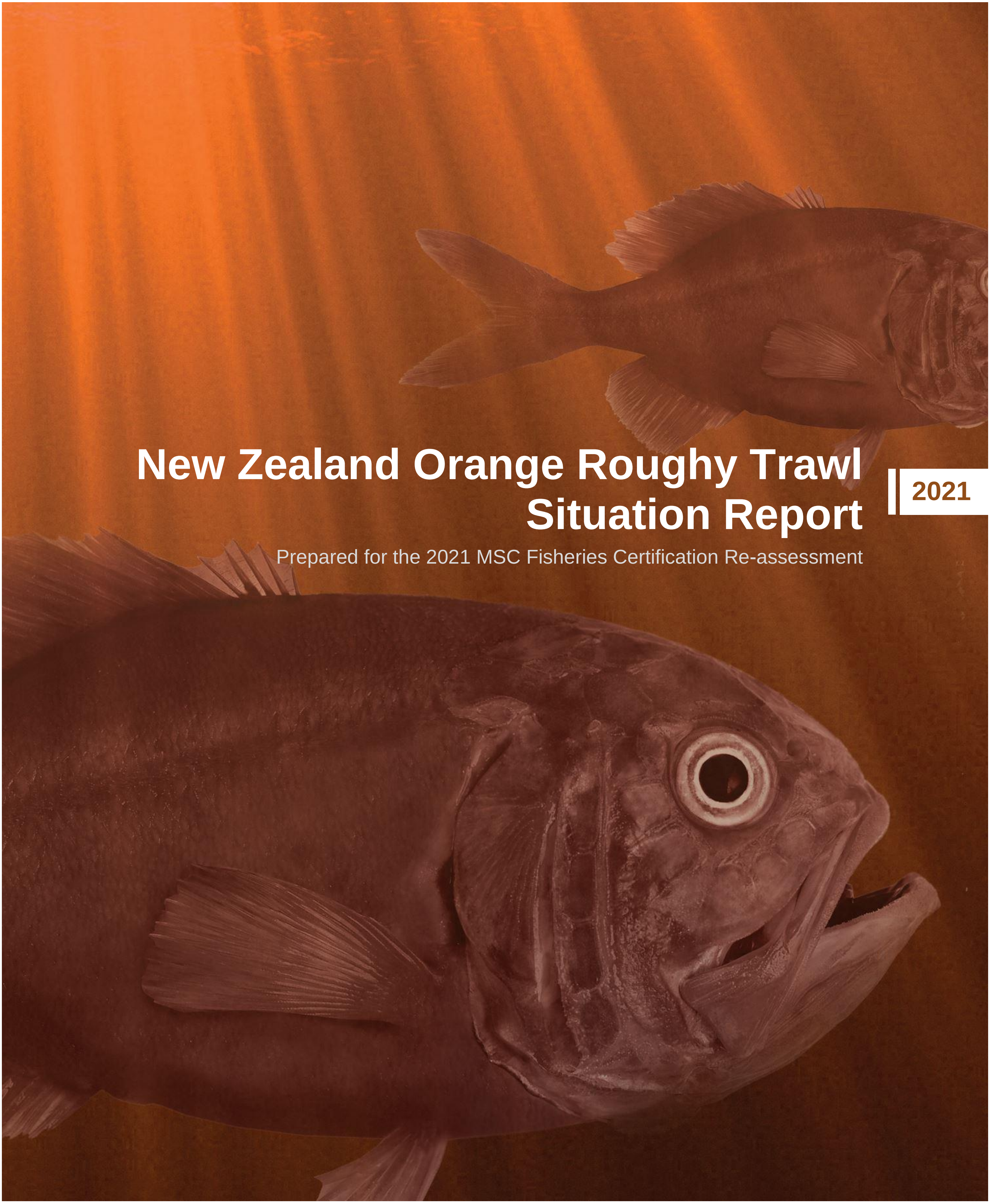

# New Zealand Orange Roughy Trawl Situation Report

**2021**

Prepared for the 2021 MSC Fisheries Certification Re-assessment

deepwater group

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## Purpose of This Report

This report is prepared for the fourth annual MSC surveillance audit and re-assessment of three New Zealand orange roughy units of Certification (UoC): ORH 3B Northwest Chatham Rise (NWCR), ORH 3B East & South Chatham Rise (ESCR) and ORH 7A Challenger Plateau & Westpac Bank (ORH7A-WB) trawl fisheries.

Cited references for which links are not provided are available here:

https://deepwatergroup.org/certification/orange-roughy-msc-reassessment/

## Overview of Fishery MSC Certification

### Orange roughy trawl certification details

| | |
|---|---|
| Certification date | 8 September, 2016 |
| Stock areas | UoC 1: ORH 3B NWCR<br>UoC 2: ORH 3B ESCR<br>UoC 3: ORH 7A-WB |
| Species | *Hoplostethus atlanticus* |
| Method/gear | Trawl |

# PRINCIPLE 1: OVERVIEW OF STOCK MONITORING, STATUS, AND INFORMATION

## Overview of Stock Monitoring, Status, and Information

### Orange roughy sustainability management

Biomass surveys and stock assessments are performed at four-year intervals based on a Management Strategy Evaluation (MSE), (Cordue, 2014) and scheduled by Fisheries New Zealand's Medium Term Research Plan for Deepwater Fisheries 2020/21 to 2024/25 (FNZ, 2020).

The MSE underpinned the development of a Harvest Control Rule (HCR), which involved testing the performance of a number of potential harvest control rules against simulated stock trajectories over long periods of time to allow for uncertainty in the inputs. The agreed HCR is estimated to have a greater than 97% probability of maintaining the stock above the lower bound of the management target range (30% $B_0$) under a range of assumptions about stock-recruit relationships and estimates of natural mortality.

The HCR is used to suggest catch limits based on the estimated stock status in relation to the management target range. Where a stock is estimated to be below the midpoint of the target range ($F_{mid}$ = 0.045), recommended catch limits are lower than for a stock near the top of the target range (125% $F_{mid}$). Likewise, the HCR allows for a higher catch limit for stocks that are above the mid-point of the target range. A review of the HCR in 2019 included revised estimates of natural mortality (*M*) and stock-recruitment steepness (*h*) from recent stock assessments but did not recommend any changes to the HCR (Cordue, 2019).

The most recent acoustic biomass surveys of ORH 3B NWCR and ORH 3B ESCR were undertaken in 2016 (Ryan & Tilney, 2017). These surveys were scheduled to be repeated in 2020 but were postponed and will take place during June-July 2021 (Ryan & Tilney, 2021). The most recent trawl and acoustic biomass survey of ORH 7A was undertaken in 2018 (Ryan et al., 2019) and will be repeated in 2022.

### Stock status, TACCs, catch limits & catches

**UoC 1 - ORH 3B NWCR**

| | |
|---|---|
| Update on stock status (Dunn & Doonan, 2018) | ORH 3B NWCR: $B_{2017}$ estimated to be 38% $B_0$. 'Very Likely' (>90%) to be at or above the lower end of the management target range. |
| ORH 3B TACC 2020-21 | 7,967 t |
| ORH 3B TACC 2019-20 | 6,772 t |
| ORH 3B TACC 2018-19 | 6,091 t |
| ORH 3B TACC 2017-18 | 5,197 t |
| NWCR Catch Limit 2020-21 | 1,150 t |
| NWCR Catch Limit 2019-20 | 1,150 t |
| NWCR Catch Limit 2018-19 | 1,149 t |
| NWCR Catch Limit 2017-18 | 1,250 t |
| UoA share of TACC | 100% |
| UoC share of TACC | 95.8% |
| NWCR catch 2019-20 | 223 t |
| NWCR catch 2018-19 | 294 t |
| NWCR catch 2017-18 | 724 t |

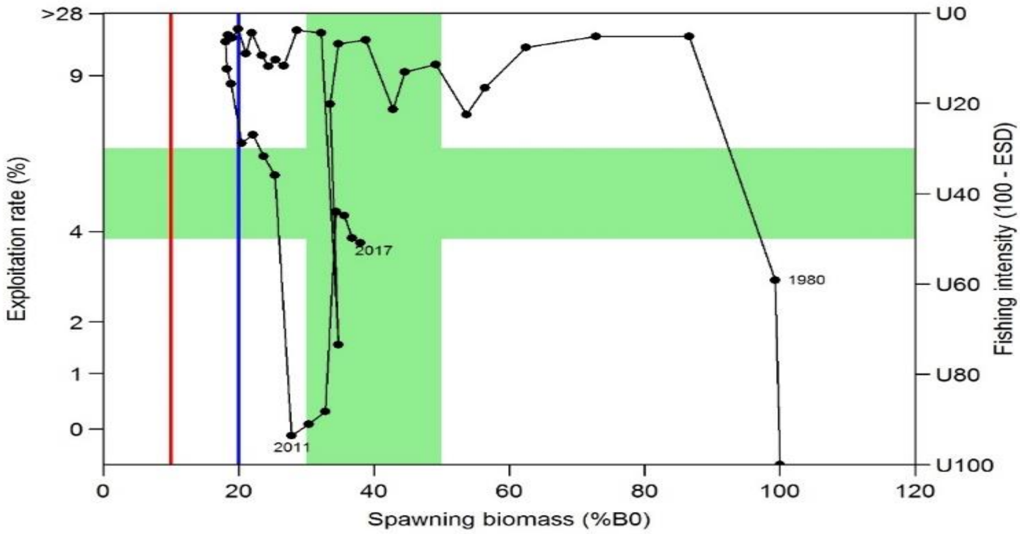


**Figure 1: Historical trajectory of spawning biomass (% B0), median exploitation rate (%) and fishing intensity (100-ESD) (base model, medians of the marginal posteriors). The biomass target range of 30–50 % B0 and the corresponding exploitation rate range are marked in green. The soft limit (20% B0) is marked in blue and the hard limit (10% B0) in red. Note that the Y-axis is non-linear (FNZ, 2021).**

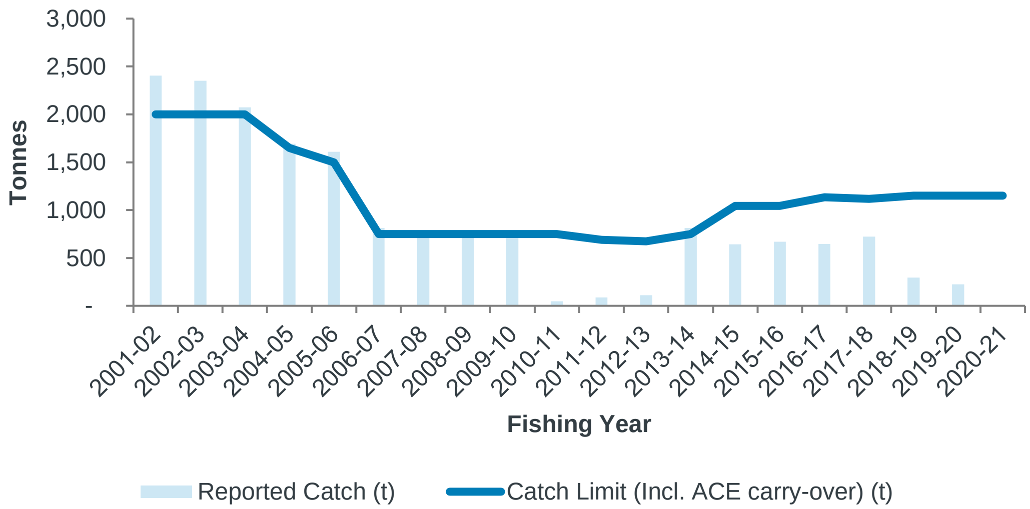


**Figure 2: ORH 3B NWCR Catch Limits and Commercial Catches. Voluntary fishery closure from 2010-11 to 1012-13 to promote stock rebuilding.**

**Biomass projections:**

Five-year biomass projections were made for the Base model run assuming future catches to be the TACC (1 250 t), or the current agreed catch limit (1,043 t; 207 t has been shelved). For each projection scenario, future recruitment variability was sampled from actual estimates between 1940 and 1979. At the TACC (1,250 t) and the current agreed catch limit (1,043 t), SSB is predicted to remain stable or slowly increase over the next five years, and the probability of the SSB going below the soft or hard limits is zero.

**The NWCR fishery:**

The NWCR catch limit from 2014-15 of 1,250 t, was established prior to development of the HCR. The industry chose a more conservative approach by shelving 207 t annually. Application of the HCR to the 2018 stock assessment resulted in a reduced catch limit of 1,150 t. Catches have been below the catch limit since 2014-15. Much of the biomass during the spawn in NWCR resides on the Underwater Topographical Feature (UTF) Morgue, which is closed to fishing by Regulation. Most of the catch is taken outside of the spawning season over flat/undulating grounds in the western part of NWCR.

