) though studies have shown post release mortality occurs even for apparently good condition individuals (Francis 2013). Therefore, projects targeted at mitigation, safe release and education and/ awareness could yield reductions in captures and/or increased post-release survival.

Reported basking shark interactions by contrast are the most evenly distributed over time, space and fishery group (Francis and Sutton 2012). It is likely that no single mitigation

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<sup>1</sup> Listed as 'Near Threatened'

approach will deal with these interactions. Therefore, it will be necessary to better understand the distribution and population dynamics of this species to better target actions to avoid or mitigate commercial fisheries bycatch. Distribution information from Observers should include both bycatch records and observations of free-swimming sharks.

White pointer sharks have been reported captured in both inshore and offshore trawl fisheries but primarily in inshore setnet around Stewart Island, Fiordland and Taranaki. Given the sparse nature of observer coverage in these fisheries it will be important to increase monitoring in order to better understand the nature and extent of these interactions. A number of these shark interactions are reported as resulting in live releases, however it is uncertain as to the level of post release mortality. These data gaps would best be filled through the use of pop-off or survival tags to record the animal's activity following release. Methodologies to investigate these interactions are identified by Francis (2017).

Bycatch of oceanic white-tip sharks has been reported in surface longline fisheries, in northern New Zealand and the Kermadec region. Understanding the nature and extent of these interactions has been limited by a combination of a lack of species-specific reporting codes available to fishers and low (<10%) and patchily distributed observer coverage in the domestic surface longline fisheries (Hjorvarsdottir 2017, Hjorvarsdottir and Isaacs 2018). Increased focus on data collection for observers in this fishery along with studies on post release survival would help inform future management action or research. Acknowledging that there would be an underreporting rate for this species, Francis and Lyon (2014) still concluded that it is likely that these sharks are rarely caught and therefore a lower priority for management.

Improving understanding of life history characteristics of shark species informs assessments of their vulnerability to fisheries related mortality. Collection of biological samples from bycaught animals can be used in the estimation of these life history characteristics for example: growth and longevity, size at sexual maturity, litter size and gestation period (Francis and Lyon 2012). Such data is poor for most protected fish species (Francis and Lyon 2012; 2014).

## **5. Research planning**

Table 3 indicates the knowledge gaps in our understanding of population parameters relevant to meeting CSP and NPOA-Sharks objectives. Prioritisation of these data gaps will be further informed by work underway on the quantitative NPOA-Sharks Risk Assessment. This risk assessment is planned to be completed in a series of iterations. The initial stage, a Level 1 expert based assessment, has been completed (Ford et. al. 2018). A first tranche of species will be run through a Level 2, semi quantitative, assessment in order to prove the concept with more data rich species. Once the approach is refined it will then be applied to less data rich species. Each iteration will be reviewed by a technical working group which will identify data gaps that will drive the research direction. With each iteration, more species will be added and models will be refined with improved input data.

The information on our understanding of population parameters for protected fishes, relevant to NPOA-Sharks and CSP objectives, given in Table 3 and the relative prioritisation of shark species in Table 4 forms the basis of the CSP research response proposed in Table 7. The CSP research response has been developed to meet the following criteria:

- Method and species-specific bycatch mitigation options developed for each protected fish species known to interact with commercial fisheries.
- Development of live release methods and protocols to maximise post-release survival probability of protected fish species for fisheries where live captures are relatively frequent.
- Where protected fish species are known to be released alive following capture, assess post-release survival to better estimate bycatch mortality.
- Population structure should be determined (by genetic analysis and tagging) in order to identify both population structuring within the NZ EEZ and differentiation from worldwide populations. This will enable adequate population level management.
- Improvement of both government observer and commercial fisher identification of protected fish species through training and educational materials to improve catch assessment for protected species. This should be informed by review of historic observer identification and photo logs.
- Optimise sampling of biological materials from dead protected fishes, including collection of vertebrae and gonads to inform New Zealand specific understanding of life history characteristics such as age at maturity and fecundity.
- Examination of population structuring should be assisted by collection of biopsy samples from live released bycaught animals.
- Leveraging any international initiatives to investigate population dynamics through collaboration and provision of bycatch samples for the purpose of genetic analysis.
- Tracking studies of highly motile protected fish species to inform estimates of spatial overlap between commercial fisheries and protected fish species. These studies should be designed to be informative on seasonal movements.

