Seafood Risk Assessment

New Zealand Squid Fishery

Prepared for the OpenSeas Programme

Assessment Summary

New Zealand Squid Fishery	Unit/s of Assessment:	
	Product Name/s:	***Gould's squid, Arrow squid***
	Species:	*Nototodarus gouldii, N. sloanii*
	Stock:	New Zealand SQU1T, SQU6T, SQU1J
	Gear type:	Trawl (1T, 6T), Jig (1J)
	Year of Assessment:	2017

Fishery Overview

This summary is adapted from MPI (2017):

The New Zealand arrow squid fishery is based on two related species. *Nototodarus gouldi* is found around mainland New Zealand north of the Subtropical Convergence, whereas *N. sloanii* is found in and to the south of the convergence zone.

Except for the Southern Islands fishery, for which a separate TACC is set, the two species are managed as a single fishery within an overall TACC. The Southern Islands fishery (SQU 6T) is almost entirely a trawl fishery. Although the species (*N. sloanii*) is the same as that found around the south of the South Island, there is evidence to suggest that the Auckland Island shelf stock is different from the mainland stocks. Because the Auckland Island shelf squid are readily accessible to trawlers, and because they can be caught with little finfish bycatch and are therefore an attractive resource for trawlers, a quota has been set separately for the Southern Islands. Figure 1 shows the QMA areas relevant for the squid fishery.

The New Zealand squid fishery began in the late 1970s and reached a peak in the early 1980s when over 200 squid jigging vessels came to fish in the New Zealand EEZ. The discovery and exploitation of the large squid stocks in the southwest Atlantic substantially increased the supply of squid to the Asian markets causing the price to fall. In the early 1980s, Japanese squid jiggers would fish in New Zealand for a short time before continuing on to the southwest Atlantic. In the late 1980s, the jiggers stopped transit fishing in New Zealand and the number of jiggers fishing declined from over 200 in 1983 to around 15 in 1994. The jig catch in SQU 1J declined from 53 872 t in 1988–89 to 4865 t in 1992–93 but increased significantly to over 30 000 t in 1994–95, before declining to just over 9000 t in 1997–98. The jig catch declined to low levels for the next four years but then increased back up to almost 9000 t in 2004–05, before declining again to 891 t in 2009–10. The 2010–11 and 2011–12 fishing years have seen an increase from this eight year low to 1811 t.

From 1987 to 1998 the trawl catch fluctuated between about 30 000–70 000 t, but in SQU 6T the impact of management measures to protect the Hooker's sea lion *(Phocarctos hookeri*) restricted the total catch in some years between 1999 and 2005.

The recreational and customary catch of squid is not known, but is likely to be negligible in comparison to the commercial catch. An allowance of 10t each has been made under the SQU 1J TAC (MPI, 2016a)

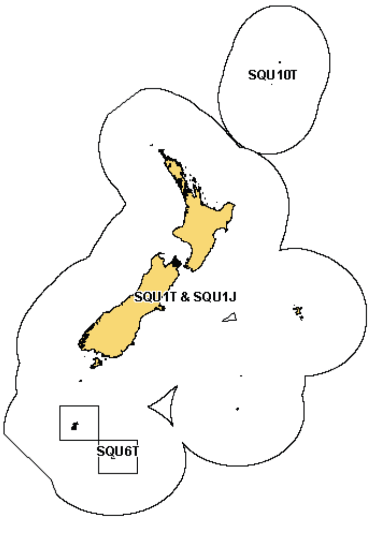


Figure 1: New Zealand squid quota management areas. (MPI, 2017)

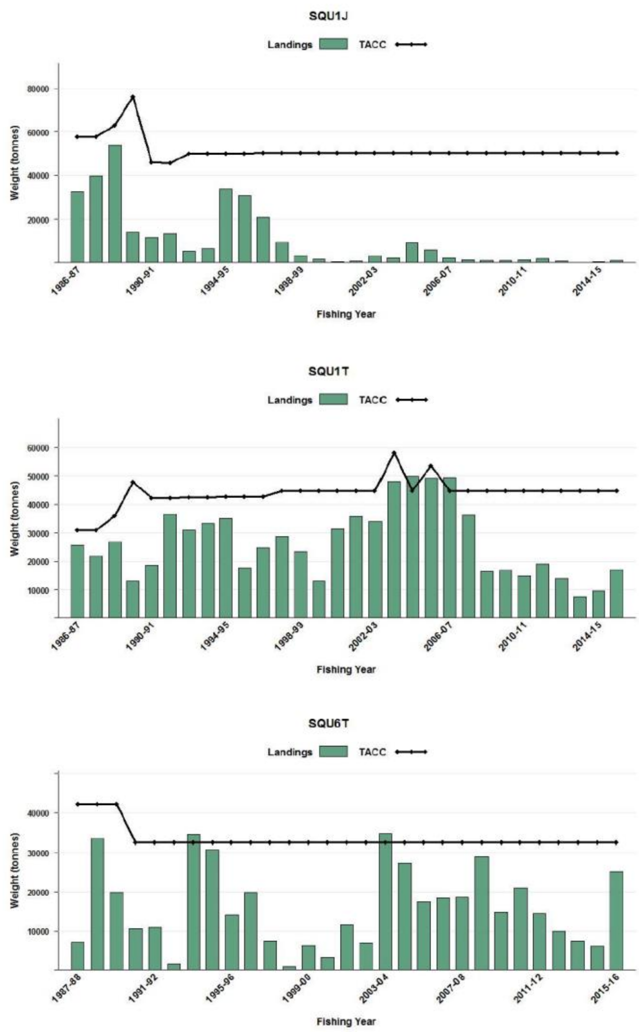


Figure 2: Reported catches of squid in comparison to the TACC between 1987-8 and 2015-16 (MPI, 2017).

Scoring

Performance Indicator	SQU1T	SQU6T	SQU1J
COMPONENT 1			
1A: Stock Status	MEDIUM RISK	MEDIUM RISK	MEDIUM RISK
1B: Harvest Strategy	MEDIUM RISK	MEDIUM RISK	MEDIUM RISK
1C: Information and Assessment	PRECAUTIONARY HIGH RISK	PRECAUTIONARY HIGH RISK	PRECAUTIONARY HIGH RISK
OVERALL	MEDIUM RISK	MEDIUM RISK	MEDIUM RISK
COMPONENT 2			
2A: Non-target Species	LOW RISK	LOW RISK	LOW RISK
2B: ETP Species	LOW RISK	LOW RISK	LOW RISK
2C: Habitats	LOW RISK	LOW RISK	LOW RISK
2D: Ecosystems	LOW RISK	LOW RISK	LOW RISK
OVERALL	LOW RISK	LOW RISK	LOW RISK
COMPONENT 3			
3A: Governance and Policy	LOW RISK	LOW RISK	LOW RISK
3B: Fishery-specific Management System	LOW RISK	LOW RISK	LOW RISK
OVERALL	LOW RISK	LOW RISK	LOW RISK

Summary of main issues

- Arrow squid is a highly variable annual stock, which makes conventional stock assessment difficult. No estimates of current and reference biomass are available, although MPI conclude that the stock is unlikely to be below the hard limit reference point;
- Given the highly variable nature of the stock and the absence of biologically-based reference points, there is no well-defined harvest control rule which would serve to constrain exploitation as the limit reference point is approached;
- The SQU 6T fishery has a bycatch of NZ sea lions which are listed under NZ environment legislation as 'nationally critical'. Interactions in the fishery are subject to a Fishery-Related Mortality Limit (FRML) which triggers the closure of the fishery if reached. The trawl fishery also interacts with seabirds.
- The trawl fishery uses gear fished on or near the bottom which is likely to result in some habitat modification.

Outlook

SQU1T, SQU6T

Component	Outlook	Comments
Target species	Improving	Efforts are underway as part of a formal DWG Fisheries Improvement Plan to develop a robust stock assessment methodology and harvest control rules.
Environmental impact of fishing	Improving	Additional analysis of catch composition and impacts on ETP species are expected are part of the DWG FIP for the SQU1T and SQU6T fisheries.
Management system	Stable	No substantial changes are expected in C3 risk scoring

SQU1J

Component	Outlook	Comments
Target species	Improving	Efforts are underway as part of a formal DWG Fisheries Improvement Plan to develop a robust stock assessment methodology and harvest control rules.
Environmental impact of fishing	Stable	Low effort is expected to continue for the foreseeable future.
Management system	Stable	No substantial changes are expected in C3 risk scoring

Contents

Disclaimer

Background

This report sets out the results of an assessment against a seafood risk assessment procedure, originally developed for Coles Supermarkets Australia by MRAG Asia Pacific. The aim of the procedure is to allow for the rapid screening of uncertified source fisheries to identify major sustainability problems, and to assist seafood buyers in procuring seafood from fisheries that are relatively well-managed and have lower relative risk to the aquatic environment. While it uses elements from the GSSI benchmarked MSC Fishery Standard version 2.0, the framework is not a duplicate of it nor a substitute for it. The methodology used to apply the framework differs substantially from an MSC Certification. Consequently, any claim made about the rating of the fishery based on this assessment should not make any reference to the MSC or any other third party scheme.

This report is a "live" document that will be reviewed and updated on an annual basis.

Methods

Risk Assessment

Detailed methodology for the risk assessment procedure is found in MRAG AP (2015). The following provides a brief summary of the method as it relates to the information provided in this report.

Assessments are undertaken according to a 'unit of assessment' (UoA). The UoA is a combination of three main components: (i) the target species and stock; (ii) the gear type used by the fishery; and (iii) the management system under which the UoA operates.

Each UoA is assessed against three components:

1. Target fish stocks;
2. Environmental impact of fishing; and
3. Management system.

Each component has a number of performance indicators (PIs). In turn, each PI has associated criteria, scoring issues (SIs) and scoring guideposts (SGs). For each UoA, each PI is assigned one of the following scores, according to how well the fishery performs against the SGs:

- Low risk;
- Medium risk;
- Precautionary high risk; or
- High risk

Scores at the PI level are determined by the aggregate of the SI scores. For example, if there are five SIs in a PI and three of them are scored low risk with two medium risk, the overall PI score is low risk. If three are medium risk and two are low risk, the overall PI score is medium risk. If there are an equal number of low risk and medium risk SI scores, the PI is scored medium risk. If any SI scores precautionary high risk, the PI scores precautionary high risk. If any SI scores high risk, the PI scores high risk.

