



**Fisheries New Zealand**

Tini a Tangaroa

# Medium Term Research Plan for Deepwater Fisheries

2021/22 – 2025/26

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# Contents

<b>Introduction</b>	<b>2</b>
<b>Surveys</b>	<b>2</b>
Trawl Surveys	2
Wide-area, multi-species trawl surveys	2
Scampi surveys	4
Acoustic Surveys	4
<b>Stock Assessments &amp; Monitoring</b>	<b>7</b>
Stock Assessments	7
Tier 1 species	7
Tier 2 Stocks and species	11
<b>Informing Management</b>	<b>12</b>
Data collection	12
Land-based catch sampling	12
Observer Coverage	13
Industry based sampling	13
Ageing of deepwater fish species	14
Management Strategy Evaluation	18
Methodology & Development	19
<b>Aquatic Environment specific to Deepwater</b>	<b>21</b>

## Introduction

This medium term research plan (MTRP) is intended to reflect research needs to inform management of New Zealand's deepwater fisheries. Research needs in this MTRP are based on the longer term planning that has previously been consulted on with stakeholders but not provided publicly with descriptions, context and rationale for the planned work.

This MTRP remains a living document and will be updated regularly to reflect changes in management priorities where these occur, and identification of new information requirements. Budget constraints are also a consideration resulting in trade-offs not just between deepwater research projects, but across all of the fisheries research that is conducted. Annual research plans will continue to be consulted with stakeholders through the Deepwater Fish Plan Advisory Group, and reported in the Annual Operational Plans and Annual Review Reports for deepwater fisheries.

The MTRP should be read alongside the National Fisheries Plan for Deepwater and Middle-depth fisheries ([National Deepwater Plan](#)). Deepwater and middle-depth fisheries are those generally between 12 nautical miles and 200 nautical miles offshore. Fisheries are categorised into three tiers:

- Tier 1 – high volume, high value quota management system stocks that commercial fishers usually target;
- Tier 2 – are quota management system stocks that are smaller or less valuable bycatch fisheries, or are only targeted at certain times of the year; and
- Tier 3 – bycatch species that aren't managed through the quota management system.

## Surveys

Surveys provide important fishery-independent information for monitoring a number of deepwater fish stocks.

All tables in this document reflect the financial year (July – June) in which contracts will be initiated which may be the year before the actual delivery of the work. Where available, project codes are provided.

## TRAWL SURVEYS

### Wide-area, multi-species trawl surveys

Wide-area trawl surveys collect biological information and provide abundance indices for a wide range of species. There are three deepwater and middle-depth wide-area trawl surveys which cover the three main deepwater fishing grounds: Chatham Rise, Sub-Antarctic, and the West Coast of the South Island (WCSI). The surveys are optimised to provide information on relevant Tier 1 middle-depth fish stocks, but also provide valuable information on a range of Tier 2 and non-QMS species, including data that informs risk assessments for sharks, and important ecosystem data (e.g. sea temperature, stomach sampling) in these key fishery areas.

**Table 1: Wide-area trawl survey schedule by financial year (incl. month of delivery)**

	2021/22	2022/23	2023/24	2024/25	2025/26
<b>Chatham Rise</b>	Jan 2022 (MID2018-01)		Jan 2024 (MID2021-02)		Jan 2026 (MID2021-02)
<b>Sub-Antarctic</b>		Dec 2022 (MID2021-02)		Dec 2024 (MID2021-02)	
<b>WCSI</b>	June/July 2021 (MID2018-01)			June/July 2024 (MID2021-02)	

*Chatham Rise wide-area trawl survey*

The Chatham Rise trawl survey was completed annually from 1992 – 2014 at which point the frequency was decreased to every other year because of the high cost and other priorities in the Fisheries New Zealand research budget. Information collected during all Chatham Rise trawl surveys was compiled in 2012.<sup>1</sup> The survey series provides biomass trend and distribution information on 142 species which are included as data inputs to stock assessments for a number of species, including hoki, hake and ling. The data compilation is being considered for an update in 2022/23.

The Chatham Rise trawl survey will continue to be carried out in January every other year.

*Sub-Antarctic wide-area trawl survey*

The Sub-Antarctic trawl survey was completed annually between 1992–1994 and 2001–2010. The survey frequency was then changed to be biennial because of the high cost and other priorities in the Fisheries New Zealand research budget, although surveys were completed in sequential years in 2012 and 2013 to address additional information needs. The Sub-Antarctic trawl survey provides information on 134 species and data inputs to stock assessments for a number of Tier 1 species, including hoki, hake and ling. A compilation of data from the Sub-Antarctic survey is being considered for 2022/23.

The Sub-Antarctic trawl survey will continue to be carried out in December every other year in the alternate financial year to the Chatham Rise trawl survey.

*West Coast South Island (WCSI) wide-area trawl survey*

The WCSI trawl survey was initially developed and designed as an acoustic survey focused on indexing spawning hoki abundance on the WCSI each winter. The survey was completed annually from 1988 to 1993, and again in 1997. In 2000, a trawl survey component was added to the survey to provide information on other middle depth species, which was repeated in 2012, 2013, and 2016. The survey methodology was amended in 2016 to focus on hake and ling rather than hoki following a review of the hoki model which concluded that the west coast acoustic index was not significantly influential in the model. The importance of the trawl survey to other species, including hake and ling, is the key reason the survey has continued.

The last WCSI trawl survey was completed in 2021 and is scheduled for completion in June/July every third year thereafter. The 2018 survey included an acoustic survey of spawning hoki, but the 2021 survey did not. Consideration has been given to the inclusion of

<sup>1</sup> O'Driscoll, R L et. al. (2011). *A review of hoki and middle-depth trawl surveys of the Chatham Rise, January 1992-2010*. New Zealand Fisheries Assessment Report 2011/47. 72p.

an acoustic survey of spawning hoki, but is not considered to provide added value at this time.

