RA1_04_22

RASS profile; Arrow squid (*Nototodarus gouldi, N. sloanii*) in New Zealand waters, trawl fishery

February 2022

RASS scoring

Risk Assessment for Sourcing Seafood (RASS) by Seafish, provides UK commercial seafood buyers and processors with information on the biological status and management of fish stocks from which fish are either landed or imported into the UK, and the environmental impacts of fisheries catching these stocks.

The risk scores are derived from the RASS scoring guidance, which is a framework which risk assesses the stock, management, and environmental impact of the fishery. The assessment is informed by a review of the literature.

RASS scoring presents risk scores for four categories: stock status, stock management, bycatch and habitat impact. There are five level of risk scores for each category:

Risk score	Numerical risk score	Symbolised risk score
Very low risk	1	●○○○○
Low risk	2	●●○○○
Moderate risk	3	●●●○○
High risk	4	●●●●○
Very high risk	5	●●●●●

The scores should not be used in isolation to decide on a purchase or otherwise of Seafood from a fishery. The scores enable the main features of the fishery to be examined within a structured format, and hence inform buyers of the questions they might ask about the fishery and where improvements could be made to improve sustainability.

This document is divided into:

- An Overview, which gives a summary of information of the biology, fishery and catches
- Risk assessment scores and summaries of information in each category
- Detailed information under each risk category, linked from the summary scores sections
- Finally, there is a section on Fisheries Improvement Projects and further reading where appropriate

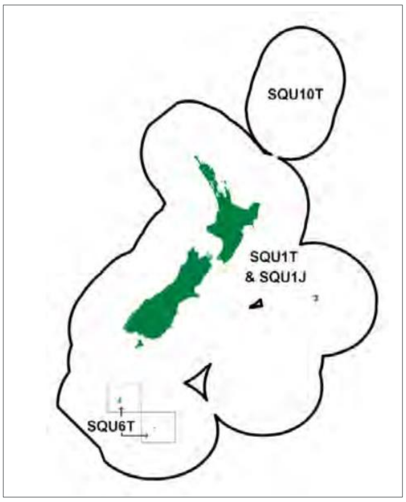
Overview

The two closely related species in this fishery *Nototodarus gouldi* and *N sloanii* are separated geographically. *N gouldi* is found around mainland New Zealand, north of the subtropical convergence zone and *N sloanii* is found in and to the south of this zone. The subtropical convergence zone lies around 45° S so *N sloanii* is found in waters around the southern South Island of New Zealand. Both species are found over the continental shelf in water up to 500 m depth, though they are most prevalent in water less than 300 m depth.

There is evidence (at least for *N. sloanii*) that the animals live for one year, and that the squid taken by the fishery have not spawned. Growth is very rapid at 3.0-4.5 cm per month. This short-lived species has highly variable abundance from year to year.

The predominant gears used for catching these species are seabed contact otter trawls and some midwater trawls, with very small quantities of squid being landed by jigging since 2016-17.

Map showing stock areas



Recent catches

Currently, the fishery is managed under two main TACCs (Total Allowable Commercial Catches), SQU1T around mainland New Zealand and SQU6T around the Southern Islands. Catches in SQU10T, the Kemerdec Islands are low and there have been negligible catches by jigging (SQU 1J) since 2016-17. The TACC year in New Zealand is 1st October – 30th September

Stock area	Code (see Map)	TACC (2019-20) (tonnes)	Landings (2019-20) (tonnes)
Mainland New Zealand trawl	SQU1T	44,741	25,683
Mainland New Zealand jig	SQU1J	5000	<1
Southern Islands trawl	SQU6T	32,369	16,393
Kemerdec Islands trawl	SQU10T	10	<1

Stock status

Risk score	Symbolised risk score
High risk	●●●●○

There are no formal assessments on the stocks of arrow squid in New Zealand waters. According to information on Sealife base, the vulnerability is low to moderate for both species (*N. gouldi* 25/100 and *N. sloanii* 32/100) and the population trend is unknown. With these characteristics, the stock assessed as high risk under the RASS scoring guidelines. However, this is a risk assessment approach used in a data limited situation, to highlight the need to understand further information about the stock, not necessarily a statement of the stocks' status.