For this assessment, each component has also been given an overall risk score based on the scores of the PIs. Overall risk scores are either low, medium or high. The overall component risk score is low where the majority of PI risk scores are low. The overall risk score is high where any one PI is scored high risk, or two or more PIs score precautionary high risk. The overall risk score is medium for all other combinations (e.g. equal number of medium/low risk PI scores; majority medium PI scores; one PHR score, others low/medium).

Outlook

For each UoA, an assessment of the future 'outlook' is provided against each component. Assessments are essentially a qualitative judgement of the assessor based on the likely future performance of the fishery against the relevant risk assessment criteria over the short to medium term (0-3 years). Assessments are based on the available information for the UoA and take into account any known management changes. Outlook scores are provided for information only and do not influence current or future risk scoring.

Table 1: Outlook scoring categories.

Outlook score	Guidance
Improving	The performance of the UoA is expected to improve against the relevant risk assessment criteria.
Stable	The performance of the UoA is expected to remain generally stable against the relevant risk assessment criteria.
Uncertain	The likely performance of the UoA against the relevant risk assessment criteria is uncertain.
Declining	The performance of the UoA is expected to decline against the relevant risk assessment criteria.

Information sources

Information to support scoring is obtained from publicly available sources, unless otherwise specified. Scores will be assigned on the basis of the objective evidence available to the assessor. A brief justification is provided to accompany the score for each PI.

Assessors will gather publicly available information as necessary to complete or update a PI. Information sources may include information gathered from the internet, fishery management agencies, scientific organisations or other sources.

Assessment Results

COMPONENT 1: Target fish stocks

1A: Stock Status

CRITERIA: (i)The stock is at a level which maintains high productivity and has a low probability of recruitment overfishing.

(a) Stock Status

MEDIUM RISK

MFish (2016a) report that "*no estimates of current and reference biomass are available. There is also no proven method at this time to estimate yields from the squid fishery before a fishing season begins based on biomass estimates or CPUE data. Because squid live for about one year, spawn and then die, and because the fishery is so variable, it is not practical to predict future stock size in advance of the fishing season. As a consequence, it is not possible to estimate a long-term sustainable yield for squid, nor determine if recent catch levels or the current TACC will allow the stock to move towards a size that will support the MSY. There will be some years in which economic or other factors will prevent the TACC from being fully taken, while in other years the TACC may be lower than the potential yield. It is not known whether New Zealand squid stocks have ever been stressed through fishing mortality*."

For this type of species, a fixed TACC will mean that a highly variable proportion of the stock is removed each year, and a significant stock-recruit relationship is only likely if the stock is very strongly depleted over a number of years. On this basis, since recruitment is largely decoupled from biomass, it appears that the fishing mortality rate exerted by this fishery is not likely to pose a significant problem, even though the biomass at any given moment is unknown. Overall, the New Zealand government concludes that it is 'unlikely' (>60%) the stock is below its 'hard limit' and no corrective management action is recommended[1].

On the basis of the highly variable nature of the stock, the likelihood that the stock is not below the hard limit and MPI advice that maintaining the stock at the 2014-15 TAC would "*ensure the long term sustainability of the stock*" (MPI, 2016b), there is probably a reasonable basis to conclude that the stock is at least likely to be above the point of recruitment impairment (PRI).

Nevertheless, we note that work is currently underway as part of the Deepwater Group's Fishery Improvement Plan (FIP) for the New Zealand EEZ Arrow Squid Trawl Fishery to develop a quantitative assessment model for squid (DWG, 2016). McGregor and Tingley (2016) tested a De Lury depletion model based on that used in the Falkland Islands *Loligo gahi* fishery using the Auckland Islands 2008 data as a case study and found the approach to have promise. McGregor and Large (2016) further developed the methodology, applying it to fisheries around the Snares and Auckland Islands in the fishing years 1990–2014. The model struggled to fit to the data for many of the datasets and the authors concluded that additional information to inform 'priors' on initial abundance (e.g. through a pre-season survey) is likely to improve the ability of the model to optimise correctly. Further work is currently being undertaken and is expected to be completed in late 2017 (DWG, 2016).

PI SCORE	MEDIUM RISK – All stocks

1B: Harvest Strategy

CRITERIA: (i) There is a robust and precautionary harvest strategy in place.

(a) Harvest Strategy

MEDIUM RISK

The harvest strategy in the NZ squid fisheries consists of:

- Catch controls through TACs and ITQs;
- Gear restrictions;
- Monitoring through logbooks and catch returns;
- Monitoring through VMS; and
- Annual review of catches through Working Group/Plenary process.

Squid is listed on Schedule 3 of the *Fisheries Act 1996*, which provides power under s14(6) to do in-season increases to the TAC. The in-season increase applies for the fishing year in which it is done and the TAC reverts to the baseline TAC at the end of the fishing year.

No formal mathematical harvest control rule (HCR) exists for the fishery, largely because of the absence of a quantitative stock assessment. Nevertheless, the fishery is implicitly covered by the requirements of the *Fisheries Act 1996* and the NZ Harvest Strategy Standard (HSS) which establishes default target (25% - 45% B_0, depending on the productivity of the stock), soft limit (20% B_0) and hard limit (10% B_0) reference points which guide Ministry advice to the Minister (MFish, 2008; MFish, 2011). Under the Standard, TACs are set at levels that aim to maintain biomass at levels consistent with the Target Reference Point (TRP), a breach of the soft limit triggers a requirement for a formal, time-constrained rebuilding plan and a breach of the hard limits leads to consideration for closure. While no formal target, soft or hard limit reference points have been prescribed for the fishery, some judgement is made by MPI annually about the prospect of the stock being below an assumed hard limit[2]. As a Schedule 3 stock, the Minister is provided flexibility to use alternative TACs to meet the purposes of the Act.

[1] http://fs.fish.govt.nz/Doc/24003/Stock%20Status%20Table%20Nov%202015%20symbols.pdf.ashx

[2] http://fs.fish.govt.nz/Doc/24003/Stock%20Status%20Table%20Nov%202015%20symbols.pdf.ashx

The National Plan for Middle-Depth and Deepwater Fisheries lists squid as a Tier 1 species and notes that a formal harvest control rule will be developed over the life of the plan (MFish, 2010), and the DWG (2016) report that a formal HCR will be developed following the development of an acceptable stock assessment. This work is planned to be completed by the first half of 2018.

The main weaknesses in the current harvest strategy are the absences of a robust stock assessment, agreed reference points and a formal HCR. Nevertheless, these are yet to be developed given the highly variable and 'annual' nature of the stock, and do not of themselves mean there is an immediate sustainability risk. For example, in providing advice to the Minister on options for recent TAC reductions in SQU 1J, which included maintaining the SQU 1J at a historically high 50,242t (with no change proposed to SQU 1T or 6T), MPI advised that "*MPI considers that all options presented in this paper satisfy the purpose of the Act in that they provide for utilisation in the SQU 1J fishery while ensuring sustainability. Available information suggests all management options will ensure the long term sustainability of the stock*" (MPI, 2016b).

The TACCs for SQU1T and SQU6T have remained essentially static at 44,741 t and 32,369 t respectively since the late 1990s, while SQU 1J has recently been reduced from 50,242t to 5,030t (albeit not linked to any measure of stock status). To that extent, the harvest strategy is not responsive to the state of the stock, although given the difficulties in predicting stock abundance and the annual nature of the stock this is not surprising. Nevertheless, given the conclusion that it is unlikely that the stock is below its hard limit, and the largely decoupled relationship between recruitment and biomass, and MPI (2016b) advice to the Minister that the existing (pre-SQU 1J quota reduction) measures are likely to satisfy the objectives of the Act, there is at least some basis to conclude that the harvest strategy could be expected to maintain the stock at a high productivity and with low probability of recruitment overfishing. Accordingly, the fishery meets the medium risk, but not the low risk SG.

Nevertheless, we note the fishery is likely to be considerably better positioned against this SI following the completion and implementation of the stock assessment/harvest strategy/HCR work proposed under the DWG Fishery Improvement Plan.

(b) Shark-finning

NA

CRITERIA: (ii) There are well defined and effective harvest control rules (HCRs) and tools in place.

(a) HCR Design and application MEDIUM RISK

The squid fisheries are managed as part of the NZ Quota Management System (QMS) which has very strong mechanisms to reduce the exploitation rate where evidence exists that the PRI is being reached, and there is good evidence to indicate that such mechanisms have been used in other fisheries (e.g. hoki). As discussed above, there is no formal mathematical harvest control rule (HCR) for the fishery, largely because of the absence of a quantitative stock assessment. Nevertheless, the fishery is implicitly covered by the requirements of the *Fisheries Act 1996* to maintain stocks at levels capable of producing MSY or higher, and the HSS. While no formal target, soft or hard limit reference points have been prescribed for the fishery, some judgement is made by MPI annually about the prospect of the stock being below an assumed hard limit[3]. Moreover, updated fishery catches and other relevant considerations are assessed annually through the Working Group/Plenary process, which ultimately informs TAC setting through MPI and the Minister. In 2016, the TAC for SQU 1J was reduced from 50,242t to 5,030t through this process, which requires MPI to provide the Minister advice about the consistency of proposals with legislative objectives.

To that extent, the default obligations in the Fisheries Act and HSS, together with the process of annual TAC review and TAC adjustment where necessary, could be considered to be generally understood HCRs and tools which are likely to reduce the exploitation rate as the PRI is approached. To that end, we have scored each UoA medium risk against this SI.

Nevertheless, we note the fishery is likely to be considerably better positioned against this SI following the completion and implementation of the stock assessment/harvest strategy/HCR work proposed under the DWG Fishery Improvement Plan.