### Scampi surveys

Scampi is fished in 4-5 key areas using light bottom trawl gear. Export statistics for scampi are not readily available, but were estimated at ~\$41M in the 2020 calendar year.

The key scampi stocks, where most fishing occurs, are currently monitored using trawl/photographic surveys completed every third year. Scampi surveys have not been conducted in SCI 4A to date, however a characterisation of SCI 4A was completed in 2019 (FNZ FAR 2020/04). Options for utilising industry vessels to conduct a survey in SCI 4A are being considered, but if this is not feasible it is proposed that the first SCI 4A survey, and future SCI 4A surveys, are conducted alongside the SCI 3 survey (starting Sep 2023). Future monitoring approaches will be informed by the scampi MSE being undertaken in 2021/22.

**Table 2: Scampi survey schedule**

	2021/22	2022/23	2023/24	2024/25	2025/26
SCI 1				April 2025	
SCI 2				April 2025	
SCI 3			Sep 2023		
SCI 4A			Sep 2023		
SCI 6A	Feb/March 2022	Feb/March 2023			Feb/March 2026

## ACOUSTIC SURVEYS

Acoustic surveys are often used to monitor and estimate abundance of fish stocks that aggregate for either spawning or feeding. Acoustic surveys rely on the reflection of sound waves to estimate the abundance of fish as the vessel (or acoustic system) passes above the aggregation or fishing grounds.

Acoustic technology has improved significantly in recent years, with the development of multi-frequency and acoustic-optical systems that have allowed the technology to be used to monitor species where the lack of air-filled swim bladders or mixture of fish species in schools had previously made acoustics unfeasible.

For some species/stocks, to successfully measure abundance, any acoustic survey must deploy either a towed acoustic system (a towbody or trawl net-mounted system), a multi-frequency acoustic system, or an acoustic optical system. For clarity, this requirement is specified in the description of each planned acoustic survey below.

Acoustic surveys at regular cycles are employed to monitor hoki in the Cook Strait, orange roughy, southern blue whiting, and some oreo stocks; all during their respective spawning periods. Survey outputs are used as key inputs to stock assessments. Specific details for these are provided below.

### *Hoki (HOK)*

Cook Strait is the main area for spawning of the eastern hoki stock. Because hoki aggregate and aggregations are often in mid-water during spawning, acoustic surveys are considered

more effective than trawl surveys. In 2019, this survey of the eastern spawning stock was expanded to include the Pegasus Canyon and Conway Trough spawning areas on the east coast of the South Island. This extension to the survey will be continued in 2021 and after.

The survey may be completed using a hull-mounted echosounder and has mostly been carried out from an industry vessel platform during commercial fishing trips in the past. The 2019 and 2021 surveys have been completed aboard the *RV Kaharoa*.

The Cook Strait and Pegasus hoki acoustic survey is scheduled to be completed every two years. Note that from 2020/21, this project will be contracted in the financial year prior to the completion of the survey, as reflected in the table below.

**Table 3: Cook Strait and Pegasus hoki survey schedule**

	2021/22	2022/23	2023/24	2024/25	2025/26
Cook Strait		July/Aug 2023		July/Aug 2025	

The main spawning area for the western hoki stock is off the west coast of the South Island. Because hoki spawning aggregations are often in mid-water during spawning, acoustic surveys can be used to estimate the biomass of the west coast spawning stock. This survey has been completed irregularly in the past, and consideration has been given to delivering this survey in future. However, given the work to revise the hoki stock assessment model and discussions of the Deepwater Fisheries Assessment Working Group, there are no plans to carry out an acoustic survey for hoki on the west coast of the South Island in the near future.

#### *Orange roughy (ORH)*

Orange roughy is a long-lived, deepwater species that occurs throughout the New Zealand EEZ with the largest fisheries occurring on the Chatham Rise, Challenger Plateau, and around the north of the North Island. In the 2020 calendar year, exports of orange roughy were worth an estimated \$54M.

In 2014, a Management Strategy Evaluation indicated that surveys and assessments of orange roughy could be completed every four years would provide for utilisation while ensuring that stocks are not overfished and to allow fisheries managers to respond appropriately to any changes in abundance.

There are currently no surveys planned for ORH 1 or ORH 3B-Sub-Antarctic. In ORH 1, there remains large uncertainties around stock structure. A standard protocol was developed to allow vessels fishing in ORH 1 to take acoustic snapshots of aggregations they locate to provide some information on biomass. Fisheries New Zealand will continue to work with the ORH 1 quota owners to develop a research programme specific to ORH 1 in future. For ORH 3B Sub-Antarctic (Subants), there is a low level of fishing and little information on stock structure.

The fishing industry has progressed orange roughy acoustic surveys, both within and outside of Fisheries New Zealand contracting processes for ORH 3B Northwest Chatham Rise, East & South Chatham Rise, Puysegur, in ORH MEC (2A, 2B, and 3A), ORH 7A, and in ORH 7B.

Acoustic surveys for orange roughy take place in winter, which can complicate contracting given the government financial year of July – June. Therefore, the surveys below are

reflected in the year they will be contracted with dates of completion shown in the table. Note that due to COVID-19 and other factors, the ORH 3B Northwest Chatham Rise and East & South Chatham Rise survey did not take place as planned in June/July 2020. It was rescheduled and completed in June/July 2021.

**Table 4: Orange roughy survey schedule**

	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26
ORH 1						
ORH 2A North		<b>June 2022</b>			<b>June 2025</b>	
ORH MEC	July 2021			June 2024		
ORH 3B – NW Rise	<b>July 2021</b>		July 2023			July 2026
ORH 3B – ES Rise	<b>July 2021</b>		July 2023			July 2026
ORH 3B – Puysegur			<b>July 2023</b>			
ORH 7A		July 2022			July 2025	
ORH 7B	<del>July 2021</del>					

*Dates in bold reflect planned industry-led survey initiatives*

#### *Oreos (OEO, BOE, SSO, WOE, SOR)*

There are four species of oreo in New Zealand that are caught in commercial fisheries. Of those, the vast majority of effort and catch is for black and smooth oreos. The species mix in the catch varies from area to area.