In order to plan a five-year research programme to deliver the CSP research response described in Table 7, the following operational principles were applied:

- studies on highest risk species were prioritised for earlier years, as informed by Level 1 and in, the future, Level 2 risk assessments;
- mitigation, live release and post-release survival studies should focus on fisheries with most frequent interactions;
- annual grouping of CSP projects by location across protected species taxa, in order to maximise synergies with other research projects, for example vessel-based research in

the Auckland Island squid fishery can assist sea lion, white shark and basking shark research;

- planning live release, survival estimation and tracking studies in a complementary manner;
- aim to leverage from existing studies, of both the Department and other organisations;
- prioritise taxonomic and review projects, ensuring adequate data collection is advanced in early years, as these are relatively low cost and may result in finding current risk estimates are under-estimated for potential new taxa; and
- prioritise studies which make better use of existing research platforms such as biological sampling by government observers.



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## Tables

Table 1. Protected fish species

Common name	Scientific Name	Family	NZTCS Status	Criteria	Qualifier	IUCN Threat Ranking
<b>Basking shark</b>	<i>Cetorhinus maximus</i>	Centorhinidae	Threatened –Nationally Vulnerable	<i>moderate population, with population trend that is declining, 1000–5000 mature individuals, predicted decline 10–50%</i>		Vulnerable
<b>Deepwater nurse shark</b>	<i>Odontaspis ferox</i>	Odontaspidae	At Risk – Naturally Uncommon		Threatened Overseas	Vulnerable (decreasing population)
<b>Oceanic whitetip shark</b>	<i>Carcharhinus longimanus</i>	Carcharhinidae	Migrant		Stable Overseas	Vulnerable
<b>Whale shark</b>	<i>Rhincodon typus</i>	Rhincodontidae	Migrant		Stable Overseas	Vulnerable (decreasing population)
<b>White pointer shark</b>	<i>Carcharodon carcharias</i>	Lamnidae	Threatened –Nationally Endangered	small stable population (unnatural)	Data Poor, Threatened Overseas	Vulnerable
<b>Manta ray</b>	<i>Mobula birostris</i> ( <i>Manta birostris</i> )	Mobulidae	Data Deficient		Threatened Overseas	Vulnerable
<b>Spinetail devil ray</b>	<i>Mobula mobular</i> ( <i>M. japonica</i> )	Mobulidae	Data Deficient		Stable Overseas	Near Threatened
<b>Giant grouper</b>	<i>Epinephelus lanceolatus</i>	Serranidae	N/A			Vulnerable
<b>Spotted black grouper</b>	<i>Epinephelus daemeli</i>	Serranidae	N/A			Near Threatened

**Table 2.** Guiding objectives of the NPOA-Sharks and CSP.

NPOA-Sharks

Goal	Five-year objectives
<p><b>Biodiversity and long-term viability of shark populations</b></p> <p>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.</p>	<p><b>Objective 1.1</b> Develop and implement a risk assessment framework to identify the nature and extent of risks to shark populations.</p> <p><b>Objective 1.2</b> Systematically review management categories and protection status to ensure they are appropriate to the status of individual shark species.</p> <p><b>Objective 1.3</b> For shark species managed under the QMS, undertake an assessment to determine the stock size in relation to <math>B_{MSY}</math> or other accepted management targets and on that basis review catch limits to maintain the stock at or above these targets.</p> <p><b>Objective 1.4</b> 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.</p> <p><b>Objective 1.5</b> Identify and conserve habitats critical to shark populations.</p> <p><b>Objective 1.6</b> Ensure adequate monitoring and data collection for all sectors (including commercial, recreational and customary fishers and non-extractive users) and that all users actively contribute to the management and conservation of shark populations.</p>
<p><b>Utilisation, waste reduction and the elimination of shark finning</b></p> <p>2. Encourage the full use of dead sharks, minimise unutilised incidental catches of sharks, and eliminate shark finning<sup>2</sup> in New Zealand</p>	<p><b>Objective 2.1</b> Review and implement best practice mitigation methods, as required, in all New Zealand fisheries (commercial and non-commercial).</p> <p><b>Objective 2.2</b> Minimise waste by promoting the live release of bycaught shark species, and develop and implement best practice guidelines for handling and release of live sharks.</p> <p><b>Objective 2.3</b> Develop and implement best practice guidelines for non-commercial fishing and handling of sharks.</p> <p><b>Objective 2.4</b> Eliminate shark finning in New Zealand fisheries by 1 October 2016.</p>