PI SCORE	MEDIUM RISK – All stocks

1C: Information and Assessment

CRITERIA: (i) Relevant information is collected to support the harvest strategy.

(a) Range of information MEDIUM RISK

Some information is available to support the harvest strategy, although some elements are not completely understood. It is assumed that the stock of *N. gouldi* (the northern species) is a single stock, and that *N. sloanii* around the mainland comprises a unit stock for management purposes, though the detailed structure of these stocks is not fully understood. The distribution of the two species is largely geographically separate but those occurring around the mainland are combined for management purposes. The Auckland Islands Shelf stock of *N. sloanii* appears to be different from the mainland stock and is managed separately (MPI, 2017).

Very good monitoring of catch and effort exists through the QMS documentation, VMS and Government observers.

The main information weaknesses appear to be those highlighted by McGregor and Large (2016) which are needed to further develop a robust in-season stock assessment model (e.g. information to inform 'priors' on initial abundance [e.g. through a pre-season survey]).

(b) Monitoring and comprehensiveness MEDIUM RISK

[3] [3] http://fs.fish.govt.nz/Doc/24003/Stock%20Status%20Table%20Nov%202015%20symbols.pdf.ashx

UoA removals are closely monitored through the QMS reporting arrangements. Catch rates are monitored and have been used to increase TACCs in season in some years (2003-4; 2005-6; MPI,2017). Nevertheless, the fishery faces challenges in applying the results of monitoring to future years given the inability to conduct conventional stock assessments and the fact that CPUE is essentially independent from year to year. Further development of the stock assessment work undertaken by McGregor and Large (2016) is likely to better position squid UoAs against this SI.

CRITERIA: (ii) There is an adequate assessment of the stock status.

(a) Stock assessment **PRECAUTIONARY HIGH RISK**

MPI (2017) report that *"arrow squid live for one year, spawn once then die. Every squid fishing season is therefore based on what amounts to a new stock. It is not possible to calculate reliable yield estimates from historical catch and effort data for a resource which has not yet hatched, even when including data which are just one year old. Furthermore, because of the short life span and rapid growth of arrow squid, it is not possible to estimate the biomass prior to the fishing season. Moreover, the biomass increases rapidly during the season and then decreases to low levels as the animals spawn and die."*

Because there is no assessment that estimates status relative to reference points, the stock does not meet the medium risk SG. Nevertheless, there does not appear to be an immediate sustainability risk to the squid stock so the SI is scored precautionary high risk. Notwithstanding that, we note that efforts are currently underway to develop a robust, in-season stock assessment methodology, as described above (e.g. McGregor and Large, 2016; McGregor and Tingley, 2016) which, if successful, will better position squid UoAs against this SI.

(b) Uncertainty and Peer review **PRECAUTIONARY HIGH RISK**

There is no formal peer review of a stock assessment for these species, although other stock indicators (catch against TAC, CPUE, etc) are monitored through the MPI Fishery Working Group process. Reports attempting to apply a De Lury depletion model based on that used in the Falkland Islands *Loligo gahi* fishery (McGregor and Large, 2016; McGregor and Tingley, 2016) were reportedly reviewed prior to publishing.

PI SCORE	PRECAUTIONARY HIGH RISK – All stocks

COMPONENT 2: Environmental impact of fishing

2A: Other Species

CRITERIA: (i) The UoA aims to maintain other species above the point where recruitment would be impaired (PRI) and does not hinder recovery of other species if they are below the PRI.

(a) Main other species stock status

SQU1T; SQU6T **LOW RISK**

Based on models using observer and fisher-reported data, total bycatch in the arrow squid trawl fishery ranged from 4500 to 25 000 t per year between 1991 and 2010–11 (Anderson 2013). Over that time, arrow squid comprised about 80% of the total estimated catch recorded by observers in this fishery. The remainder of the observed catch comprised mainly the commercial fish species barracouta (8.5%), spiny dogfish (1.7%), and jack mackerel (1.1%) (Figure 3). Of these species, only barracouta meet the 5% threshold as a main other species.

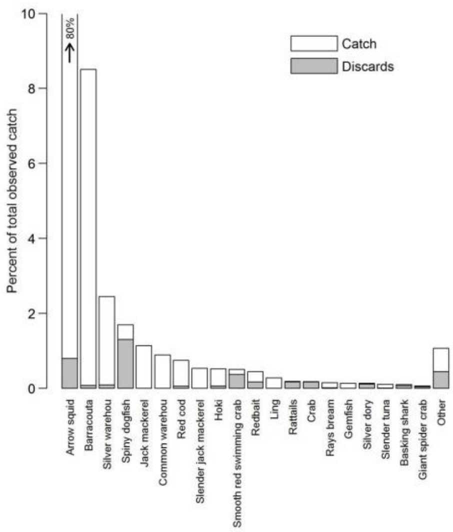


Figure 3: Percentage of the total catch contributed by the main bycatch species (those representing 0.05% or more of the total catch) in the observed portion of the arrow squid fishery, and the percentage discarded. (MPI, 2017; from Anderson, 2013)

The main barracouta stocks likely to be harvested by the squid trawl fishery are BAR 1, 5 and 7, albeit there may be some overlap between these 'stocks' which are managed separately for management purposes. Of these, the bulk of the catch is likely to be taken from BAR 5.

The most recent assessment of BAR 1 was undertaken in 2016, using standardised CPUE as well as East Coast South Island (ECSI) trawl survey results. Assessments of status are made against a B_{MSY}-compatible proxy based on CPUE (average from 1989–90 to 2013–14 of the BAR 1 ECSI CELR/TCER model as defined by Baird (2016; in MPI, 2017). The BAR 1 CPUE series increased steeply from 2002–03 to a peak in 2012–13. The 2013–14 value was lower than the peak, but well above the series mean. The winter ECSI trawl survey series for recruited fish has a trend that is similar to the BAR 1 CPUE index, with a peak in 2014. MPI (2017) conclude that the stock is very likely (>90%) to be at or above the target reference point.

The most recent assessment of BAR 1 was undertaken in 2017, using standardised CPUE (MPI, 2017). The WG agreed that the CPUE from the SQU target fishery in Statistical Area 028 was the best series of abundance indices for BAR 5. CPUE has remained at a high level since 2008 despite catches at or above the TACC. MPI (2017) conclude that the stock is very unlikely (< 10%) to be below both the soft and hard limits. Accordingly, the stock is highly likely to be above the point of recruitment impairment.

The most recent assessment of BAR 1 was undertaken in 2016, using standardised CPUE (MPI, 2017). The WG considered that the tow level CPUE was the best data to use to monitor this stock. The CPUE shows an increasing trend from 2000 to 2004 and is then generally flat. Similar trends were observed in West Coast North Island (WCNI) and West Coast South Island (WCSI) trawl surveys. MPI (2017) conclude that the stock is very unlikely (< 10%) to be below both the soft and hard limits. Accordingly, the stock is highly likely to be above the point of recruitment impairment.

SQU1J **LOW RISK**

Little information is available on catches of non-target, non-ETP species in the New Zealand squid jig fishery. This is probably because incidental catches are likely to be negligible. In the equivalent Australian southern squid jig fishery, for example, AFMA (2009) noted "*as squid jigging has a very high, target-specific catch rate, there have been negligible levels of bycatch documented to date in the SSJF. Since 2001 AFMA logbook records have reported only small quantities of Blue Shark, Garfish and Barracouta being taken. These species constitute less than 1 per cent of the total catch for the fishery*." In the NZ fishery, observer coverage in 1998/9 found minimal interactions with ETP species and few other interactions were reported (Burgess and Blezard, 1999).

Given the extremely unlikely occurrence of any significant levels of bycatch, it is reasonable to conclude that this fishery would not be hindering any recovery of the species to levels above PRI (if necessary) and therefore, this indicator has been scored as low risk.

CRITERIA: (ii) There is a strategy in place that is designed to maintain or to not hinder rebuilding of other species; and the UoA regularly reviews and implements

(a) Management strategy in place

SQU1T, SQU6T **LOW RISK**

The main management measures for barracouta are those associated with the QMS. The species is managed in five Quota Management Areas (QMAs), with four areas (1,4,5,7) accounting for all of the catch since the 1980s (MPI, 2017). TACCs are set for each QMA, with TACCs divided into ITQs and Annual Catch Entitlements (ACE). As a QMS species, barracouta are subject to the NZ Harvest Strategy Standard which establishes default target, soft limit and hard limit reference points. All catches of QMS species must be retained and reported.

The catch of barracouta in the NZ squid fishery accounted for around 8% of the total NZ barracouta harvest in 2012-13.

Assuming TACCs are set at levels consistent with the intent of the harvest strategy standard, these measures appear capable of maintaining barracouta at levels above PRI.

SQU1J **LOW RISK**

No measures other than limiting the fishery to benign apparatus are likely to be necessary.

(b) Management strategy evaluation

SQU1T, SQU6T **LOW RISK**

The most recent stock assessments for BAR 1, 5 and 7 (MPI, 2017) provide an objective basis for confidence that the strategy will work and is being implemented successfully.

SQU1J **LOW RISK**

Regular management planning and evaluation documents are developed (for example, MFish, 2010 and MPI, 2017) which address environmental issues where identified. The use of jig apparatus and evidence of minimal interactions in analogous fisheries (e.g. AFMA, 2009) provides an objective basis for confidence that the strategy will work.

(c) Shark-finning

NA

CRITERIA: (iii) Information on the nature and amount of other species taken is adequate to determine the risk posed by the UoA and the effectiveness of the strategy to manage other species.

(a) Information

SQU1T, SQU6T **LOW RISK**

All barracouta are required to be retained and reported according to the QMS reporting arrangements. Together with monitoring through VMS, observer surveys and fishery-independent trawl surveys, this provides quantitative information to assess the impact of the UoA with respect to status and to detect any increased risk.

SQU1J MEDIUM RISK

Qualitative information is available indicating squid jig fishing typically has minimal interactions with non-target species, and some quantitative information is available from analogous fisheries for the same species (e.g. Australian southern squid jig fishery). Nevertheless, few quantitative data appeared to be publicly available for the UoA.