**UoC 2 – ORH 3B ESCR**

| | |
|---|---|
| Update on stock status (Cordue, 2021) | ORH 3B ESCR: $B_{2020}$ estimated to be 36% $B_0$. 'Likely' (>60%) to be at or above the lower end of the management target range. |
| ORH 3B TACC 2020-21<br>ORH 3B TACC 2019-20<br>ORH 3B TACC 2018-19<br>ORH 3B TACC 2017-18 | 7,967 t<br>6,772 t<br>6,091 t<br>5,197 t |
| ESCR Catch Limit 2020-21<br>ESCR Catch Limit 2019-20<br>ESCR Catch Limit 2018-19<br>ESCR Catch Limit 2017-18 | 5,970 t<br>4,775 t<br>4,095 t<br>3,100 t |
| UoA share of TACC<br>UoC share of TACC | 100%<br>95.8% |
| UoA ESCR catch 2019-20<br>UoA ESCR catch 2018-19<br>UoA ESCR catch 2017-18 | 4,769 t<br>4,143 t<br>3,328 t |

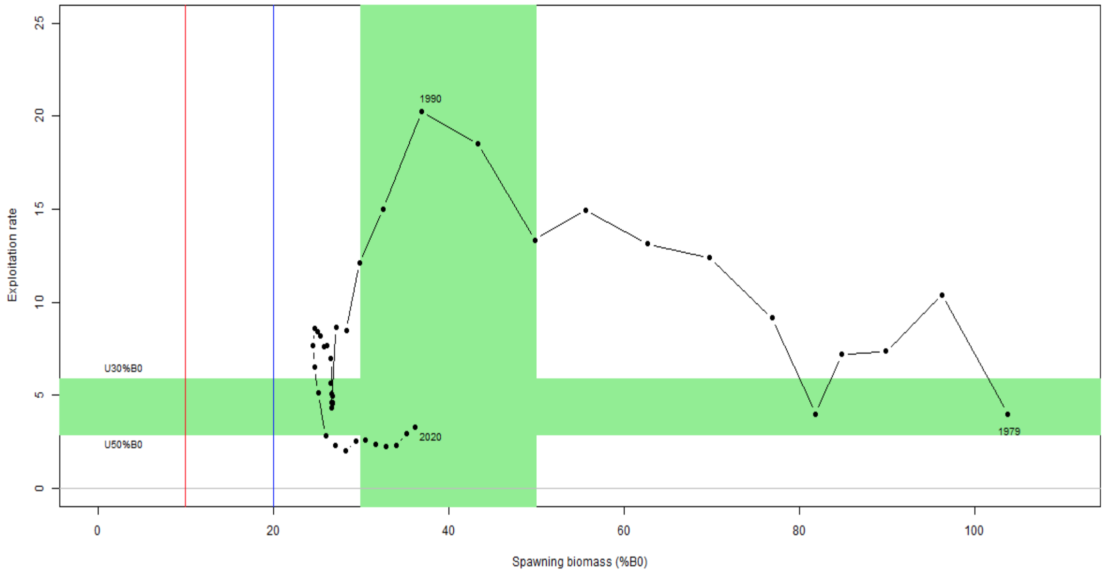


**Figure 3: Historical trajectory of spawning biomass (% B0) and exploitation rate (%) (current model, medians of the marginal posteriors). The biomass target range of 30–50 % B0 and the corresponding exploitation rate range are marked in green. The soft limit (20% B0) is marked in blue and the hard limit (10% B0) in red (FNZ, 2021).**

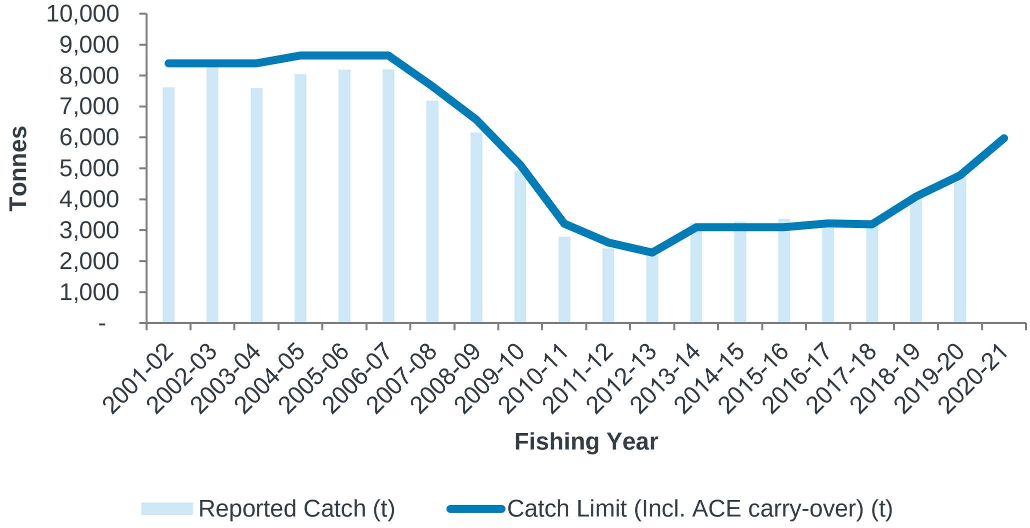


**Figure 4: ORH 3B ESCR Catch Limits and Commercial Catches.**

### Biomass projections:

Eight-year biomass projections were made for the Base model run assuming future catches to be the Catch Limit (3,100 t) plus 5% to allow for incidental mortality. Random recruitment was brought in from 1991 by resampling from the last 10 years of estimated YCS (i.e., 1981-1990). At the Catch Limit, the SSB is projected to slowly increase and the probability of the SSB going below the soft or hard limits is zero (FNZ, 2021).

### The ESCR Fishery:

The catch limit from 2013-14 through to 2017-18 of 3,100 t, was set before the HCR-recommended yield estimate was calculated in 2014-15. While the HCR indicated a catch limit of 3,772 t, industry chose to adopt a more conservative approach to promote stock rebuilding and elected to retain the limit of 3,100 t. Following the 2018 stock assessment the HCR indicated a catch limit of 5,670 t (FNZ, 2018). Industry again adopted a conservative approach by agreeing to a phased increase over three years. The 2018-19 catch limit of 4,095 t marked the first of three increases.

The 2018 stock assessment estimated the stock was at 33% $B_0$ with an 86% probability that it was above the lower bound of the management target range of 30% of $B_0$ and was increasing. Projections from the stock assessment showed the median biomass increasing each year for the next five years to 37% of $B_0$ by 2023 under the increased catch limit (FNZ, 2019). The 2019-20 catch limit of 4,775 t marked the second increase.

A revised stock assessment in 2020 (Cordue, 2021), estimated the stock had increased to 36% $B_0$. Application of the HCR suggested a catch limit of 6,348 t, based on the exploitation rate of 0.043. Forward projections estimated that at this catch, plus 5% to allow for other sources of mortality caused by fishing, the biomass would continue to increase to 40% $B_0$ in 2028. The third scheduled increase in the catch limit was set at the more conservative level of 5,970 t for the 2020-21 fishing year (FNZ, 2020a).

## UoC 3 – ORH 7A-WB

| | |
|---|---|
| Update on stock status (Cordue, 2019a) | ORH 7A-WB: $B_{2019}$ estimated to be 47% $B_0$. 'Very Likely' (>90%) to be at or above the lower end of the management target range and 'About as Likely as Not' (40-60%) to be at or above the upper end of the target range of 30-50% $B_0$. |
| ORH 7A TACC 2020-21<br>ORH 7A TACC 2019-20<br>ORH 7A TACC 2018-19<br>ORH 7A TACC 2017-18 | 2,058 t<br>2,058 t<br>1,600 t<br>1,600 t |
| UoA share of TACC<br>UoC share of TACC | 100%<br>93.9% |
| ORH 7A catch 2019-20<br>ORH 7A catch 2018-19<br>ORH 7A catch 2017-18<br>ORH 7A catch 2016-17 | 1,897 t<br>1,589 t<br>1,780 t<br>1,623 t |

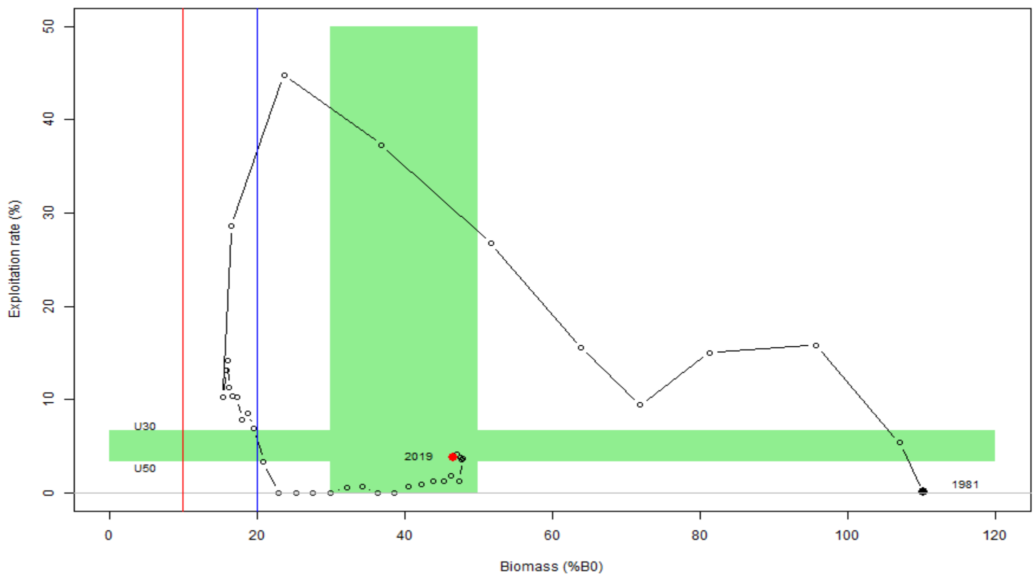


**Figure 5: Historical trajectory of spawning biomass (% $B_0$) and fishing intensity (exploitation rate) (base model, medians of the marginal posteriors). The biomass target range of 30–50% $B_0$ and the corresponding exploitation rate (fishing intensity) target range are marked in green. The soft limit (20% $B_0$) is marked in blue and the hard limit (10% $B_0$) in red (FNZ, 2021).**

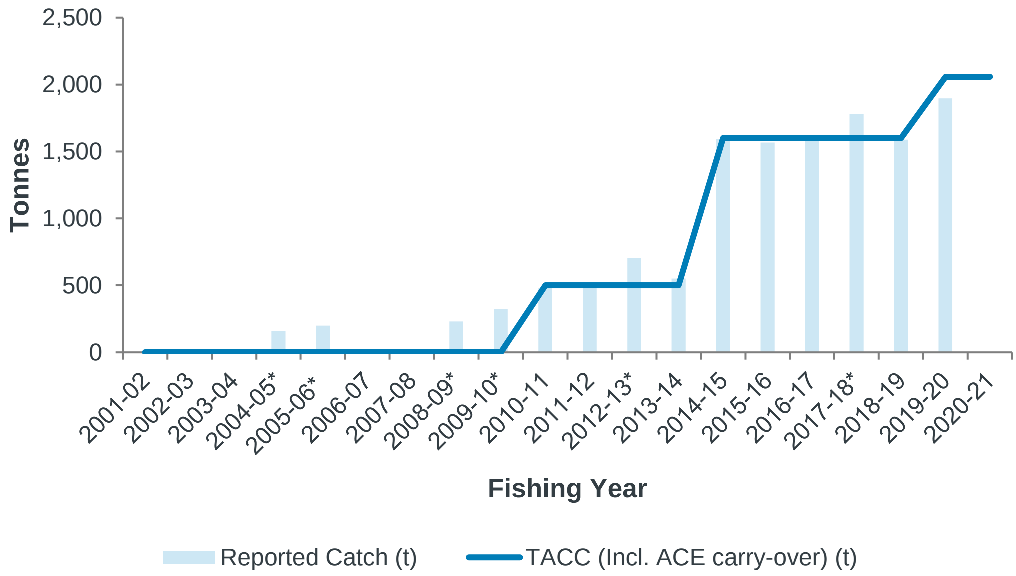


**Figure 6: ORH 7A Challenger TACCs and reported catches. The fishery was closed to fishing from 2001-02 to 2009-10. Asterisks on the x-axis denote years where biomass survey catches were taken against a special permit.**

### Biomass projections:

Five-year projections were conducted (with resampling from the last 10 estimated YCS, 1986–1995) for a constant catch of 1,600 t (i.e., the current TACC). A 5% catch over-run was assumed. Projections were done for the base model and for the LowM-Highq sensitivity model (as a "worst case" scenario). SSB is predicted to decrease slowly over the next five years for both models, while staying within the target biomass range. For both models the estimated probability of SSB going below either the soft limit (20% $B_0$) or the hard limit (10% $B_0$) is zero. For the base model projection, exploitation rates are predicted to slowly increase but still be at the lower end of the fishing intensity target range in 2024 (95% CI 0.030–0.054 compared to the target range of 0.033– 0.067), (FNZ, 2021).