There have been trial assessments using a depletion model, where the stock abundance is tracked through the fishing season, and the fishery would be closed when stock abundance reaches a level considered sufficient to ensure adequate spawning. However, in a trial assessment carried out on data from 24 years fishing in the main areas of the stock, the model did not consistently fit the data in every year, making it difficult to carry out assessments. It was suggested that a pre-season survey could help inform the model used. For details see Stock assessment and time-trends

Management

Risk score	Symbolised risk score
High risk	●●●●○

This fishery is scored a high risk under the RASS scoring guidelines. This is because data are too limited to develop any form of management controls to adjust fishing opportunities on the stock. However, there are management measures in place to control effort in the SQU6T fishery, in response to mortality levels of New Zealand sea lions. Surveillance in the form of observer coverage and enforcement is considered to be good. For further information see Management details

Bycatch

Risk score	Symbolised risk score
Moderate risk	●●●○○

This fishery is assessed as a moderate risk under the RASS scoring guidelines. This is because there is a risk of capture of New Zealand sea lions in the fishery and the population of this species is considered threatened. However, mitigation measures in the form of Sea lion Exclusion Devices (grids designed to deflect sea lions out of the trawl before they reach the cod end) are mandatory in the areas of high bycatch risk and a management plan has been implemented designed to limit the effects of fishing on the sea lion population.

Other Protected Endangered or Threatened (PET) species are also encountered in this fishery, including albatross species and sharks.

There is a quantitative risk assessment on the albatross species, indicating that the overall mortality rate due to encounters with fishing gear is less than the Potential Biological Removal (PBR) rate, and this fishery accounts for small proportion of that mortality. Mitigation is in place in the form of bird scarers to reduce the risk of birds striking the trawl warps.

Basking sharks have been subject to a qualitative risk assessment which ranked them at a lower risk than other shark species, and there is quantitative information on the factors which are indicators of levels of bycatch of these species. Bycatch rates and quantities of basking sharks caught in the fishery are decreasing, but it is unknown whether this is due to changes in the shark populations or fishery practices. There is a catch of white pointer, or great white shark, in these fisheries and there is some evidence that the population is stable. For more information see

Bycatch details

Habitat

Risk score	Symbolised risk score
Moderate risk	●●●○○

This fishery is scored a moderate risk for habitat. There is comprehensive spatial data on fishing effort which indicates a relatively small footprint for the fishery. There are marine protected areas around the Island groups in the vicinity of the squid trawl fisheries, and a significant amount of protection from trawling within the New Zealand EEZ and territorial seas. Thus, an argument can be made that the footprint of mobile bottom gears is managed to significantly reduce damage to vulnerable habitats, which corresponds to a moderate risk under the RASS scoring guidelines.

There are co-ordinated efforts to protect areas of importance to fisheries and biodiversity, through the development of mapping of fishing effort, seabed habitats and biodiversity. Work in this area is ongoing. See Habitat details

Detailed information

Stock assessment and time-trends

There is no assessment or reference points set for the stocks of New Zealand squid, Total Allowable Commercial Catches (TACCs) are set but they are not based on stock assessments. In a few years for example 2005-6 for SQU1T an increased TACC has been agreed in response to higher than average catch rates, but the TACCs automatically reverted to their previous levels for subsequent years.

The time series of reported catches and TACCs from Fisheries New Zealand (2021) are shown below;

