The extinction risk of New Zealand chondrichthyans

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Abstract

1. The national extinction risk of New Zealand chondrichthyans (sharks, rays, and chimaeras), which accounts for ~10% of the global chondrichthyan fauna, was evaluated for the first time using the IUCN Red List of Threatened Species Categories and Criteria. Across 32 families, 103 species were assessed.

2. New Zealand holds a high degree of species endemism (20%) with deepwater species dominating the fauna (77%). Sharks were the most speciose group with 68 species (66%), followed by 24 rays (23%), and 11 chimaeras (10%).

3. Most species were assessed as Least Concern (60%, 62 species) or Data Deficient (32%, 33 species), with four (3.8%) species listed as Near Threatened, and four (3.8%) in a threatened category (Vulnerable, Endangered, Critically Endangered). Threatened species are all oceanic pelagic, of which two are only visitors to New Zealand waters, and their status the result of broader regional declines.

4. These results are in stark contrast to other recent regional assessments in Europe and the Arabian Sea and adjacent areas, where up to half of species were listed in a threatened category. However, given New Zealand’s extensive deepwater fishing effort and rapid collapses of deepwater chondrichthyan fisheries elsewhere, it is possible that New Zealand populations of many deepwater species are the remnants of previously reduced populations which are now at a low, yet stable level. Ongoing species-level catch monitoring will be required to ensure these species do not become threatened.

5. Recommendations for future research and conservation efforts include resolving taxonomic uncertainties, understanding habitat use, and increasing regional collaborations to better understand the effects of fishing on wider-ranging species.

1. Introduction

Sharks, rays, and chimaeras (Class Chondrichthyes) are under increasing global threat. Their general life history features (e.g. late maturity, slow growth, low fecundity) which result in low biological productivity, as well as demand for shark products in domestic and international markets, increase their susceptibility to overfishing (Daley, Stevens, & Graham, 2002; Dulvy et al., 2014). Population declines have been recorded across a number of regions and species (e.g. Graham, Andrew, & Hodgson, 2001; Jabado et al., 2017), with some species disappearing from areas altogether (e.g. Luiz & Edwards, 2011; Dulvy et al., 2016).

One hundred and twelve chondrichthyan species from 32 families have been reported from New Zealand's Exclusive Economic Zone (EEZ) (Ford et al., 2018). The diversity of cartilaginous fishes (~10% of the global chondrichthyan fauna) includes coastal, pelagic, and deepwater species, some of which are wide-ranging while others are known only from limited distributions within New Zealand. With improved species identification, taxonomic resolution, and further exploration of the marine environment, this diversity continues to increase. New species (e.g. Kemper, Ebert, Naylor, & Didier, 2014), and new species records (e.g. Duffy, Forrester, Gibson, & Hathaway, 2017) are documented regularly.

Commercial fishing is the primary threat to New Zealand chondrichthyans (Ford et al., 2018). While chondrichthyans do not make up large proportions of catches from commercial fisheries, New Zealand does have a long history of shark, ray, and chimaera fisheries (see Francis, 1998). Commercial fisheries for species such as school shark (*Galeorhinus galeus* (L., 1758)) began as early as the 1900s, but landings are thought to have remained low until demand for flesh and liver oil rose in the 1940s and 1950s (Francis, 1998). Today. chondrichthyans are often not targeted in New Zealand, but bycatch is regularly utilized both locally and internationally (Clarke, Francis, & Griggs, 2013; Francis, 1998). Approximately 80 species are reported in the catches of commercial vessels, with spiny dogfish (*Squalus acanthias* L., 1758) being the most recorded species (~24 000 t recorded between 2008-13, Francis, 2015). In addition, small quantities of chondrichthyans such as rig (*Mustelus lenticulatus* Phillipps, 1932) and elephantfish (*Callorhinchus milii* Bory de Saint-Vincent, 1823) are taken by recreational fishers, while larger species like the shortfin mako (*Isurus oxyrinchus* Rafinesque, 1810) have been popular with big game fishers (Francis, 1998, MPI, 2013). These species, and others, also have customary significance, as chondrichthyans were an important source of food, oil, jewellery, and tools for Maori communities (Francis, 1998).

New Zealand chondrichthyans are managed under one of the following categories to ensure sustainable utilization or protection: 11 species are managed under the Quota Management System (QMS), seven species are fully protected, and two species are prohibited as targets under Schedule 4C of the *Fisheries Act 1996* (Table 1). All other species (i.e. most New Zealand chondrichthyans) are open access. These are predominately deepwater species with negligible economic value. There is no species-specific management of these species and little mitigation in place to protect them or to reduce catches (MPI, 2013).

In addition to this legislation, New Zealand has implemented several strategies to guide the management and conservation of its chondrichthyan species. These have included the development of its National Plan of Action for sharks (NPOA), first released in 2008, reviewed in 2013, and expected to be reviewed again in 2018 (MPI, 2013). Outlined as an objective for the NPOA, a qualitative (Level 1) risk assessment with a modified Scale Intensity Consequence Analysis (SICA) was conducted in 2014 for all New Zealand chondrichthyans to assess risk from commercial fishing, with the intention to inform management and assist prioritizing action (Ford et al., 2015). This assessment was reviewed and updated for 50 taxa in 2017 (Ford et al., 2018). New Zealand is a member of Regional Fisheries Bodies (RFBs), including the Western and Central Pacific Fisheries Commission (WCPFC), and internationally, is a Party to the Convention on Migratory Species (CMS), signatory of the Memorandum of Understanding on the Conservation of Migratory Sharks (Sharks MOU, also an NPOA objective), and a Party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). More recently, the conservation status of all known New Zealand chondrichthyan taxa was reassessed using the New Zealand Threat Classification System (NZTCS) (Duffy et al., 2018), a system tailored for New Zealand (Townsend et al., 2008), but which differs considerably from the IUCN Red List of Threatened Species, the world’s most utilized extinction risk framework (IUCN, 2012a).

The IUCN Red List is the most comprehensive inventory of the global status of animal, plant and fungi species, employing a single standardized set of categories and criteria to evaluate the extinction risk of tens of thousands of species worldwide (Collen et al., 2016; IUCN, 2012a; Mace et al., 2008). The IUCN Species Survival Commission’s Shark Specialist Group (SSG) is currently undertaking a global reassessment of all chondrichthyan fishes worldwide (~1 250 species), which will provide the first baseline of changes in the global and regional status of chondrichthyans since the original assessments conducted >10 years ago (Dulvy et al., 2014).

This paper aims to assess the extinction risk of New Zealand chondrichthyans at the national level. Previous assessments of New Zealand species have been included within broader regional or global reviews (e.g. Cavanagh, Kyne, Fowler, Musick, and Bennett, 2003). By applying the IUCN Red List of Threatened Species Categories and Criteria, the following work presents a comparative view of the extinction risk of New Zealand chondrichthyans relative to other regions where similar regional-level assessments have been undertaken. The completion of a comprehensive national assessment will complement management tools and assist in guiding future conservation and research efforts.

2. Methods

A preliminary species list of 112 New Zealand chondrichthyans was compiled using the most recently available knowledge as presented in *Fishes of New Zealand*, a comprehensive review of all New Zealand fishes published by the Museum of New Zealand Te Papa Tongarewa (Roberts, Stewart, & Struthers, 2015). This species list was refined by removing vagrants (a taxon only occasionally found within the boundaries of a region) and species with unresolved taxonomy, including formally undescribed species, to produce a final list of 103 species. Species were assessed as breeding (reproduces within the region, which may involve the entire reproductive cycle or any essential part of it), or visiting (does not reproduce within a region but regularly occurs within its boundaries) populations (IUCN, 2012b). All available information, including published reports (e.g. fisheries-independent research surveys, national fisheries stock assessments, indicator analyses, technical reports), government documents (e.g. National Plan of Action-Sharks, risk assessments), relevant scientific journal publications, and unpublished literature was compiled for each species.

