

# Conservation Services Programme

## DRAFT Coral medium-term research plan

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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](#). The 2010 amendment of Schedule 7A of the Wildlife Act 1953 protects all hard corals and some soft corals in New Zealand waters, including: black corals (all species in the Order Antipatharia), gorgonian corals (selected species in the Order Alcyonacea), stony corals (all species in the Order Scleractinia) and hydrocorals (all species in the Family Stylasteridae). Those encountered in New Zealand waters and subject to this plan are detailed in Table 1.

The CSP coral medium-term research plan (CSP coral plan) will be updated annually and used as a tool to develop projects for the CSP Annual Plan to deliver on the coral population, mitigation, and interaction research components 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 medium-term research plan focuses on deep water corals and the impact of trawling on these taxa, as there is interaction data available for this fishery. Notably, some coral taxa can also be found in shallower habitats (e.g. Fiordland, Port Pegasus) and may possibly interact with other commercial fishing methods (e.g. rock lobster potting). However, due to a lack of observer coverage in these fisheries, interaction data is non-existent, which limits the ability to scope research in this area. Coral research that falls outside the scope and mandate of CSP and relates to threats other than the direct and indirect effects of commercial fishing (e.g. research on the effect of ocean acidification on coral skeletal growth), is not included in this plan.

## 2. Guiding objectives and risk framework

The CSP coral medium-term research plan is guided by several key documents and processes, these include the CSP Strategic Statement, relevant action and management plans, and the New Zealand Threat classification system and relevant risk assessments. These are detailed below.

The relevant CSP objectives that have guided the development of this plan are as follows (for further details see the [CSP Strategic Statement 2018](#)):

- **Objective A:** Proven mitigation strategies are in place to avoid or minimise the adverse effects of commercial fishing on protected species across the range of fisheries with known interactions.
- **Objective B:** The nature of direct adverse effects of commercial fishing on protected species is described.
- **Objective C:** The extent of known direct adverse effects of commercial fishing on protected species is adequately understood.
- **Objective D:** The nature and extent of indirect adverse effects of commercial fishing are identified and described for protected species that are at particular risk to such effects.
- **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.

The risk referred to in the guiding objectives is the risk of direct and indirect fisheries-related impacts, both of which could result in population level effects, to coral taxa found in New Zealand waters (Table 1).

Currently a quantitative risk assessment of the effect of commercial fishing on protected coral species in New Zealand waters has not been attempted. However, in 2014 a semi-quantitative pilot ecological risk assessment on the effect of bottom trawling on the Chatham Rise was conducted for 15 coral species (Clark *et al.*, 2014, summary results: Table 2). In this pilot assessment, risk is estimated by a Productivity-Susceptibility-Analysis (PSA), which considers the extent of impact on the relevant species due to fishing activity (“susceptibility”), and the potential of the species to recover from the impact (“productivity”). This assessment indicated that most of the coral species considered in the analysis are at risk from trawl fisheries on the Chatham rise. However, although this vulnerability was evaluated adequately based on the available data, the assessment highlighted several knowledge gaps that limited the analysis.

In October 2017, a workshop on the research needs for protected corals in New Zealand waters was held. As a product of this workshop, 58 knowledge gaps were identified and designated into six categories: ‘Biological Gaps’, ‘Environmental Gaps’, ‘Spatial Gaps’, ‘Modelling Gaps’, ‘Threat and Pressure Gaps’, and ‘Data, Management & Communication Gaps’ (View the meeting minutes and a list of the knowledge gaps [here](#)).

Compared to other protected taxa such as sea birds and sharks, protected corals do not have a National Plan of Action and the associated risk assessment framework to guide management actions and research objectives. In lieu of this, this medium-term research plan will act as an interim guiding framework, aiming to:

- 1) Inform research prioritisation
- 2) Provide structure to facilitate research synergies and
- 3) Support improved management

### 3. Data Requirements

There is a lack of data on the status of protected coral populations in New Zealand waters, reflected by the limited number of taxa that have a conservation classification. Of the 319 protected coral species found in NZ waters, only 66 species (32 genera) have been classified via the New Zealand Threat Classification System (Freeman *et al.*, 2014). Of these 66 species, 33 are classified as naturally uncommon, 6 are classified as declining, and 1 is nationally vulnerable (Table 3). The remaining 26 species are classified as data deficient, meaning there is not enough information to determine their threat status. Notably, the conservation status of New Zealand marine invertebrates is currently being reviewed and will include additional coral taxa (publication date to be determined). The results of this revision will be reflected in this document when the report becomes available.