### The ORH 7A fishery:

Following a 10-year closure, the fishery was re-opened to commercial fishing on 1 October 2010 with a TACC of 500 t. Following implementation of the HCR in 2014-15 the TACC was increased to 1,600 t. Application of the HCR following the 2019 assessment indicated there was an opportunity to increase the TACC for this stock by up to 833 t. Industry agreed to adopt a precautionary approach by accepting a lower increase of 460 t, which increased the TACC to 2,060 t from 1 October 2019 (FNZ, 2019a).

## Orange Roughy Harvest Control Rules (HCR) and Tools

### Standard Ministry HCR Procedures

The process followed by the Ministry has a long-established history.

The TACC-setting process must conform to section 13 (2) of the 1996 Fisheries Act, which states:
The Minister shall set a total allowable catch that -

(a) maintains the stock at or above a level that can produce the maximum sustainable yield, having regard to the interdependence of stocks; or

(b) enables the level of any stock whose current level is below that which can produce the maximum sustainable yield to be altered -

   i. in a way and at a rate that will result in the stock being restored to or above a level that can produce the maximum sustainable yield, having regard to the interdependence of stocks; and

   ii. within a period, appropriate to the stock, having regard to the biological characteristics of the stock and any environmental conditions affecting the stock; or

(c) enables the level of any stock whose current level is above that which can produce the maximum sustainable yield to be altered in a way and at a rate that will result in the stock moving towards or above a level that can produce the maximum sustainable yield, having regard to the interdependence of stocks.

The Harvest Strategy Standard for New Zealand Fisheries (MPI 2008), outlines the form of the Harvest Control Rule (HCR) which, by default, is used to inform sustainable harvesting of all New Zealand fisheries. It consists of three core elements:

- A specified target based upon MSY-compatible reference points (e.g. BMSY and FMSY), or better, about which a stock should fluctuate with at least a 50% probability of achieving the target.
- Soft limit (default of 50% BMSY or 20% B0 whichever is higher) that triggers a requirement for a formal, time-constrained rebuilding plan when the probability that stock biomass is below this soft limit is greater than 50%.
- Hard limit (default of 25% BMSY or 10% B0 whichever is higher) below which fisheries should be considered for closure when the probability that stock biomass is below this hard limit is greater than 50%.

The status of fisheries and stocks is characterised according to these reference points (RPs):

- If the MSY-compatible fishing mortality rate, FMSY, or an appropriate proxy, is exceeded on average (over 3 to 5 years), overfishing is deemed to have been occurring, as stocks fished at rates exceeding FMSY will ultimately be depleted below BMSY.
- A stock that is determined to be below the soft limit will be designated as depleted and in need of time-constrained rebuilding.
- A stock that is determined to be below the hard limit is designated as collapsed.
- The relationship amongst these various RPs and the management actions that should be invoked are illustrated (Figure 1) in the HCR outlined in the Operational Guidelines

(MPI, 2011). The example is applicable only for high information stocks, such as the orange roughy

stocks under assessment, where it is possible to estimate biomass relative to BMSY and fishing mortality relative to FMSY (or some other measure of fishing intensity). However, MPI (2011) notes that it can also be adapted to other, lower information situations. When biomass is between the target and the soft limit, management actions to reduce catch are to be taken to prevent stocks declining to the level of the soft limit. Besides TACCs, these could consist of measures such as changes in minimum legal sizes of fish caught (through, for example, increases in the minimum allowable mesh size of fishing nets), and closures of areas with high levels of catches of juveniles. MPI (2011) emphasizes that Figure 1 is primarily for illustrative purposes, to provide an example of one type of control rule that is likely to achieve the requirements of the HSS.

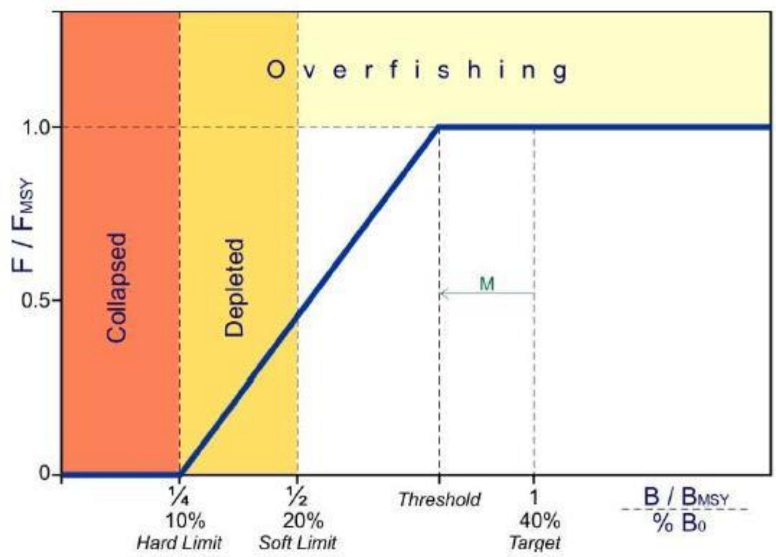


**Figure 1. Illustrative example of a harvest strategy control rule that would be in conformance with the Harvest Strategy Standard; *M* is natural mortality (from MPI, 2011)**

The requirements of the HSS are outlined in its Implementation Guidelines (MPI, 2011). These outline the MSY-compatible target and limit RPs as noted above, and the actions to be taken if and when stock biomass declines below the target. The latter include formal rebuilding plans when biomass is below 20% *B0* and actions when current biomass is likely to be above soft and hard limits but below targets: Rebuilding Plans:

1. Science Working Groups (SWGs) will estimate the probability that current and/or projected biomass is below 50% *BMSY* or 20% *B0*, whichever is higher. If this probability is greater than or equal to 50%, SWGs should calculate TMIN where TMIN is the number of years required to rebuild in the absence of fishing.
2. SWGs will work with fisheries managers to define and evaluate alternative rebuilding plans that will rebuild the stock back to the target with a 70% probability within a timeframe ranging from TMIN to 2 * TMIN.
3. The Ministry will provide advice to the Minister on a range of rebuilding plans that satisfy the TMIN to 2 * TMIN time constraint (or an alternative that can be adequately justified), and the specified probability levels.

4. Once a rebuilding plan has been implemented, SWGs will regularly evaluate and report on the performance of the rebuilding plan.
5. The Ministry will provide advice to the Minister on appropriate TACCs to achieve the rebuilding plan.

Actions when current biomass is likely to be above soft and hard limits but below targets (or thresholds):

1. SWGs will provide best estimates and confidence intervals for current biomass and/or fishing mortality (or related biological reference points).
2. If current biomass is estimated to be between the target (or the threshold) and the soft limit, SWGs should work with fisheries managers to define and evaluate the TACC consequences of:
    a. reducing fishing mortality proportionately to the estimated decrease in biomass below the target or threshold (or taking steps to approximate this for low information stocks), in order to avoid breaching either the soft or hard limits, and/or
    b. reducing catch super-proportionately to the estimated decrease in biomass below the target or threshold (or taking steps to approximate this for low information stocks), in order to avoid breaching either the soft or hard limits.
3. If current biomass is estimated to be above some threshold, SWGs will work with fisheries managers to define and evaluate the TACC consequences of:
    a. maintaining a constant *F* that will achieve the target biomass on average (or taking steps to approximate this for low information stocks), and/or
    b. reducing catch proportionately to the estimated decrease in biomass towards the threshold (or taking steps to approximate this for low information stocks), and/or
    c. increasing catch proportionately to the estimated increase in biomass above the threshold (or taking steps to approximate this for low information stocks).

Stocks will be considered to have been fully rebuilt when it can be demonstrated that there is at least a 70% probability that the target has been achieved and there is at least a 50% probability that the stock is above the soft limit.

In its consideration of TACC options, the Ministry follows the HSS.

The HCRs for the orange roughy fisheries seeking MSC re-certification are consistent with the HSS and associated Operational Guidelines and consist of the following:

- A stock assessment developed about every 4 years, with peer review provided by the Deepwater Fisheries Assessment Working Group (DWFAWG), to estimate the probability of current biomass and/or fishing mortality relative to limit and target reference points or ranges.
- Conduct of multi-year projections and to evaluate in a probabilistic manner, where the stock is and will be in future years in relation to the RPs. This is typically done for a base case model and for models which explore the main uncertainties in the assessment.
- The decision by the New Zealand Minister of Oceans and Fisheries on the setting of the TAC (and associated TACC) is consistent with HSS and informed by DWFAWG and stakeholder engagement; consultation during this step can result in additional projections undertaken by the Ministry.
- There is monitoring of the fishery and stock performance during projection period to ensure that stock status is not being compromised by the management actions.

### Management Strategy Evaluation

The HSS and its associated Operational Guidelines describe the role of Management Strategy Evaluation (MSE) in the management system. MSE, rather than focusing solely on biological RPs, seeks to take into account the robustness of alternative management procedures and socio-economic implications of management decisions. MSE attempts to model and simulate the whole management process. It makes projections about the state of the fishery resources and other ecosystem parameters for a number of years into the future under a variety of decision-rule options. The management measures and rules that achieve the best results in terms of specified objectives can then be selected and applied. This procedure greatly assists in identifying management strategies that are resilient to uncertainties in scientific understanding. The HSS provides minimum performance standards, or minimum performance measures, for MSEs and does not restrict alternative management objectives, or innovative management strategies, or additional performance measures beyond this. It states that MSEs should be designed to ensure that:

- the probability of achieving the MSY-compatible target or better is at least 50%
- the probability of breaching the soft limit does not exceed 10%, and
- the probability of breaching the hard limit does not exceed 2%

The MSE developed by Cordue (2014) had higher performance characteristics than those required as a minimum by the HSS, with, for example, a zero probability of breaching the soft limit. This MSE, and the HCR developed at the same time, were reviewed by the DWFAWG (Reeve, 2014) and applied from 2016 (MPI, 2016 footnote on page 685). The MSE and HCR were reviewed and found to still be fit for purpose (Cordue 2019), however, this review has not as yet been peer reviewed.

### Application of the HCR

DWG Ltd will continue to apply the HCR to provide guidance on the setting of catch limits for these orange roughy fisheries. The output results from running the HCR will be provided to the Ministry to assist them in formulating the options and advice to the Minister.

DWG Ltd will ensure that, if there is a difference between the HCR recommended catch limits and those selected by the Minister, the lower limit of the two will be implemented and observed as a precautionary measure.

### Implementation Tools

The tools to control fishing to achieve the objectives of the harvest strategy have not changed since the previous full certification assessment. To summarize, since 1986, fish stocks harvested by the major commercial fisheries in New Zealand fisheries waters, have been managed through a quota management system (QMS) using individual transferable quotas (ITQs). Each fish stock has 100,000,000 quota shares issued in perpetuity. The quota shares are a property right. This system is fully described on MPI's website (QMS link) Within the QMS, fisheries sustainability objectives are achieved by setting an overall annual total allowable catch (TAC) that is consistent with the productivity of each stock. The TAC is apportioned amongst user groups such as the TACC for the commercial fishery, allocations for the customary and recreational sectors and an allocation to address other fishing-related mortality such as illegal fishing or accidental loss of fish from nets. Note, however, that there is no allowance for customary or recreational fisheries for orange roughy.

Regarding other fishing-related mortality, in its consideration of TACC options, the Ministry explicitly addresses whether or not illegal catch and misreporting are issues. Determination on whether or not adjustment to the TACC is required is based upon risk analyses undertaken by the Ministry as part of its advice to the Minister when he sets the TAC and TACC.

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# PRINCIPLE 2: OVERVIEW OF ENVIRONMENTAL INFORMATION

## Overview of Environmental Information

### Observer Coverage

Observer coverage of deepwater fisheries is based on biological sampling requirements, international requirements, percentage-level coverage targets and observer programme capacity. Coverage is monitored throughout the year to ensure information is available to support stock assessments and to understand interactions with protected species (FNZ, 2020).

MPI's Scientific Observer Programme (SOP) collects data from fisheries, including Endangered, Threatened and Protected (ETP) incidental capture information. The ETP component of observer coverage, under New Zealand law, is administered and funded by the Department of Conservation (DOC) through levies recovered from relevant fisheries' quota owners. All observer deployment is managed by the SOP.

The objective of the SOP is to collect data from fisheries for the following purposes:

- As an input to monitor key fisheries against harvest strategies
- As an input to monitor biomass trends for target and bycatch species
- To enable reliable estimations and nature of ETP species interactions and captures
- To enable timely responses to sustainability and environmental impact issues
- To provide a high level of confidence in fishers' at sea compliance with regulatory and non-regulatory measures.

The level of observer coverage for the different fisheries/sectors is tailored to suit the data and information requirements, including for stock assessment, compliance monitoring and ETP species captures. FNZ considers that 35-45% coverage is sufficient for most fisheries/sectors but implements high (80-100%) coverage for fisheries where there may be what are deemed by management to be high-risk ETP species (e.g. squid and southern blue whiting trawl fisheries where operations overlap with sea lions). MPI's planned observer coverage for the ORH 3B Chatham Rise and ORH 7A deepwater fisheries in 2020-21, as specified in the Annual Operational Plan for Deepwater Fisheries 2020/21, is 250 and 60 days respectively, equivalent to ~35-45% coverage (FNZ, 2020). Performance against targeted observer coverage in previous years is reviewed in the Annual Review Report (FNZ, 2020a).