A two-day workshop was carried out by five experts and members of the IUCN Species Survival Commission's Shark Specialist Group (SSG). Each chondrichthyan species was assessed against the IUCN Red List Categories and Criteria (Version 3.1) (IUCN, 2012a; IUCN Standards and Petitions Subcommittee, 2017), together with the Guidelines for Application of IUCN Red List Criteria at Regional and National Levels (Version 4.0) (IUCN, 2012b). The regional guidelines can be applied at "any sub-global geographically-defined area, such as a continent, country, state, or province" (IUCN, 2012b). In this study, guidelines were applied at the national level, and assessments were undertaken using population sizes and trends, threats, and extinction risk only within the New Zealand EEZ. For New Zealand endemic species, the national assessment by default became the global assessment (since the species is found nowhere else), and as such these Red List assessments were submitted to IUCN for publication on the Red List of Threatened Species (http://www.iucnredlist.org/). For those species assessed as visiting, the current status of the source population was evaluated, and the species' New Zealand status was assessed to be consistent with that of regional populations.

Each species was assessed against each of five quantitative criteria, referred to as criteria A-E: Criterion A, population size reduction; B, geographic range; C, small population size and decline; D, very small or restricted population; and E, quantitative analysis (for example, a population viability analysis indicating a probability of extinction; these are not available for any New Zealand chondrichthyan). Species were assigned to one of the following IUCN Red List categories: Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), (collectively, CR, EN, and VU are the 'threatened' categories), Near Threatened (NT), Least Concern (LC), or Data Deficient (DD) (for definitions, see IUCN, 2012a). The DD category is applied to taxa where there is inadequate information available to make an assessment of extinction risk (IUCN, 2012a). If a species qualified for a change in status from a previously published assessment (a 'down-listing' or 'up-listing' in status), changes were classified as genuine (a change in its extinction risk), or non-genuine (due to new information, or an error in the previous assessment) (IUCN Standards and Petitions Subcommittee, 2017). Following the regional IUCN guidelines, an evidentiary attitude was considered, and a species was listed as threatened only when evidence to support a threatened classification was presented. See IUCN (2012a) and IUCN Standards and Petitions Subcommittee (2017) for explanations and guidelines of use.

To evaluate the diversity and degree of threat across chondrichthyan groups, species were divided into subgroups based on their geographic occurrence [New Zealand endemic, Australasia (New Zealand, Australia, and neighbouring Pacific nations), wider Pacific Ocean, global (wide-ranging across multiple ocean basins)], and major habitat and depth associations [coastal: primary distribution from the shore to 12 nautical miles, nm (New Zealand's Territorial Sea); pelagic: primary distribution beyond 12 nm and at depths <200 m; deepwater: primary distribution at depths >200 m). Geographic occurrence and habitat association data were largely compiled from Last and Stevens (2009), Roberts et al. (2015), and Last et al. (2016). The New Zealand regional assessment was compared with regional chondrichthyan extinction risk assessments, which have been conducted recently for Europe (Nieto et al., 2015) and the Arabian Sea and adjacent areas (hereinafter referred to as Arabian Sea, Jabado et al., 2017).

3. Results

Species Diversity and Endemism

A total of 103 species across 32 families were considered for assessment (Table 2). Sharks were the most speciose group with 68 species from 22 families (66%), followed by 24 rays from seven families (23%), and 11 chimaeras from three families (10%). Twenty percent of species were endemic to New Zealand waters, with rays and chimaeras having high levels of endemism at 38% and 36%, respectively, while shark endemism was 12%. Half of the species assessed from New Zealand are globally distributed, 17% are restricted to Australasia, and 12% to the greater Pacific region. Most chimaeras (>70%) were restricted to New Zealand or Australasian waters, while most sharks (64%) were distributed globally. The majority of species (77%) were classified as deepwater, with chimaeras having the highest proportion of deepwater species (91%). Across all chondrichthyans, 17% and 8% of species were classified as pelagic and coastal, respectively (Table 2).

Extinction risk

Most species were assessed as either Least Concern (60%, 62 species) or Data Deficient (32%, 33 species) with four (3.8%) listed as Near Threatened, two (1.9%) as Vulnerable, and one each as Endangered (<1%) and Critically Endangered (<1%) (Table 3). Across groups, chimaeras were primarily LC (91%, 10 species) with one DD species, leopard chimaera (*Chimaera panthera* Didier, 1998). Rays were equally assessed as LC or DD, and sharks were mostly LC (56%), followed by DD (32%), NT (6%), VU (3%), EN (1.5%), and CR (1.5%) (Figure 2). Twelve families were found to have high levels of data deficiency (>30% of species within the family assessed as DD). Arhynchobatidae and Somniosidae were the most speciose families with high levels of data deficiency, with 77% and 50%, respectively (Table 4).

Threatened breeding species

Two species (1.9%) were listed as VU: white shark (*Carcharodon carcharias* L., 1758,) and basking shark (*Cetorhinus maximus* (Gunnerus, 1765)). Both species are now protected in New Zealand, but are still caught incidentally in trawl and set net fisheries (Francis & Lyon, 2012a, Francis, 2017a, Francis, 2017b). The total population of white sharks on the east coast of

Australia and New Zealand was recently estimated to be 5460 individuals, including 750 mature individuals (Bruce et al., 2018), suggesting the population within New Zealand waters alone met Criterion D ('very small or restricted population', <1000 mature individuals). Given their naturally low population size, combined with a low estimate of maximum intrinsic rate of population increase (r_{max}) (Pardo, Kindsvater, Reynolds, & Dulvy, 2016), and documented interactions with fishers, some continuing population decline is projected (10% over three generations; generation length = 39 years based on age data from Natanson and Skomal, 2015), the white shark also met Criterion C ('small population size and decline').

Basking shark met the criteria for VU under Criterion A ('population reduction measured over the longer of 10 years or three generations') and Criterion C. Observed raw catch per unit effort (CPUE) by trawlers showed that peak abundance of basking shark occurred in 1988-91, corresponding with Japanese vessels catching relatively large numbers (>50) in some years (Francis & Sutton, 2012). It is unknown if basking shark was targeted for liver oil and fins, or if there was a high abundance of sharks during this period, however, catch has been near or at zero since the mid-2000s, which may reflect a change in fishing gear, regional availability of sharks, or a true decline in abundance (Francis, 2017b). A total of 922 individuals were estimated to have been taken as commercial bycatch from 1994-95 to 2007-08, although this estimate does not include captures in unobserved set net and inshore trawl fisheries (Francis & Smith, 2010). This level of catch is comparable to that which took place from 1945 to 1970 off the coast of British Columbia, Canada, where an estimated minimum population size of 750 was reduced to a near local extinction (COSEWIC, 2007). Population trend therefore met Criterion A, that is, a suspected population decline of >30% over the past three generations [generation length estimated as 34 years, Pauly (1978) and Compagno (1984)], due to 'actual levels of exploitation'. Furthermore, population size within New Zealand is likely to be <10 000 mature individuals, with a projected continuing decline over three generations (Criterion C) based upon estimates of global population size and trend (e.g. Westgate, Koopman, Siders, Wong, & Ronconi, 2014).

Near Threatened breeding species

Two species (1.9%) were listed as NT. Plunket shark (*Scymnodon plunketi* (Waite, 1910)) and prickly dogfish (*Oxynotus bruniensis* (Ogilby, 1893)) were close to meeting the criteria for the threatened categories, and were thus listed as NT. Both species have life histories suggestive of low productivity (Finucci, Bustamante, Jones, & Dunn, 2016; Francis, Jones, Ó Maolagáin, & Lyon, 2018), as well as high distribution overlap with fishing across much of their range (45-60% and > 60% overlap, respectively) (Ford et al., 2015, 2018). While research trawl survey relative biomass showed no trends in the Fisheries Management Areas (FMAs) where plunket shark and prickly dogfish have been caught, monitoring of the species is poor (coefficient of variation, CV, of biomass estimates >40% or greater), and, at least in the case of plunket shark, reasons for a lack of trends is unknown (Francis, Roberts, & MacGibbon, 2016). With estimated generation lengths of 20 (prickly dogfish) and 34 (plunket shark) years, it is suspected that a population decline has occurred over three generations for both species given fisheries overlap, but not at a level (30%) that would qualify for a threatened category.