Knowledge of temperate coral biology and ecology is limited, which restricts our understanding of the susceptibility of these taxa to impacts from commercial fisheries. Of the 58 knowledge gaps identified during the 2017 protected corals workshop, the following data requirements cover the main research needs that align with the CSP objectives:

- A. Over recent years there have been research efforts to increase the knowledge of the species composition and distribution of corals in New Zealand waters. Despite these efforts, more data is required in the following areas:

- Improved data on abundance/density/biomass to support analyses and models that better reflect the relative importance of certain species or areas (e.g. biodiversity hot spots)
- Identification of source and sink coral populations
- Improved understanding of small effective population sizes to identify potential constraints on the resilience of populations to fishing impacts
- Improved understanding of the taxonomy of corals found in fisheries bycatch to provide a greater understanding of coral biodiversity and fishing impacts

Gaining this knowledge is important to ensure modelling accuracy and improve knowledge of species and their population connectivity. In addition, accurate biomass data is essential for performing risk assessments and determining the vulnerability of species and areas to fishing impacts.

- B. A significant knowledge gap identified from the pilot ecological risk assessment is the paucity in data on coral productivity (age, growth, reproduction). It is important to understand how population connectivity and fecundity determine the vulnerability of species to fishing impacts and their ability to recover from these disturbances. Data is required in the following areas:
- Improved understanding of reproductive and dispersal capabilities. Specifically, to understand if asexual budding is more or less common than sexual broadcast release
  - Increased knowledge of larval duration for broadcast spawners and their dispersal distance
  - Improved understanding of the colonisation and settlement patterns of larvae
  - Understanding of genetic and demographic population connectivity
  - Improved understanding of age and growth characteristics
- C. There is a lack of quantitative monitoring data on deep sea corals to identify changes in deep-sea coral populations/habitats over space and time, in relation to fishing effort. A survey plan is required to:
- Improve the understanding of changes in genetic and community structure, as well as species distribution over time
  - Identify regions/areas where there is rapid change in response to fishing effort

Monitoring deep-sea coral populations could increase also our knowledge on dispersal, connectivity, and genetic hot spots. In addition, it will provide quantitative data on the potential of impacts of fishing activity on deep sea coral populations to feed into risk assessments.

- D. Further investigation into the impacts of trawling on protected coral species is required, specifically:
- Improved understanding on how long recovery from trawling impacts take and if communities recover to a non-fishing damaged state
  - Improved understanding on what facilitates the recovery of corals/habitat after trawling
  - Further investigation into the impacts of trawling on ecosystem function/services (e.g. carbon cycling, habitat provision for juveniles, fish etc.)
  - Better understanding on how long spatial closures may need to be in place, and if recovered areas will provide similar ecosystem function/services

This will increase our understanding of the wider impacts of fishing on corals and their communities and may help direct the design of mitigation measures.

We note for this data requirement, as well as the preceding one, that time series surveys of benthic communities (dominated by corals) have been carried out on the Chatham Rise at the 'Graveyard Knolls' (2001-2015) (Clark et al., 2019), and the 'Diamond Head' knolls (2009-2015) (Clark et al., 2009; Clark et al. 2015). These surveys included seamounts which have been exposed to varying degrees of trawling history, providing insight into the spatial and temporal trends in coral populations in response to trawling. These studies could be used to guide the development of research approaches aiming to address the data requirements described in points C and D above.

- E. Coral taxa found in shallow water habitats (e.g. 10-40m in Fiordland, Port Pegasus) in New Zealand possibly interact with commercial fishing methods such as potting for crayfish and blue cod. These fisheries operate from small vessels on which observer coverage is virtually non-existent. Currently there is no quantitative data on the interaction between these fisheries and protected coral species. Gaining this data is essential to identifying the potential impacts of these fisheries on the protected corals in these waters.
- F. There is currently no comprehensive ecological risk assessment on the impact of commercial fishing on protected coral species in New Zealand waters. Undertaking this assessment is essential to understand and quantify risk. This information will direct the prioritisation of research, the development of mitigation measures, and provide options for management action.