Over the most recent 5-year period, observer coverage in the NWCR and ESCR UoA fishery areas has averaged 27% and 31% respectively, while for the ORH 7A-WB UoA it has averaged 41% (FNZ, pers. comm.), (Table 1, Fig. 1). This level of coverage is considered by MPI to be sufficient given the low level of ETP species captures and high level of overall compliance by orange roughy fisheries.

**Table 1: Numbers of commercial trawl tows and associated observer coverage for tows that targeted ORH/OEO in the orange roughy UoA trawl fisheries, 2015-16 to 2019-20 (R. Tinkler, FNZ, pers. comm.).**

| NWCR UoA | 2015-16 | 2016-17 | 2017-18 | 2018-19 | 2019-20 | 5-year Average |
|---|---|---|---|---|---|---|
| Commercial tows | 392 | 456 | 385 | 220 | 171 | 325 |
| Observed tows | 91 | 100 | 106 | 61 | 61 | 84 |
| % Observed tows | 23% | 22% | 28% | 28% | 36% | 26% |
| **ESCR UoA** | **2015-16** | **2016-17** | **2017-18** | **2018-19** | **2019-20** | **5-year Average** |
| Commercial tows | 1229 | 1179 | 1151 | 1247 | 1358 | 1233 |
| Observed tows | 690 | 324 | 30 | 350 | 411 | 361 |
| % Observed tows | 56% | 27% | 3% | 28% | 30% | 29% |
| **ORH 7A-WB UoA** | **2015-16** | **2016-17** | **2017-18** | **2018-19** | **2019-20** | **5-year Average** |
| Commercial tows | 560 | 533 | 547 | 478 | 555 | 535 |
| Observed tows | 242 | 153 | 304 | 108 | 193 | 200 |
| % Observed tows | 43% | 29% | 56% | 23% | 35% | 37% |

ORH3B Chatham Rise

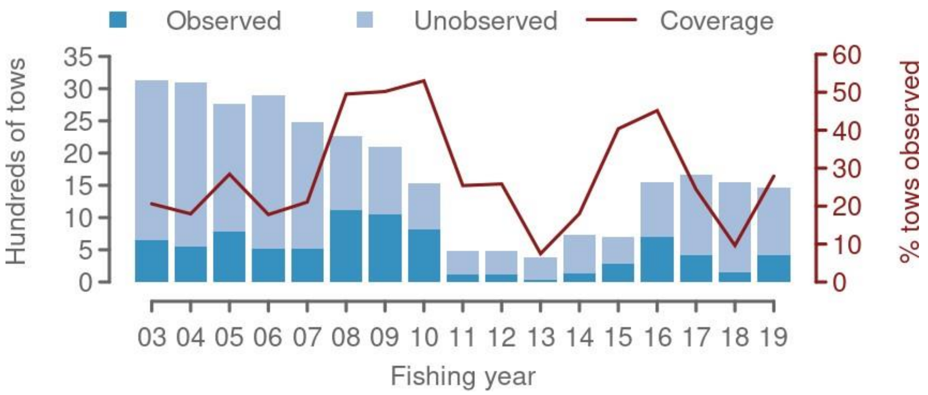



**Figure 1: Observer coverage and fishing effort in orange roughy fisheries in ORH 3B Chatham Rise (MPI, 2021). The most recent fishing year for which data are presented is 2018-19.**

## Retained & bycatch species

### EEZ catch analysis

The most recent available analysis of fish and invertebrate catch by New Zealand deepwater fisheries covers the period 1990-91 to 2016-17 (Finucci et al., 2019). Analysis of catch trends for 156 species/species groups taken by the orange roughy and oreo trawl fisheries over this period revealed the following (Table 2):

1. 69% of all species/species groups showed no detectable trend. This included all of the corals and crustaceans, 75% of the sponges, anemones and echinoderms, 60% of the cephalopods, 62% of the elasmobranchs (sharks, rays & chimaeras), 83% of the non-QMS teleosts and 46% of the QMS species.

2. 12% of all species/species groups showed a significant increase in abundance, including 25% of the sponges/anemones/echinoderms, 20% of the cephalopods, 20% of the elasmobranchs (sharks, rays & chimaeras) and 7% of the non-QMS teleosts.

3. 19% of all species/species groups showed a significant decrease in abundance, including 20% of all cephalopods, 18% of the elasmobranchs (sharks, rays & chimaeras), 11% of the non-QMS teleosts and 54% of the QMS species.

**Table 2: Bycatch trends (none/positive/negative) in all EEZ orange roughy and oreo trawl fisheries by taxon category for the period 1990-91 to 2016-17.**

| Taxon | Zero Bycatch Trend | | Positive Bycatch Trend | | Negative Bycatch Trend | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % |
| Corals | 7 | 100% | 0 | 0% | 0 | 0% |
| Sponge/anemone/echinoderm | 9 | 75% | 3 | 25% | 0 | 0% |
| Crustaceans | 4 | 100% | 0 | 0% | 0 | 0% |
| Cephalopods | 6 | 60% | 2 | 20% | 2 | 20% |
| Sharks/chimaeras | 28 | 62% | 9 | 20% | 8 | 18% |
| Rattail spp | 5 | 71% | 1 | 14% | 1 | 14% |
| Johnson's cod spp | 0 | 0% | 1 | 100% | 0 | 0% |
| Non-QMS teleost species/groups | 38 | 83% | 3 | 7% | 5 | 11% |
| QMS species/groups | 11 | 46% | 0 | 0% | 13 | 54% |
| **Totals** | **108** | | **19** | | **29** | |
| **%** | **69%** | | **12%** | | **19%** | |

A full list of all species/species groups assessed, by category (i.e. 'no catch trend', 'positive catch trend' and 'negative catch trend'), is provided in Appendix 1.

### UoA catch analysis

Catch composition by weight for each of the three UoAs was determined based on observer sampling data sourced from FNZ for the five-year period 2015-16 to 2019-20. The observer catch estimates are unadjusted.

NWCR UoA:

QMS species: Targeted orange roughy trawl tows account for 54.55% of the total estimated catch by weight. The two most abundant QMS bycatch species are smooth oreo (4.82%) and hoki (3.03%),(Table 3). There are no main primary species. The OEO4 management area for smooth oreo (reporting code SSO) overlaps the NWCR and ESCR UoAs. A 2019 stock assessment of SSO in OEO4 estimated $B_{2018}$ at 40%$B_0$ for the base model. $B_{2018}$ is 'About as Likely as Not (40-60%)' to be at or above the target of 40%$B_0$. Stock projections indicate there would be little change in biomass over the next five years at annual catches of 2,300 – 3,000 t (Cordue, 2019). The catch limit for SSO in OEO4 is currently 2,600 t (DWG, 2021).

**Table 3: NWCR UoA estimated catch composition of QMS species catch based on observer data, 2017-18 to 2019-20 (R. Tinkler, FNZ pers. comm.) Catches <0.01% of the total are excluded.**

| NWCR UoA QMS Species | Observer Estimated Catch (kg) | Observer Estimated Catch (%) |
|---|---|---|
| Orange roughy | 355,852 | 54.55% |
| Smooth oreo | 31,425 | 4.82% |
| Hoki | 19,784 | 3.03% |
| Hake | 2,806 | 0.43% |
| Pale ghost shark | 2,118 | 0.32% |
| Spiky oreo | 965 | 0.15% |
| Spiny dogfish | 957 | 0.15% |
| Ribaldo | 709 | 0.11% |
| Ling | 570 | 0.09% |
| Dark ghost shark | 446 | 0.07% |
| Smooth skate | 383 | 0.06% |
| Black oreo | 379 | 0.06% |
| Lookdown dory | 126 | 0.02% |
| Sea perch | 125 | 0.02% |
| Cardinalfish | 101 | 0.02% |
| White warehou | 59 | 0.01% |
| Alfonsino | 55 | 0.01% |
| **Totals** | **416,860** | **63.90%** |

Non-QMS species: Of the non-QMS finfish bycatch species, the rattail species complex (family Macrouridae), makes up 13.91% of the catch (Table 4). The rattail bycatch was consistent in 2017-18 and 2018-19 and showed a decline in 2019-20 (Fig. 2).

Rattail bycatch in all EEZ orange roughy fisheries has been variable over the 10-year period 2007-08 to 2016-17, with no detectable trend (Fig. 9). Finucci et al. (2019) found a significant negative catch trend for rattails reported under the generic species reporting code 'RAT', over the last 27 years. Biomass estimates for key rattail species, four-rayed rattail and Bollon's rattail, sampled from trawl biomass surveys on the Chatham Rise have been variable between 2010 and 2020, with no evident trend (Stevens et al., 2021), (Fig. 4).

Over 30 species of macrourid rattails are known to occur in the north Chatham Rise area (Roberts et al., 2015, Vol. 3), and a recent acoustic biomass survey in NWCR recorded nine rattail species taken during target identification tows on orange roughy spawning aggregations (Ryan & Tilney, 2017, Table 20). It is likely that increasing use of species-specific reporting codes in recent years may be behind the declining trend in the catch of rattail species reported using the generic code 'RAT'.

Johnson's cod (family Moridae), of which two species occur on the Chatham Rise, make up 5.8% of the catch (Table 4). Johnson's cod bycatch in the NWCR UoA showed no trend over the most recent three-year period for which data are available (Fig. 2). For orange roughy fisheries in the entire EEZ over the 10-year period 2007-08 to 2016-17, Johnson's cod bycatch showed no detectable trend and more-or-less mirrored that of rattails (Figure 3). Biomass estimates for Johnson's cods sampled from trawl biomass surveys on the Chatham Rise showed a sharp increase from 2011 to 2013 and has been stable through to 2020 (Stevens et al., 2021), (Fig. 5).

Over the 27-year time-series, Finucci et al. (2019) found a significant positive trend in Johnson's cod bycatch for orange roughy and oreo fisheries over the entire EEZ (Appendix 1).

**Table 4: NWCR UoA composition of non-QMS finfish catch based on observer data, 2017-18 to 2019-20 (R. Tinkler, FNZ pers. comm.)**

| NWCR UoA Non-QMS Finfish | Observer Estimated Catch (kg) | Observer Estimated Catch (%) |
|---|---|---|
| Rattails | 90,744 | 13.91% |
| Johnson's cod | 38,092 | 5.84% |
| Slickhead | 16,887 | 2.59% |
| Javelin fish | 10,041 | 1.54% |
| Smallscaled brown slickhead | 5,271 | 0.81% |
| Morid cods | 4,878 | 0.75% |
| Basketwork eel | 2,995 | 0.46% |
| Black slickhead | 505 | 0.08% |
| Toadfish | 463 | 0.07% |
| Bellowsfish | 192 | 0.03% |
| Toadfish | 182 | 0.03% |
| Hairy conger | 161 | 0.02% |
| Giant lepidion | 147 | 0.02% |
| Finless flounder | 122 | 0.02% |
| Conger eel | 96 | 0.01% |
| Banded bellowsfish | 90 | 0.01% |
| Small-headed cod | 78 | 0.01% |
| Bonyskull toadfish | 70 | 0.01% |
| Deepwater eel | 60 | 0.01% |
| Brown brotula | 58 | 0.01% |
| Hakes other | 53 | 0.01% |
| Oilfish | 49 | 0.01% |
| Giant stargazer | 41 | 0.01% |
| **Totals** | **171,275** | **26.25%** |