Change in status

One species, smooth skate (*Dipturus innominatus* (Garrick & Paul, 1974)), was down-listed from NT in 2003 to LC in 2017. Implemented management efforts and indications that declines in population have ceased since its previous assessment suggested smooth skate no longer met NT due to a genuine change in status and was thus assessed as LC.

Visiting species

Five species were considered visitors to New Zealand: oceanic whitetip (*Carcharhinus longimanus* (Poey, 1861)), dusky shark (*Carcharhinus obscurus* (Lesueur, 1818)), tiger shark (*Galeocerdo cuvier* (Péron & Lesueur, 1822)), giant devilray (*Mobula mobular* (Bonnaterre, 1788)), and whale shark (*Rhincodon typus* Smith, 1828). While each species is infrequently observed in New Zealand waters (e.g. 19 records of oceanic whitetip between 1996 and 2011, Francis & Lyon, 2014), the source populations for these species from the wider Indo-Pacific have undergone declines, which for some species have been considerable (>90%, Young et al., 2016). These declines are expected to affect the number of individuals that visit New Zealand waters over time. Thus, to be consistent with the current status of regional populations, these visiting species met the following criteria: Oceanic whitetip listed as CR, with a population reduction of >80% over three generations based on data presented in Young et al. (2016). Dusky shark is globally VU, but the source population for New Zealand is Australia, which is regionally

NT (close to meeting VU A1bd) on account of additional fisheries management measures implemented in 2006 (Musick, Grubbs, Baum, & Cortés, 2009); dusky shark was thus listed as NT. Tiger shark was listed as NT (close to meeting criterion A2 for VU) (Simpfendorfer, 2009), and whale shark as EN (past and future population reduction of >50% over three generations) based on the assessment for the source population in the Indo-Pacific (Pierce & Norman, 2016). Some declines in catch of *Mobula* spp. have been reported in fisheries managed under the Western and Central Pacific Fisheries Commission (Tremblay-Boyer & Brouwer, 2016), but it is not possible to determine species-specific trends in abundance since species are listed under an aggregate code. Therefore, giant devilray was listed as DD at this time as the effects of fishing on the species within New Zealand and in regional waters are unknown. In addition, there is some evidence to suggest that the species may in fact breed within New Zealand (Duffy and Tindale, 2018).

Regional comparison

When compared regionally, endemism in New Zealand (20%) was higher than in Europe (15.2%; Nieto et al., 2015) and comparable to that of the Arabian Sea region (19.6%; Jabado et al., 2017). New Zealand had a much lower proportion of threatened species (4%) than Europe (32%; Nieto et al., 2015) and the Arabian Sea region (51%; Jabado et al., 2017). New Zealand had the highest proportion of both DD and LC species, but unlike the other regions, had no breeding species listed as EN or CR (Table 5). Forty-two species assessed in New Zealand were also assessed in Europe or the Arabian Sea, 17 of which were assessed across all three regions. Only one species, pelagic stingray (*Pteroplatytrygon violacea* (Bonaparte, 1832)) was assessed as LC across all three regions. No species had a higher threat assessment in New Zealand than Europe or the Arabian Sea. For some species, the extinction risk was much greater in the other regions [e.g. leafscale gulper shark (*Centrophorus squamosus* (Bonnaterre, 1788)), LC in New Zealand; EN in other regions] (Fig. 3, Appendix I).

4. Discussion

New Zealand waters contain ~10% of the global chondrichthyan diversity, with a low overall risk of extinction. Many species are endemic to the region (20%), and New Zealand also hosts a substantial proportion of the recognized chimaeroid diversity (~20%). The low extinction risk of the region (4%) is a stark contrast to other recent regional assessments, where a third and over half of species in Europe and the Arabian Sea were listed in a threatened category, respectively (Jabado et al., 2017; Nieto et al., 2015). Where chondrichthyans were found across regions, species were listed at much higher risk of extinction outside New Zealand, particularly those that are deepwater. These contrasting scenarios between New Zealand and two other regions may result from New Zealand having some of the better studied and managed chondrichthyan fisheries in the world, and continued effective regional management may be critical for globally threatened and near-threatened species. Alternatively, historical declines in these species in New Zealand may have gone undocumented, and if so, population recovery would be expected to be slow, as many species are presumed to have low productivity.

New Zealand chondrichthyan management under the QMS

On a global scale, several New Zealand Quota Management System (QMS) chondrichthyans, including elephantfish, pale ghost shark (*Hydrolagus bemisi* Didier, 2002), and school shark, have been recognized as some of the more sustainable and well managed shark fisheries (Simpfendorfer & Dulvy, 2017). Sustainable management actions have been reflected in these species' extinction risk. School shark, for example, was assessed as LC in New Zealand, where relative CPUE biomass indices have been increasing or remained stable (between 1990/91 to 2013/14 fishing seasons) (MPI, 2017). Globally, the species is listed as VU, with considerable suspected population decline in part of its range due to intensive fishing and habitat degradation (Walker et al., 2006). In neighbouring Australia, school shark is listed as Conservation Dependent, and targeted fishing in the Southern and Eastern Scalefish and Shark Fishery (SESSF) is prohibited (AFMA, 2013). Available data suggest other species, such as blue shark (*Prionace glauca* (L., 1758)) and shortfin mako, are increasing in abundance in New Zealand (Francis, Clarke, Griggs, & Hoyle, 2014), and were listed nationally as LC. Elsewhere, these species have been assessed to have a much higher extinction risk (e.g. both are listed as CR in the Mediterranean, Walls & Soldo, 2016). In the North Atlantic, the mako is considered overfished (Sims, Mucientes, & Queiroz, 2018).

The implementation of species-specific management in New Zealand has been shown to improve species status. For example, smooth skate, originally assessed as NT in 2003, was down-listed to LC as a result of active management. While not targeted, this species has been, and continues to be commonly caught as bycatch by benthic trawlers and longliners throughout New Zealand waters (MPI, 2017). In 2002, it was highlighted that a combination of fishing activities, small latitudinal range and limited depth refuge, as well as life history traits (large body size; longevity >24 years; late age at maturity, 13 years for females) may threaten this species (Dulvy & Reynolds, 2002). Smooth skate catches were regularly lumped together with the similar looking rough skate (*Zearaja nasuta* (Müller & Henle, 1941)), making it impossible to accurately quantify catches to the species level. In addition, landings for smooth skate had exceeded quota every year since the introduction of quotas in the 1991-1992 fishing season off the east coast of South Island, where most catches were recorded (Francis, 2003). Without management measures to adequately regulate fishing mortality at a sustainable level, declines were expected to continue, and the smooth skate was listed as NT (Francis, 2003).

In the same year that it was assessed, the smooth skate was introduced into the QMS, along with the rough skate. The 2003 assessment of the species suggested a review of the species' status after its QMS introduction was operational and CPUE data indicated a stable population. Since then, more sustainable catch limits were set, identification of skate catch improved and lumped recording of the two species reduced, and live release of smooth skate catch has been encouraged with its inclusion under Schedule 6 of the *Fisheries Act 1996* (MPI, 2017, Table 1). Relative biomass estimates of smooth skate have increased with each fisheries-independent survey, with the 2015 estimate the highest in the time series (MPI, 2017). New Zealand's inclusion of chondrichthyans within the QMS with annually reviewed catch limits can be viewed as a successful example of sustainable shark management. Catches of all QMS chondrichthyans are currently at levels not considered to be overfished (MPI, 2017). These efforts, however, cover only a small fraction of New Zealand's chondrichthyan species.