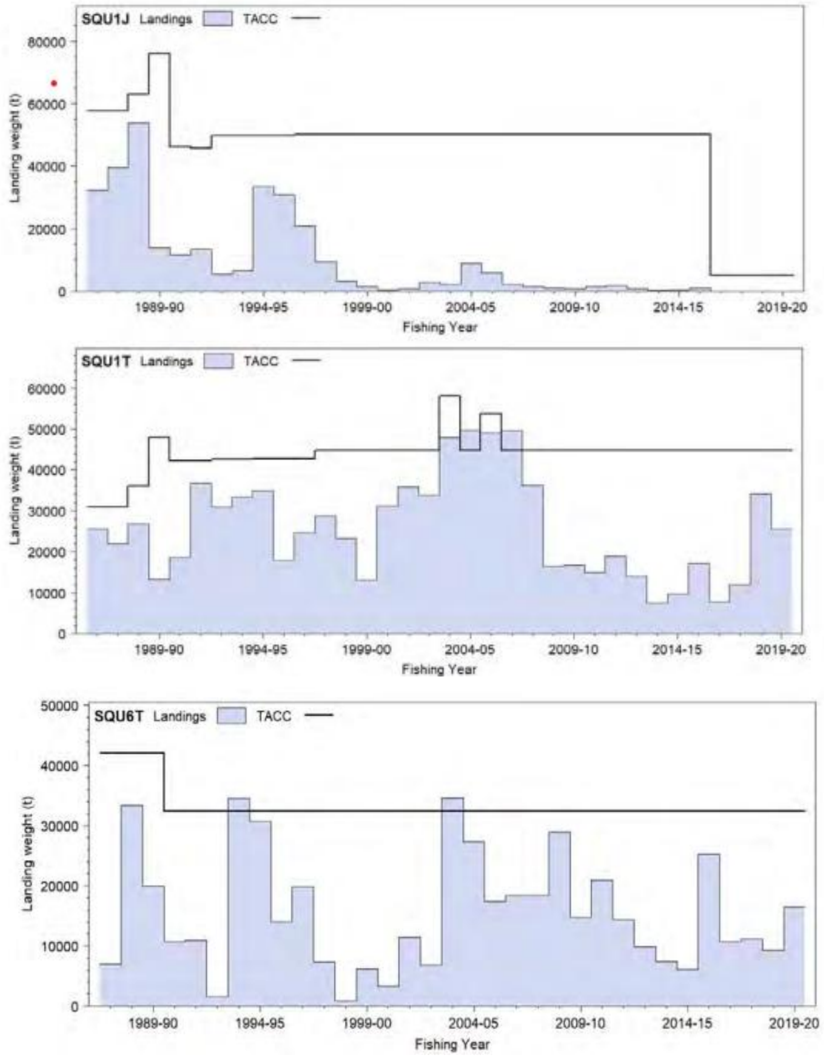


Figure 1. Reported commercial landings and TACCs for the three main New Zealand squid stocks. Separate TACCs are set for SQU1T and SQU1J; squid trawl and jig fisheries around mainland New Zealand and SQU6T squid trawl fisheries around the Southern Islands (see map).
Note the New Zealand fishing year is 1 October – 30 September.
(Note SQU10T around Chatham Islands North of New Zealand which has a minimal catch)

Assessment in development

Squid, have a short life cycle; arrow squid live for around one year, spawn and then die, do so they not fit into the standard fish population modelling approaches. For some squid stocks it is feasible to use a ‘depletion’ approach in which the abundance of the squid stock is estimated by tracking the catches and catch per unit effort during the course of the fishing year. The fishery would then be closed when a pre agreed abundance threshold is reached, congruent with allowing sufficient stock for spawning the next generation. This assessment approach has been tested by MacGregor and Tingley (2016) for the SQU6T trawl fisheries around the Southern Islands, for a single year; 2008.

The approach, based on the assessment model used for Falkland Islands squid fisheries produced promising results, providing that an appropriate value for the natural mortality (that is mortality due to causes other than fishing) can be estimated. There was also a need to test the approach on a number of years to evaluate the likelihood that the method will succeed in a given year.

A further assessment was carried out by McGregor and Large, (2016) using the same depletion model for the Snares (SQU 1T; shelf fisheries SE of New Zealand South Island) and Auckland Island (SQU6T) stocks, used data for all the years 1990 until 2014. It was found that the model did not converge (that is the model did not fit the data) for several of the seasons in the assessment, hence making it difficult to obtain a valid assessment. It was considered that this situation could be improved if a pre-season squid survey was undertaken, to help inform the model on squid abundance. This is the approach taken in the Falkland Islands fisheries to inform the model on the initial abundance of squid.

Stock structure and recruitment

For management purposes the two species are not distinguished. However, there is evidence that the Auckland shelf stock of *N. sloanii* found around the Southern Islands (SQU6) is different from the stocks found around mainland New Zealand (SQU1). This stock is readily accessible to trawlers, and a separate TACC is set for this stock.