*Only catches ≥0.01% of the total are provided

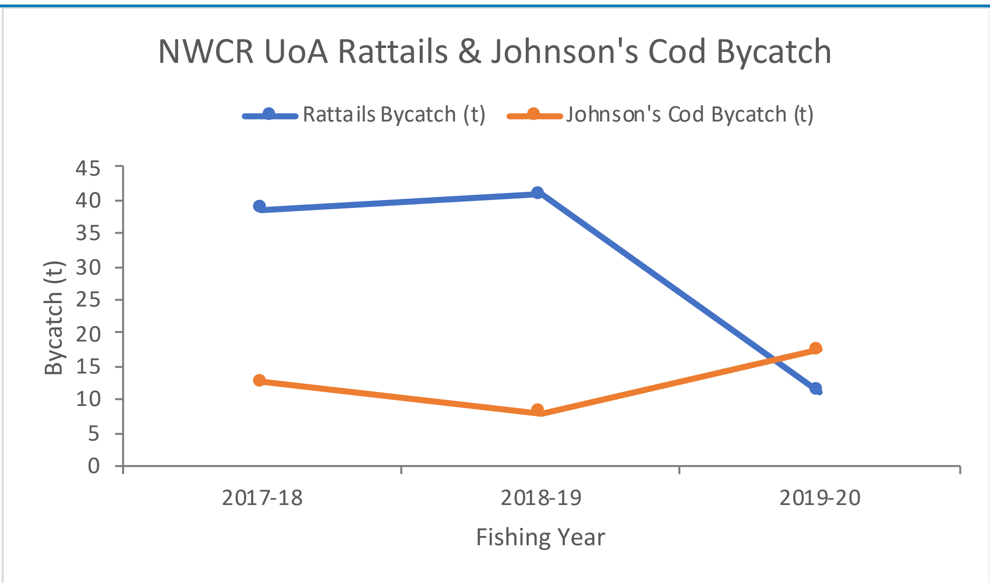



**Figure 2: Bycatch of rattail spp and Johnson's cod spp in the NWCR UoA 2017-18 to 2019-20.**

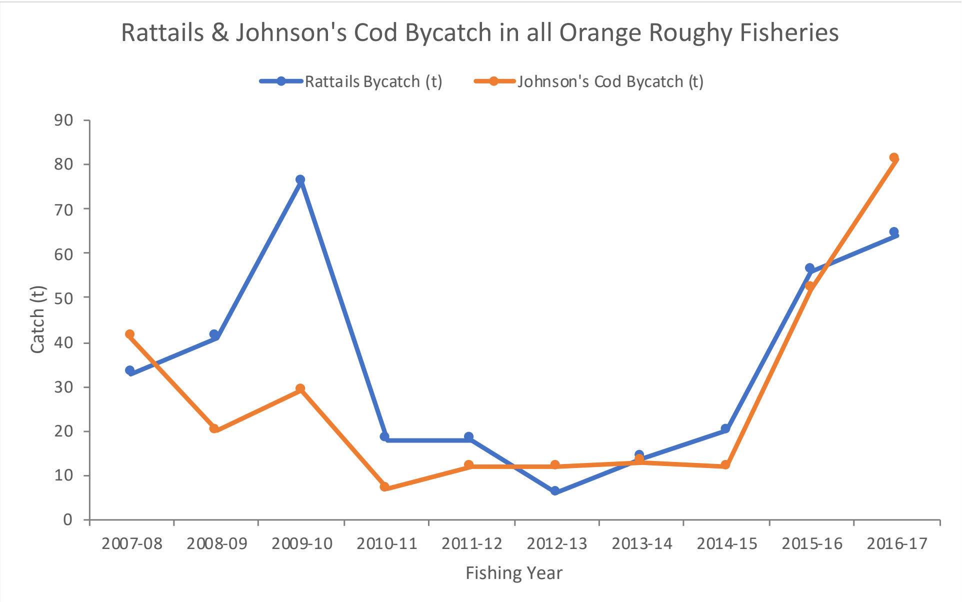



**Figure 3: Bycatch of rattail spp and Johnson's cod spp in all New Zealand orange roughy fisheries 2007-08 to 2016-17.**

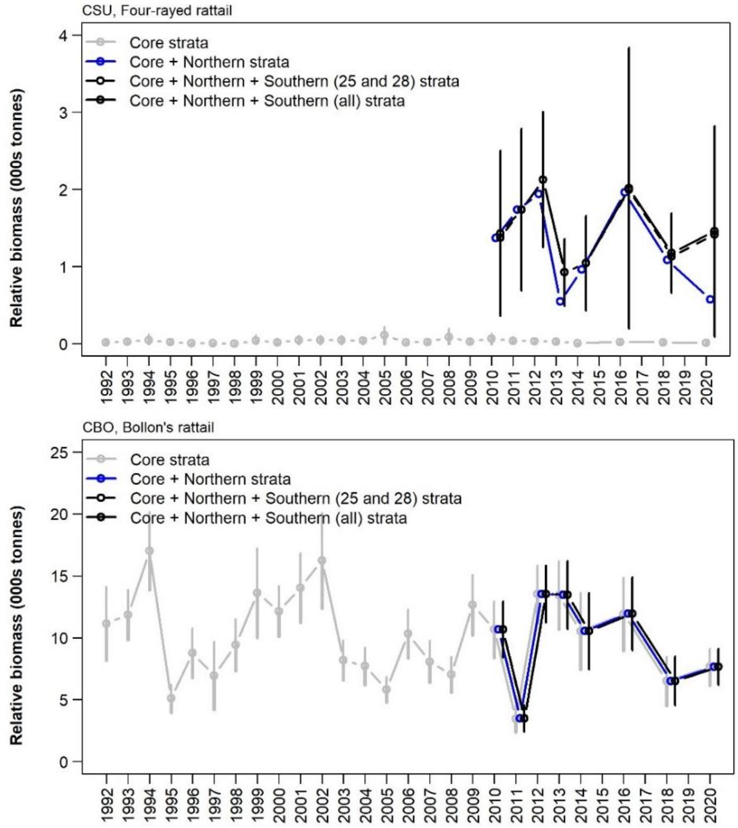



**Figure 4: Relative biomass estimates of four-rayed (above) and Bollon's (below) rattails sampled by annual Chatham Rise trawl surveys. Black solid lines, black dotted lines and blue solid lines are biomass estimates from the core strata plus northern and southern deep strata (Stevens et al., 2021).**

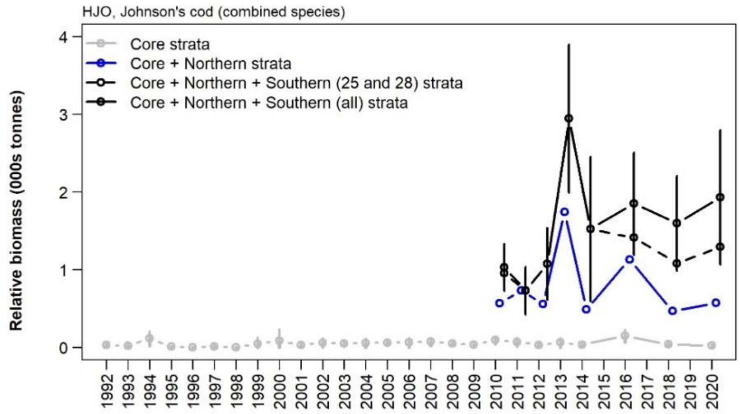



**Figure 5: Relative biomass estimates of Johnson's cods sampled by annual Chatham Rise trawl surveys. Black solid lines, black dotted lines and blue solid lines are biomass estimates from the core strata plus northern and southern deep strata (Stevens et al., 2021).**

The elasmobranch with the highest catch is the longnosed chimaera at 1.00% of the catch. The seal shark at 0.81%, is the next most abundant (Table 5). Finucci et al. (op cit.) found no significant trend in long-nosed chimaera bycatch in their 27-year catch analysis, while for seal shark there was a negative catch trend (Appendix 1). Seal shark is a deepwater demersal species that occurs widely over the continental shelf and slope of New Zealand. It has a depth range of 40 to 1800 metres but is more commonly found in depths between 450 and 850 metres. The Ministry has in the past consulted on whether seal shark should be incorporated into the QMS, but the level of concern around sustainability was deemed insufficient to do so (MFish, 2005). It has been noted that identification of seal sharks aboard fishing vessels has been poor and that past records may contain more than one species, which may account for the decreasing catch trend over time. Trawl survey indicators suggest that there has been no major change in the abundance of juvenile seal sharks over a long period, while adult seal sharks are not well monitored by the surveys (FNZ, 2018).

**Table 5: NWCR UoA composition of non-QMS elasmobranch and chimaerid catch based on observer data, 2017-18 to 2019-20 (R. Tinkler, FNZ pers. comm.).**

| NWCR UoA Non-QMS Elasmobranchs & Chimaerids | Observer Estimated Catch (kg) | Observer Estimated Catch (%) |
|---|---|---|
| Long-nosed chimaera | 6,518 | 1.00% |
| Seal shark | 5,292 | 0.81% |
| Deepwater dogfish other | 4,462 | 0.68% |
| Shovelnose spiny dogfish | 4,413 | 0.68% |
| Widenosed chimaera | 3,207 | 0.49% |
| Smooth skin dogfish | 2,715 | 0.42% |
| Baxters lantern dogfish | 2,410 | 0.37% |
| Longnose velvet dogfish | 2,288 | 0.35% |
| Plunket's shark | 1,502 | 0.23% |
| Chimaera, brown | 1,233 | 0.19% |
| Longnosed deepsea skate | 813 | 0.12% |
| Lucifer dogfish | 583 | 0.09% |
| Giant chimaera | 525 | 0.08% |
| Leafscale gulper shark | 380 | 0.06% |
| Deepwater spiny skate | 245 | 0.04% |
| Skate other | 142 | 0.02% |
| Catshark | 86 | 0.01% |
| Ghost shark other | 59 | 0.01% |
| Portugese dogfish | 40 | 0.01% |
| **Totals** | **36,913** | **5.66%** |

**Only catches ≥0.01% of the total are provided*

Invertebrates: Several species of starfish together comprise 1.26% of the catch (Table 6).

**Table 6: NWCR UoA composition of non-QMS invertebrate catch based on observer data, 2017-18 to 2019-20 (R. Tinkler, FNZ pers. comm.).**

| NWCR UoA Non-QMS Invertebrates | Observer Estimated Catch (kg) | Observer Estimated Catch (%) |
|---|---|---|
| Starfish | 8,205 | 1.26% |
| Warty squid | 6,022 | 0.92% |
| Armless stars | 1,144 | 0.18% |
| Sea cucumber | 520 | 0.08% |
| Sea urchin other | 342 | 0.05% |
| Echinothuriidae (family) | 297 | 0.05% |
| Deepsea anemone | 182 | 0.03% |
| Violet squid | 117 | 0.02% |
| Anemones | 90 | 0.01% |
| King crab | 75 | 0.01% |
| Jellyfish | 67 | 0.01% |
| Octopus | 43 | 0.01% |
| Squid Todarodes filippovae | 36 | 0.01% |
| **Totals** | **17,140** | **2.63%** |

**Only catches ≥0.01% of the total are provided*

Non-living material brought up in the nets comprises small quantities of rocks and wood (Table 7).

**Table 7: NWCR UoA catch of non-living matter based on observer data, 2017-18 to 2019-20 (R. Tinkler, FNZ pers. comm.).**

| NWCR UoA Non-living matter | Observer Estimated Catch (kg) | Observer Estimated Catch (%) |
|---|---|---|
| Rocks & stones | 8,731 | 1.34% |
| Wood | 448 | 0.07% |
| **Totals** | **9,179** | **1.41%** |

**Only catches ≥0.01% of the total are provided*

ESCR UoA:

QMS species: targeted orange roughy trawl tows account for 89.33% of the total estimated catch by weight (Table 8). The next-most abundant QMS species is smooth oreo at 4.30% of the catch. There are no main primary species.

**Table 8: ESCR UoA composition of QMS catches based on observer data, 2017-18 to 2019-20 (R. Tinkler, FNZ pers. comm.).**

| ESCR UoA QMS Species | Observer Estimated Catch (kg) | Observer Estimated Catch (%) |
|---|---|---|
| Orange roughy | 4,053,962 | 89.33% |
| Smooth oreo | 195,005 | 4.30% |
| Black oreo | 25,015 | 0.55% |
| Hoki | 22,849 | 0.50% |
| Ribaldo | 18,260 | 0.40% |
| Spiky oreo | 10,762 | 0.24% |
| Alfonsino | 4,025 | 0.09% |
| Cardinalfish | 1,779 | 0.04% |
| Pale ghost shark | 1,434 | 0.03% |
| Hake | 1,092 | 0.02% |
| Warty oreo | 907 | 0.02% |
| Ling | 369 | 0.01% |
| Smooth skate | 227 | 0.01% |
| **Totals** | **4,335,686** | **95.54%** |

**Only catches ≥0.01% of the total are provided*

Non-QMS species: the most abundant non-QMS finfish species, Johnson's cod (family Moridae) makes up 0.59% of the catch (Table 9). No single species exceeds 5% of the overall catch and none is therefore a minor primary species.

**Table 9: ESCR UoA composition of non-QMS catches based on observer data, 2017-18 to 2019-20 (R. Tinkler, FNZ pers. comm.).**

| ESCR UoA Non-QMS Finfish | Observer Estimated Catch (kg) | Observer Estimated Catch (%) |
|---|---|---|
| Johnson's cod | 26,760 | 0.59% |
| Morid cods | 20,062 | 0.44% |
| Slickhead | 16,335 | 0.36% |
| Smallscaled brown slickhead | 16,118 | 0.36% |
| Javelin fish | 8,195 | 0.18% |
| Basketwork eel | 7,250 | 0.16% |
| Rattails | 6,744 | 0.14% |
| Small-headed cod | 830 | 0.02% |
| Deepsea cardinalfish | 602 | 0.01% |
| Banded bellowsfish | 249 | 0.01% |
| **Totals** | **103,145** | **2.27%** |

Elasmobranchs: Unidentified deepwater sharks (0.31%) make up the largest elasmobranch catch. The single elasmobranch species with the greatest catch is shovelnose spiny dogfish (0.28%). The most abundant chimaerid is the longnosed chimaera at 0.04% of the catch (Table 10). No elasmobranch is therefore a minor primary species.