The need for improved deepwater species monitoring

Most New Zealand chondrichthyans (~80%) have no species-specific management or monitoring. These are predominately deepwater species and are reported as bycatch in commercial fisheries (Francis, 2015). At this time, these species were largely assessed as LC as there was no available information to suggest any population decline or increased extinction risk. Notwithstanding their sensitive life histories (Simpfendorfer & Kyne, 2009), deepwater species are generally less threatened than their shallow water relatives because their distributions extend beyond the depth range of most fishing effort (Dulvy et al., 2014). Without sufficient management and monitoring, however, deepwater chondrichthyan populations can rapidly decline from exploitation. Targeted fishing and incidental bycatch have depleted deepwater chondrichthyan populations in places such as Australia (Graham et al., 2001) and the North Atlantic (ICES, 2009), resulting in management arrangements such as the implementation of zero catch limits (Villasante et al., 2012), and scientific recommendations to cease fishing beyond 600 m (Clarke, Milligan, Bailey, & Neat, 2015).

In the absence of species-specific information, there is uncertainty about whether, and to what degree, changes in the abundance of New Zealand chondrichthyan species have occurred over time. Catch histories, which may indicate change in abundance over time when scaled with fishing effort, are difficult, if not impossible, to construct for deepwater chondrichthyan bycatch species in New Zealand. When recorded, catches were often aggregated under a generic code, such as “deepwater dogfish” or “other sharks and dogfish” (Parker & Francis, 2012). While species identification has improved over time (Francis & Lyon, 2012b), fisheries-independent research trawl surveys, which assess the status of commercially valuable species on Chatham Rise and the Campbell Plateau (Bagley, Ballara, O’Driscoll, Fu, & Lyon, 2013; O’Driscoll, MacGibbon, Fu, Lyon, & Stevens, 2011), are the only sources of data for most deepwater chondrichthyans in New Zealand. Abundance indices from these data suggest there have been few trends (no change) in relative biomass for some species since the early 1990s, however, monitoring for most species is poor (Ford et al., 2018; Francis et al., 2016).

It is possible that the abundance indices observed today in New Zealand reflect previously depleted populations which are now at a low, yet stable level. Deepwater fisheries in New Zealand emerged in the late 1970s, and over time, these fisheries have dominated global catches of some commercial species found on the continental slope and seamounts, such as hoki (*Macruronus novaezelandiae* (Hector, 1871)) and orange roughy (*Hoplostethus atlanticus*

Collett, 1889), with current total allowable commercial catches (TACCs) of 150 000 t and 9800 t, respectively (Clarke, 2009, MPI, 2017). At least 77 chondrichthyans are reported as bycatch from commercial fisheries (Anderson, 2017; Francis, 2015). Considerable declines of some bycatch species associated with these deepwater fisheries has been observed. For example, over a ten year period, biomass of plunket shark on north-east Chatham Rise was reported to have declined in 1994 to 6% of that in the previous decade (Clark, Anderson, Francis, & Tracey, 2000). It is unknown how representative this area is of the entire range of plunket shark in New Zealand, however, for many deepwater species there is high spatial overlap of fishing in New Zealand waters (Black & Tilney, 2015; Ford et al., 2018). Eighty-five percent of trawled fishing effort in New Zealand occurs at depths <800 m (Black & Tilney, 2015), overlapping with peak depth distributions (Anderson et al., 1998). On Chatham Rise, New Zealand’s most productive fishing ground, hoki and orange roughy stocks are considered sustainable, currently managed at targets of 35-50% and 30-40% of unexploited biomass, respectively (MPI, 2017). These targets may be considered desirable to achieve maximum commercial yield, however, declines of this nature for deepwater chondrichthyan species with low productivity and no species-specific management measures could meet the criteria for threatened categories.

With their generally low productivity, deepwater species are less likely to recover from exploitation, and it may take decades to observe any signs of recovery towards unexploited biomass levels, particularly with limited monitoring (Simpfendorfer & Kyne, 2009). Species such as leafscale gulper shark and seal shark (*Dalatias licha* (Bonnaterre, 1788)), which are regularly caught in New Zealand, have been assessed as EN in other regions on account of documented declines and limited recovery (Nieto et al., 2015; Jabado et al., 2017). While this is a cause for concern, under current fishing effort and management arrangements in New Zealand, as well as a lack of new information since the completion of previous assessments to suggest declines in populations, these species were listed as LC. This does, however, come with the caveat that ongoing species-level catch monitoring is required to ensure they do not become threatened.

Knowledge gaps and future efforts

Taxonomic resolution for improved fisheries reporting

For many species, regardless of their assessment, there was a lack of species-specific data. Of those species listed as DD, nearly all (91%) were deepwater and included many skate species. There is a need for improved taxonomic resolution of morphologically conservative species (e.g. *Brochiraja* spp.) as concerns were raised over the accuracy of catch records and there was uncertainty in assessing the degree of threat for these species. Additional species (e.g. members of the catshark genus *Apristurus*) could not be assessed at this time because of taxonomic uncertainty and the use of generic codes in fishery reporting. Some of these species were previously identified as having a high risk from fishing by Ford et al. (2015), with little knowledge of life histories, habitat use, movement and connectivity, and population size or structure. Despite having consistent, and sometimes, considerable catch records for some of these species, it is difficult to assess how fishing pressures are truly affecting these populations.

Understanding habitat use and conserving habitats of importance

Identification and protection of habitats of importance should be investigated and implemented to conserve the diversity of New Zealand's chondrichthyans. Spatial use of the water column or depth preference of different life history stages, which may increase vulnerability to fishing mortality from multiple types of fishing gear (Speed, Field, Meekan, & Bradshaw, 2010), is also not well known, and thus, cannot be taken into account for assessments. Without an understanding of habitat use, it is difficult to assess if these areas provide any refuge for most New Zealand chondrichthyans.

New Zealand has a series of Benthic Protected Areas (BPAs), seamount closures, and marine reserve areas within its EEZ designed to manage and protect the marine environment (Cryer, Mace, & Sullivan, 2016). BPAs, which protect seabed habitats through the prohibition of benthic trawling and dredging, are unlikely to provide any major refuge for most chondrichthyans given the distribution of species and spatial occurrence of the BPAs themselves (see Black & Tilney, 2015). New industries, such as deepwater mining, should also be closely monitored as they will most likely impact the New Zealand deepwater environment and benthic-associated species (Leduc, Rowden, Torres, Nodder, & Pallentin, 2015). The current known range of one species, the Kermadec Spiny Dogfish (*Squalus raoulensis* Duffy & Last, 2007), lies exclusively within the Kermadec Islands Marine Reserve, where fishing and mining is currently prohibited. The species may also occur beyond the reserve on nearby unexplored habitat located within a designated BPA. Of all chondrichthyans, it is the only species with its known range entirely within a marine protected area (Davidson & Dulvy, 2017). Virtually nothing is known about the biology of this species, however, many *Squalus* spp. are known for their low biological productivity (Graham et al., 2001). Although unlikely under the current political environment, opening this area to exploitative activities may result in rapid depletion of the species.

Increased collaborations

With limited budgets for fisheries research, priority is given to monitoring and assessing high value fish stocks, while species with little or no commercial value, such as many chondrichthyans, receive little, if any, research attention (Mace, Sullivan, & Cryer, 2014). As research surveys are generally the only means of data collection for many species, the collection of detailed life history information beyond the usual standard length, mass, and sex measurements (O'Driscoll et al., 2011), are needed to adequately describe species knowledge gaps. Increased collaboration with the fishing industry and the government-sponsored observer program is encouraged, as it can also allow for greater sampling coverage beyond the spatial and temporal range of research surveys.