Surveying oreo stocks has proved to be difficult. In the early years of the fishery, trawl surveys were used to estimate abundance; however, the aggregated nature of the fish led to very uncertain abundance estimates. From 1997, acoustic surveys were employed to survey oreos; however, there are issues with species composition in acoustic marks, and no surveys have been completed since 2016.

Work is currently underway to investigate monitoring approaches for oreo species and surveys may be considered based on the outputs of that work (OEO2020-01).

#### *Southern blue whiting (SBW)*

Southern blue whiting mainly occurs in the Sub-Antarctic waters of New Zealand, with the largest stock found around Campbell Island (SBW 6I). Smaller stocks are also found around the Auckland Islands (SBW 6A), Bounty Island (SBW 6B), and on the Pukaki Rise (SBW 6R). In the 2020 calendar year, exports of southern blue whiting were worth an estimated \$17M.

Southern blue whiting exhibit highly variable year class strength and are characterised by episodic recruitment events. Stocks are therefore surveyed (and assessed) regularly, both to allow for utilisation of significant recruitment events, but also to respond when large year classes leave the fishery or fish abundance declines suddenly.

Since the 2013/14 fishing year there has been very little fishing in SBW 1, 6A, and 6R (excluding 2019/20 in SBW 1), so no dedicated acoustic surveys are planned for these stocks. If landings from any of these stocks exceed 500 tonnes for 2 years in a row or a TACC is fully caught, consideration will be given to additional monitoring/assessment. Catches did not exceed 500 tonnes for SBW 1 or SBW 6A in 2018/19 or 2019/20. The catch for SBW 6R was over 500 tonnes (3,631 tonnes) in 2019/20, but significantly less than 500 tonnes (63 tonnes) in 2020/21.



The survey for SBW 6B is planned to be completed annually. This hull-mounted acoustic survey is currently completed using a commercial fishing vessel. The survey was most recently completed successfully in 2017, surveys were attempted in 2018, 2019, 2020 and 2021 but timing, weather, and operational factors meant that no usable biomass estimate was generated. Additional work will be completed to maximise the chances of a successful survey in 2021. Should the survey not be successful, consideration will be given to other monitoring approaches.

The survey for SBW 6I is scheduled to be completed every third year using the *RV Tangaroa*.

**Table 6: Southern blue whiting survey schedule**

	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26
SBW 6B	Aug 2020	Aug 2021	Aug 2022	Aug 2023	Aug 2024	Aug 2025
SBW 6I		Sep 2022			Sep 2025	

## Stock Assessments & Monitoring

### STOCK ASSESSMENTS

#### Tier 1 species

##### *Hoki (HOK)*

Hoki is New Zealand's largest fishery with a current TACC of 115 000 tonnes. The TACC is set for the whole area; however, hoki is assessed and managed through a non-regulatory catch limit agreement as two biological stocks; western and eastern. Juveniles from both stocks are assumed to mix on the Chatham Rise and to recruit to their respective stocks as they approach sexual maturity.

In the 2020 calendar year, hoki exports were worth an estimated \$169M. Hoki first achieved Marine Stewardship Council (MSC) certification in 2001 and has been re-certified three times; most recently in 2018, when it was certified as a fisheries complex with hake and ling trawl fisheries.

Significant work to review and amend the hoki stock assessment model was undertaken in the 2020/21 financial year.

Stock assessments for hoki are completed annually.

##### *Hake*

Hake fisheries have changed significantly in recent years, mainly as the result of changes in the fleet following new regulations. In the 2020 calendar year, hake exports were worth an estimated \$13M. New Zealand's three hake fisheries achieved MSC Certification in 2013 and were recertified in 2018 as part of the hoki, hake, ling trawl fishery complex. Hake stocks are currently assessed on three-year cycles (Table 8). Due to the current low level of targeted effort in HAK 4 and the 2020 stock assessment estimating the current biomass (55%  $B_0$ ) to be well above the management target (40%  $B_0$ ), future stock assessments will only be conducted in HAK 4 when the catch reaches certain threshold values. These thresholds will be two

consecutive fishing years with a catch greater than 360 tonnes or a single fishing year with a catch greater than of 720 tonnes.

**Table 8: Hake Assessment schedule**

	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26
HAK 1	Assessment			Assessment		
HAK 4			Assessment			Assessment
HAK 7		Assessment			Assessment	

### *Ling*

Ling is fished by a variety of fishing methods and fleets. Just over half of targeted ling catch is from vessels fishing using bottom longlines. A significant amount of ling is also taken in the hoki trawl fishery. The ling biological stocks do not align with the ling Quota Management Areas. Assessments are completed based on assumed biological stock structure, although this remains uncertain, especially for the Cook Strait and North Island areas.

In the 2020 calendar year, ling exports were worth \$51M. Five of New Zealand’s ling stocks (10 fisheries) were certified by the MSC in 2013 and recertified in 2018, with the five trawl ling fisheries included in the hoki/hake/ling trawl fishery complex. Key ling stocks are currently assessed on three-year cycles.

No assessments are currently planned for LIN 2 or LIN CS (Cook Strait) primarily because of uncertainty in stock structure. According to this research plan, if the catch from LIN 6B exceeds 200 tonnes in 2 consecutive years, an assessment will be considered. Catch from LIN 6B has been over 200 tonnes every year since 2015/16 and a characterisation (and possible stock assessment) was scheduled for 2020/21. Due to competing priorities, this characterisation was deferred to the 2022/23 financial year.