PI SCORE	LOW RISK – SQU1T, SQU6T, SQU1J

2B: Endangered Threatened and/or Protected (ETP) Species

CRITERIA: (i) The UoA meets national and international requirements for protection of ETP species.
The UoA does not hinder recovery of ETP species.

(a) Effects of the UoA on populations/stocks

SQU6T MEDIUM RISK

The arrow squid trawl fishery has a bycatch of New Zealand (Hooker's) sea lions, New Zealand fur seals and seabirds. Fur seals were classified in 2008 as "Least Concern" by IUCN and in 2010 as "Not Threatened" under the NZ Threat Classification System and are not considered further here.

Sea lions

The New Zealand sea lion (rapoka) *Phocarctos hookeri*, is the rarest sea lion in the world. The estimated total population of around 11,800 sea lions in 2015 is classified by the Department of Conservation as 'Nationally Critical' under the New Zealand Threat Classification System (Baker et al 2010). New Zealand sea lions were classified in 2015 as 'Endangered' by the International Union for Conservation of Nature (IUCN) on the basis of a projected ongoing decline in pup production of 4% per year at the largest breeding colonies on the Auckland Islands. Pup production at the main Auckland Island rookeries showed a steady decline between 1998 and 2009 but has been stable since (MPI, 2017).

Sea lions interact with some trawl fisheries which can result in incidental capture and subsequent drowning (e.g. Thompson & Abraham 2010, Abraham & Thompson 2011). Since 1988, incidental captures of sea lions have been monitored by government observers on-board a proportion of the fishing fleet (MPI, 2017). The trend in observed and estimated captures is downwards. Historically, captures occurred most frequently in the SQU 6T fishery around the Auckland Islands, and a limit on the number of fishery-related mortalities in this fishery has been set since 1992.

The existing annual Fishing-Related Mortality Limit (FRML) for NZ sea lions is 68. The FRML is calculated based on tests of the likely performance of candidate mortality limit control rules (and, hence, mortality limits) using an integrated population and fishery model (Breen et al 2010; in MPI, 2017). Candidate rules are assessed against the following two Performance Indicators:

(a) A rule should provide for an increase in the sea lion population to more than 90% of carrying capacity, or to within 10% of the population size that would have been attained in the absence of fishing, and that these levels must be attained with 90% certainty, over 20-year and 100-year projections.
(b) A rule should attain a mean number of mature mammals that exceeded 90% of carrying capacity in the second 50 years of 100-year projection runs.

These management Performance Indicator were developed and approved in 2003 by a Technical Working Group comprised of MFish, DOC, squid industry representatives, and environmental groups (MPI, 2017).

Likely performance is also assessed against two additional Performance Indicators proposed by DOC:

(a) A rule should maintain numbers above 90% of the carrying capacity in at least 18 of the first 20 years.
(b) A rule should lead to at least a 50% chance of an increase in the number of mature animals over the first 20 years of the model projections.

The original FRML was calculated using the potential biological removal approach (PBR; Wade 1998; in MPI, 2016c) and was used from 1992/93 to 2003/04 (Smith and Baird 2007a; in MPI, 2016c). Since 2003/04 the FRML has been translated into a maximum permitted number of tows after which the SQU6T fishing season may be halted by the Minister regardless of the observed NZ sea lion mortality. This approach has been taken because NZ sea lion mortality can no longer be monitored directly since the introduction of SLEDs

Mortalities in season are progressively calculated through regular reporting by vessels and observer coverage (86-88% in 2012-3 – 2014-5, between 26-45% in 2009-10 to 2011-12). Interaction rates from 1995-6 to 2014-5 are summarised in MPI (2017) and in Thompson et al (2016). Thompson et al (2016) reported that there were no observed sea lion captures in the Auckland Islands fishery in 2010–11 and 2011–12, and less than three each year from 2012-13 to 2014-15. The mean estimate of captures in SQU6T since 2010–11 has been four sea lions or fewer (95% c.i.: 0 to 11).

A quantitative risk assessment of all threats to the New Zealand sea lion has recently been undertaken to inform the development of a Threat Management Plan for the species (Roberts and Doonan, 2016). The assessment used a demographic assessment model were developed for females at the Auckland Islands, integrating information from mark-recapture observations, pup census and the estimated age distribution of lactating females (MPI, 2017). A panel of national and international experts was convened to guide and review the process and provide opinion-based input where data availability was poor. The assessment found that a range of human and non-human induced mortalities influence the population dynamics of sea lions, and that addressing single sources of mortality alone will not be sufficient to achieve long-term population growth (Roberts and Doonan, 2016). Population modelling found that "when assuming the most pessimistic view of cryptic mortality (all interactions resulted in mortality and associated death of pups), alleviating the effects of commercial trawl-related mortality resulted in an increased population growth rate relative to the base run, but did not reverse the declining trend (λ2037 = 0.977, 95% CI 0.902–1.036)". Retrospective modelling showed that "even with the most-pessimistic view of cryptic mortality and of associated loss of pups, commercial trawl-related mortality does not appear sufficient alone to explain the observed decline in pup production at the Auckland Islands".

Based on the above, it is clear that the number of mortalities in the SQU6T fishery are below the national limit set and that other factors (e.g. *Klebsiella*) may be more influential in the observed decline in the Auckland Islands sea lion population. Nevertheless, alleviating the impacts of commercial trawling (based on the most pessimistic scenario) resulted in an increase in the population growth rate (albeit still declining overall). Accordingly, while it appears at least likely that the SQU6T fishery is not hindering recovery of sea lions, it is not clear that the low risk SG is met.

Seabirds

Between 2002–03 and 2014–15, there were 2848 observed captures of all birds in squid trawl fisheries (Abraham and Thompson, 2015). Observed captures were of white-chinned petrel (1006), New Zealand white-capped albatross (849), sooty shearwater (780), southern Buller's albatross (110), antarctic prion (29), Salvin's albatross (21), southern royal albatross (8), mid-sized petrels & shearwaters (7), giant petrels (7), common diving petrel (7), albatrosses (5), prions (3), grey-backed storm petrel (3), white-headed petrel (1), seabirds (1), royal albatrosses (1), grey petrel (1), gadfly petrels (1), fairy prion (1), black-browed albatross (1), black-bellied storm petrel (1), New Zealand white-faced storm petrel (1), Chatham Island albatross (1), Cape petrel (1), Campbell black-browed albatross (1), and Buller's albatross (1). Based on this, Abraham and Thompson (2015) estimated total seabird mortalities of between 237 and 1,338 between 2002-03 and 2014-15, with the trend generally declining over time.

Risks to sea birds associated with New Zealand's commercial fisheries have been assessed through a hierarchical series of risk assessments (e.g. Rowe, 2013, Richard and Abraham, 2013; Richard and Abraham, 2015, Richard and Abraham, in prep.). The most recent iteration derives for each taxon a risk ratio, which is an estimate of annual potential fatalities (APF) across trawl and longline fisheries relative to the Population Sustainability Threshold, PST (an analogue of the Potential Biological Removals, PBR, approach) (Richard & Abraham in prep; in MPI, 2016c). This index represents the amount of human-induced mortality a population can sustain without compromising its ability to achieve and maintain a population size above its maximum net productivity (MNPL) or to achieve rapid recovery from a depleted state. The management criterion used for developing the seabird risk assessment was that seabird populations should have a 95% probability of being above half the carrying capacity after 200 years, in the presence of ongoing human-caused mortalities, and environmental and demographic stochasticity (Richard & Abraham, 2013).

In the most recent assessment, only one species of seabird, black petrel (1.15), had a median risk ratio higher than 1 (or upper 95% confidence limit higher than 2) taking into account fishing related mortality across all trawl and longline fisheries (MPI, 2016c). For all other species, current rates of fishing related mortality were not expected to hinder the achievement of management targets (i.e. the risk ratio was <1). There are no national or international limits on black petrel bycatch. Squid fisheries have not been observed to interact with black petrels (Abraham and Thompson, 2015).

Of the main seabirds observed to be captured in squid trawl fisheries, white-chinned petrel had median a risk ratio of 0.05 (95% c.i. 0.03 – 0.09), New Zealand white-capped albatross had a median risk ratio of 0.35 (95% c.i. 0.21 – 0.58), sooty shearwater had median risk ratios of 0.00 (95% c.i. 0.00 – 0.01) and southern Buller's albatross had a median risk ratio of 0.39 (95% c.i. 0.22 – 0.66) (MPI, 2016c). Accordingly, the direct effects of the squid trawl fisheries appear highly unlikely to hinder recovery of ETP seabird species.

SQU1T **LOW RISK**

Sea lions

Smaller numbers of NZ sea lions are captured in the squid trawl fishery on the Stewart-Snares shelf (SQU 1T) (MPI, 2017). Formal estimates of total captures in this fishery have not been calculated but captures across all trawl fisheries on the Stewart-Snares shelf were estimated by Thompson & Abraham (2010) to vary from 3 to 9 sea lions each year. The SQU1T fishery is estimated to be responsible for two or fewer interactions annually since 2006-07 (MPI, 2017).

Seabirds

As above for SQU6T.

SQU1J **LOW RISK**

Burgess and Blezard (1999) reported few interactions with either marine mammals or sea birds on squid jig vessels in New Zealand. Few interactions are also reported in the analogous Australian Southern Squid Jig Fishery.

MPI (2016a) reports that "*there are no known marine mammal or protected fish interactions in SQU 1J, however seabirds are caught. Management of seabird interactions with New Zealand's commercial fisheries is driven through the 2013 National Plan of Action to Reduce the Incidental Captures of Seabirds in New Zealand fisheries (NPOA Seabirds). The NPOA Seabirds reflects New Zealand's obligations under customary international law to take into account the effects of fishing on associated species such as seabirds. Observer coverage in SQU 1J has historically been low, but in the last two fishing years (2013/14 and 2014/15), there was 100% observer coverage on two Japanese squid jiggers. These data record incidental captures of 32 seabirds, the majority of which were sooty shearwaters. The risk from commercial fisheries to the New Zealand population of sooty shearwater was assessed in 2011 as negligible*." Given the benign nature of squid jig apparatus and the limited reported interactions, it is highly unlikely the UoA is hindering recovery of ETP species.