As some species migrate beyond New Zealand waters, including species with heightened threat statuses regionally and globally, continued collaboration with neighbouring nations is crucial, particularly for those species susceptible to capture in wider Pacific fisheries. For example, tagging studies have indicated that giant devilray migrate seasonally between New Zealand and northern subtropical or tropical areas (Francis & Jones, 2017). Catches of mobulids are high outside New Zealand, however, species reporting is aggregated (Tremblay-Boyer & Brouwer, 2016), limiting population monitoring. While there is little to suggest there have been changes in catch rates of giant devilray within New Zealand waters, the impact of fishing outside the New Zealand EEZ, and how that may affect the New Zealand visiting population, is unknown (Francis & Jones, 2017). Species such as oceanic whitetip and whale shark, now listed as CR and EN, respectively, have undergone considerable population declines in the Indo-West Pacific due to intensive fishing pressure (Pierce & Norman, 2016; Young et al. 2016). These species are considered low research priority for New Zealand given infrequent recordings (e.g. Francis & Lyon, 2014), but any continued deterioration of their population outside New Zealand waters will likely affect the number of visiting individuals observed within New Zealand.

Ongoing collaborative projects across the South Pacific are underway to assess species' mortality of shortfin mako and silky shark (*Carcharhinus falciformis* (Müller & Henle, 1839)) in pelagic longline fisheries (Western and Central Pacific Fisheries Commission unpub. data), and such efforts could extend to other species in the future.

The national risk of extinction for New Zealand chondrichthyans has been assessed, and overall, it is concluded that there is a low proportion of threatened species. When compared to other assessed regions, the low risk of extinction suggests that New Zealand chondrichthyans are generally well managed. However, there is a lack of species-specific data and species-specific management for most species, which can impede assessing the degree of threat, past or present, with certainty. Increased monitoring is highly recommended to improve knowledge and ensure changes in species status, resulting from management measures or resolution in species identification, can be accurately assessed.

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FIGURE LEGENDS

Figure 1. Map of New Zealand showing the boundary of its Exclusive Economic Zone (EEZ), North Island (NI), South Island (SI) and Kermadec Ridge, major plateaus, and the 1000 m isobath (grey line).

Figure 2. By species group, proportion of New Zealand chondrichthyans in each of the IUCN Red List of Threatened Species categories.

Figure 3.Of the New Zealand species (*n* = 42) which have also been assessed in the Arabian Sea (*n* = 20), and Europe (*n* = 39), the proportion of species assessed each of the IUCN Red List of Threatened Species categories by region (DD, Data Deficient; LC, Least Concern; NT, Near Threatened; VU, Vulnerable; EN, Endangered; CR, Critically Endangered).

Table 1. Management categories for chondrichthyans in New Zealand (MPI, 2013).

Management Category	**Quota Management System (QMS) Fisheries Act 1996**	**Protected Schedule 7A Wildlife Act 1953**	**Schedule 4C Fisheries Act 1996**	**Open Access Fisheries Act 1996**
Management action	Individual transferable quotas (ITQs)	No utilization permitted	No target fishing; may only be taken as bycatch	No species-specific measures
Species	Elephantfish (*Callorhinchus milii* Bory de St Vincent, 1823)	Oceanic whitetip (*Carcharhinus longimanus* (Poey, 1861))†	Sharpnose sevengill shark (*Heptranchias* perlo (Bonnaterre, 1788))	All other species
	Smooth skate (*Dipturus innominatus* (Garrick & Paul, 1974))‡	White shark (*Carcharodon carcharias* (L., 1758))†	Smooth hammerhead (*Sphyrna zygaena* (L., 1758))	
	School shark (*Galeorhinus galeus* (L., 1758))‡	Basking shark (*Cetorhinus maximus* (Gunnerus, 1765))†		
	Pale ghost shark (*Hydrolagus bemisi* Didier, 2002	Giant manta ray (*Mobula birostris* (Walbaum, 1792))		
	Dark ghost shark (*Hydrolagus novaezealandiae* (Fowler, 1911))	Spinetail devilray (*Mobula japanica* (Müller & Henle, 1841))§		
	Shortfin mako (*Isurus oxyrinchus* Rafinesque, 1810)‡	Smalltooth sand tiger (*Odontaspis ferox* (Risso, 1810))		
	Porbeagle	Whale shark		

	(*Lamna nasus* (Bonnaterre, 1788))‡	(*Rhincodon typus* Smith, 1828)		
	Rig (*Mustelus lenticulatus* Phillipps, 1932)‡			
	Blue shark (*Prionace glauca* (L., 1758))‡			
	Spiny dogfish (*Squalus acanthias* L., 1758)‡			
	Rough skate (*Zearaja nasuta* (Müller & Henle, 1841))‡			

†Species also protected under the Fisheries Act 1996

‡ Species also included in Schedule 6 of the Fisheries Act 1996 where catch can be returned alive if the individual is likely to survive and the return takes place as soon as possible (blue shark, porbeagle, mako, and spiny dogfish can be returned dead or alive)

§*Mobula japanica* is a junior synonym of *Mobula mobular* (Bonnaterre, 1788) (White et al., 2018)

Table 2. The number of New Zealand chondrichthyans assessed against the IUCN Red List of Threatened Species Categories and Criteria by major taxonomic group, and the proportion of each group by major geographic occurrence and habitat association.

			Geographic Occurrence				Habitat Association		
Group	n families	n species	Endemic	Australasia	Greater Pacific	Global	Coastal	Pelagic	Deepwater
Sharks	22	68	0.120	0.100	0.150	0.630	0.060	0.200	0.740
Rays	7	24	0.380	0.290	0.040	0.290	0.125	0.125	0.750
Chimaeras	3	11	0.365	0.365	0.090	0.180	0.090	0.000	0.910
All Chondrichthyans	32	103	0.200	0.180	0.120	0.500	0.080	0.160	0.760

Table 3. National extinction risk of all New Zealand chondrichthyans (in alphabetical order by family, genus and species) assessed against the IUCN Red List of Threatened Species Categories and Criteria. IUCN Red List of Threatened Species categories: DD, Data Deficient; LC, Least Concern; NT, Near Threatened; VU, Vulnerable; EN, Endangered; CR, Critically Endangered. See IUCN (2012a) for explanations of Categories and Criteria.

Family	**Species name**	**Common name**	**National Red List Assessment**
Alopiidae	*Alopias superciliosus*	Bigeye thresher	LC
	Alopias vulpinus	Thresher shark	DD
Arhynchobatidae	*Arhynchobatis asperrimus*	Longtail skate†	LC
	Bathyraja pacifica	Pacific blonde skate†	LC
	Bathyraja richardsoni	Richardson's skate	LC
	Bathyraja shuntovi	Longnose deepsea skate†	DD
	Brochiraja albilabiata	Whitemouth skate†	DD
	Brochiraja asperula	Smooth deepsea skate†	DD
	Brochiraja heuresa	Eureka skate	DD
	Brochiraja leviveneta	Blue deepsea skate	DD
	Brochiraja microspinifera	Dwarf skate†	DD
	Brochiraja spinifera	Prickly deepsea skate	DD
	Brochiraja vittacauda	Ribbontail skate	DD
	Notoraja alisae	Velcro skate	LC
	Notoraja sapphira	Sapphire skate	DD
Callorhinchidae	*Callorhinchus milii*	Elephantfish	LC
Carcharhinidae	*Carcharhinus brachyurus*	Bronze whaler	LC
	Carcharhinus galapagensis	Galapagos shark	LC
	Carcharhinus longimanus	Oceanic whitetip shark‡	CR A2bd
	Carcharhinus obscurus	Dusky shark‡	NT
	Carcharhinus plumbeus	Sandbar shark	DD
	Galeocerdo cuvier	Tiger shark‡	NT
	Prionace glauca	Blue shark	LC