**Table 10: ESCR UoA composition of non-QMS elasmobranch and chimaerid catch based on observer data, 2017-18 to 2019-20 (R. Tinkler, FNZ pers. comm.).**

| ESCR UoA Non-QMS Elasmobranchs & Chimaerids | Observer Estimated Catch (kg) | Observer Estimated Catch (%) |
|---|---|---|
| Deepwater sharks other | 14,047 | 0.31% |
| Shovelnose spiny dogfish | 12,637 | 0.28% |
| Deepwater dogfish other | 8,876 | 0.20% |
| Seal shark | 6,146 | 0.14% |
| Baxters lantern dogfish | 6,136 | 0.14% |
| Longnose velvet dogfish | 3,598 | 0.08% |
| Long-nosed chimaera | 1,949 | 0.04% |
| Widenosed chimaera | 1,539 | 0.03% |
| Plunket's shark | 1,399 | 0.03% |
| Leafscale gulper shark | 1,093 | 0.02% |
| Smooth skin dogfish | 841 | 0.02% |
| Brown chimaera | 746 | 0.02% |
| Velvet dogfish | 515 | 0.01% |
| Catshark | 304 | 0.01% |
| Giant chimaera | 276 | 0.01% |
| Chimaera spp. | 256 | 0.01% |
| **Totals** | **60,358** | **1.33%** |
| **Totals** | **4,335,686** | **95.54%** |

**Only catches ≥0.01% of the total are provided*

Warty squid, at 0.63% of the catch, is the most abundant invertebrate species (Table 11).

**Table 11: ESCR UoA composition of non-QMS invertebrate catch based on observer data, 2017-18 to 2019-20 (R. Tinkler, FNZ pers. comm.).**

| ESCR UoA Non-QMS Invertebrates | Observer Estimated Catch (kg) | Observer Estimated Catch (%) |
|---|---|---|
| Warty squid | 28,762 | 0.63% |
| Sponges | 335 | 0.01% |
| **Totals** | **29,097** | **0.64%** |

**Only catches ≥0.01% of the total are provided*

Non-living material brought up in the nets includes small quantities of rocks and stones and miscellaneous rubbish and fishing textiles (Table 12).

**Table 12: ESCR UoA catch of non-living matter based on observer data, 2017-18 to 2019-20 (R. Tinkler, FNZ pers. comm.).**

| ESCR UoA Non-living matter | Observer Estimated Catch (kg) | Observer Estimated Catch (%) |
|---|---|---|
| Rocks & stones | 3,057 | 0.07% |
| Misc. rubbish | 2,004 | 0.04% |
| **Totals** | **5,061** | **0.11%** |

**Only catches ≥0.01% of the total are provided*

ORH 7A-WB UoA:

QMS species: targeted orange roughy trawl tows account for 93.17% of the total estimated catch by weight (Table 13). The next-most abundant QMS species is spiky oreo at 1.28% of the catch. There are therefore no main primary species.

**Table 13: ORH 7A-WB UoA composition of QMS catches based on observer data, 2017-18 to 2019-20(R. Tinkler, FNZ pers. comm.).**

| ORH 7A-WB UoA QMS Species | Observer Estimated Catch (kg) | Observer Estimated Catch (%) |
|---|---|---|
| Orange roughy | 2,285,065 | 93.17% |
| Spiky oreo | 31,304 | 1.28% |
| Ribaldo | 19,839 | 0.81% |
| Hake | 8,173 | 0.33% |
| Pale ghost shark | 3,156 | 0.13% |
| Cardinalfish | 2,317 | 0.09% |
| Hoki | 1,984 | 0.08% |
| Sea perch | 847 | 0.03% |
| Smooth oreo | 798 | 0.03% |
| Smooth skate | 460 | 0.02% |
| Rough skate | 315 | 0.01% |
| **Totals** | **2,354,258** | **95.99%** |

**Only catches ≥0.01% of the total are provided*

Non-QMS species: the largest non-QMS finfish component is the rattail species complex which makes up 0.91% of the catch (Table 14). No single species exceeds 5% of the overall catch and none is therefore a minor primary species.

**Table 14: ORH 7A-WB UoA composition of non-QMS finfish catch based on observer data, 2017-18 to 2019-20 (R. Tinkler, FNZ pers. comm.).**

| ORH 7A-WB UoA Non-QMS Finfish | Observer Estimated Catch (kg) | Observer Estimated Catch (%) |
|---|---|---|
| Rattails | 22,297 | 0.91% |
| Black slickhead | 4,593 | 0.19% |
| Smallscaled brown slickhead | 4,376 | 0.18% |
| White rattail | 3,591 | 0.15% |
| Morid cods | 3,461 | 0.14% |
| Johnson's cod | 2,977 | 0.12% |
| Slickhead | 2,063 | 0.08% |
| Cape scorpionfish | 1,169 | 0.05% |
| Basketwork eel | 572 | 0.02% |
| Javelin fish | 368 | 0.02% |
| Unicorn rattail | 266 | 0.01% |
| Pink frogmouth | 208 | 0.01% |
| Pale toadfish | 180 | 0.01% |
| Spinyfin | 170 | 0.01% |
| Deepwater eel | 139 | 0.01% |
| **Totals** | **46,430** | **1.89%** |

**Only catches ≥0.01% of the total are provided*

Unidentified deepwater sharks (0.40%) make up the largest elasmobranch catch. The most abundant chimaerid is the longnosed chimaera at 0.28% of the catch (Table 15). No elasmobranch is therefore a minor primary species.

**Table 15: ORH 7A-WB composition of non-QMS elasmobranch and chimaerid catch based on observer data, 2017-18 to 2019-20 (R. Tinkler, FNZ pers. comm.).**

| ORH 7A-WB UoA Non-QMS Elasmobranchs & Chimaerids | Observer Estimated Catch (kg) | Observer Estimated Catch (%) |
|---|---|---|
| Deepwater sharks other | 9,707 | 0.40% |
| Shovelnose spiny dogfish | 8,148 | 0.33% |
| Long-nosed chimaera | 6,843 | 0.28% |
| Deepwater dogfish other | 6,003 | 0.24% |
| Seal shark | 3,034 | 0.12% |
| Baxters lantern dogfish | 2,256 | 0.09% |
| Leafscale gulper shark | 2,205 | 0.09% |
| Smooth skin dogfish | 1,940 | 0.08% |
| Plunket's shark | 1,909 | 0.08% |
| Longnose velvet dogfish | 962 | 0.04% |
| Widenosed chimaera | 705 | 0.03% |
| Portugese dogfish | 512 | 0.02% |
| Skate other | 197 | 0.01% |
| Longnosed deepsea skate | 165 | 0.01% |
| Lucifer dogfish | 128 | 0.01% |
| **Totals** | **44,714** | **1.82%** |

**Only catches ≥0.01% of the total are provided*

Unidentified octopus species, at 0.05% of the catch, are the most abundant of the invertebrates (Table 16).

**Table 16: ORH 7A-WB UoA composition of non-QMS invertebrate catch based on observer data, 2017-18 to 2019-20 (R. Tinkler, FNZ pers. comm.).**

| ORH 7A-WB UoA Non-QMS Invertebrates | Observer Estimated Catch (kg) | Observer Estimated Catch (%) |
|---|---|---|
| Octopus | 1,315 | 0.05% |
| Warty squid | 666 | 0.03% |
| Squid other | 735 | 0.03% |
| Starfish | 492 | 0.02% |
| Deepsea anemone | 564 | 0.02% |
| Jellyfish | 133 | 0.01% |
| Squid Todarodes filippovae | 130 | 0.01% |
| Violet squid | 128 | 0.01% |
| **Totals** | **4,163** | **0.17%** |

**Only catches ≥0.01% of the total are provided*

Non-living material brought up in the nets includes small quantities of rocks and stones and miscellaneous rubbish (Table 17).

**Table 17: ORH 7A-WB UoA catch of non-living matter based on observer data, 2017-18 to 2019-20 (R. Tinkler, FNZ pers. comm.).**

| ORH 7B-WB UoA Non-living Matter | Observer Estimated Catch (kg) | Observer Estimated Catch (%) |
|---|---|---|
| Rocks & stones | 458 | 0.02% |
| Misc. rubbish | 337 | 0.01% |
| **Totals** | **795** | **0.03%** |

**Only catches ≥0.01% of the total are provided*

### Bycatch management strategy

Analyses of bycatch trends for deepwater fisheries are updated every four-to-five years. Where there are concerns around persistent observed declines for particular species, FNZ will, in consultation with stakeholders, propose bringing such species into the Quota Management System (QMS) so that TACCs can be set towards managing catches to sustainable levels.

The Fisheries Act 1996 allows for species to be brought into the QMS in order to effect improved management of species/stocks or to promote improved utilisation. progressive increase in the number of species and stocks incorporated into the QMS over time is testament to the implementation of this management approach.

Section 6 of the Fisheries Act 1996 allows the return of certain elasmobranchs to the sea if they are alive and likely to survive. Deepwater Schedule 6 species include: rough skate, smooth skate, spiny dogfish, mako shark, porbeagle shark and blue shark (Fisheries Act, 1996). Shark finning (i.e. retention of fins while returning carcasses to the sea) is prohibited by Regulation. To allow at-sea processing of QMS sharks aboard vessels, exceptions to the ‘fins attached’ requirement is provided for seven species. Landings of these shark species are subject to strictly applied ratios of shark fin weights to greenweights (FNZ, 2020b).

### Bycatch information

Vessels routinely report catch estimates for the top five most abundant non-QMS bycatch species on a tow-by-tow basis. FNZ’s fishery observers monitor and report total bycatch composition on a tow-by-tow basis. As observer coverage has averaged around 30% in the three UoA fisheries over the recent five-year period (Table 1), representative information is being collected on an ongoing basis to inform bycatch trends. Information on catch composition from regular research trawl biomass surveys adds to the information base on bycatch abundance.  Analyses of bycatch trends for deepwater fisheries are updated every four-to-five years.

### ETP species

All fishing vessels are required by law to report all captures of Endangered, Threatened and Protected (ETP) species to the Ministry for Primary Industries on Non-Fish Protected Species forms (FNZ, 2019).

Information on incidental captures of ETP species, reported by vessels and by MPI observers, is summarised in the Aquatic Environment and Biodiversity Annual Review report (FNZ 2020d), and for ETP species other than corals on MPI's Protected Species website (MPI, 2021). The latter provides open access to multi-year records of ETP species captures by fishery sector and fishing method, based on MPI observer data, and is updated annually through FNZ's Science Working Group process.

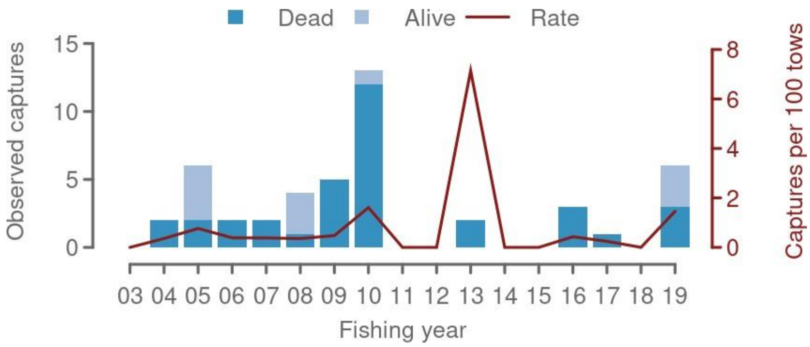
In addition to MPI's scientific observer programme, a range of management measures, including some industry-led, non-regulatory initiatives, are employed to monitor environmental interactions in deep water fisheries and to reduce the risk of any adverse effects on protected species populations. Responsibilities relating to the mitigation and monitoring of ETP species are described in DWG's Operational Procedures (DWG, 2021) and Vessel Management Plans for mitigating seabird captures. Ministry Operational Plans additionally prescribe mitigation requirements for application in fisheries at high risk of capturing ETP species. For example, in the squid and southern blue whiting trawl fisheries these include a limit on the number of sea lion mortalities during the fishing season and a requirement for the use of sea lion excluder devices in (DWG, 2019a). The orange roughy trawl fisheries are deemed to be low-risk in relation to captures of ETP seabirds, marine mammals and sharks.

#### Seabirds

Observed incidental seabird captures are used to model the estimated number of annual captures based on the total number of trawl tows undertaken. The estimated number of captures does not discriminate between birds killed and birds released alive. The proportion of birds released alive has increased in recent years as the main type of interaction has shifted from warp strikes (all fatal) to net captures (varying degrees of mortality but rarely less than 30% released alive. It is acknowledged that some birds released alive may not survive injuries sustained and, for modelling purposes, the Spatially Explicit Fisheries Risk Assessment (SEFRA),(Richard et al., 2017) assumes 50% of released alive birds will not survive. Net captures frequently involve birds foraging on top of the net when it's on the surface on hauling and getting their heads or feet tangled in the meshes. Practical solutions are being sought to resolve these net captures.