#### 4. Current risk and uncertainty

Some knowledge exists on the risk commercial fishing poses to protected coral species in New Zealand waters. Generally larger branching coral genera are considered more susceptible to impacts from fishing activity, while smaller genera are less vulnerable. However, other factors such as distribution, genetic diversity and productivity also determine vulnerability. The pilot ecological risk assessment on the impact of trawling on the Chatham rise classified cup-coral genera, as well as hydrocorals, as relatively low risk and thus would be a lower priority for research (Clark *et al.*, 2014, summary results: Table 2). Alternately, all black corals and the octocoral genus *Paragorgia* were identified as high risk, with most other reef-building scleractinians and other octocorals as medium. The classification of scleractinians as medium risk was due to their modelled spatial distribution being larger than the bottom trawl fishery footprint (Clark *et al.*, 2014). Although this pilot risk assessment only considered bottom trawl fishing, corals are also impacted by other fishing methods including bottom longline, dredging and precision seafood harvesting, the impacts of which are less understood.

It is important to highlight that although the pilot risk assessment is semi-quantitative, results are not an absolute measure of risk and are relative, as some of the criteria are comparative rather than based on definitive thresholds. Several uncertainties and limitations in this assessment were highlighted:

- The understanding of coral productivity is limited, restricting the determination of recovery ability from fishing impacts

- The risk assessment considered trawling impacts on the Chatham Rise as a whole, however, localised fishing impacts in particular areas may pose much higher risk to corals
- The risk assessment only considered the impacts of orange roughly bottom trawling on protected coral species on the Chatham Rise, when there may be cumulative effects of other fisheries (e.g. hoki) that operate at shallower depths
- Coral distributions were predicted based on the probability of presence or absence and did not consider abundance. Little is known about the spatial scale of the populations of many coral species

In addition to the pilot risk assessment, a current CSP research project aiming to improve habitat suitability modelling for protected corals in New Zealand waters (POP2018-01) will provide quantitative data on the overlap between predicted species distributions and the trawl footprint in New Zealand waters. The results of this research could direct the prioritisation of research through the identification of coral species in areas that are at the highest risk of interacting with fishing gear or in need of protection from changes in the distribution of fishing.

## 5. Research priorities

Due to the lack of biological knowledge across the diversity of protected coral species found in New Zealand waters, the CSP coral medium-term research plan is intended to be a living document that provides guidance for the prioritisation of research projects undertaken through the Conservation Services Programme in the near future, as opposed to a fixed-five year plan of research. Table 4 details the CSP coral research priorities that have been developed to meet the following outputs specifically related to the risk from fishing:

- A. Increased observer coverage to cover all fishery methods with seafloor contact (all trawl fisheries, bottom long line fisheries, dredging, potting and set net fisheries), in order to maximise the bycatch data collected through the fisheries observer programme. An increase in geo-referenced image-based sampling and the expert identification of bycatch coral taxa, will support quantitative analysis of bycatch across all New Zealand fisheries.
- B. The collection of tissue samples from protected coral bycatch by fisheries observers to allow the genetic determination of species as well as ascertain genetic connectivity between populations. Currently this work is being undertaken for the black coral species *Bathypathes* spp. through the CSP POP2018-06 project and for selected octocorals CSP INT201905. Based on the success of this project similar work could be performed for other species with the prioritisation of other black coral, octocorals and scleractinian corals.
- C. Determination of coral age and growth rates to inform evaluation of recoverability from fishing impacts. While some information is available for particular species (see summary in Tracey *et al.*, 2018; Marriott *et al.*, 2019), for many species knowledge is limited. Notably, to obtain linear growth rates, complete colonies are required for some species such as black corals, sea fans and octocorals. While the NIWA invertebrate collection currently holds several coral specimens that may be appropriate for this

analysis, investigation into methods to obtain more specimens for additional species may be required.