<sup>2</sup> Shark finning is defined for the purpose of this NPOA as the removal of the fins from a shark (Class Chondrichthyes – excluding Batoidea (rays and skates)) and the disposal of the remainder of the shark at sea. As such, removal of the fins from a shark where the trunk is also retained for processing is not defined as ‘shark finning’.

Goal	Five-year objectives
<p><b>Domestic engagement and partnerships</b></p> <p>3. All commercial, recreational and customary fishers, non-extractive users, Maori, and interested members of the New Zealand public know about the need to conserve and sustainably manage shark populations and what New Zealand is doing to achieve this.</p>	<p><b>Objective 3.1</b> Capture and reflect, through meaningful engagement, the social and cultural significance of sharks, including their customary significance to Maori, in their conservation and management.</p> <p><b>Objective 3.2</b> Communication and information sharing between government agencies and stakeholders is effective, with strategies developed and implemented to promote the conservation and sustainable management of shark populations.</p> <p><b>Objective 3.3</b> Encourage compliance with regulations, implementation of best practice (including catch avoidance and correct handling), and cooperation with ongoing research among commercial and non-commercial stakeholders. In particular, encourage reporting of any illegal practices (especially live finning) that may be observed.</p>
<p><b>Non-fishing threats</b></p> <p>4. New Zealand's non-fishing anthropogenic effects do not adversely affect long-term viability of shark populations and environmental effects on shark populations are taken into account</p>	<p><b>Objective 4.1</b> Non-fishing anthropogenic and environmental threats to shark populations are understood and, where appropriate, managed.</p>
<p><b>International engagement</b></p> <p>5. New Zealand actively engages internationally to promote the conservation of sharks, the management of fisheries that impact upon them, and the long-term sustainable utilisation of sharks.</p>	<p><b>Objective 5.1</b> New Zealand ensures that it meets its international obligations and receives positive recognition for its efforts in the conservation, protection and management of sharks through active engagement in international conservation and management agreements relevant to sharks.</p> <p><b>Objective 5.2</b> New Zealand actively investigates and decides whether to become a signatory to the Convention on Migratory Species (CMS) Memorandum of Understanding on the Conservation of Migratory Sharks (MoU) in advance of the next Meeting of Signatories in 2015.</p> <p><b>Objective 5.3</b> New Zealand collaborates with neighbouring countries to better understand the population dynamics of highly migratory sharks, protected sharks and any other shark species of special interest.</p> <p><b>Objective 5.4</b> New Zealand proactively contributes to and advocates for improved data collection and information sharing of commercial catches and incidental bycatch of sharks within relevant Regional Fisheries Management Organisations (RFMOs).</p> <p><b>Objective 5.5</b> New Zealand encourages fishing countries, coastal States, and other regional organisations to develop and implement best practice Plans of Action for conserving and managing sharks, where they have not already done so.</p>
<p><b>Research and information</b></p> <p>6. Continuously improve the information available to conserve sharks and manage fisheries that impact on sharks, with prioritisation guided by the risk assessment framework.</p>	<p><b>Objective 6.1</b> Ensure information collection systems and processes are sufficient to inform management of shark populations</p> <p><b>Objective 6.2</b> Undertake a research programme, guided by the risk assessment framework, to increase understanding of and improve the management of shark populations.</p> <p><b>Objective 6.3</b> Implement research to inform the development of recovery plans appropriate to protected species</p>