Centrophoridae	*Centrophorus harrissoni*	Harrisson's dogfish	DD
	Centrophorus squamosus	Leafscale gulper shark	LC
	Deania calcea	Shovelnose dogfish	LC
	Deania hystricosa	Rough shovelnose dogfish	DD
	Deania quadrispinosum	Longsnout dogfish	DD
Cetorhinidae	*Cetorhinus maximus*	Basking shark	VU A2d; C1
Chimaeridae	*Chimaera carophila*	Brown chimaera†	LC
	Chimaera lignaria	Giant purple chimaera	LC
	Chimaera panthera	Leopard chimaera†	DD
	Hydrolagus bemisi	Pale ghost shark†	LC
	Hydrolagus homonycteris	Black ghost shark	LC
	Hydrolagus novaezelandiae	Dark ghost shark†	LC
	Hydrolagus trolli	Pointynose blue ghost shark	LC
Chlamydoselachidae	*Chlamydoselachus anguineus*	Frilled shark	LC
Dalatiidae	*Dalatias licha*	Seal shark	LC
	Euprotomicrus bispinatus	Pygmy shark	LC
	Isistius brasiliensis	Cookiecutter shark	LC
Dasyatidae	*Bathytoshia brevicaudata*	Shorttail stingray	LC
	Bathytoshia lata	Longtail stingray	LC
	Pteroplatytrygon violacea	Pelagic stingray	LC
Echinorhinidae	*Echinorhinus brucus*	Bramble shark	DD
	Echinorhinus cookei	Prickly shark	DD
Etmopteridae	*Centroscyllium kamoharai*	Bareskin dogfish	DD
	Etmopterus granulosus	Baxter's dogfish	LC
	Etmopterus lucifer	Lucifer dogfish	LC
	Etmopterus molleri	Moller's lanternshark	LC
	Etmopterus pusillus	Smooth lanternshark	LC
	Etmopterus unicolor	Shortspine lanternshark	LC
	Etmopterus viator	Traveler lanternshark	LC
Hexanchidae	*Heptranchias perlo*	Sharpnose sevengill shark	DD
	Hexanchus griseus	Bluntnose sixgill shark	DD
	Notorynchus cepedianus	Broadnose sevengill shark	LC

Lamnidae	*Carcharodon carcharias*	White shark	VU C1+2(i,ii); D1
	Isurus oxyrinchus	Shortfin mako	LC
	Lamna nasus	Porbeagle	LC
Mitsukurinidae	*Mitsukurina owstoni*	Goblin shark	DD
Mobulidae	*Mobula birostris*	Giant manta ray	LC
	Mobula mobular	Giant devilray‡	DD
Myliobatidae	*Myliobatis tenuicaudatus*	New Zealand eagle ray	LC
Narkidae	*Typhlonarke aysoni*	Blind electric ray†	LC
Odontaspididae	*Odontaspis ferox*	Smalltooth sand tiger	LC
Oxynotidae	*Oxynotus bruniensis*	Prickly dogfish	NT
Pentanchidae	*Apristurus albisoma*	Grey roundfin catshark	DD
	Apristurus ampliceps	Roundfin catshark	LC
	Apristurus exsanguis	New Zealand catshark†	LC
	Apristurus garricki	Garrick's catshark†	LC
	Apristurus melanoasper	Fleshynose catshark	DD
	Apristurus pinguis	Bulldog catshark	LC
	Apristurus sinensis	Freckled catshark	LC
	Parmaturus macmillani	McMillan's catshark†	DD
Pseudocarchariidae	*Pseudocarcharias kamoharai*	Crocodile shark	DD
Pseudotriakidae	*Gollum attenuatus*	Slender smoothhound	LC
	Pseudotriakis microdon	False catshark	DD
Rajidae	*Amblyraja hyperborea*	Thorny skate	LC
	Dipturus innominatus	Smooth skate†	LC
	Zearaja nasuta	Rough skate†	LC
Rhincodontidae	*Rhincodon typus*	Whale shark‡	EN A2bd+4bd
Rhinochimaeridae	*Harriotta haeckeli*	Smallspine spookfish	LC
	Harriotta raleighana	Longnose spookfish	LC
	Rhinochimaera pacifica	Pacific spookfish	LC
Scyliorhinidae	*Bythaelurus dawsoni*	Dawson's catshark†	LC
	Cephaloscyllium isabellum	Carpet shark†	LC
Somniosidae	*Centroscymnus coelolepis*	Portuguese dogfish	LC

	Centroscymnus owstonii	Owston's dogfish	LC
	Centroselachus crepidater	Longnose velvet dogfish	LC
	Scymnodalatias albicauda	Whitetail dogfish	DD
	Scymnodon plunketi	Largespine velvet dogfish	NT
	Scymnodalatias sherwoodi	Sherwood's dogfish	DD
	Scymnodon ringens	Knifetooth dogfish	DD
	Somniosus antarcticus	Pacific sleeper shark	LC
	Somniosus longus	Little sleeper shark	DD
	Zameus squamulosus	Velvet dogfish	LC
Sphyrnidae	*Sphyrna zygaena*	Smooth hammerhead shark	LC
Squalidae	*Cirrhigaleus australis*	Southern mandarin dogfish	LC
	Squalus acanthias	Spiny dogfish	LC
	Squalus griffini	Northern spiny dogfish†	LC
	Squalus raoulensis	Kermadec spiny dogfish†	LC
Torpedinidae	*Tetronarce nobiliana*	Great torpedo	DD
Triakidae	*Galeorhinus galeus*	School shark	LC
	Mustelus lenticulatus	Rig†	LC

†Species endemic to New Zealand

‡Species treated as a visiting population to New Zealand

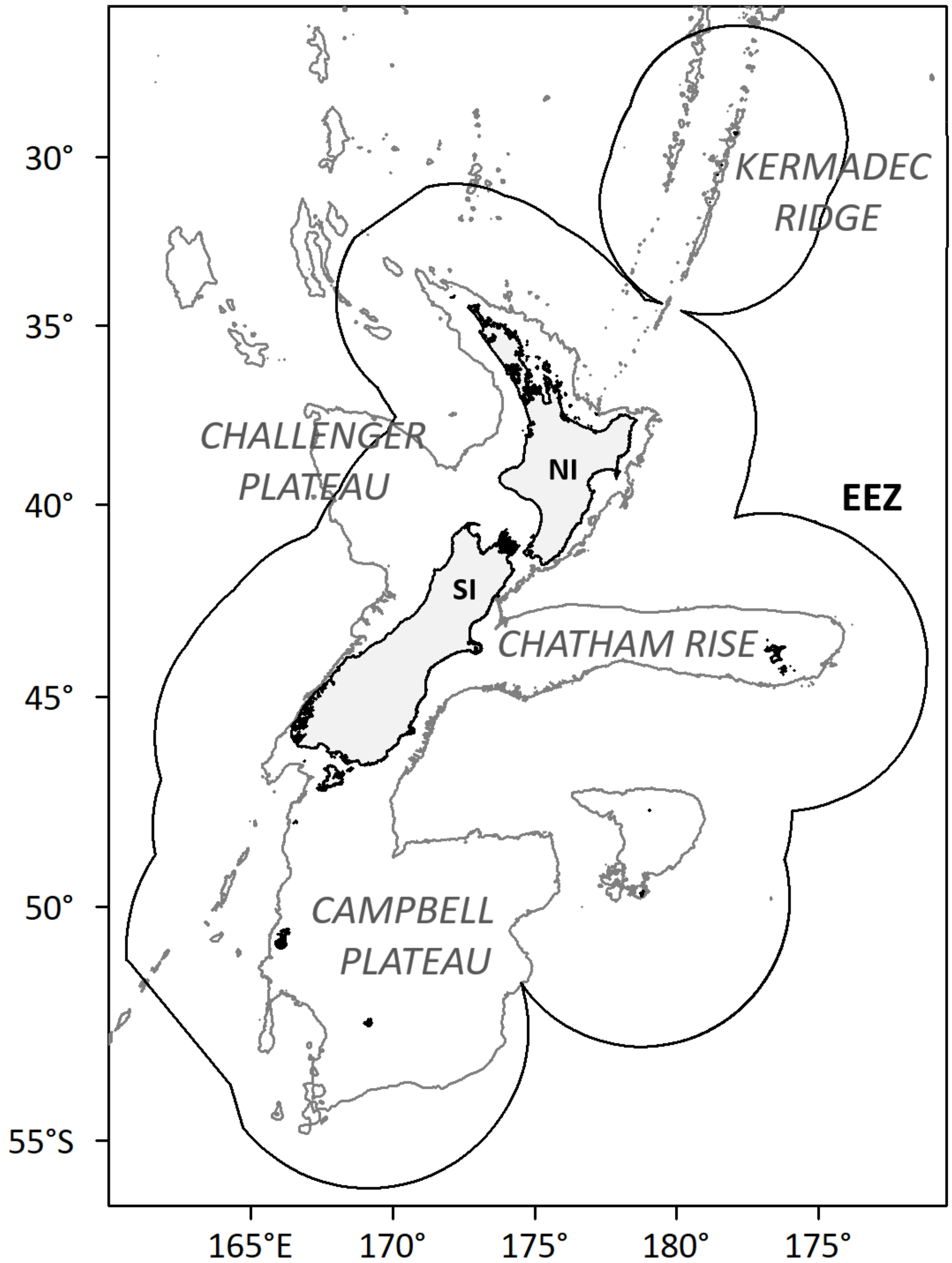
Table 4. Poorly-known New Zealand chondrichthyan families, where >30% of New Zealand species were assessed as Data Deficient.