- D. Building species distribution models that predict abundance in addition to presence/absence. This will allow the estimation of biomass distribution which is key for managing population status. This could support work in identifying high value areas, and/or species that have a greater need for protection.
- E. Investigation into the reproductive and dispersal capabilities of coral species to determine the ability of taxa to recolonise and recover from fisheries related disturbance.
- F. Establish a monitoring programme across several key locations or habitat types within New Zealand's EEZ to measure spatial and temporal trends in coral populations in response to commercial fishing effort (i.e. trawling). This will identify whether populations are being maintained at sustainable levels or negatively affected by commercial fishing activities. Notably, MPI funded repeated surveys (monitoring) of some of the seamounts on the Chatham Rise between 2001-2015. To promote research synergies, it is recommended that the continuation of these surveys is incorporated into the monitoring programme.
- G. Investigation into potential mitigation measures to minimise the impact of commercial fishing on protected coral species. Such as:
- Trawling in the same trawl footprint to avoid damaging new areas.
  - Finding an alternate fishing method to bottom trawling.
  - Spatial closures: informed by the identification of biodiversity hot spots or source areas (distribution data), in addition to species biological characteristics
  - The implementation of a network of protected areas linking current individual Benthic Protection Areas and Special Conservation Areas.
- H. A formal quantitative risk assessment of the impacts of commercial fishing on protected coral species is an essential action. However, this type of assessment requires data input from the research priorities described above in order to ascertain risk accurately. Based on the learnings from the pilot assessment the following recommendations were made:
- The pilot risk assessment was based on the methods of the Ecological Risk Assessment for the Effects of Fishing (ERAEF, Hobday *et al.* 2007, 2011), which is a framework developed in Australia and adopted by the Marine Stewardship Council. It is recommended this framework is used for the formal risk assessment
  - Compared to the pilot risk assessment which considered the entire Chatham rise as one spatial unit, it would be more appropriate to examine smaller spatial units or to conduct the analysis in a more spatially explicit way such as has been done for seabirds and marine mammals (e.g., Richards & Abraham 2013)
  - The pilot risk assessment notified that species within taxonomic groups had different vulnerability to fishing impacts. Thus, it is recommended that risk is assessed at the lowest possible taxonomic level

## 6. References

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## 7. Tables

Table 1. Protected coral taxon found in the New Zealand EEZ.

Order	Common name	Number of species
Order Scleractinia	Stony corals (cup and branching forms)	116
Order Antipatharia	Black corals	33
Order Alcyonacea	Soft corals, stoloniferans, sea fans, sea whips, bubblegum corals (there are at least 12 families containing deep-water structure-forming gorgonian octocorals).	114
Order Anthoathecata	Stylasteridae: stylasterids, lace corals	56
	<b>Total</b>	<b>319</b>

Table 2. The overall risk ranking of the 15 coral genera/groups included in the pilot risk assessment for the impact of trawling on protected coral taxa on the Chatham Rise. Adapted from Clark *et al.*, 2014.

Coral Taxa	Observer Code	Overall Risk Ranking
<i>Solenosmilia</i>	SVA	Medium
<i>Goniocorella</i>	GDU	Medium
<i>Madrepora</i>	MOC	Medium
<i>Oculina</i>	OVI	Medium
<i>Enallopsammia</i>	ERO	Medium
Black corals	COB	High
<i>Bathypathes</i>	BTP	High
Gorgonians	GOC	Medium
<i>Paragorgia</i>	PAB	High
<i>Primnoa</i>	PRI	Medium
Bamboo corals	KER-LEP	Medium
<i>Metallogorgia</i>	MTL	Medium
<i>Flabellum</i>	COF	Low
<i>Caryophyllia</i>	CAY	Low
Hydrocorals	COR	Low

Table 3. Protected coral taxa found in New Zealand waters for which the conservation status has been established (Freeman *et al.*, 2014).

Order	Common name	Family	Species name	Conservation Status
Antipatharia	Black coral	Myriopathidae	<i>Antipathella fiordensis</i> (Grange, 1990)	Naturally Uncommon
	Black coral	Antipathidae	<i>Antipathes fruticosa</i> (Gray, 1857)	Data Deficient
	Black coral	Antipathidae	<i>Antipathes n. sp.</i>	Naturally uncommon
	Black coral	Schizopathidae	<i>Lillipathes lillei</i> (Totton, 1923)	Naturally uncommon
Alcyonacea (previously Gorgonacea)	Golden coral	Chrysogorgiidae	<i>Metallogorgia sp.</i>	Declining
	Bamboo coral	Isididae	<i>Chathamisis bayeri</i> (Grant, 1976)	Nationally Vulnerable
	Bamboo coral	Isididae	<i>Mopsea sp.</i>	Data Deficient
	Bamboo coral	Isididae	<i>Peltastisis sp.</i>	Data Deficient
	Bamboo coral	Isididae	<i>Primnoisis sp. C</i>	Data Deficient
	Bamboo coral	Isididae	<i>Acanella spp.</i>	Naturally uncommon
	Bamboo coral	Isididae	<i>Chathamisis spp.</i> (Kermadec Ridge)	Naturally uncommon
	Bamboo coral	Isididae	<i>Echinisis spicata</i> (Hickson, 1907)	Naturally uncommon
	Bamboo coral	Isididae	<i>Echinisis spp.</i>	Naturally uncommon
	Bamboo coral	Isididae	<i>Keratoisis n. sp.</i>	Naturally uncommon
	Bamboo coral	Isididae	<i>Minuisis</i>	Naturally uncommon
	Bamboo coral	Isididae	<i>Sclerisis sp.</i> (NIWA J. Sanchez)	Data Deficient
	Bamboo coral	Isididae	<i>Circinisis circinata</i> (Grant, 1976)	Data Deficient
	Bamboo coral	Isididae	<i>Echinisis spicata</i> (Hickson, 1907)	Naturally Uncommon
	Bamboo coral	Isididae	<i>Keratoisis glaesa</i> (Grant, 1976)	Naturally Uncommon
	Bamboo coral	Isididae	<i>Keratoisis hikurangiensis</i> (Grant, 1976)	Naturally Uncommon
	Bamboo coral	Isididae	<i>Keratoisis projecta</i> (Grant, 1976)	Naturally Uncommon
	Bamboo coral	Isididae	<i>Keratoisis tangentis</i> (Grant, 1976)	Naturally Uncommon
	Bamboo coral	Isididae	<i>Keratoisis zelanica</i> (Grant, 1976)	Naturally Uncommon
	Bamboo coral	Isididae	<i>Primnoisis ambigua</i> (Wright & Studer, 1889)	Data Deficient
	Bamboo coral	Isididae	<i>Primnoisis antarctica</i> (Studer, 1878)	Data Deficient