Estimated age data suggest that *N. sloanii* hatches in July and August, with spawning occurring in June and July. It also appears that *N. gouldi* may spawn one to two months before *N. sloanii*, although there are some indications that *N. sloanii* spawns at other times of the year. The squid taken by the fishery SQU1T fishery which occurs between December and May, with peak harvest from January to April, do not appear to have spawned.

Data gaps and research priorities

There has clearly been research into stock assessment methods with some success. However, these two assessments have highlighted the need for better knowledge of the pre- season abundance of squid to improve the assessments.

References

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Stock Assessments and Stock Status Volume 1: Introductory section and Alfonsino to Hake
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A preliminary evaluation of depletion modelling to assess New Zealand squid stocks. (fish.gvt.nz)

Management details

Advised and agreed catches

There is no assessment derived catch advice upon which to make management decisions. In most years, the catch has been well below to the TACC. In certain in the 2000s years TACCs have been increased to accommodate high levels of squid abundance as evidenced by high catch rates, but they have reverted to previous levels after these periods.

Stock harvesting strategy

Apart from the trial assessments using a depletion model discussed above, there are no assessments of the squid stocks to form the basis for management decisions. However, closures of the SQU6T fishery on the basis of mortality of the main bycatch species (the New Zealand sea lion) take place when the Fisheries Related Mortality Limit (FRML) for the New Zealand sea lion is exceeded. If this limit is reached, the fishery is closed for the remainder of the season.

Surveillance and enforcement

MRAG (2017) report high compliance rates (94%) for inspections of Certificates of registry, Fishing gear, Fishing permit, Sea Lion Exclusion Device (SLED), Effort Returns, Landing documents and Landing return books. There is also widespread observer coverage (90% +). This indicates a high level of compliance in the fishery

References

Fisheries New Zealand (2021)
Fisheries Assessment Plenary; Stock Assessments and Stock Status Volume 1: Introductory section and Alfonsino to Hake
Volume 1.pdf.ashx (fish.govt.nz)
MRAG (2017) Seafood Risk Assessment New Zealand squid fishery, prepared for the OpenSeas Programme NZ.

Bycatch details

Targeting and behaviour

The fishery uses bottom and midwater trawl configurations, but most of the current catch is made using bottom trawls. During the period 2002-3 until 2016 arrow squid comprised 79% of the observed catches in the targeted trawl fishery. This indicates a well targeted fishery, with some areas, most notably around the Auckland Islands off Southern New Zealand (SQ6T see map), squid are relatively accessible to trawl fisheries and there is a separate TACC for this area.

Evidence of bycatch risk.

Discards

The arrow squid trawl fisheries in New Zealand waters are well monitored by observers (with observer rates meeting 90% in some fisheries; see below). Non-target catch quantity has shown a significant decreasing trend since 2005-6, and total annual discards also showed a decreasing trend over time from 16,000 tonnes (t) in 2002-3 to about 1500 t in 2013-14. The discard fraction for the period 2002-3 to 2015-6 was 0.12 or 12% (Fisheries New Zealand, 2021). This level of discard would constitute a moderate risk (10-30% discards) under the RASS scoring guidelines.

Protected species

The bycatch of protected species most notably New Zealand sea lion (rapoka) (*Phocarctos hookeri)*, and some bird species are the most studied risk in this fishery. There are also bycatches of fur seals (*Arctocephalus forsteri*) which are not considered at risk, and some shark species: basking sharks (*Cetorhinus maximus*) and white pointer shark (*Carcharodon carcharias*, also known as the great white shark). The latter two species are considered ‘threatened Nationally vulnerable’ and ‘threatened Nationally endangered’ respectively.

Sea lions

The New Zealand sea lion is the rarest sea lion in the world and is classified as endangered by IUCN. The overall population was estimated at 11,800 sea lions in 2015. The Auckland Islands population which is adjacent to the SQ6T squid fishery showed a decline by 40% between 2000 and 2009.