CRITERIA: (ii) The UoA has in place precautionary management strategies designed to:

- meet national and international requirements; and
- ensure the UoA does not hinder recovery of ETP species.

Also, the UoA regularly reviews and implements measures, as appropriate, to minimise the mortality of ETP species

(a) Management strategy in place

SQU1T, SQU6T **LOW RISK**

Sea Lions

In the Auckland Islands (SQU6T), a limit on the number of fishery-related mortalities in this fishery has been set since 1992. These limits have been determined using various approaches, but the current approach is to limit the number of sea lions estimated to have been captured using control rules calculated using the number of pups born in the previous two years. Estimated captures for a year are calculated from the estimated strike rate per tow and the number of tows. These measures are set out in the 5-year plan - '*Operational Plan to Manage the Incidental Capture of New Zealand Sea Lions in the Southern Squid Trawl Fishery (SQU6T).*' This plan was first developed in 2006 to set out all the regulatory and non-regulatory measures in place in the SQU6T fishery to manage and mitigate the capture of sea lions. The SQU6T Operational Plan is agreed by the Minister for Primary Industries and all operators intending to fish in the SQU6T fishery must sign and agree to the measures.

Sea Lion Exclusion Devices (SLEDs) were introduced into the SQU 6T fishery in 2001–02 and were in widespread use by 2004–05 leading to a sharp drop in observed incidental captures (MPI, 2016c). SLEDs are designed to allow sea lions to escape from a trawl and consist of a grid of steel bars that prevents sea lions entering the codend and an escape hole. From their introduction, SLEDs were subject to continuous design improvements for 10–15 years and, since 2007, a standard Mark 3/13 version has been used by all vessels in the SQU 6T fishery. Tows undertaken using an approved SLED receive a discount on the pre-determined sea lion strike rate, based on the assumption that some sea lions that encounter a trawl equipped with a SLED that would have drowned in the absence of a SLED will survive. This discount was originally set at 20%, was increased to 35% in 2007–08, and further increased to 82% in August 2012. The recent increase in discount rate was made to acknowledge recent research indicating that a high proportion of sea lions encountering a SLED are likely to survive the encounter (summarised in Abraham & Thompson, 2011; in MPI, 2016c) There is some remaining uncertainty, including the unknown probability that a sea lion that enters a net but is not subsequently captured will exceed its breath holding limit and die after exiting the trawl via the SLED or the front of the net.

A specific Operational Plan is in place to mitigate the impacts of the SQU6T fishery on sea lions. Measures include the Fishing-Related Mortality Limit (FRML), used of approved SLEDs, notification requirements to both MPI and the Deepwater Group, observer coverage (>85% in the past 3 years) and trigger points for the plan's review. Mandatory closures have occurred seven times (1996 to 1998, 2000, and 2002 to 2004) since FRML limit was first adopted in 1993.

A national-scale Threat Management Plan (TMP) for New Zealand sea lions is being developed by the Department of Conservation and Ministry for Primary Industries, with a consultation draft released for public comment in mid-2016[4].

Seabirds

Management measures to mitigate impacts of commercial fisheries on seabirds are included in the NPOA-Seabirds (MPI, 2013). The measures in the NPOA-Seabirds 2013 are given effect through the national fisheries planning process. Mitigation methods such as streamer (tori) lines, Brady bird bafflers, warp deflectors, and offal management are used in the squid trawl fishery. Warp mitigation was voluntarily introduced from about 2004 and made mandatory in April 2006 (MFish, 2006). The 2006 notice mandated that all trawlers over 28 m in length use a seabird scaring device while trawling (being "paired streamer lines", "bird baffler" or "warp deflector" as defined in the notice). These measures are designed to achieve or maintain a favourable conservation status for albatrosses and petrels, as required by ACAP. Non-regulatory measures include vessel-specific Vessel Management Plans, which describe how fishery waste will be managed to reduce the risk of seabird captures. Richard and Abraham (2015) report that "*white-capped albatross had very high capture rates in squid trawl fisheries. In the 1990–91 season, observers recorded capture rates of 27.9 white-capped albatross per 100 tows (Bartle 1991, Hilborn & Mangel 1997). With the prohibition on the use of net sonde cables, the introduction of mandatory warp mitigation, and with an emphasis on practices such as better offal management, the capture rate of white-capped albatross in this fishery reduced to 4.1 (95% c.i.: 2.4 to 6.4) white-capped albatrosses per 100 tows (Abraham& Thompson 2011)*."

Together with very high levels of independent observer coverage (>85% in the last 3 years), these measures are likely to be considered a strategy that is expected to ensure the UoA does not hinder the recovery of seabird species.

SQU1J **LOW RISK**

The main measures in place are the restriction to benign apparatus and the requirement to report all interactions with protected species under New Zealand legislation. Given the nature and intensity of the fishery, and the general absence of ETP interactions, these measures are probably sufficient to ensure that the UoA is not hindering recover of ETP species.

(b) Management strategy implementation

SQU1T, SQU6T **LOW RISK**

Sea lions interactions are monitored through observer coverage, and reporting. Notwithstanding a declining trend in the population size around the Auckland Islands between 1998 and 2009 (MPI, 2017), the measures in the Operational Plan are considered likely to work over time and there is good evidence that they are being implemented. Thompson et al (2016) reported that "*the number of estimated captures of 2 (95% c.i.: 0 to 7) sea lions in 2011–12 was the lowest value of all the years in the data series. The low estimated captures in both 2010–11 and 2011–12 correspond with there being no observed sea lion captures in the Auckland Islands squid fishery in those years, at a time when observer effort was relatively high at 34 and 44%, respectively. The Auckland Islands squid fishery, primarily through the use of SLEDs, has been effective at reducing the number of sea lion captures*."

[4] http://www.doc.govt.nz/Documents/conservation/native-animals/marine-mammals/nz-sea-lion-tmp/nzsl-tmp-consultation-document.pdf

The main uncertainties appears to be the extent of cryptic mortality and uncertainties in the model used for FRML calculations (MPI, 2016c). MPI are working through comments and recommendations from an independent review panel on the model and if successfully addressed may provide an objective basis for confidence that the strategy is working.

The effectiveness of the NPOA-Seabirds is reviewed annually through a review of the performance of each fishery against its management plan. Each year the fisheries managers within MPI, who are accountable for achieving the objectives in the plans, assess performance against the objectives through the annual review process.

Since the introduction of mandatory warp mitigation in 2006, there has been a decrease in the number of white-capped albatross killed in the New Zealand squid fishery (Abraham et al. 2013). In the four complete fishing years after mitigation was made mandatory, the average rate of capture for white-capped albatross (90% of albatross captures in this fishery) was 3.2 birds per 100 tows compared with 7.9 per 100 tows in the three complete years before mitigation was made mandatory.

Moreover, periodic risk assessments (e.g. Richard and Abraham, 2015; Richard and Abram, in prep in MPI, 2016c) are conducted and assess the impact of individual fishery sectors on seabird populations. The most recent assessment indicates that fatalities associated with the SQU trawl fisheries are below the Potential Biological Removals.

SQU1J **LOW RISK**

Burgess and Blezard (1999) provides an objective basis for confidence that this UoA has few interactions with ETP species.

CRITERIA: (iii) Relevant information is collected to support the management of UoA impacts on ETP species, including:

- information for the development of the management strategy;
- information to assess the effectiveness of the
- management strategy; and
- information to determine the outcome status of ETP species.

(a) Information

SQU1T, SQU6T **LOW RISK**

Detailed quantitative information is available on both sea lion and seabird interactions in the squid trawl fishery which is sufficient to assess UoA related mortality and to support a strategy to manage impacts. For sea lions, demographic assessment models have been developed for females at the Auckland Islands and Otago Peninsula populations, integrating information from mark-recapture observations, pup census and the estimated age distribution of lactating females (Auckland Islands only) (Roberts and Doonan, 2016). A key component of the information available comes from observer coverage. The Operational Plan for sea lion captures aims to ensure 50% observer coverage, with between 85-88% of tows in the SQU6T fishery observed in each of the last three fishing years (Richard and Abraham, 2015).

SQU1J **LOW RISK**

Burgess and Blezard (1999) provides some quantitative information that interactions are minimal, however this study is becoming dated. Sufficient qualitative information from analogous fisheries (e.g. AFMA, 2009) exists to demonstrate minimal interactions. MPI (2016b) reports that “observer coverage in SQU 1J has historically been low, but in the last two fishing years (2013/14 and 2014/15), there was 100% observer coverage on two Japanese squid jiggers. These data record incidental captures of 32 seabirds, the majority of which were sooty shearwaters.” Given the relatively low rates of interaction, the available information is probably sufficient to support a strategy to manage impacts.

PI SCORE	**LOW RISK – All stocks**

2C: Habitats

CRITERIA: (i) The UoA does not cause serious or irreversible harm to habitat structure and function, considered on the basis of the area(s) covered by the governance body(s) responsible for fisheries management

(a) Habitat status

Examples of “serious or irreversible harm” to habitats include the loss (extinction) of habitat types, depletion of key habitat forming species or associated species to the extent that they meet criteria for high risk of extinction, and significant alteration of habitat cover/mosaic that causes major change in the structure or diversity of the associated species assemblages (MSC, 2014). Further, MSC specifies that if a habitat extends beyond the area fished then the full range of the habitat should be considered when evaluating the effects of the fishery. The ‘full range’ of a habitat shall include areas that may be spatially disconnected from the area affected by the fishery and may include both pristine areas and areas affected by other fisheries.