**Table 9: Ling Assessment schedule**

	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26
LIN 3/4		Assessment			Assessment	
LIN 5/6	Assessment			Assessment		
LIN 6B	Characterisation	Characterisation	Characterisation			
LIN 7			Assessment			Assessment

### *Southern blue whiting*

Southern blue whiting mainly occurs in the sub-Antarctic waters of New Zealand, with the largest stock found around the Campbell Islands. Smaller stocks are also found around the Auckland Islands, Bounty Island, and on the Pukaki Rise. In the 2020 calendar year, exports of southern blue whiting were worth an estimated \$17M.

Southern blue whiting are known to exhibit highly variable year class strengths and are characterised by episodic recruitment events. This leads to a need to survey these stocks regularly, both to allow for utilisation of significant recruitment events, but also to respond when large year classes leave the fishery or fish abundance declines unexpectedly.

Assessments of the SBW 6I stock are conducted every third year, aligned with the triennial survey (Table 10).

A number of technical issues have prevented adequate assessments of the SBW 6B stock being completed in recent years, which has led to an alternative approach to providing management information for this fishery. Southern blue whiting at the Bounties (SBW 6B) is currently managed using a harvest control rule (HCR) that provides guidance on an appropriate level of fishing mortality to be applied based on biomass estimates from the annual acoustic survey.

A review of the HCR for SBW 6B and Management Strategy for SBW 6I is scheduled for 2021/22, more details are available in the Management Strategy Evaluation section of this document.

There is currently very little fishing in SBW 1, 6A, and 6R, so no dedicated stock assessments are planned for these stocks. If landings from any of these stocks exceed 500 tonnes for 2 years in a row, consideration will be given to additional monitoring/assessment. Catches did not exceed 500 tonnes for SBW 1 or SBW 6A in 2018/19 or 2019/20. The catch for SBW 6R was over 500 tonnes (3,631 tonnes) in 2019/20, but significantly less than 500 tonnes (63 tonnes) in 2020/21. Aging of samples from SBW 6R is currently being considered due to the large catch in 2019/20.

**Table 10: Southern blue whiting assessment schedule**

	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26
<b>SBW 6B</b>	HCR	HCR	HCR	HCR	HCR	HCR
<b>SBW 6I</b>			Assessment			Assessment

### *Orange roughy*

Orange roughy is a long-lived, deepwater species that occurs throughout the New Zealand EEZ with the largest fisheries occurring on the Chatham Rise, Challenger Plateau, and around the north of the North Island. In the 2020 calendar year, exports of orange roughy were worth an estimated \$54M. Three key orange roughy stocks were certified by the MSC in 2016.

In 2014, a Management Strategy Evaluation indicated that surveys and assessments of orange roughy completed every four years would provide for utilisation while ensuring that stocks are not overfished and to allow TACC to respond to any changes in abundance.

Orange roughy stock assessments are scheduled to align with the relevant acoustic surveys. There are no assessments planned for ORH 1 or ORH 3B sub-Antarctic. For ORH 1, this is because of greater than usual uncertainties in stock structure and a lack of agreed biomass indices. For ORH 3B-Sub-Antarctic, this is because of the limited fishing effort and lack of available data from the fishery. Note that work is underway to better understand the stock structure of ORH 1 to enable assessment of stock(s) in future.

The ORH 3B NW Rise and ES Rise assessment was not completed as scheduled in 2020/21 because of the delay in the completion of the survey. It has been rescheduled for 2021/22 which will be industry-led.

Surveys and assessments for ORH 3B Puysegur, ORH 7B, and ORH 2A North are currently industry-led initiatives.

**Table 11: Orange roughy assessment schedule**

	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26
ORH 2A North			Assessment			
ORH MEC		Assessment				
ORH 3B – NW Rise	Assessment	Assessment			Assessment	
ORH 3B – ES Rise	Assessment	Assessment			Assessment	
ORH 3B – Puysegur				Assessment		
ORH 7A			Assessment			
ORH 7B		Assessment				

Assessments in bold reflect where data used will be from planned industry-led survey initiatives

### Oreos

There are four species of oreo in New Zealand that are caught in commercial fisheries. Of those, the vast majority of catch is black and smooth oreos. Full assessments of stock status are generally limited to the higher volume target fisheries for black and smooth oreos.

Stock assessments of oreo species have historically been challenging. Uncertainties regarding stock structure, biological parameters, and issues identified in interpreting trawl and acoustic survey data have led to a number of stock assessments not being accepted by Fisheries New Zealand Working Groups.

Work is underway on a project to investigate potential monitoring approaches for oreos, including potential survey and assessment opportunities (OEO2020-01). The results from this work will inform the future research plan for oreo species.

### Scampi

Scampi is fished in 4-5 key areas using bottom trawl gear. Export statistics for scampi are not readily available but were estimated at ~\$41M in the 2020 calendar year.

Scampi stocks are scheduled for assessments to occur the year after the relevant survey, which are scheduled for completion every third year. It has been proposed that a management strategy evaluation be completed for scampi to inform the harvest strategy and potentially the frequency of surveys and assessments. The first SCI 4A assessment will be conducted in 2024/25 based on the completion of a SCI 4A survey in 2023/24.

**Table 13: Scampi assessment schedule**

	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26
SCI 1		Assessment				Assessment
SCI 2		Assessment				Assessment
SCI 3	Assessment				Assessment	
SCI 4A					Assessment	
SCI 6A			Assessment	Assessment		

### Jack mackerels

There are three species of jack mackerel in New Zealand (*Trachyurus novaezealandiae*, *T. declivis*, *T. murphyi*) which occur in varying proportions in different areas. Two species are

considered native to New Zealand (*T. declivis* and *T. novaezealandiae*), while *T. murphyi*, or ‘Chilean jack mackerel’, is considered to be in New Zealand waters as the result of a range expansion from the wider south Pacific stock and are unlikely to spawn or reproduce in significant quantities in New Zealand waters. Exports of jack mackerel were worth an estimated \$67M in the 2020 calendar year.