The orange roughy fisheries have a negligible impact on seabird populations, with only ten observed captures in the Chatham Rise UoAs and three observed captures in the ORH 7A UoA over the recent 5-year period. In 2018–19 the six observed seabird captures in the ORH 3B UoAs were four Chatham Island albatross (of which two were released alive), one white-chinned petrel, and one common diving petrel (released alive). In 2018–19 there were no observed captures of seabirds in the ORH 7A UoA and no estimates of total captures were made (Fig. 6).

**ORH 3B Chatham Rise**




**ORH 7A**

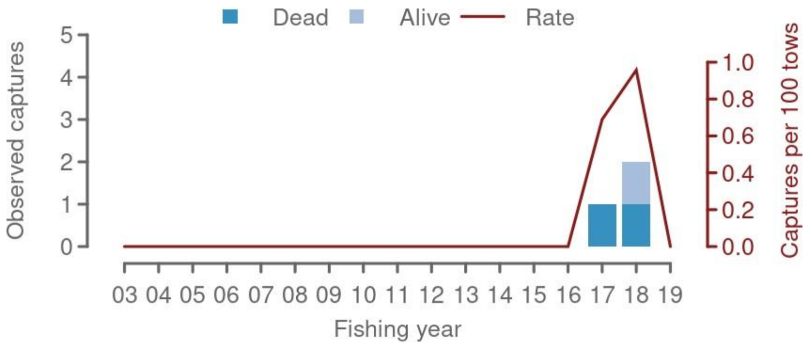



**Figure 6: Observed seabird captures in the ORH 3B UoAs on the Chatham Rise (top) and in the ORH 7A UoA (bottom), (MPI, 2021).**

New Zealand's National Plan of Action Seabirds (FNZ, 2020c, 2020d) informs the regulatory requirements for seabird mitigation, applicable to all trawlers 28 metres or greater in length. These include:

- Deployment of at least one type of seabird scaring device during all tows (i.e. bird bafflers, tori lines or warp deflectors)
- Management of fish waste discharge so as not to attract seabirds to risk areas (i.e. no discharge during shooting/hauling; mincing and batch-discharge while towing; installation of mincers/hashers/batching tanks/meal plants; gratings/trap systems to reduce fish waste discharge through scuppers/sump pumps)
- Seabird risk associated with trawl nets is minimised by:
  - Removal of stickers before shooting
  - Minimising the time fishing gear remains at/near the surface
  - Seabirds caught alive in/on the net are correctly handled and released to ensure maximum chance of survival.
- Seabird risk associated with deck landings and vessel impacts is minimised by:
  - Ensuring deck lighting does not attract/disorientate seabirds
  - Prompt removal of fish waste from the deck
  - Seabirds that land on the deck or impact with the vessel are correctly handled and released to ensure maximum chance of survival.

**DWG Liaison Programme for ETP seabirds, marine mammals and shark species risk management**

DWG employs an Environmental Liaison Officer (ELO) who visits factory vessels and fresh fish trawlers involved in all deepwater fisheries to:

- Deliver PowerPoint-assisted training courses to senior crew (and at times vessel managers) on the need for ETP species capture mitigation and on best practice mitigation methods
- Provide training material on best practice environmental operations and procedures and ensure updated versions of all OPs are on each vessel
- Check that VMP's are updated and appropriate for each vessel's fishing operations
- Physically check their seabird mitigation equipment is fit-for-purpose and functional and ensure officers and crew are aware of the need to maintain conformance with offal control and mitigation systems to reduce seabird interactions.
- Be on-call 24/7 for any communications or requests for support, including trigger capture events
- Compare fishery information with that from observers to ensure the best information is available regarding the nature of significant capture events.

The ELO additionally visits any vessel that has reported trigger-point captures in order to assess the possible reasons for the captures, whether they could have been prevented, and to educate the skipper on how to reduce the risk of such events re-occurring (Cleal, 2019, 2020). While all deepwater trawl vessels are visited each year, including orange roughy vessels, the orange roughy fleet is not singled out for any specific attention as it is not associated with a high level of ETP seabird or marine mammal interactions.

In summary, the existing seabird mitigation strategy applied by the orange roughy trawl fisheries has a high probability of ensuring the UoAs neither hinder nor threaten the recovery of any seabird populations.

**New Zealand fur seal**

There has been only one observed fur seal capture by an orange roughy vessel in recent years (Fig. 7).

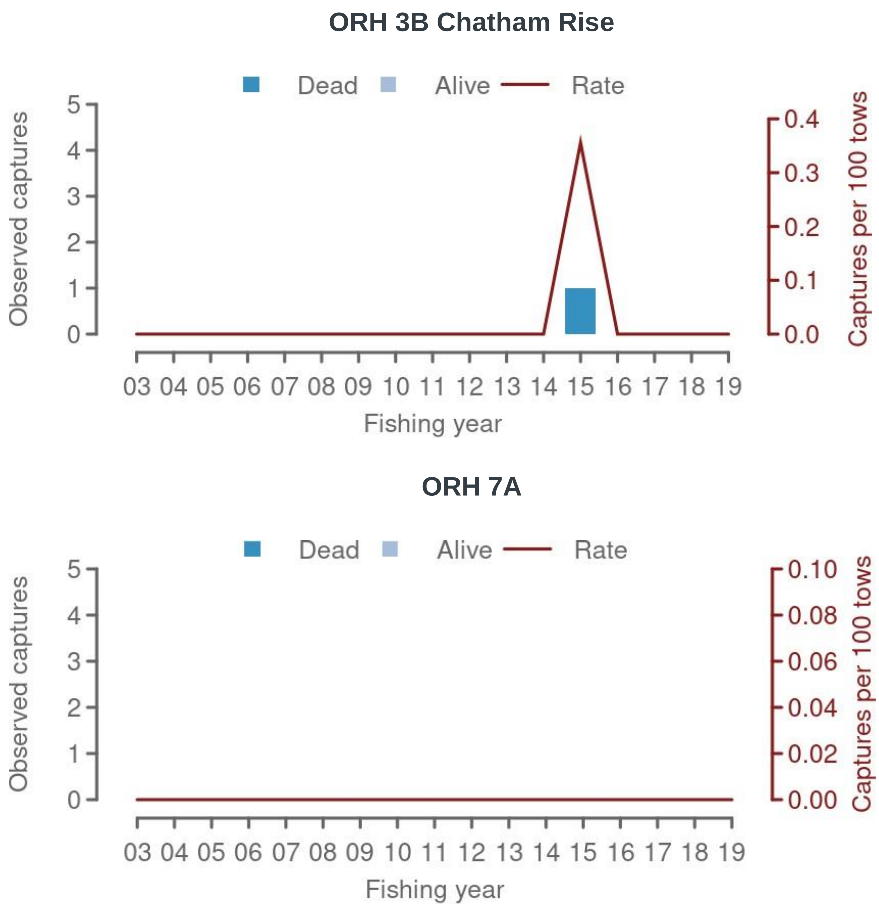



**Figure 7: Observed New Zealand fur seal captures by orange roughy trawl fisheries on the Chatham Rise (top) and in ORH 7A (bottom), 2002-03 to 2018-19 (MPI, 2021).**

### New Zealand sea lion

There have been no observed or reported captures of a New Zealand sea lion by any orange roughy trawl fisheries during the period 2003-03 to 2018-19 (Fig. 8), (MPI, 2021).

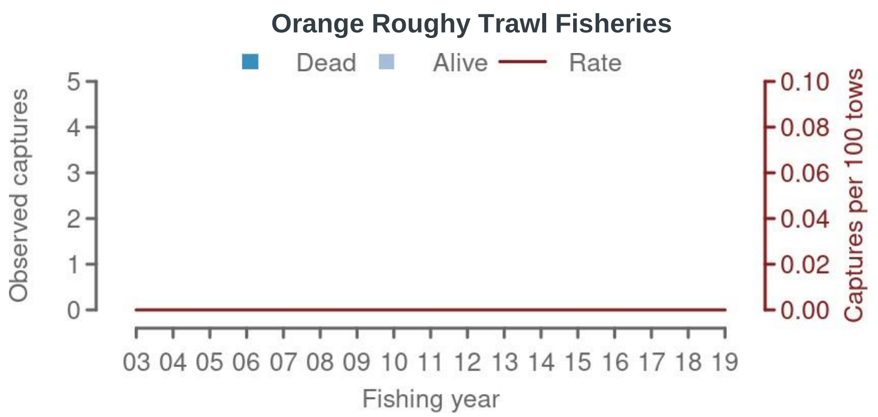



**Figure 8: Observed New Zealand seal lion captures by orange roughy trawl fisheries, 2002-03 to 2018-19 (MPI, 2021).**

## Whales & dolphins

There have been no observed or reported captures of whales or dolphins by orange roughy UoA trawl fisheries during the period 2003-03 to 2018-19 (Fig. 9), (MPI, 2021).

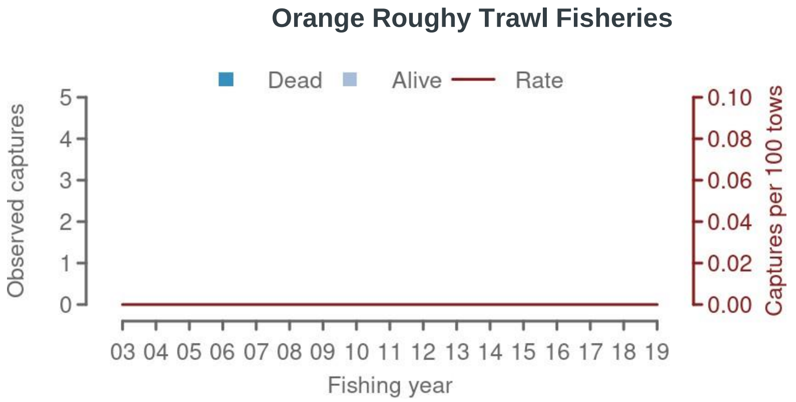



**Figure 9: Observed whale and dolphin captures by orange roughy trawl fisheries, 2002-03 to 2018-19 (MPI, 2021).**

## Sharks

A single basking shark was captured in the NWCR UoA, during 2018-19 (R. Tinkler, FNZ pers. comm.).

## Turtles

There have been no observed or reported captures of turtles by orange roughy UoA trawl fisheries during the period 2003-03 to 2018-19 (Fig. 10), (MPI, 2021).

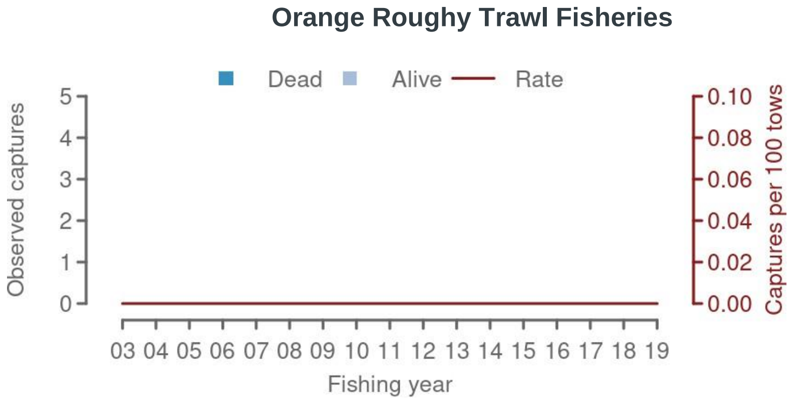



**Figure 10: Observed turtle captures by orange roughy trawl fisheries, 2002-03 to 2018-19 (MPI, 2021).**

## ETP Corals

### Distribution of corals and other sessile benthos

Of the approximately 420 species of corals in New Zealand waters, the majority are distributed globally and around 25% are endemic (Consalvey et al., 2006). Around 83% are solitary (i.e. not habitat forming), occurring in small, patchily distributed, individual colonies throughout the EEZ (Cairns 1995). Only 3% are reef-forming stony corals, which form beds and reefs (e.g. *Goniocorella dumosa*, *Solenosmilia variabilis, Enallopsammia rostrata* and *Madrepora oculata*), which are habitat forming and provide refugia to other organisms (Consalvey et al., op. cit.). These matrix (i.e. coral bed), and reef-building corals span depths from 70 – 2,850 m in New Zealand waters (Finucci et al., 2019), occurring both shallower and deeper than the orange roughy fishing grounds. In other oceans, these scleractinian stony corals have been found down to depths of over 6,000 m (Cairns, 1995 in Consalvey et al., 2006).

Underwater images have demonstrated that corals occur in discrete locations on both flat habitat and on knolls and hills. Most often, corals are seen to be in groups or clumps rather than as contiguous beds or reefs covering large areas (e.g. Clark et al., 2015).