The decreasing population trends and the low level of pup production has led to the development of a Threat Management Plan (TMP) for this species by the New Zealand Government an outline of which can be found on page 5 and 6 of the Chapter 4 - NZ Sea Lions – Aquatic environment and biodiversity annual review (AEBAR) – 2019/20 (mpi.govt.nz). The overarching objectives of this TMP are to;

1) Halt the decline of the New Zealand sea lion population within 5 years

2) Ensure the New Zealand sea lion population is stable or increasing within 20

years, with the ultimate goal of achieving 'Not Threatened' status.

The effects of fishery and human pressures on the sea lion population have been modelled using a sea lion population model which includes natural variations in pup production defines a Population Sustainability Threshold (PST).

This threshold means that the objective is that (Fisheries New Zealand, 2021);

"Fisheries mortalities will be limited to ensure that the impacted population is no more than 5% lower than it would otherwise be in the absence of fishing mortality, with 90% confidence, over five years".

Mitigation measures

As capture of sea lions in squid trawls in the Auckland Islands fishery (SQ6T) has been identified as a significant source of mortality for this species, a number of mitigation measures have been implemented.

1. A high level of observer coverage at a minimum of 90% is maintained in the fishery

2. Fisheries Related Mortality Limits (FRML) have been imposed on this fishery since 1992, whereby the fishery is closed for the remainder of the season when a certain level of number of sea lions have been captured. Fisheries mortalities related include an element of 'cryptic mortality' whereby sea lions may be killed by interaction with the gear, but not retained by the gear.

3. Sea Lion Excluder Devices (SLEDs), consisting of a steel metal grid which deflects the sea lions, upwards and out of the trawl through a hole in the upper panel of the net, have been implemented in the fishery, with a standardised design being used in all vessels in the SQU 6T fleet from 2007-08.

These elements are all built into a SQU 6T Operational Plan for this fishery, which was updated in 2019 to reflect improved scientific data collection and are designed to fulfil the above objective. It is now possible to monitor the performance of the fishery against the operational plan.

Sea birds

A risk assessment (Richard et al., 2020) has been carried out covering the whole of the New Zealand fisheries-seabird population interactions. This showed that the squid fishery posed a small risk to the southern Buller's albatross (*Thalassarche bulleri bulleri*) and the New Zealand white-capped albatross (*Thalassarche cauta steadi*). The risk assessment method uses an estimate of the Potential Biological Removal rate or PBR based on biological parameters of the population, which estimates how much mortality a population can withstand and maintain itself at 50% of the environmental carrying capacity. This is calculated as a Risk Ratio (RR), the Annual Potential Fatalities (APF) as a ratio to the PBR:

$$RR = APF/PBR$$

So if RR>1 implies that the APF due the fisheries exceeds the PBR

For the squid trawl fisheries, the main sources of mortality for the albatross species striking the trawl wires and capture in the net. The total RR for all fisheries is 0.39 for southern Buller's albatross and 0.35 for New Zealand white-capped albatross of which this fishery contributes 0.05 and 0.03, of the risk respectively. This indicates that because the Risk Ratio is less than 1 overall the APF does not exceed the PBR, and the squid trawl fishery contributed approximately 13% to the risk for Southern Buller's albatross and 8.5% of the risk to New Zealand white-capped albatross. To set the RR of the arrow squid fishery in context see Table 3.2 page 18 (pdf) of [AEBAR 2019–20: Spatially Explicit Fisheries Risk Assessment (SEFRA)].

Along with these population estimates are sensitivity estimates of the effects of uncertainty in the input parameters. Examples of these sensitivity estimates are given in Figure 5 (page 20) of the SEFRA, which shows that vulnerability to trawl fisheries, cryptic mortality and adult survival contribute most to the uncertainty in these estimates for both these species (note this is an example only).

Mitigation measures

A large-scale trial was carried out in 2005-06 to test out the various methods to reduce trawl warp strikes, such as the use of tori lines or bird bafflers as bird scarers. The experiment found that there were very few wire strikes by birds when there was no offal discharge, and the presence of tori lines were the most effective at reducing trawl warp strikes, though the birds would strike the tori lines. The use of bird scarers was mandated in the squid trawl fishery in 2006 and the warp capture rate of white capped albatross has decreased from more than 3 per 100 tows to less than 1 per 100 tows in in the period until 2017-18. There is still a mortality due to direct capture in the net. See Figure 2.