Two of the three main jack mackerel quota management areas (JMA 3 and JMA 7) are managed by the Deepwater Fisheries Management Team and are therefore covered by this research plan.

There are no current estimates of stock status for any of the three jack mackerel species, and an assessment was undertaken in 2020. The assessment identified some issues with species identification and sampling at-sea. Additional work has been scheduled to resolve this issue, and Fisheries New Zealand is intending to carry out an assessment using revised data in 2021/22. If the assessment is successful, the approach may be expanded to JMA 3 in 2022/23.

Based on the life history characteristics of jack mackerel species (including maximum age of ~30 years), it is proposed to conduct assessments every third year.

**Table 14: Jack mackerels assessment schedule**

	2021/22	2022/23	2023/24	2024/25	2025/26
JMA 3	Assessment	Assessment			
JMA 7	Assessment			Assessment	

### *Arrow squid*

New Zealand’s squid fishery comprises two species, *Nototodarus sloanii* and *N. gouldi*. There are two main squid fisheries, the first on the Stewart-Snares shelf and the second around the Auckland Islands. There is a small amount of squid taken in other areas (e.g. Chatham Rise). Squid exports from New Zealand were worth an estimated \$192M in the 2020 calendar year.

Squid have a very different life cycle to most fish, which does not fit with standard fish population modelling approaches. Most squid are thought to live for around one year, spawn and then die. The result of this is an entirely new stock each year, the size of which tends to be driven by environmental factors. As a result, there may be high variability in abundance from year-to-year with recruitment varying between years by a factor of up to ten.

Attempts were made to estimate stock status for New Zealand squid from 2012-2014. However, because of the lack of any pre-recruit indicators and apparent pulses in squid recruitment in the fisheries, the method tried was not successful.

Fisheries New Zealand is exploring approaches to assess the sustainability of squid fisheries in project SQU2020-01, with some indicative updates expected in early 2022. This work will inform the future research plan for squid in New Zealand.

## **Tier 2 Stocks and species**

Tier 2 species and stocks are typically less valuable bycatch fisheries or are only target fisheries at certain times of the year. Because of the nature of these fisheries, Tier 2 fisheries are often data limited making full stock assessments problematic. The abundance of Tier 2

stocks may be monitored using a number of approaches including stock assessment, CPUE indices, age and/or size structure, and trawl survey indices.

In 2016, a workshop was held at which New Zealand fisheries experts considered each Tier 2 deepwater species and stock to characterise available information and potential monitoring approaches for each stock.

Reviews of stock status for Tier 2 stocks are primarily undertaken based either on significant changes in catch volume (e.g. decrease in bycatch in another target fishery suggesting a potential sustainability issue or an increase suggesting an increase in abundance), or when specific concerns are raised by stakeholders.

In addition, trends in the bycatch of Tier 2 (and non-QMS) species and stocks will continue to be monitored through bycatch reports prepared through the Aquatic Environment research stream, and the three wide area multi-species trawl surveys.

Fisheries New Zealand will identify priority Tier 2 stocks annually based on the catch balancing prioritisation process and monitoring of trends in catch or survey indices.

#### Tier 2 stock research

	2020/21	2021/22	2022/23	2023/24
<b>Barracouta</b>	Update			
<b>Gemfish</b>	CPUE Update			
<b>Ling</b>		LIN 6B Update	LIN 6B Update	
<b>Silver warehou</b>		Update		
<b>Orange roughy</b>			ORH 1	
<b>Alfonsinos</b>				BYX2 characterisation

In addition, Fisheries New Zealand is considering a project for 2022/23 to summarise trends and all available information on Tier 2 & Tier 3 species from the multi-species trawl surveys (Chatham Rise, Sub-Antarctic, and west coast South Island). This work will inform future priorities for Tier 2 research.

## Informing Management

Information and data that underpins the management of New Zealand’s fish stocks are wider than those surveys and stock assessments detailed in the previous sections.

This section of the research plan covers data collection (land-based sampling and observer coverage planning), ageing of observer samples, management strategy evaluations, and methods development work (e.g. survey design).

## DATA COLLECTION

### Land-based catch sampling

Results from the sampling of commercial catches is a key input to a number of stock assessments. For these stocks, sufficient, representative samples of the length and/or age of the commercial catch must be available for the stock assessments to accurately estimate stock status.

For most deepwater fisheries, at-sea observers provide adequate sampling to support stock assessments. However, for some fisheries, getting sufficient observer coverage to collect representative samples can be challenging. Where fish are not fully processed at sea, research providers can be contracted to visit the landing sites and collect the required samples at that point.

This mechanism is currently in place for the hoki fishery to collect samples from the Cook Strait and the West Coast South Island within 25nm of the coast. This project is scheduled to be completed annually.

### **Observer Coverage**

Fisheries New Zealand plans at-sea observer coverage based on biological sampling targets for stock monitoring (e.g. length frequencies (LF) and otolith samples) and percentage coverage targets for the estimation of protected species interactions. Observer coverage is planned and delivered based on the number of 'observer days' required for each fishery on a financial year basis.

The number of observer days necessary to achieve biological sampling requirements are calculated using the following information from the most recent fishing year:

- The total number of target tows in each area
- The number of observed target tows in each area
- The number of samples collected by observers for each species/area combination
- The number of sea days delivered for each area

Because of the variability in fishing effort over the range of fisheries each year, it is challenging to plan required observer coverage in advance, and delivery can be affected by fishing activities during a year (e.g. if there is no fishing in a particular fishery, it will appear that coverage did not meet the target).

The table below provides indicative estimates of the required coverage in each of the main deepwater fisheries, and also the main objectives which drive the setting of coverage requirements.