SQU1T, SQU6T **MEDIUM RISK**

This sector of the fishery uses trawl apparatus either on or near the bottom (MPI, 2016a). Black et al (2013) estimated that arrow squid has accounted for 13.5% of all tows reported on TCEPR forms since 1989–90. Between 2006–07 and 2010–11, 95% of arrow squid catch was reported on TCEPR forms. The great majority of tows are conducted on the Stewart-Snares shelf or north and east of the Auckland Islands, with smaller numbers off the east coast of the South Island and the Chatham Rise (Figure 4). Tows were located in Benthic Optimised Marine Environment Classification (BOMEC, Leathwick et al 2009) classes E (outer shelf), F, H (upper slope), I, J, L, and M (mid-slope) (Baird & Wood 2012), and 92% were between 100 and 300 m depth (Baird et al 2011). The number of trawl tows for squid varies between years, largely without trend and presumably in response to variations in the abundance of squid and management measures to limit the number of sea lions caught. The average duration of trawls has increased over this time so the trend in aggregate swept area will not be the same.

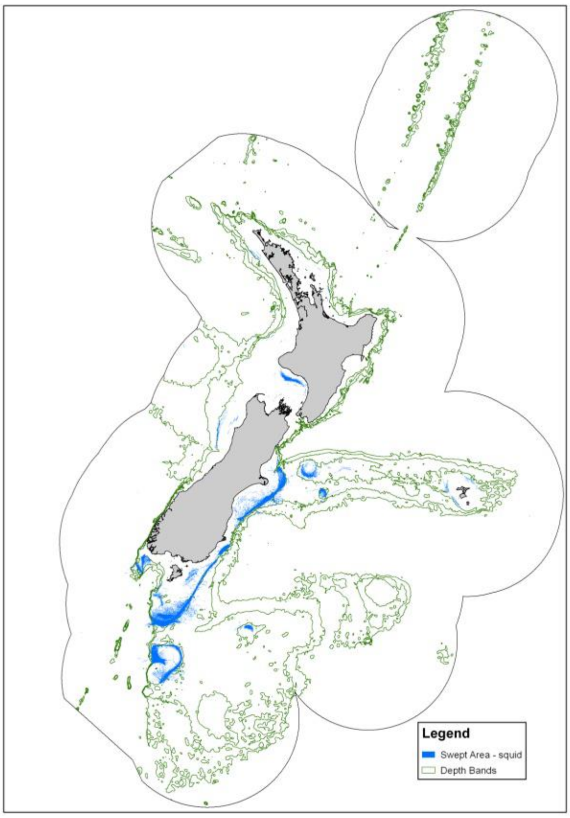
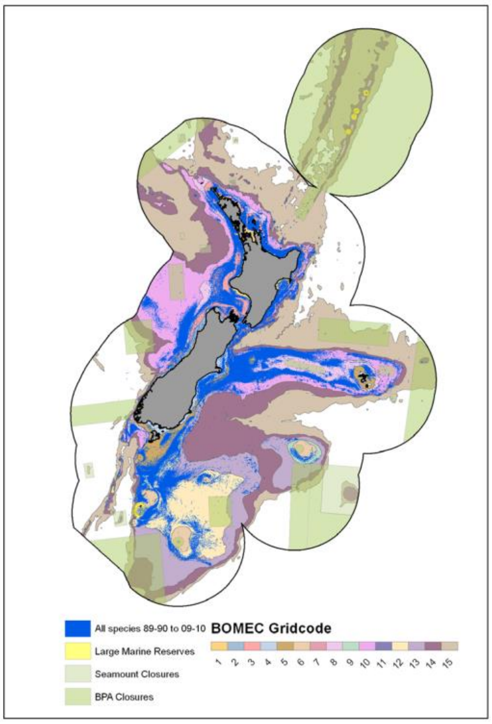
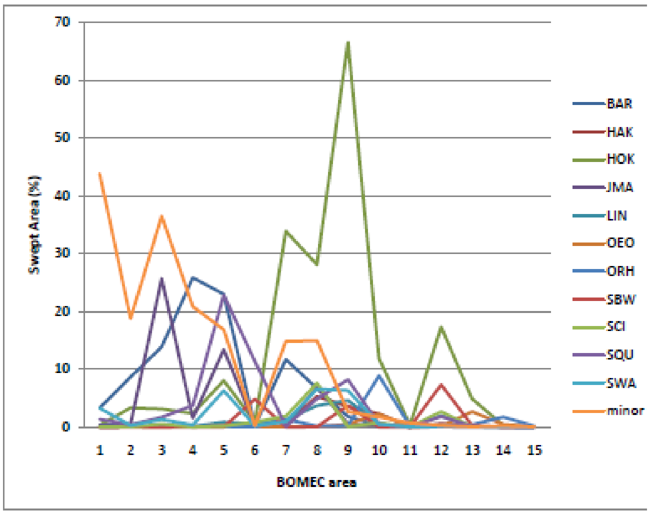


Figure 4: Swept area in the squid trawl fishery between 1989/90 and 2009/10. (Black et al, 2013)

A number of quantitative assessments have been undertaken on the footprint of New Zealand's trawl fisheries against BOMEC regions (e.g. Baird et al, 2009; Baird et al, 2011; Black et al, 2013). These assessments provide quantitative data in relation to the area of the various bioregions covered by combined trawl footprint across all trawl fisheries. In total, the 15 BOMEC classification areas cover 2,627,073 km², approximately 64% of the EEZ (Figure 5a).

The swept area of squid trawling was highest in BOMEC area 5, covering around 23% of the area in the period 1989-90 to 2009-10 (Black et al, 2013; Figure 5b). Coverage rates in all other areas were less than 10%. MPI (2016d) reports that the fishable area trawled by squid targeted trawls in 2010/11 was 0.37%, while the cumulative amount between 1989-90 and 2010-11 was 2.65%. The full MSC assessment for the hoki fishery examined similar issues, noting that coverage rates of some BOMEC classes in that fishery were considerably higher than in the squid fishery (Black et al, 2013; Figure 5b). In the hoki assessment, notwithstanding the likelihood of some localised impacts, Ackroyd and Pierre (2012) concluded that "*at the aggregated scale considered here, with the extent of habitats remaining outside the areas in which hoki is bottom trawled, the ongoing contraction of the cumulative bottom trawl footprint including in the most heavily trawled habitat types, and the ecosystem function apparent from Chatham Rise trawl surveys, it is reasonable to conclude that currently the fishery meets SG80 of PI 2.4.1 and is highly unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm*." Given the proportion of relevant BOMEC classes covered by the squid fishery are considerably smaller than the hoki fishery, we have assumed on that basis that the squid fishery is also probably highly unlikely reduce habitat structure and function to the point of serious or irreversible harm. Nevertheless, we note that efforts to understand the vulnerability and recovery dynamics of trawled habitats are ongoing (e.g. Ford et al, 2016) and the outcomes of further research should be considered in future assessments.





(a) *(b)*

Figure 5: (a) The BOMEC classification and trawl footprint for all species, 1989/90 to 2009/10; (b) Percentage of BOMEC areas swept by trawls for each of the 11 major species for fishing years 1989/90 to 2009/10. (Black et al, 2013)

SQU1J **LOW RISK**

There are no known habitat impacts from the squid jigging method (MPI, 2016a).

CRITERIA: (ii) There is a strategy in place that is designed to ensure the UoA does not pose a risk of serious or irreversible harm to the habitats.

(a) Management strategy in place

SQU1T, SQU6T **LOW RISK**

Overall management objectives for the deepwater and middle depth fisheries are set out on the National Fisheries Plan and include "Identify and avoid or minimise adverse effects of deepwater and middle-depths fishing activity on the benthic habitat". The main measures to manage fisheries impacts on habitat under a range of different legislative tools include:

(i) the closing of about one third of the New Zealand EEZ to bottom fishing though the designation of Benthic Protection areas (BPAs);
(ii) the designation or Marine Protected Areas (MPAs);
(iii) the designation of Marine Reserves; and
(iv) monitoring vessel position.

MRAG Americas (2016) report that "*in the New Zealand Territorial Sea (TS) and EEZ there are substantial areas closed to bottom fishing, including marine reserves, marine protected areas (MPAs) and large Benthic Protected Areas (BPAs) and all contribute to protecting the environment generally and from the impact of trawling (SR 2007/308). These areas are largely based on the analysis of physical and some biological attributes and in total exclude bottom trawling from around 30% of the New Zealand EEZ to minimize benthic impact, safeguard habitats and protect representative marine benthic ecosystems and biodiversity in accordance with s 8(1) of the Fisheries Act 1996 which focuses on avoidance, mitigation or remedy of "any adverse effects of fishing on the aquatic environment." Marine reserves are closed to all fishing and BPAs are open only to trawling that does not contact the seabed (any trawling fewer than 100 meters directly above the seabed is prohibited, and trawling above this level has substantial verification requirements including Electronic Net Monitoring Systems; SR 2007/308). Penalties for violating bottom trawl bans in BPAs include fines of up to NZD 100,000 and criminal charges. To qualify as Marine Protected Areas (MPAs), sites must be under a level of protection that allows their habitats and ecosystems to remain at (or recover to) a healthy state*". Overall, they conclude that while the NZ benthic impacts strategy is not fully implemented, "*the network of MPAs and BPAs, the representativeness of habitat they encompass, and the restrictions on bottom trawling they include within the UoC areas and the bioregion as a whole comprise at least a partial strategy that is expected to achieve the Habitat Outcome 80 level of performance or above*."

SQU1J **LOW RISK**

Given the nature of the gear type, a management strategy is not considered necessary. The main measure in place is to limit the UoA to benign apparatus.

(b) Management strategy implementation

SQU1T, SQU6T MEDIUM RISK

Consistent with the hoki MSC assessment, the main basis for confidence that the measures will work is the closure of some areas to mitigate fishing effects (e.g. seamounts, Benthic Protection Areas). Fisheries observers monitor compliance with the boundaries of Benthic Protection Areas or other closed areas. The Ministry of Fisheries and DWG are able to follow up if compliance anomalies are detected. Periodic evaluations of the likely impact of the deepwater fisheries on habitat types are also performed (e.g. Baird et al, 2009; Baird et al, 2011; Black et al, 2013).

SQU1J LOW RISK

Given the pelagic nature of the gear type, there is an objective basis for confidence that the measures will work.

CRITERIA: (iii) Information is adequate to determine the risk posed to the habitat by the UoA and the effectiveness of the strategy to manage impacts on the habitat.