	Bubblegum coral	Paragorgiidae	<i>Paragorgia alisonae</i> (Sanchez, 2005)	Nationally Vulnerable
	Bubblegum coral	Paragorgiidae	<i>Paragorgia aotearoa</i> Sanchez, 2005	Data Deficient
	Bubblegum coral	Paragorgiidae	<i>Paragorgia arborea</i> (Linnaeus, 1758)	Declining
	Bubblegum coral	Paragorgiidae	<i>Paragorgia kaupeka</i> (Sanchez, 2005)	Data Deficient
	Bubblegum coral	Paragorgiidae	<i>Paragorgia maunga</i> (Sanchez, 2005)	Data Deficient
	Bubblegum coral	Paragorgiidae	<i>Paragorgia wahine</i> (Sanchez, 2005)	Data Deficient
	Bubblegum coral	Paragorgiidae	<i>Paragorgia whero</i> (Sanchez, 2005)	Data Deficient
	Bubblegum coral	Paragorgiidae	<i>Sibogorgia dennisgordoni</i> (Sanchez, 2005)	Data Deficient
	Bubblegum coral	Paragorgiidae	<i>Sibogorgia tautahi</i> (Sanchez, 2005)	Data Deficient
	Sea fan	Primonoidae	<i>Calyptrophora cristata</i> (Cairns, 2012)	Data Deficient
	Sea fan	Primonoidae	<i>Calyptrophora diaphana</i> (Cairns, 2012)	Data Deficient
	Sea fan	Primonoidae	<i>Calyptrophora niwa</i> (Cairns, 2012)	Data Deficient
	Sea fan	Primonoidae	<i>Helicopriono fasciola</i> (Cairns, 2012)	Data Deficient
	Sea fan	Primonoidae	<i>Metanarella nannolepis</i> (Cairns, 2012)	Data Deficient
	Sea fan	Primonoidae	<i>Narelloides crinitus</i> (Cairns, 2012)	Data Deficient
	Sea fan	Primonoidae	<i>Calyptrophora cucullata</i> (Cairns, 2012)	Naturally Uncommon
	Sea fan	Primonoidae	<i>Calyptrophora inornata</i> (Cairns, 2012)	Naturally Uncommon
	Sea fan	Primonoidae	<i>Narella mosaica</i> Cairns, 2012	Data Deficient
	Sea fan	Primonoidae	<i>Narella hypsocalyx</i> Cairns, 2012	Naturally Uncommon
	Sea fan	Primonoidae	<i>Narella mesolepis</i> Cairns, 2012	Naturally Uncommon
	Sea fan	Primonoidae	<i>Narella vulgaris</i> Cairns, 2012	Naturally Uncommon
Scleractinia	Stony coral	Dendrophylliidae	<i>Balanophyllia chnous</i> (Squires, 1962)	Naturally Uncommon
	Stony coral	Oculinidae	<i>Madrepora oculata</i> (Linnaeus, 1758)	Declining
	Stony coral	Oculinidae	<i>Oculina virgosa</i> (Squires, 1958)	Naturally Uncommon
	Stony coral	Dendrophylliidae	<i>Craterithea novaezelandiae</i> (Thompson, 1879)	Naturally Uncommon
	Stony cup coral	Flabellidae	<i>Falcatoflabellum raoulensis</i> (Cairns, 1995)	Naturally Uncommon