### **Industry based sampling**

Due to the potential disruption of observer coverage of the West Coast South Island hoki fishery in 2020 from COVID-19 restrictions, Fisheries New Zealand requested implementation of industry-based length sampling to augment observer sampling. Four companies and eight freezer vessels participated in the length frequency sampling when an observer was not on board. For each sampling day, length measurements and sexing was performed for a random selection of 100 hoki taken from the conveyor as fish exited the pound. Sampling was conducted by experienced factory staff after a briefing by suitably qualified coordinator. Approximately 16,500 fish were measured between mid-June - early September. Industry-based sampling is being considered as an option to expand upon current sampling performed by observers for certain fisheries (e.g. sub-Antarctic hoki).

**Table 15: Objectives and rationale for deepwater observer coverage**

Fishery complex & stocks covered	Main objective(s)	Rationale and comment
<b>Deepwater trawl fisheries</b>		
<b>North Island Deepwater</b> ORH 1, 2A, 2B, 3A BYX 2, CDL 2	Biological sampling of ORH	30 ORH LFs per area (ORH 1 A, B, C, D, ORH 2ANorth, Mid-East Coast) (total 180 LFs) Estimated 1 LF per day <sup>2</sup>
<b>Chatham Rise Deepwater</b> ORH 3B OEO 3A, 4 BYX 3	Biological sampling of ORH 30% effort coverage target for MSC stocks	50 LFs (300 otoliths) per ORH sub-stock (600 total) Estimated 1 LF per day
<b>Sub-Antarctic Deepwater</b> ORH 3B OEO 1, 6	Biological sampling of ORH	100 LFs for Puysegur (300 otoliths), no target for Sub-Antarctic ORH stock Estimated 1 LF per day
<b>West Coast Deepwater</b> ORH 7A, 7B	Biological sampling of ORH 30% effort coverage target for MSC stocks	50 LFs for ORH 7A (300 otoliths), same to apply for ORH 7B if re-surveyed or re-opened – Estimated 1 LF per day 30% effort coverage for ORH 7A only
<b>Hoki &amp; Middle depth trawl fisheries</b>		
<b>West Coast North Island</b> JMA 7, EMA 7, BAR 7	Biological sampling of JMA Protected species capture monitoring	200 LFs (900 otoliths) for each JMA species Estimated 2 LFs per day 20-30% effort coverage to allow estimation of protected species interactions
<b>West Coast SI (FMA7)</b> HOK 1 HAK 7, LIN 7 SWA 1	Biological sampling of HOK, HAK, LIN 30% effort coverage target for MSC stocks Protected species capture monitoring	400 LFs (1600 otoliths) for HOK, 200 LFs (1,000 otoliths) for HAK, 200 LFs (1,100 otoliths) for LIN Estimated 2 LFs per day, species are generally not sampled at the same time as one another
<b>WCSI HOK (Inside the line)</b> HOK 1	Biological sampling of HOK Protected species capture monitoring	200 LFs (600 otoliths) for HOK (note sampling is supplemented by shore-based sampling)

<sup>2</sup> Estimated LF per day was calculated by dividing the total number of LF collected for all the fishstocks in the complex for the fishing year by the total number of observer days achieved for this fishery complex during the fishing year. JMA LFs were split evenly between the Chatham Rise and Sub-Antarctic middle depth fisheries for the purposes of this calculation. This number was averaged across 2017/18, 2018/19 and 2019/2020 fishing years



Fishery complex & stocks covered	Main objective(s)	Rationale and comment
		20-30% effort coverage to allow estimation of protected species interactions
<b>Cook Strait HOK</b> HOK 1	Biological sampling of HOK Protected species capture monitoring	200 LFs (1600 otoliths) for HOK Estimated 1 LF day 20-30% effort coverage to allow estimation of protected species interactions
<b>Chatham Rise Middle depths (FMA3 /FMA4)</b> HOK 1 HAK 1, 4 LIN 3, 4 SWA 3, 4, JMA 3, BAR 1, BAR 4	Biological sampling of HOK, HAK, LIN 30% effort coverage target for MSC stocks Protected species capture monitoring	400 LFs (1600 otoliths) for HOK, 100 LFs (1000 otoliths) per area for HAK, 100 LFs (1100 otoliths) for LIN Estimated 1 LF per day, species are generally not sampled at the same time as one another
<b>Sub-Antarctic Middle depths (ex SQU/SBW)</b> HOK 1 HAK 1 LIN 5, 6 SWA 4, WWA 5B, BAR 5, JMA 3	Biological sampling of HOK, HAK, LIN 30% effort coverage target for MSC stocks Protected species capture monitoring	400 LFs (1600 otoliths) for HOK, 100 LFs (1000 otoliths) for HAK, 100 LFs (1100 otoliths) for LIN Estimated 2 LFs per day, species are generally not sampled at the same time as one another
<b>Southern blue whiting</b> SBW (All)	Protected species capture monitoring Biological sampling of SBW	100% coverage required for monitoring of interactions with New Zealand sea lions 100 LFs (900 otoliths) for SBW 6I, 50 LFs (600 otoliths) for SBW 6B Estimated 1 LFs per day
<b>Squid</b> SQU 1T, 6T	Protected species capture monitoring	90% coverage required for monitoring of interactions with New Zealand sea lions and seabirds
<b>Squid jig fishery</b>		
<b>Squid jig</b>		No squid jig effort
<b>Bottom longline fishery</b>		
<b>Bottom longline</b> LIN 3-7	Protected species capture monitoring 20% effort coverage target for MSC stocks Biological sampling of LIN	20-30% effort coverage target to monitor protected species interactions Estimated 1 LF per day

Fishery complex & stocks covered	Main objective(s)	Rationale and comment
<b>Shellfish fishery</b>		
<b>Scampi</b> SCI (All)	Protected species capture monitoring Catch composition Biological sampling of SCI	20-30% effort coverage target to monitor protected species interactions 50 LFs per area (SCI 1, 2, 3, 4A, 6A) Estimated 1 LF per day

## AGEING OF DEEPWATER FISH SPECIES

Information on the age structure of catches from commercial fisheries and resource surveys are key inputs to stock assessments of middle depth and deepwater species. Two main protocols are used to provide catch-at-age from fisheries. Where the fishery is discrete in time (e.g. spawning fisheries) this may take the form of an age-length key (ALK) which is used with length frequency samples to determine the age distribution of the catch. The second is the ageing of otoliths collected throughout the year to represent the age distribution of the catch, which requires a larger number of otoliths to obtain a representative age distribution.