## CSP Objectives

<p><b>Objective A: Proven mitigation strategies are in place to avoid or minimise the effects of commercial fishing on protected species across the range of fisheries with known interactions.</b></p>	<p>Addressing this objective will consist of continued identification of new mitigation methods, application of methods used overseas (including development for New Zealand fisheries), and at-sea testing. Priority will be given to protected species/fisheries interactions for species identified as at high risk from commercial fishing effects.</p>
<p><b>Objective B: The nature of direct effects of commercial fishing on protected species is described.</b></p>	<p>This objective will be achieved through the collection and reporting of observational information on captures and other direct interactions of protected species across a representative portion of fishing effort. The protected species involved, the characteristics of the fishing operation, and the nature of each interaction will be determined and recorded.</p>
<p><b>Objective C: The extent of known direct effects of commercial fishing on protected species is adequately understood.</b></p>	<p>This objective will be achieved when:</p> <ul style="list-style-type: none"> <li>• a robust risk assessment can be completed to assess the extent of risk posed by direct effects of commercial fishing;</li> <li>• for species identified at medium or high risk<sup>3</sup>, information is available to allow the meaningful monitoring of captures rates over time; and</li> <li>• the extent of commercial fishing effects that allow for the protection and recovery of protected species have been identified.</li> </ul> <p>Addressing this objective will require the collection of representative independent information on interaction rates of protected species with commercial fishing, at levels determined through risk analysis.</p>

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<sup>3</sup> These risk categories will be determined during the prioritisation phase of the CSP research planning cycle, with reference to relevant risk assessments as detailed in Section 3 and Appendix 4.

<p>Objective D: The nature and extent of indirect effects of commercial fishing are identified and described for protected species that are at particular risk to such effects.</p>	<p>Addressing this objective will involve multi-disciplinary research including ecosystem modelling focussed on identifying and describing the mechanisms of indirect effects from fisheries on protected species. Priority will be given to those relevant protected species/fisheries combinations where existing knowledge or related research programmes exist.</p>
<p>Objective E: Adequate information on population level and susceptibility to fisheries effects exists for protected species populations identified as at medium or higher risk from fisheries.</p>	<p>This information is required in order to inform detailed risk assessment and/or fisheries management. Addressing this objective will involve the collection of data on population trend, demographic parameters and at-sea foraging information for medium to high risk protected species.</p>

**Table 3.** Summary of the level of population information available for each of eight protected fish species. Species and their score sums which are coloured purple have a moderate–high proportion of their population in New Zealand waters for at least part of the year (Francis and Lyon 2012).

Species	Proportion of stock in NZ	Stock identification - population unit				Sum	Biological information - species productivity					Sum
		Genetic stock structure	Movement	World distribution	Habitat		Growth	Longevity	Maturity	Reproduction	Natural mortality	
Basking shark	High	1	2	3	2	8	1	1	1	1	1	5
White shark	High	3	3	3	3	12	2	1	2	1	1	7
Whale shark	Low	2	2	3	3	10	1	1	1	1	1	5
Deepwater nurse shark	High?	0	0	2	1	3	0	0	1	1	0	2
Spinetail devilray	Moderate	0	1	3	3	7	1	1	2	2	0	6
Manta ray	Low?	1	1	3	2	7	0	1	2	2	0	5
Spotted black grouper	High	1	0	4	3	8	2	2	1	1	2	8
Giant grouper	Low	0	0	3	3	6	0	0	1	0	0	1
Sum		8	9	24	20		7	7	11	9	5	
Species	Proportion of stock in NZ	Species and fishery distribution - extent of overlap in NZ				Response to exploitation in NZ			Sum	Information level		
		Stock distribution	Fishery distribution	Vulnerable components in commercial fisheries	Sum	Catches and biomass	Size composition					
Basking shark	High	3	2	> 4 m	5	2	0	2	0 = none			
White shark	High	3	2	All	5	0	0	0	1 = poor			
Whale shark	Low	3	4	Not vuln.	7	NA	NA	0	2 = moderate			
Deepwater nurse shark	High?	1	1	All	2	0	0	0	3 = good			
Spinetail devilray	Moderate	3	3	All	6	0	0	0	4 = excellent			
Manta ray	Low?	2	3	Not vuln.	5	NA	NA	0	NA = not applicable			
Spotted black grouper	High	3	3	All	6	0	0	0				
Giant grouper	Low	3	2	Not vuln.	5	NA	NA	0				
Sum		21	20			2	0					