(a) Information quality

SQU1T, SQU6T MEDIUM RISK

Much of the information known about the impact of trawl fisheries on benthic habitats in NZ is summarised in MPI (2016c) and Black et al (2013). Benthic surveys have been performed of seabed types around the New Zealand continental shelf and seamounts. There have been several attempts to use this information to develop a Territorial Sea and EEZ marine environment classification (e.g. MEC, BOMEC). There is ongoing collection of relevant data from observer, vessel monitoring and research programs providing robust information on trawl footprint. Various research programs and projects are current and planned to address gaps in benthic and habitat knowledge.

The existing information is sufficient to broadly understand the types and distribution of main habitats, but less information appears to be available on the vulnerability and recoverability of impacts at a level of detail relevant to the scale and intensity of the fishery. Questions also exist on the utility of the BOMEC classification system to support effective assessments of fishery habitat impacts.

We note that the questions about the extent to which existing management measures protect benthic habitats at the species level may be better answered by the type analysis recommended by Ford et al (2016) (i.e. rather than simply the extent to which habitat classes may be impacted by trawling, what is the impact of trawling at the species/population level, taking into the account the likely vulnerability of each species to trawling and the likely capacity to recover). The outcomes of any follow up research should be factored into future assessments.

SQU1J LOW RISK

Given the nature of the apparatus, the existing information is sufficient to broadly understand the types and distribution of main habitats.

(b) Information and monitoring adequacy

SQU1T, SQU6T MEDIUM RISK

Information on the impacts of benthic trawls on structured and unstructured habitats is relatively well-studied and there is reliable information through VMS on the spatial extent of the fishery. VMS, observer and fishery-independent research program information is likely to be sufficient to detect increased risk from the fishery. The main uncertainty is the distribution, vulnerability and recovery of individual species and communities at spatial scales smaller than the existing BOMEC classes. We note that the questions about the extent to which existing management measures protect benthic habitats at the species level may be better answered by the type analysis recommended by the 2015 expert workshop (Ford et al, 2016).

SQU1J LOW RISK

Information on the nature of squid jigging, as well as logbook information on fishing effort and distribution is sufficient to detect increased risk.

PI SCORE	LOW RISK – All stocks

2D: Ecosystems

CRITERIA: (i) The UoA does not cause serious or irreversible harm to the key elements of ecosystem structure and function.

(i)(a) Ecosystem Status

Serious or irreversible harm in the ecosystem context should be interpreted in relation to the capacity of the ecosystem to deliver ecosystem services (MSC, 2014). Examples include trophic cascades, severely truncated size composition of the ecological community, gross changes in species diversity of the ecological community, or changes in genetic diversity of species caused by selective fishing.

SQU1T, SQU6T **LOW RISK**

Arrow squid are short-lived and abundance is highly variable between years. MPI (2017) report that:

- Hurst et al (2012) reviewed the literature and noted that arrow squid are an important part of the diet for many species. Stevens et al (2012) reported that, between 1960 and 2000, squids (including arrow squid) were important in the diet of banded stargazer (59% of non-empty stomachs), bluenose (26%), giant stargazer (34%), gemfish (43%), and hapuku (21%), and arrow squid were specifically recorded in the diets of alfonsino, barracouta, hake, hoki, ling, red cod, red gurnard, sea perch, and southern blue whiting.
- Arrow squid have also been recorded as important in the diet of marine mammals such as NZ fur seals and NZ sea lions, particularly during summer and autumn (Fea et al 1999, Harcourt et al 2002, Chilvers 2008, Boren 2008) and in the diet of common dolphins (Meynier et al 2008, Stockin 2008). They are also important in the diet of seabirds such as shy albatross in Australia (Hedd & Gales 2001) and Buller's albatross at the Snares and Solander Islands (James & Stahl 2000).

The main impact from the fishery, apart from the direct impact on the target and other/ETP species and habitats (which are subject to specific management arrangements), is likely to come from the removal of harvested squid from the ecosystem. Given the annual and highly variable nature of the stock, and the largely decoupled relationship between biomass and recruitment, it is highly unlikely that the UoA under current arrangements will disrupt the key elements underlying ecosystem structure and function to a point where there would be serious or irreversible harm.

SQU1J **LOW RISK**

The main impact from the fishery is likely to come from the removal of harvested squid from the ecosystem. Given the annual and highly variable nature of the stock, and the extremely low level of harvest, it is highly unlikely that the UoA under current arrangements will disrupt the key elements underlying ecosystem structure and function to a point where there would be serious or irreversible harm.

CRITERIA: (ii) There are measures in place to ensure the UoA does not pose a risk of serious or irreversible harm to ecosystem structure and function.

(a) Management Strategy in place **LOW RISK**

The management measures in place which serve to limit ecosystem impacts are largely those detailed in the harvest strategy for target species (limited entry, TACs/ITQs, gear restrictions) and other/ETP species (non-target species reporting, limits of mortality of ETP species, NPOA-Seabirds, observer monitoring, VMS monitoring).

The New Zealand Fisheries Act 1996 s 8 provides for "the utilisation of fisheries resources while ensuring sustainability." All persons exercising powers under the Act are required to take the 'environmental principles' (s9) into account, namely:

a) associated or dependent species should be maintained above a level that ensures their long-term viability:
b) biological diversity of the aquatic environment should be maintained:
c) habitat of particular significance for fisheries management should be protected.

Ecosystem-based management is achieved through a multi-layered approach that considers fishery management (e.g., QMS), vulnerable species needs (e.g., NPOA sharks), ETP management (a host of protected species and related initiatives such as NPOA seabirds, NPOA sharks, the protection of marine mammals, and habitat considerations (e.g. BPAs).

Legislated protection of areas of sea bottom to fishing activities, coupled with good quality monitoring of all fisheries removals that might impact on trophic structure and function and management of fishery removals (e.g. through TACCs) represent a partial strategy. Data from the fishery, including observer data together with fishery independent surveys and other research projects are taken into account in the management of the fishery. There has been the establishment of substantial areas closed to bottom fishing, including marine reserves, MPAs and large areas of BPAs (about 32% of the EEZ), largely based on analysis of physical and some biological attributes. These all contribute to protecting both the environment generally and limiting the impacts of trawling.

(b) Management Strategy implementation

SQU1T, SQU6T **LOW RISK**

Periodic assessment and monitoring of some of the key risk areas (e.g. Black et al, 2013; Richard and Abraham, 2015; Thompson et al, 2016; Richard and Abraham, in prep; in MPI, 2016c) provides some objective basis for confidence that the management measures will work, while information from observers (>85% coverage in past 3 fishing years) plus monitoring of the effectiveness of the Operational Plan for sea lions and the NPOA-Seabirds provides evidence that the strategy is being implemented.

SQU1J **LOW RISK**

The absence of impacts on the key elements of the ecosystem other than the target species and the very low level of catch in the UoA provides an objective basis for confidence that the measures in place will work.

CRITERIA: (iii) There is adequate knowledge of the impacts of the UoA on the ecosystem.

(a) Information quality **LOW RISK**

The main impacts of the UoA on the ecosystem, apart from direct impacts on target, bycatch and ETP species, are likely to come from the removal of the target species. Sufficient information exists to infer the impact of the UoA on the key ecosystem elements. A number of studies have been undertaken to examine the role of squid in the ecosystem (e.g. Stevens et al, 2012), and the impacts of the fishery on some key ecosystem elements (e.g. protected species) have been investigated in detail.

(b) Investigations of UoA impacts

SQU1T, SQU6T **LOW RISK**

The main impacts of the UoA on the ecosystem, apart from direct impacts on target, bycatch and ETP species, are likely to come from the removal of the target species. Sufficient information exists to infer the impact of the UoA on the key ecosystem elements. A number of studies have been undertaken to examine the role of squid in the ecosystem (e.g. Stevens et al, 2012), and the impacts of the fishery on some key ecosystem elements (e.g. protected species) have been investigated in detail.

SQU1J **MEDIUM RISK**

The main impacts of the UoA on the ecosystem are likely to come from the removal of the target species. Sufficient information exists to infer the impact of the UoA on the key ecosystem elements. A number of studies have been undertaken to examine the role of squid in the ecosystem (e.g. Stevens et al, 2012), although it is not clear that the ecosystem impacts of the SQU1J UoA have been investigated in detail.

PI SCORE	LOW RISK – All stocks

COMPONENT 3: Effective management

3A: Governance and Policy

CRITERIA: (i) The management system exists within an appropriate and effective legal and/or customary framework which ensures that it:

- Is capable of delivering sustainability in the UoA(s)
- Observes the legal rights
- Created explicitly or established by custom of people dependent on fishing for food or livelihood; and
- Incorporates an appropriate dispute resolution framework.

(a) Compatibility of laws or standards with effective management **LOW RISK**

The 1996 Fisheries Law and subsequent amendments provide a binding legislative and legal framework for delivering the objectives of Components 1 and 2. The law identifies and sets requirements for cooperation among the parties involved in fishing activities.

The legal system transparently deals with resolution of legal disputes, as demonstrated by the protracted negotiations and court cases that settled the Maori claims. The resolution demonstrated that the system is effective and has been tested.

(b) Respect for Rights **LOW RISK**

Ackroyd et al (2012) report that "*the Ministry of Fisheries is responsible for the administration of the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992, which implements the 1992 Fisheries Deed of Settlement under which historical Treaty of Waitangi claims relating to commercial fisheries have been fully and finally settled. The Ministry is also responsible for the Maori Fisheries Act 2004, which provides that the Crown allocates 20% of quota for any new quota management stocks brought into the QMS to the Treaty of Waitangi Fisheries commission. For non-commercial fisheries, the Kaimoana Customary Fishing Regulations 1998 and the Fisheries (South Island Customary Fishing) Regulations 1998 strengthen some of the rights of Tangata Whenua to manage their fisheries. The management system therefore has a mechanism to observe the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood in a manner consistent with the objectives of MSC Principles 1 and 2*."