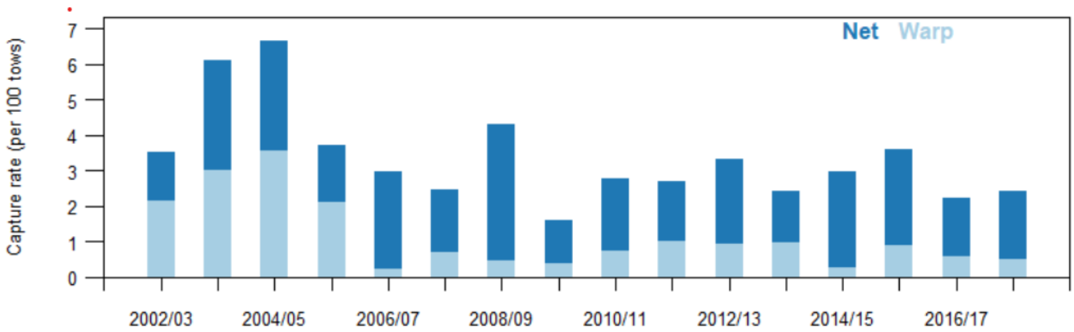

Figure 2: Capture rates of white-capped albatross in squid trawl fisheries for warp and net captures

Chondrichthyan (sharks, rays and chimaera) species

The characteristics of these species, usually long-lived, low fecundity and in some cases slow growing, which make these species more vulnerable to fishing effects. For New Zealand waters the risk assessments have been carried out qualitatively, using expert judgment, in 2014 and 2017. Full details can be found on page 2 of Chapter 10:– Aquatic environment and biodiversity annual review (AEBAR) – 2019/20 (mpi.govt.nz). The consensus was that the highest estimated risks were for some quota managed species and deepwater shark species, whereas protected species (i.e. basking shark, spinetail devilray and white pointer shark) had lower risk scores

Basking sharks

Bycatch records of basking sharks have been studied (Francis, 2017; see this report for full details) with a view to understanding the factors such as depth, target species, location, gear design (principally headline height) or nationality of the vessels are important indicators of levels of bycatch. Historically, vessel nationality had been an important indicator, but depths (catch rates were greater in 200-400 m of water, the deeper end of the squid fishery depth range) and headline height (trawls with headlines of > 4m appeared to catch more sharks) are possible indicators. There has been a marked decline in basking shark bycatch rates and total quantities in since the 1980s, but it is unknown whether this is due to changes in the shark population or fishing practices.

Mitigation measures

Measures have been on place since 2013, implemented by the Deepwater Group Ltd which represents deepwater quota owners, designed to improve reporting and potentially implement a ‘move on’ rule if there are apparent hotspots of basking shark bycatches. However, Frances (2017) points out that the move on rule is unlikely to be successful unless coupled with a clear understanding of when and where sharks are concentrated otherwise vessels may move into areas where more sharks are present than the one they have just left. Given the low and variable catch rates of sharks any effect will be difficult to detect.

White pointer or great white shark

Fishers reported catching a total of 20 white pointer shark individuals in arrow squid trawls since 2016, 3 of which were dead upon capture and the remainder were released alive. Little is known about the survival of released individuals, but it is assumed to be low. A review of fishery – white shark interactions in which gear, spatial and temporal factors have been analysed was carried out in 2012 (Francis and Lion, 2012).

There is evidence from tagging and genetic studies that New Zealand and eastern Australian white pointer sharks constitute single stock. Using population genetic studies to estimate population size and trends this population is estimated to be stable see page 12 of Chapter 10: Chondricthyans – Aquatic environment and biodiversity annual review (AEBAR) – 2019/20 (mpi.govt.nz)

References

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Richard, Y Abraham, E R Berkenbusch, K (2020) Assessment of the risk of commercial fisheries to New Zealand seabirds, 2006–07 to 2016–17. New Zealand Aquatic Environment and Biodiversity Report No. 237. 57 p Seabird risk assessment, 2006–07 to 2016–17 (bmis-bycatch.org)

Habitat details

Error! Reference source not found.**Gear effects, targeting and behaviour**
There is very little information available on the types of trawl used in the New Zealand squid fishery, except that bottom and midwater trawls are used.