Key Tier 1 species are aged each year, even if assessments are on longer cycles. This provides a basic monitoring tool and could potentially identify significant changes in age structure that occurred in years between assessments. Other fisheries are aged specifically to inform planned projects. There are also some species where the ageing data is either not used in the stock assessment, or it is not yet possible to accurately age the fish. For some of these species, otoliths are still collected, but are not aged on a regular basis.

**Table 16: Details of ageing for Tier 1 species, including planned frequency**

Fishery	Area	Source	Method	# to be read	Planned freq.
<b>Hoki</b>					
HOK 1	WCSI spawning	Obs.	ALK	750	Annual
		Research	ALK		Annual
	Cook Strait spawning	Obs.	ALK	750	Annual
		Research	ALK		Annual
	Chatham Rise	Obs.	Direct	1200	Annual
		Research	ALK	750	Biennial
	Sub-Antarctic	Obs.	Direct	1200	Annual
		Research	ALK	750	Biennial
<b>Hake</b>					
HAK 1	Sub-Antarctic	Obs.	ALK	600	Annual
		Research	ALK	600	Biennial
HAK 4	Chatham Rise	Obs.	ALK	600	Annual
		Research	ALK	600	Biennial
HAK 7	WCSI	Obs.	ALK	600	Annual
		Research	ALK	600	Triennial
<b>Ling</b>					
LIN CS	Cook Strait	Obs.	ALK	600	Not currently planned
LIN 3&4	Chatham Rise (trawl)	Obs.	ALK	500	Annual
		Research	ALK	600	Biennial
	Chatham Rise (BLL)	Obs.	ALK	500	Annual
LIN 5&6	Sub-Antarctic (trawl)	Obs.	ALK	500	Annual
		Research	ALK	600	Biennial
	Sub-Antarctic spawning (BLL)	Obs.	ALK	500	Annual
	Sub-Antarctic non-spawning (BLL)	Obs.	ALK	500	Annual
LIN 7	WCSI	Obs.	ALK	500	Annual
		Research	ALK	600	Triennial
<b>Southern blue whiting</b>					
SBW 6A	Auckland Islands	Obs.	ALK		Not currently planned
SBW 6B	Bounty Platform	Obs.	ALK	600	Annual
SBW 6I	Campbell Island	Obs.	ALK	600	Annual
		Research	ALK	600	Triennial
SBW 6R	Pukaki Rise	Obs.	ALK	(600)	Not currently planned

Orange roughy					
ORH 1		Obs.	Direct		Not currently planned
ORH MEC		Obs.	Direct		Every 4 years
		Research	Direct	900	
ORH 3B	Northwest Rise	Obs.	Direct		Every 4 years
		Research	Direct	900	
	East & South Rise	Obs.	Direct		Every 4 years
		Research	Direct	900	
	Puyssegur	Obs.	Direct		Following surveys
		Research	Direct	500	
	Sub-Antarctic	Obs.	Direct		Not planned
ORH 7A	WCSI	Obs.	Direct		Every 4 years
		Research	Direct	900	
ORH 7B	Southern WCSI	Research.	Direct	500	Following surveys
ORH ET					As required for assessments
Oreos					
OEO 3A	Black oreo	To be confirmed following confirmation of monitoring approach			
	Smooth oreo				
OEO 4	Smooth oreo				
OEO 1 & 6	Pukaki smooth				
	Pukaki black				
	Southland smooth				
	Bounty smooth				
Jack mackerels					
JMA 3	Murphyi	Obs.	ALK	600	Annual
	Novaezealandae	Obs.	ALK	600	Annual
	Declivis	Obs.	ALK	600	Annual
JMA 7	Murphyi	Obs.	ALK	600	Annual
	Novaezealandae	Obs.	ALK	600	Annual
	Declivis	Obs.	ALK	600	Annual

Ageing of Tier 2 species is done on an as-needed basis to support assessments, characterisations, or other analyses to estimate stock status. The scheduling of this work will be based on the scheduling of other work, and therefore cannot be detailed in full here. However, during the 2021/22 fishing year 900 ALK readings from BAR 4 & 5 fisheries (Chatham Rise and Southland) will be collected through a combination of research trips and the observer programme and 600 ALK readings from SKI 3 & 7 fisheries (Southeast coast and Challenger) will be collected through the observer programme.

As needs for ageing of additional species are often not identified until after the beginning of the financial year, Fisheries New Zealand will generally provide flexibility within the ageing project to age a significant number of additional otoliths as needed over the course of the fishing year (e.g. 2400 otoliths were aged in addition to those explicitly detailed in 2019/20).

## MANAGEMENT STRATEGY EVALUATION

Management Strategy Evaluation (MSE) is a general term used to describe the use of simulations to compare the effectiveness of management strategies (data collection, harvest strategies/rules, analysis methods) to achieve specified management objectives.

MSEs can take a wide range of forms, and the objectives against which management strategies are being assessed can range from developing a harvest control rule or informing

research frequency to working through voluntary measures and operational parameters to maximise economic yield from a fishery.

Under the National Deepwater Plan, Fisheries New Zealand intends to run MSEs for Tier 1 stocks wherever possible to inform species-specific management approaches. The first MSE of a deepwater stock was completed for hoki in 2011 and defined a management target range to manage the fishery for economic yields and desired fish size.

An MSE was completed in 2014 for orange roughy. That MSE supported definition of biological reference points, research frequency, and a harvest control rule to maintain stocks within the management target range. The harvest control rule for orange roughy is a priority for review in the next few years and the HCR and management strategies for southern blue whiting are being considered for review in 2022/23.