CRITERIA: (ii) The management system has effective consultation processes that are open to interested and affected parties. The roles and responsibilities of organisations and individuals who are involved in the management process are clear and understood by all relevant parties.

(a) Roles and Responsibilities **LOW RISK**

The Ministry of Primary Industries (responsible for effective fishery management), the Department of Conservation (responsible for conservation issues such as ETP species and MPAs), and Deepwater Group Ltd (DWG) (management within the quota management system) are identified as those involved in the management process. Each has clearly and explicitly defined roles. The MOU between DWG and MPI provide in detail the responsibilities for managing the deepwater fisheries.

(b) Consultation Process **LOW RISK**

The Fishery Act requires consultations among stakeholders with an 'interest' in the decision to be made, and the Stakeholder Consultation Process Standard provides guidelines for implementing the consultations. The consultation regularly seeks and accepts information, explains the use and results, and provides opportunity and encouragement for engagement. The Minister of Fisheries is required to consult with those classes of persons having an interest (including, but not limited to, Maori, environmental, commercial and recreational interests) in the stock or the effects of fishing on the aquatic environment in the area concerned.

The majority of commercial quota owners of the species that will be managed through the National Deepwater Plan are represented by DWG. In 2006 MFish and the DWG (on behalf of deepwater quota owners) formed a collaborative partnership to manage New Zealand's deepwater fisheries. This partnership was given effect through a Memorandum of Understanding (MOU) signed by the Chief

Executive of MFish and the Chair of the DWG. The MOU does not in any way affect section 12 consultation requirements that are set out in the Fisheries Act 1996. Rather, it establishes how we can ensure more efficient and effective engagement with the commercial sector in a more structured and managed forum before the formal consultation phase.

CRITERIA: (iii) The management policy has clear long-term objectives to guide decision making that are consistent with the outcomes expressed by Components 1 and 2, and incorporates the precautionary approach.

(a) Objectives **LOW RISK**

Long-term objectives to guide decision making are set out in the Fisheries Act, in Fisheries 2030, in the National Fisheries Plan for Deepwater and Middle-depth Fisheries. These are explicit in requirements and management policy. The Annual Operational Plan outlines the management policy, and the actions required for the currently fishing year. These documents provide clear long-term objectives to guide decision-making, consistent with Components 1 and 2 and the precautionary approach, and are explicit within and required by management policy. Precautionary Approach – in regarding information principles, Section10 of Fisheries Act states: "*All persons exercising or performing functions, duties, or powers under this Act, in relation to the utilisation of fisheries resources or ensuring sustainability, shall take into account the following information principles:*

- *a) Decisions should be based on the best available information;*
- *b) Decision makers should consider any uncertainty in the information available in any case;*
- *c) Decision makers should be cautious when information is uncertain, unreliable, or inadequate; and*
- d) *The absence of, or any uncertainty in, any information should not be used as a reason for postponing or failing to take any measure to achieve the purpose of this Act."*

Thus, there are clear long-term objectives that guide decision-making, consistent with Components 1 and 2 and the precautionary approach is explicit within management policy.

PI SCORE	**LOW RISK**

3B: Fishery Specific Management System

CRITERIA: (i) The fishery specific management system has clear, specific objectives designed to achieve the outcomes expressed by Components 1 and 2.

(a) Objectives **LOW RISK**

Fisheries 2030, the National Fisheries Plan, and the Annual Operational plan provide well defined and explicit long and short term objectives.

CRITERIA: (ii) The fishery specific management system includes effective decision making processes that result in measures and strategies to achieve the objectives and has an appropriate approach to actual disputes in the fishery.

(a) Decision making **LOW RISK**

Sections 10, 11, and 12 of the Fisheries Act establish the requirements for the decision-making process), and Section 10 further requires the use of best available information for all decisions. This results in measures and strategies to achieve the fishery-specific objectives. The Fisheries Act requirement for best available information leads to scientific evaluation in advance of decisions. The Fisheries Act further requires consultation with such persons or organisations as the Minister considers are representative of those classes of persons having an interest in the stock or the effects of fishing on the aquatic environment in the area concerned including Maori, environmental, commercial, and recreational interests.

(b) Use of the Precautionary approach **LOW RISK**

The precautionary approach must be followed by MPI. Section 10 of the Fisheries Act Information principles states: "*All persons exercising or performing functions, duties, or powers under this Act, in relation to the utilisation of fisheries resources or ensuring sustainability, shall take into account the following information principles:*

- *a) Decisions should be based on the best available information:*
- *b) Decision makers should consider any uncertainty in the information available in any case:*
- *c) Decision makers should be cautious when information is uncertain, unreliable, or inadequate:*
- d) *The absence of, or any uncertainty in, any information should not be used as a reason for postponing or failing to take any measure to achieve the purpose of this Act*."

Evidence of the application of the precautionary approach is seen in the 2016 review of management controls for the SQU1J stock (MPI, 2016a).

(c) Accountability and Transparency **LOW RISK**

Information available suggests that feedback is provided in accordance with the MOU between MPI and the DWG, as well as through other structures established under the National Fisheries Plan, involving planning, consultation, project development, and scientific enquiry, thus responding to important issues in a transparent manner. Information on the performance of the fishery is available through MPI Plenary Reports and other information published on the MPI and DWG websites.

CRITERIA: (iii) Monitoring, control and surveillance mechanisms ensure the management measures in the fishery are enforced and complied with.

(a) MCS Implementation **LOW RISK**

The deepwater fisheries management system has documented a comprehensive and effective monitoring, control and surveillance system through 1) a compulsory satellite Vessel Monitoring System (VMS) with an on board an automatic location communicator (ALC); 2) government observers who may be placed on board to observe fishing, any transhipment and transportation, and collect any information on fisheries resources (including catch and effort information) and the effect of fishing on the aquatic environment; and 3) accurate recordkeeping and recording requirements to establish auditable and traceable records to ensure all catches are counted and do not exceed the ACE held by each operator. Other measures include:

- fishing permit requirements;
- requirement to hold ACE to cover all target and bycatch species caught, or alternatively, to pay deemed values;
- fishing permit and fishing vessel registers;
- vessel and gear marking requirements;
- fishing gear and method restrictions;
- vessel inspections;
- control of landings (e.g. requirement to land only to licensed fish receivers);
- auditing of licensed fish receivers.

(b) Sanctions and Compliance **LOW RISK**

For offences against the Fisheries Act 1996 or any of the Fisheries Regulations, the offender has to satisfy a reverse onus and establish that the offence was outside their control, that they took reasonable precautions and exercised due diligence to avoid the contravention, and, where applicable, they returned fish that was unlawfully taken and complied with all recording and reporting requirements. A wide range of sanctions from fines ($250 to 500,000) and imprisonment, forfeiture of catch and potential forfeiture of vessel, to prohibition from participating in fishing in the future constitute an effective deterrent to offenses and lead to industry compliance.

To meet the low risk SG against this SI, sanctions to deal with non-compliance must exist and some evidence must exist that fishers comply with the management system under assessment including, where required, providing information of importance to the effective management of the fishery. In the first instance, it is clear that sanctions to deal with non-compliance exist for a range of offences, and these sanctions are regularly applied by MPI (for example, Heron [2016] notes that MPI undertakes about 300 fishing related prosecutions per year with [ordinarily] over 80% or more resulting in convictions). Evidence also exists from compliance monitoring of deepwater fisheries that fishers comply with the management system. In the 2013/4 management year, MPI (2015) reports 70 compliance inspections were completed covering 24 vessels. Very high rates of compliance were evident across both fishing authorisation and gear requirements, as well as catch and effort reporting (Table 2).

Table 2: Summary of 2013/14 performance against pre-fishing preparation and fishing documentation regulatory requirements (from MPI, 2015)

Inspection detail	# of inspections	# of breaches	Compliance rate
Certificate of registry	43	1*	95%
Fishing gear	25	0	100%
Fishing permit	52	0	100%
SLED	16	0	100%

Inspection detail	# of inspections	# of breaches	Compliance rate
Effort returns	27	0	100%
Landing documents	11	0	100%
Landing return book	23	1	94%

In addition, MPI (2016d) reports that towards the end of the 2013 calendar year, MPI introduced 'interim observer trip reports'. Under these reports, observers rate the performance of vessels against 15 questions with a rating of A, B, C or N/A. It is considered that ratings of A and B are acceptable performance. Overall, 160 interim trip reports relating to observed trips on deepwater vessels were completed in the 2014/15 year. The majority of factors were rated A (81%) or B (7%), however over the year, six C ratings were given by observers (less than 1%). Observer coverage in the squid trawl fisheries has been >85% in recent years.

Accordingly, evidence is available for deepwater fisheries that sanctions to deal with non-compliance exist, and are applied if necessary, and that fishers comply with the management system, including providing information of importance to the effective management of the fishery.

Nevertheless, we note there has been considerable debate in recent years about the adequacy of the MPI compliance system, and in particular its response to alleged dumping of QMS species (e.g. Simmons et al, 2016; Heron, 2016). Email correspondence quoted by Heron (2016) suggests there has been a view internally amongst MPI that discarding has been a more general problem in some sectors.

(c) Systematic non-compliance **LOW RISK**

The results of compliance inspections in Table 2 together with observer reports (MPI, 2016d) appear to indicate no systematic non-compliance.

CRITERIA: (iv) There is a system for monitoring and evaluating the performance of the fishery specific management system against its objectives.
There is effective and timely review of the fishery specific management system.

(a) Evaluation coverage	**LOW RISK**

The development and implementation of the Fisheries Plan framework – National Deepwater Plan, fishery specific chapters, Annual Operational Plan and Annual Review Report – ensures there is a structured process to ensure the performance of the fishery specific management system against its objectives. There is full stakeholder engagement on the development of all components of the Fisheries Plan framework and all documents are publicly available. The Ministry implements a comprehensive peer-review process for all science research that is used to inform fisheries management decisions.

(b) Internal and/or external review	**LOW RISK**

The fishery management system has internal and external review through the Fisheries 2030, Statements of Intention, the National Deepwater Plan, the Annual Operational Plan and Annual Review Report.

PI SCORE	**LOW RISK**

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