Habitat risks

The New Zealand Government recognises the need to assess and manage the risks to marine habitats due to trawling. It has a programme which is designed to map the seabed habitats in areas shallower than 3000 m within its EEZ using observational and modelling techniques, known as Benthic-Optimised Marine Environment Classification (BMEC). There is also a programme designed to describe the extent and intensity of seabed contact. For the arrow squid fishery the overall trawl footprint is well described;

	Footprint as a percentage of area	
Habitat (letters refer to BMEC habitat)	**1989-90 to 2018-19**	**2018-19**
Waters shallower than 200 m	9.7	1
200-400 m	8.5	1
400-1600 m	0.7	<0.1
Stewart-Snares shelf (E) to the southeast of South Island (SQU 1T fisheries)		2.5
Sub-Antarctic island shelves (F) around the Auckland Islands (SQU 6T fisheries)		2.0
Chatham Rise slope and shelf edge of the east coast South Island (I) SQU 1T fisheries		0.6

Work is ongoing to improve predictive modelling to map seabed habitats, refine methods to estimate the extent and effects of bottom fishing and recovery rates and develop decision support tools for management see AEBAR 2019-20 Benthic Impacts.

A very recent paper by Pitcher et al., (2022) reports Relative Benthic Status (RBS) for seabed sedimentary habitats for 24 regions worldwide, including New Zealand. The RBS value describes status of benthic habitats. The value ranges from ranging from 0 to 1, where 1 describes a habitat where the benthic biomass is at full carrying capacity, whereas low RBS values describe benthic habitats that are in state altered by fishing impact, with organisms adapted to those conditions.

The majority of the New Zealand continental shelf was estimated to have an RBS value of between 0.8 and 1 indicating a relatively low overall impact by trawl fisheries on sedimentary habitats. However, there was no specific information on the arrow squid fishery.

Mitigation measures

There are area controls on fishing within New Zealand's 'trawlable' depth zone of < 1600 m which close 15% of this area to fishing within 100 m of the seabed, these are known as benthic protection areas (BPAs). Within the territorial sea (<12 miles) 19.6 % of the area is closed to bottom fishing. Of particular relevance to this fishery are areas closed to trawling around the Sub-Antarctic island shelves around the Auckland Islands.

Work is ongoing to improve predictive modelling to map seabed habitats, refine methods to estimate the extent and effects of bottom fishing and recovery rates and develop decision support tools for management.

Under national legislation (NZ Fisheries Act 1996) there is scope for introducing protection for Habitats of Particular Significance for Fisheries Management (HPFSM; see AEBAR 2019-20), although HPFSMs have not been identified or applied but some candidate habitats such as spawning or nursery areas, have been proposed. Under the New Zealand Biodiversity strategy (AERBAR 2019-20; Marine Biodiversity) there is also a programme of seabed mapping to identify habitat and biodiversity hotspots and integrated this aspect into fishery management, which require a greater understanding of biodiversity and habitat distribution

References

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Fisheries Improvement

The Deepwater Group Ltd, which represents quota owners of New Zealand deepwater fisheries, has been involved in a number of initiatives to improve New Zealand trawl fisheries including initiation of MSC certification for – New Zealand EEZ Squid Trawl Fishery (SQU1T) and Auckland Islands Squid Trawl Fishery (SQU6T). However, this has been withdrawn from assessment in 2015.

The Deepwater group has been instrumental in developing Operational procedures relating to marine mammals, benthic habitats and sharks, an operational plan (outlined above) for management of squid fisheries in 6T and other plans and procedures. There are also 'Ten commandments' for a number of fisheries issues to be found on the same page as the Operational procedures.

Further reading

See also squid page of OpenSeasNZ.

It is worth noting that the relative scoring of arrow squid in this assessment is similar to that obtained from the RASS scoring, with scores;

	SQ1T_Trawl	SQU6T_Trawl	SQU1J_Jig
Target species	Medium	Medium	Medium
Bycatch and Ecosystems	Low	Low	Low
Management systems	Low	Low	Low

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