	Stony cup coral	Turbinoliidae	<i>Sphenotrochus squiresi</i> (Cairns, 1995)	Naturally Uncommon
	Stony branching coral	Dendrophylliidae	<i>Enallopsammia rostrata</i> (Pourtales, 1878)	Declining
	Stony cup coral	Caryophylliidae	<i>Coenocyathus brooki</i> (Cairns, 1995)	Data Deficient
	Stony branching coral	Caryophylliidae	<i>Goniocorella dumosa</i> (Alcock, 1902)	Declining
	Stony branching coral	Caryophylliidae	<i>Solenosmilia variabilis</i> (Duncan, 1873)	Declining
Anthoathecata	Red hydrocoral	Stylasteridae	<i>Errina bicolor</i> (Cairns, 1991)	Naturally Uncommon
	Red hydrocoral	Stylasteridae	<i>Errina chathamensis</i> (Cairns, 1991)	Naturally Uncommon
	Red hydrocoral	Stylasteridae	<i>Errina cheilopora</i> (Cairns, 1983)	Naturally Uncommon
	Red hydrocoral	Stylasteridae	<i>Errina cooki</i> (Hickson, 1912)	Data Deficient
	Red hydrocoral	Stylasteridae	<i>Errina dendyi</i> (Hickson, 1912)	Data Deficient
	Red hydrocoral	Stylasteridae	<i>Errina hicksoni</i> (Cairns, 1991)	Data Deficient
	Red hydrocoral	Stylasteridae	<i>Errina laevigata</i> (Cairns, 1991)	Naturally Uncommon
	Red hydrocoral	Stylasteridae	<i>Errina novaezelandiae</i> (Hickson, 1912)	Naturally Uncommon
	Red hydrocoral	Stylasteridae	<i>Errina reticulata</i> (Cairns, 1991)	Naturally Uncommon
	Red hydrocoral	Stylasteridae	<i>Errina sinuosa</i> (Cairns, 1991)	Naturally Uncommon

Table 4. CSP Research Priorities\* for New Zealand Protected Corals.

Research priority	Priority level*
<p>Interaction studies:</p> <ul style="list-style-type: none"> <li>• An updated formal risk assessment estimating the impact of commercial fishing (e.g. trawling) on protected coral populations</li> <li>• Investigate recovery dynamics post trawling impacts</li> <li>• Determine what facilitates the recovery of corals/habitat after trawling</li> <li>• Determine the impact of trawling on ecosystem function/services of deep sea protected corals</li> <li>• Characterisation of the impact of commercial fishing on protected corals in shallow waters (e.g. 10-40m, Fiordland, Port Pegasus)</li> </ul>	<p>Medium-High</p> <p>High</p> <p>Medium-High</p> <p>Medium-High</p> <p>High</p>
<p>Population studies:</p> <ul style="list-style-type: none"> <li>• Increase understanding of taxonomy</li> <li>• Determine small effective population sizes and their implication on resilience to fishing impacts</li> <li>• Determine reproductive and dispersal capabilities</li> <li>• Determine larval biology, duration and settlement patterns</li> <li>• Determine population connectivity</li> <li>• Identify source and sink populations</li> <li>• Determine age and growth characteristics</li> <li>• Identification of biodiversity hot spots/ areas of high protection value</li> <li>• Monitor changes in genetic and community structure, as well as species distribution over a time in relation to spatial fishing effort</li> <li>• Modelling distribution including abundance/ biomass (not just presence/absence)</li> </ul>	<p>High</p> <p>Medium-High</p> <p>High</p> <p>Medium-High</p> <p>High</p> <p>Medium-High</p> <p>High</p> <p>High</p> <p>High</p> <p>Medium-High</p>
<p>Mitigation studies:</p> <ul style="list-style-type: none"> <li>• Analysis of potential mitigation measures to minimise the impact of commercial fishing on protected coral species</li> <li>• Determine the effectiveness of spatial closures; considering design, how long the closure needs to be in place, and if recovered areas will provide similar ecosystem function/services.</li> </ul>	<p>Medium-High</p> <p>Medium-High</p>

\*Note: Priority level has been assigned qualitatively by DOC based on the importance of the work (i.e. whether the research addresses significant data gaps and whether it is a prerequisite to another project).