**Table 4** Relative ranking of protected shark species according to risk from fisheries bycatch, based on the reviewed Level 1 Qualitative Risk Assessments in (a) 2016 and (b) 2017. For the COMPONENTS OF RISK higher numbers indicate greater intensity or consequence of impact. For RISK longer bars and larger numbers indicate higher risk, and for CONFIDENCE more ticks indicate higher confidence in the data, or greater consensus and a cross indicates a lack of consensus (Two ticks in the consensus column indicate full consensus). Where species scored identical risk scores they are presented so that higher consequences are reported first and then in alphabetical order (after Ford et. al., 2018).

(a) 2015 Qualitative (Level 1) risk assessment

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	✓✓	✓
2	4	8 - Smalltoothed sandtiger	✓	✓
1	1	1 - Whale shark	✓✓✓	✓✓
1	1	1 - Oceanic whitetip shark	✓✓✓	✓✓
1	1	1 - Manta ray	✓✓	✓✓

(b) 2017 Qualitative (Level 1) risk assessment

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	✓✓	✓

**Table 5.** Frequency of interaction between fishery group and protected fish species in each FMA for the period Jan 2015 to April to 2018.

Captures Species	FMA						Grand Total
	1/AKE	5/SOU	6/SUB	7/CHA	8/CEW	9/AKW	
<b>Basking shark</b>		7	5				12
Trawl - Hoki, Hake, Ling, and Warehou species		3	3				6
Setnet		1					1
Surface Longline - Domestic Tuna and Swordfish			1				1
Trawl - Southern blue whiting			1				1
Trawl - Squid		3					3
<b>Spine-tailed devil ray</b>	96					8	104
Purse Seine - Skipjack Tuna	94					8	102
Surface longline Swordfish	1						1
Trawl - Squid	1						1
<b>White shark</b>	2	2	6	1	2	1	14
Bottom longline - Snapper	1						1
Trawl - Hoki, Hake, Ling, and Warehou species	1				1		2
Precision Seafood Harvesting			1				1
Setnet		1			1		2
Inshore Trawl				1		1	2
Trawl - Squid		1	5				6
<b>Grand Total</b>	<b>98</b>	<b>9</b>	<b>11</b>	<b>1</b>	<b>2</b>	<b>9</b>	<b>130</b>

**Table 6** CSP Research response over the next 5 years: SURV= Post release survival estimate; TRACK= Tracking Studies; BIO Biological Sampling of specimens; L1RA= inclusion into Level1 Risk Assessment; L2RA= Inclusion into Level 2 Risk Assessment; MIT= .Mitigation Research; LIVE= Live release research; GEN= Genetic analysis.

Species	Research	Year				
		1	2	3	4	5
Basking shark	L1RA L2RA MIT SURV LIVE TRACK BIO GEN	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █
Deepwater nurse shark	L1RA L2RA MIT SURV LIVE TRACK BIO GEN	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █
Oceanic whitetip shark	L1RA L2RA MIT SURV LIVE TRACK BIO GEN	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █
Whale shark	L1RA L2RA MIT SURV LIVE TRACK BIO GEN	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █
White pointer shark	L1RA L2RA MIT SURV LIVE TRACK BIO GEN	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █
Manta ray	L1RA L2RA MIT SURV LIVE TRACK BIO GEN	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █
Spinetail devil ray	L1RA L2RA MIT SURV LIVE TRACK BIO GEN	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █
Giant grouper	L1RA L2RA MIT SURV LIVE TRACK BIO GEN	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █
Spotted black grouper	L1RA L2RA MIT SURV LIVE TRACK BIO GEN	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █	█ █ █ █ █ █ █ █

Appendix 1 – Qualitative (Level 1) Risk Assessment of the impact of commercial fishing on New Zealand Chondrichthyans - Level 1 Protected species chapter (Ford et.al. 2018)