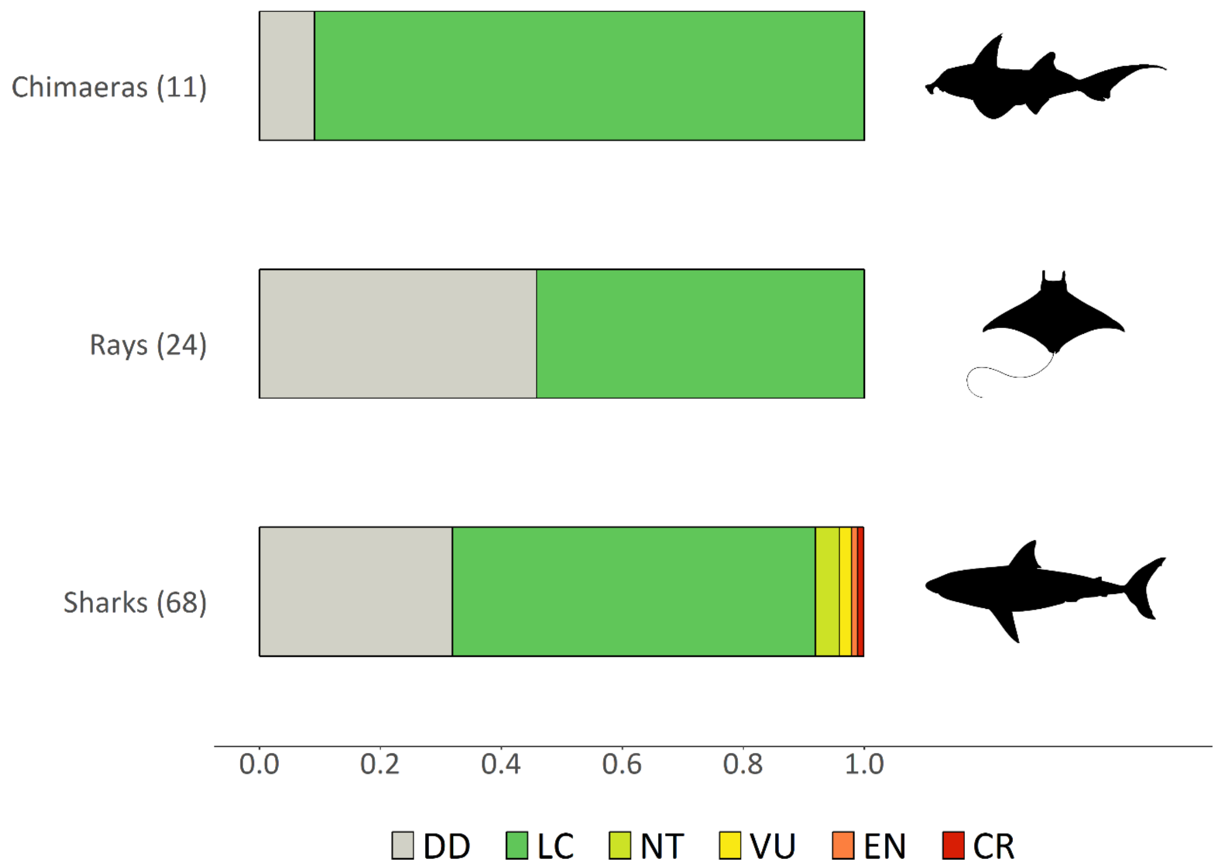
Family	Number of species in NZ	Proportion listed DD
Bramble sharks Echinorhinidae	2	1.00
Torpedo rays Torpedinidae	1	1.00
Goblin shark Mitsukurinidae†	1	1.00
Crocodile shark Pseudocarchariidae†	1	1.00
Softnose skates Arhynchobatidae	13	0.77
Cowsharks Hexanchidae	3	0.67
Gulper sharks Centrophoridae	5	0.60
Sleeper sharks Somniosidae	10	0.50
False catsharks Pseudotriakidae	2	0.50
Thresher sharks Alopiidae	2	0.50
Devilrays Mobulidae	2	0.50
Deepwater catsharks Pentanchidae	8	0.38
† Denotes a globally monospecific family		

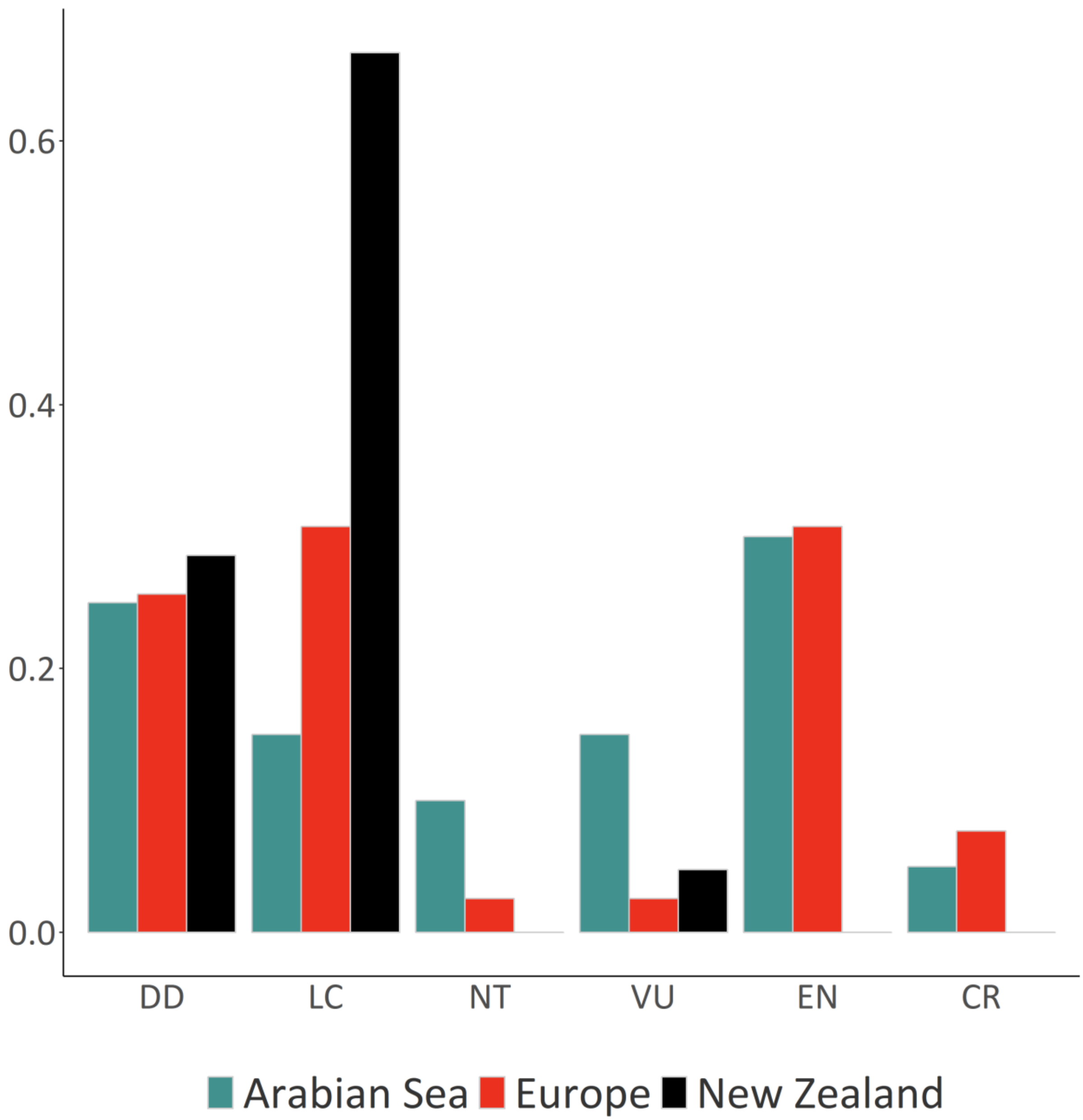
Table 5. The comparative regional extinction risk of chondrichthyans occurring in New Zealand (this study), Europe (Nieto et al., 2015), and the Arabian Seas region (Jabado et al., 2017). % threatened is the sum of the categories VU, EN and CR.