MSEs should be updated at regular intervals (or if there is substantial change in the fishery) to ensure the outcomes remain consistent with management objectives for the relevant fishery and incorporate any updated information on biology, stock status, or other factors.

An MSE is in progress for scampi (SCI2017-03), and the MSE for hoki is being considered for review after completion of the 2020/21 hoki assessment.

## **METHODOLOGY & DEVELOPMENT**

Methodology and development work will be required on an ongoing basis to ensure that there is continuous improvement in methodologies and models used to inform the management of deepwater fisheries. This kind of work can be difficult to plan in advance, and is not planned in a structured way as many other categories of research are.

At present, this section serves to identify areas where there is likely methodology and/or development work that is required or may be required in future to be prioritised as resources allow. For a more comprehensive list of potential future methodology and/or development work for each species see the May 2021 Fisheries Assessment Plenary.

In addition, recent discussions with stakeholders have highlighted an objective of continuous improvement in the availability of information to inform management including new approaches to be more cost effective or efficient, and regular external reviews of stock assessments to prompt innovation and progress. An example of work that may be undertaken include investigating technology to automate otolith ageing.

### *Hoki*

Potential future research for hoki includes, further investigations into natural, fishing and cryptic mortality, a reassessment of the value of WCSI acoustic survey, additional genetic or isotope analyses to further determine the stock structure and utilisation of catch data for the Stewart-Snares shelf to help determine recruitment patterns.

### *Hake*

Potential future research for hake includes, a review of the age-length data for the sub-Antarctic, investigating the spatial-temporal structure of sub-Antarctic hake to define the best possible definitions of fisheries for this stock and the potential exclusion of the Tangaroa sub-Antarctic trawl survey biomass estimate for 2017 from future stock assessments of HAK 1.

### *Ling*

Potential future research for ling includes, a review of the spatial-temporal stock structure for LIN 2 and LIN 5/6, the relationship between LIN 5/6 and LIN 6B, further investigation into longline CPUE standardisation, additional work on the most appropriate value of natural mortality and the potential exclusion of the Tangaroa sub-Antarctic trawl survey biomass estimate for 2017 from future stock assessments of LIN 5&6.

### *Southern blue whiting*

The main potential piece of future research for southern blue whiting is determining how to best represent mean weights at age for Campbell Island Rise southern blue whiting given the negative relationship between year class strength and growth in the model. Monitoring SBW 6B is also an area of potential future research.

### *Orange roughy*

Potential future research for orange roughy includes, examining any contamination by swim bladder species when estimating orange roughy acoustic biomass, re-examining the natural mortality assumptions for each orange roughy assessment, estimating growth parameters specifically for Puysegur and ORH 7B and reviewing the assumption of a 5% overrun, representing fish loss from trawl gear damage and ripped nets, for current and recent years.

### *Scampi*

Potential future research for scampi includes, examining the spatial and temporal patterns in grade length and sex composition, conducting additional tagging to improve growth estimates, and exploring evidence for the effects of recent fishing activity on catch rate. Another potential piece of future research includes examining recruitment patterns by obtaining better information on size composition. This could be accomplished by either re-examining the photo survey data to allocate the animals seen into size ranges and differentiating doorkeepers from emerged animals, investigating the utility of grade data for elucidating recruitment patterns or investigating the potential for developing a juvenile index from ling and sea perch stomach contents.

### *Oreos*

Potential future research for oreos includes, regular acoustic surveys, improved estimates of smooth oreo target strength and additional smooth oreo age frequency data, and sensitivity analyses to assumptions about the species composition in deriving catch histories. A current project is being conducted with the objectives to complete a review of existing data and approaches to monitoring, assessing the oreo species complex and to carry out a characterisation of the fishery (OEO2020-01). Completion of this project is expected in early 2022.

### *Jack mackerels*

A potential area of future research for jack mackerels is developing a custom stock assessment model to overcome the lack of historic species split information. There is also ongoing work to speciate jack mackerel using otolith shape.

### *Barracouta*

The main potential piece of future research for barracouta is reviewing the ECSI trawl survey for monitoring abundance including an investigation of the timing of the survey in relation to a possible seasonal northward migration of barracouta off the east coast of the South Island.

### *Gemfish*

Potential future research for gemfish includes, evaluating potential environmental influences on gemfish distribution and recruitment and assessing records of *Rexea spp.* other than *Rexea solandri* in NZ waters. There is also a plan to develop an age-based assessment model once a sufficient number of otoliths have been aged.

## **Aquatic Environment specific to Deepwater**

Under the Fisheries Act 1996, significant adverse impacts on the aquatic environment should be avoided, remedied, or mitigated. In addition, the biological diversity of the aquatic environment must be maintained. Drivers of research in this area also include the National Plan of Action (NPOA)-Seabirds, NPOA-Sharks, Threat Management Plan (TMP) for New Zealand Sea Lions and TMP for Hector's and Maui Dolphins.

Projects to monitor impacts of fisheries on the aquatic environment are planned and contracted through the Aquatic Environment research planning process. Fisheries New Zealand is currently developing a multi-year research plan for Aquatic Environment Research which will be incorporated to this MTRP when completed.

Some key recent and upcoming projects include:

2019/20	2020/21	2021/22
Trawl footprint update	Trawl footprint update & impact assessment	Catch composition in deepwater fisheries (multi-year)
Developing a spatial decision support tool to support management of bottom fishing impacts	Extent and intensity of trawl effort on or near underwater features in NZ	Review of protected shark captures
Analysis of deepwater seabird net captures	Temporal and spatial distribution of non-target catch in deepwater fisheries	Updating protected species capture estimates
Updating protected species capture estimates	Update of seabird cryptic mortality estimation	
	<del>Auckland Islands sea lion tracking</del>	
	Updating protected species capture estimates	