### 3.3 Protected species

Seven species of shark are afforded absolute protection under the Wildlife Act 1953<sup>7</sup> (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
<b>Basking shark</b>	<i>Cetorhinus maximus</i>	Threatened: Nationally Vulnerable	Vulnerable A2ad+3d
<b>Smalltooth sandtiger shark</b>	<i>Odontaspis ferox</i>	Nationally Uncommon	Vulnerable A2bd
<b>Oceanic whitetip shark</b>	<i>Carcharhinus longimanus</i>	Migrant	Vulnerable A2ad+3d+4ad
<b>Whale shark</b>	<i>Rhincodon typus</i>	Migrant	Endangered* A2bd+4bd
<b>Great white shark</b>	<i>Carcharodon carcharias</i>	Threatened: Nationally Vulnerable	Vulnerable A2cd+3cd
<b>Manta ray</b>	<i>Manta birostris</i>	Data Deficient	Vulnerable A2abd+3bd+4abd
<b>Spinetail devil ray</b>	<i>Mobula japonica</i>	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

<sup>7</sup> 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)”.

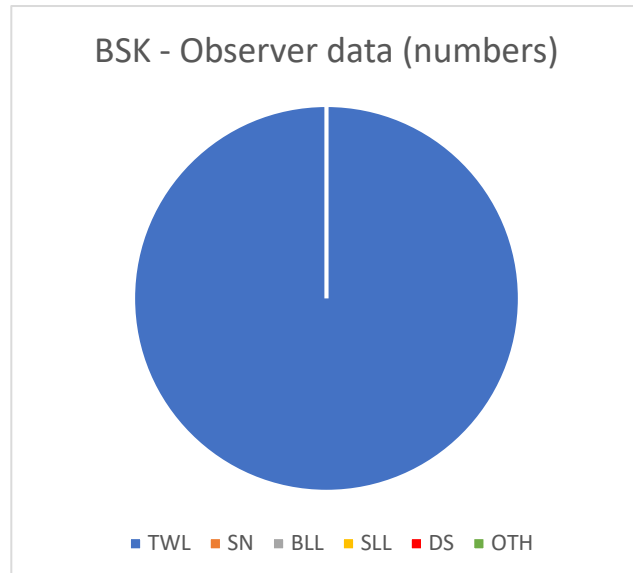
PROTECTED SPECIES RISK				
COMPONENTS OF RISK		RISK	CONFIDENCE	
Intensity	Consequence		Data	Consensus
3	4.5	13.5 – Basking shark	✓✓	✓
3	4.5	13.5 – Spinetail devil ray	✓	✓
3	4	12 – Great white shark	✓✓	✓

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.

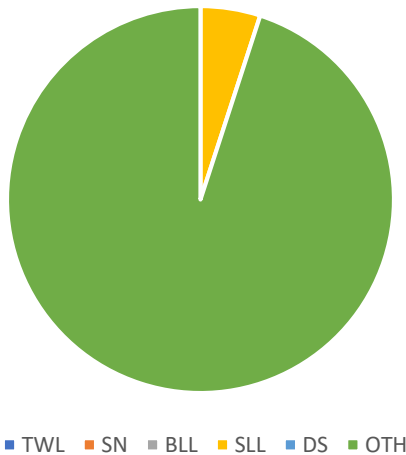
Basking shark is globally widespread (Ebert et al. 2013) but was classified as having a relatively small population in New Zealand waters. Basking shark is potentially a migrant in NZ waters but movement and connectivity information is lacking and high and localised catches can occur (Francis & Lyon 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 japonica***

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

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

MJA - Observer data (numbers)



*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.

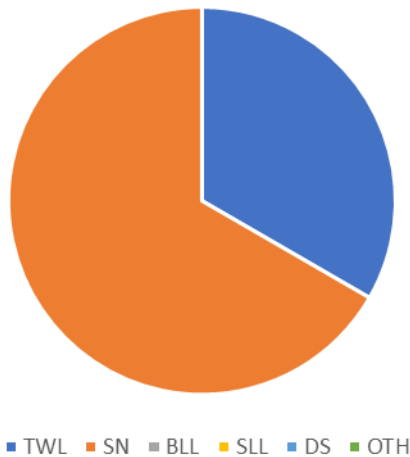


**Great white shark (WPS) *Carcharodon carcharias***

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

Total Commercially Estimated Commercial Catch (2011–12 to 2015–16 fishing years): 33 t  
Live bearer

WPS - Observer data (numbers)



*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.