	n	DD	LC	NT	VU	EN	CR	%threatened
New Zealand	103	0.32	0.60	0.04	0.02	0.01	0.01	0.04
Europe	131	0.20	0.37	0.11	0.08	0.13	0.11	0.32
Arabian Seas	153	0.19	0.12	0.18	0.20	0.22	0.09	0.51

IUCN Red List of Threatened Species categories: DD, Data Deficient; LC, Least Concern; NT, Near Threatened; VU, Vulnerable; EN, Endangered; CR, Critically Endangered.


KERMADEC RIDGE
CHALLENGER PLATEAU
NI
EEZ
SI
CHATHAM RISE
CAMPBELL PLATEAU
30°
35°
40°
45°
50°
55°S
165°E
170°
175°
180°
175°


Chimaeras (11)
Rays (24)
Sharks (68)
0.0
0.2
0.4
0.6
0.8
1.0
DD
LC
NT
VU
EN
CR


0.6
0.4
0.2
0.0
DD
LC
NT
VU
EN
CR
Arabian Sea
Europe
New Zealand

Appendix I. Comparative global (from IUCN, 2017) and regional extinction risk of widely-distributed chondrichthyans which have been assessed for a combination of New Zealand (NZ; this study), Europe (Nieto et al., 2015), and/or the Arabian Seas region (Jabado et al., 2017). Extinction risk was assessed by applying the IUCN Red List of Threatened Species Categories and Criteria at the regional level.

Family	Species	Common Name	Global Status	NZ	Europe	Arabian Seas
Alopiidae	*Alopias superciliosus*	Bigeye Thresher	VU	LC	EN	EN
	Alopias vulpinus	Thresher Shark	VU	DD	EN	--
Arhynchobatidae	*Bathyraja richardsoni*	Richardson's Skate	LC	LC	LC	--
Carcharhinidae	*Carcharhinus brachyurus*	Bronze Whaler	NT	LC	DD	--
	Carcharhinus longimanus	Oceanic Whitetip	VU	CR	EN	CR
	Carcharhinus obscurus	Dusky Shark	VU	NT	DD	--
	Carcharhinus plumbeus	Sandbar Shark	VU	DD	EN	EN
	Galeocerdo cuvier	Tiger Shark	NT	NT	DD	VU
	Prionace glauca	Blue Shark	NT	LC	NT	NT
Centrophoridae	*Centrophorus squamosus*	Leafscale Gulper Shark	VU	LC	EN	EN
	Deania calcea	Shovelnose Dogfish	LC	LC	EN	--
	Deania hystricosa	Rough Shovelnose Dogfish	DD	DD	DD	--
Cetorhinidae	*Cetorhinus maximus*	Basking Shark	VU	VU	EN	--
Chlamydoselachidae	*Chlamydoselachus anguineus*	Frilled Shark	LC	LC	LC	--
Dalatiidae	*Dalatias licha*	Seal Shark	NT	LC	EN	--
Dasyatidae	*Bathytoshia lata*	Longtail Stingray	LC	LC	--	DD
	Pteroplatytrygon violacea	Pelagic Stingray	LC	LC	LC	LC
Echinorhinidae	*Echinorhinus brucus*	Bramble Shark	DD	DD	EN	VU
Etmopteridae	*Etmopterus pusillus*	Smooth Lanternshark	LC	LC	DD	DD
Hexanchidae	*Heptranchias perlo*	Sharpnose Sevengill Shark	NT	DD	DD	LC

	Hexanchus griseus	Bluntnose Sixgill Shark	NT	DD	LC	LC
Lamnidae	*Carcharodon carcharias*	White Shark	VU	VU	CR	--
	Isurus oxyrinchus	Shortfin Mako	VU	LC	DD	NT
	Lamna nasus	Porbeagle	VU	LC	CR	--
Mitsukurinidae	*Mitsukurina owstoni*	Goblin Shark	LC	DD	LC	--
Mobulidae	*Mobula birostris*†	Giant Manta Ray	VU	LC	--	VU
	Mobula mobular‡	Giant Devilray	NT	DD	EN	EN
Odontaspididae	*Odontaspis ferox*	Smalltooth Sand Tiger	VU	LC	CR	DD
Pentanchidae	*Apristurus melanoasper*	Fleshynose Catshark	LC	DD	LC	--
Pseudotriakidae	*Pseudotriakis microdon*	False Catshark	LC	DD	DD	--
Rajidae	*Amblyraja hyperborea*	Thorny Skate	LC	LC	LC	--
Rhincodontidae	*Rhincodon typus*	Whale Shark	EN	EN	--	EN
Rhinochimaeridae	*Harriotta haeckeli*	Smallspine Spookfish	LC	LC	LC	--
	Harriotta raleighana	Longnose Spookfish	LC	LC	LC	--
Somniosidae	*Centroscymnus coelolepis*	Portuguese Dogfish	NT	LC	EN	--
	Centroselachus crepidater	Longnose Velvet Dogfish	LC	LC	LC	DD
	Scymnodon ringens	Knifetooth Dogfish	DD	DD	LC	--
	Zameus squamulosus	Velvet Dogfish	DD	LC	DD	DD
Sphyrnidae	*Sphyrna zygaena*	Smooth Hammerhead Shark	VU	LC	DD	EN
Squalidae	*Squalus acanthias*	Spiny Dogfish	VU	LC	EN	--
Torpedinidae	*Tetronarce nobiliana*	Great Torpedo	DD	DD	LC	--
Triakidae	*Galeorhinus galeus*	School Shark	VU	LC	VU	--

†*Mobula birostris* is currently listed as *Manta birostris* in the global assessment

‡*Mobula mobular* is currently listed as *Mobula japanica* in the global assessment

IUCN Red List of Threatened Species categories: DD, Data Deficient; LC, Least Concern; NT, Near Threatened; VU, Vulnerable; EN, Endangered; CR, Critically Endangered.