**Outcome status -** It is apparent that the MSC Standard v2.0 for ETP species management was not drafted with species such corals in mind. For ETP corals, the Standard requires demonstration that there is a less than 30% probability that the fishery will cause "*serious or irreversible harm to 'structure or function' of the habitat*" (i.e. to below "*80% of its unimpacted structure, biological diversity and function"*). Considering the very slow regeneration time for corals the only feasible management intervention, towards the objective of ensuring *"the impact of the UoA is low enough that if the species is capable of improving its status, the UoA will not hinder that improvement*", is to effect area closures where necessary.

Observed and estimated ETP coral catches in the three UoAs during the period 2013-14 to 2019-20, based on observer records, show the following (Tables 18 – 20) (data provided by R. Tinkler, FNZ):

- NWCR – estimated annual coral catches range from 98 - 428 kg, with no apparent trend
- ESCR – estimated annual coral catches range from 90 – 19,134 kg, with lower catches in 2018-19 and 2019-20. There was an anomalously high estimate of dead coral rubble in 2015-16, of 17,899 kg
- ORH7B-WB – estimated annual coral catches range from 18 – 116 kg, with no apparent trend

Note that the catchability of corals by trawl nets has yet to be reliably established. The above estimates may be conservative given that some captured coral is likely to fall through the meshes. Work is ongoing to establish a credible catchability coefficient for trawl nets (e.g. by SPRFMO), (Pitcher et al., 2019).

**Table 18: ORH3B NWCR observed and estimated ETP coral catch (kg), 2013-14 to and 2019-20 (R. Tinkler, FNZ, pers. comm.).**

| Common / scientific name | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 | 2018-19 | 2019-20 |
|---|---|---|---|---|---|---|---|
| Black coral - generic | | | | | 0.3 | | |
| Black coral - *Leiopathes* spp. | | | | | 0.3 | | |
| Black coral - *Parantipathes* spp. | | | | | 0.3 | | |
| Stony coral - generic | | | | 10 | | | |
| Stony coral - bushy hard | | | 11.3 | | | | |
| Stony coral branching | | 43 | | | | | |
| Stony coral - solitary bowl | | | 1 | 1 | | 6 | |
| Stony coral - cup *Flabellum* sp. | | | | | 1 | | 2 |
| Stony coral – *D. dianthus* | | | | | 3.4 | | |
| Gorgonian coral - generic | | | | | 0.4 | | 1 |
| Gorgonian coral - bamboo | | | | | | | 3 |
| Gorgonian coral - golden | | | | | | | 1 |
| Coral - unspecified | | | 37.1 | | 0.1 | | |
| Coral rubble - dead | | | 50 | | 1.7 | | |
| **ETP coral totals (kg)** | **0** | **43** | **99.4** | **11** | **7.5** | **6** | **7** |
| **No. observed tows** | **34** | **117** | **91** | **100** | **123** | **61** | **61** |
| **Observer coverage (% tows)** | **15%** | **44%** | **23%** | **22%** | **31%** | **28%** | **36%** |
| **No. tows** | **221** | **266** | **392** | **456** | **392** | **220** | **171** |
| **Estimated coral catch (kg)** | **0.0** | **97.8** | **428.2** | **50.2** | **23.9** | **21.6** | **19.6** |
| **Est. coral catch/100 tows (kg)** | **0.0** | **36.8** | **109.2** | **11.0** | **6.1** | **9.8** | **11.5** |

Table 19: ORH3B ESCR observed and estimated ETP coral catch (kg), 2013-14 to 2019-20 (R. Tinkler, FNZ, pers. comm.).

| Common / scientific name | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 | 2018-19 | 2019-20 |
|---|---|---|---|---|---|---|---|
| Black coral - generic | 1 | | 3.9 | 10 | | 2 | 5 |
| Black coral - *Antipathes* spp. | | | | | | | 2 |
| Black coral - *Bathypathes* spp. | | | | | | | 1 |
| Black coral - *Leiopathes secunda* | | | | 1 | | 2 | |
| Black coral - *Lillipathes* spp. | | 0.2 | | | | | |
| Stony coral - generic | 2.3 | | | | | | 1 |
| Stony coral - bushy *G. dumosa* | 30 | 2.2 | 6.6 | 52.6 | | 3 | 1 |
| Stony coral - *Madrepora oculata* | | | | | | 1 | |
| Stony coral - *Desmophyllum dianthus* | | | 122 | 0.5 | | | |
| Stony coral - *Solenosmilia variabilis* | | | 0.1 | | | | 2 |
| Stony coral - *Dendrophyllia* sp. | | 7 | | 4 | | 7 | 1 |
| Stony coral – solitary cup | | | | | | 1 | 7 |
| Stony coral – bowl *S. platypus* | | | 2 | 4.4 | | 2 | 10 |
| Gorgonian coral - generic | 0.3 | | 0.1 | 0.5 | | 3 | 4 |
| Gorgonian coral - *Thourella* sp. | | 0.4 | | | | | |
| Gorgonian coral - bamboo | | | | | | 4 | 12 |
| Gorgonian coral - *Keratoisis* sp. | 0.3 | 1 | 2 | 1.8 | | | |
| Gorgonian coral - bamboo Isididae | | | 0.7 | | | | |
| Gorgonian coral - *Paragorgia* spp. | | | 5 | 136 | | 3 | 8 |
| Gorgonian coral - *Primnoa* sp. | | | | | | | 1 |
| Gorgonian coral – *Gorgonoceph*. spp | | | 0.4 | | | | |
| Gorgonian coral - *Corallium* spp. | | | 1 | 1 | | | |
| Gorgonian coral - *Chrysogorgia* spp. | | 0.1 | | | | | |
| Hydrocoral - red *Errina* sp. | | | | 0.5 | | | 1 |
| Hydrocoral - *Lepidotheca* spp. | | 0.2 | 500 | | | | |
| Hydrocoral - feathery | | | | | | | 3 |
| Coral - unspecified | 7.8 | 12.7 | 57 | 15 | | 11 | 5 |
| Coral rubble | 200 | | | | | 1 | 1 |
| Coral rubble - dead | | | 10,042 | | | | |
| **ETP coral totals (kg)** | **241.7** | **23.8** | **10,743** | **227.3** | **0** | **40** | **64** |
| **No. observed tows** | **168** | **254** | **690** | **324** | **49** | **411** | **472** |
| **Observer coverage (% of tows)** | **18%** | **26%** | **56%** | **27%** | **4%** | **33%** | **35%** |
| **No. tows** | **935** | **964** | **1,229** | **1,179** | **1249** | **1247** | **1358** |
| **Estimated coral catch (kg)** | **1,345** | **90.3** | **19,134** | **827.1** | **0.0** | **121.4** | **184.1** |
| **Est. coral catch/100 tows (kg)** | **143.9** | **9.4** | **1556.9** | **70.2** | **0.0** | **9.7** | **13.6** |

deepwater group

**Table 20: ORH7A-WB observed and estimated ETP coral catch (kg) in 2018-19 and 2019-20 (R. Tinkler, FNZ, pers. comm.).**

| Common / scientific name | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 | 2018-19 | 2019-20 |
|---|---|---|---|---|---|---|---|
| Black coral - generic | | 4.4 | 6.6 | | | 3 | 10 |
| Black coral - *Bathypathes* spp. | | | | | 4.8 | 7 | |
| Black coral - *Dendropathes* spp. | | | | | 1.4 | | 2 |
| Black coral - *Dendrobathypathes* spp. | | | 0.5 | | 1 | | 1 |
| Black coral - *Leiopathes secunda* | | 2 | 6 | | | 1 | |
| Black coral - *Leiopathes* spp. | | | 1.9 | | | | |
| Black coral – Triadopathes spp. | | | | | | 1 | |
| Stony coral - generic | | | 0.1 | 25 | | | 1 |
| Stony coral - branching *E. rostrata* | | 1 | | | | | |
| Stony coral - solitary bowl *S. platypus* | | | 1.2 | | 0.1 | | 3 |
| Gorgonian coral - generic | | | 0.2 | 8.1 | 3 | | 3 |
| Gorgonian coral - *Keratoisis* spp. | | 0.2 | 0.5 | | | | |
| Gorgonian coral - Isididae | | 1 | 0.2 | | | | |
| Gorgonian coral - *Lepidisis* spp. | | | | | 0.9 | | |
| Gorgonian coral - bamboo generic | | | | | | 1 | 4 |
| Gorgonian coral - bottlebrush | | | | | | | 3 |
| Gorgonian coral – *Gorgonoceph.* spp. | | | 0.4 | | 0.6 | | |
| Gorgonian coral - *Callogorgia* spp. | | | | | | | 1 |
| Gorgonian coral - *Chrysogorgia* spp. | | 0.1 | | | 0.1 | 1 | |
| Gorgonian coral - *Metallogorgia* spp. | | | | | 1.4 | 1 | |
| Hydrocoral – red *Errina* sp. | | | | | | | 1 |
| Coral - unspecified | | | | | | 4 | |
| **ETP coral totals (kg)** | **0** | **8.7** | **17.6** | **33.1** | **13.3** | **19** | **29** |
| **No. observed tows** | **11** | **52** | **242** | **153** | **402** | **108** | **193** |
| **Observer coverage (% of tows)** | **8%** | **7%** | **43%** | **29%** | **73%** | **23%** | **35%** |
| **No. tows** | **136** | **696** | **560** | **533** | **547** | **478** | **555** |
| **Estimated coral catch (kg)** | **0.0** | **116.4** | **40.7** | **115.3** | **18.1** | **84.1** | **83.4** |
| **Est. coral catch/100 tows (kg)** | **0.00** | **16.7** | **7.3** | **21.6** | **3.3** | **17.6** | **15.0** |

The observer-reported coral catches indicate that encounters by the fisheries are occasional, suggesting that corals are patchily distributed in these areas.

### Vessel-reported coral catches:

Vessels are required by Regulation to report all protected species captures using Non-Fish Protected Species forms, whether or not an observer is aboard. NFPS records for 2018-19 and 2019-20 show that for ESCR, vessels reported considerably more coral catch than observers, while in NWCR and ORH7A-WB the raised observer-reported catches were higher than the vessel-reported catches (Table 21).

**Table 21: Observer-reported and vessel-reported coral catch (kg), 2018-19 and 2019-20 (R. Tinkler, FNZ, pers. comm.)**

| UoA | Observer-reported (raised) | | | Vessel-reported | | |
|---|---|---|---|---|---|---|
| | 2018-19 | 2019-20 | Average | 2018-19 | 2019-20 | Average |
| NWCR | 21.6 | 19.6 | **20.0** | 7.5* | 2.0 | **4.8** |
| ESCR | 121.4 | 175.5 | **149.0** | 690.7 | 592.3 | **641.5** |
| ORH7A-WB | 75.2 | 74.8 | **74.1** | 11.9 | 9.2 | **10.5** |

*Note: Excludes a single catch comprising rocks, mud, sponges and corals, estimated at 2,500 kg and erroneously reported using code CSB 'mixed corals, sponges and bryozoans'.

### EEZ coral catch:

The estimated average annual coral catch by ORH/OEO targeted fisheries over the entire EEZ over the last three years, calculated using observed coral captures raised on the basis of observer coverage rates, amounts to ~2,135 kg. Averaged over all tows, the estimated coral capture per tow amounts to 650 g on UTFs and 350 g on flat habitat. Averaged over tows that caught coral, the estimated coral capture per tow amounts to 4.8 kg on UTFs and 3.5 kg on flat habitat. For the HOK/HAK/LIN targeted fisheries, averaged over all tows the estimated coral catch per tow was 10 g, and 1.4 kg if averaged over tows that caught coral (Table 22).

**Table 22: Numbers of targeted tows, observer coverage rates and estimated average annual coral capture by ORH/OEO and HOK/HAK/LIN fisheries in the entire EEZ, 2017-18 to 2019-20 (R. Tinkler, FNZ, pers. comm.).**

| Category | ORH/OEO | | HOK/HAK/LIN |
|---|---|---|---|
| | UTFs | flats | flats |
| No. tows | 1,020 | 4,199 | 13,332 |
| Observer coverage (%) | 18% | 23% | 36% |
| Observed tows with coral (%) | 13% | 10% | 1% |
| Estimated coral capture (kg) | 662 | 1,473 | 139 |
| Estimated coral capture per tow (kg) | 0.649 | 0.351 | 0.010 |
| Estimated coral capture per coral tow (kg) | 4.837 | 3.534 | 1.352 |

### Coral capture by habitat type

Analysis of coral capture data by UoA and by habitat type shows the following:

- Overall, between 3% - 6% of all tows resulted in coral capture
- On UTF habitat, between 2% - 7% of tows resulted in coral capture
- On flat habitat, between 4% - 6% of tows resulted in coral capture
- The proportion of coral catch taken on UTF habitat was variable between 10% in NWCR, to 19% in ORH7A-WB and 68% in ESCR (Table 23).

It is evident that, in relation to total fishing effort, coral captures are infrequent events in the three UoAs.

**Table 23: Average annual numbers of coral tows and coral capture (kg) reported by observers (unraised) and vessels by habitat type and UoA over the period 2017-18 to 2019-20 (Black & Easterbrook-Clark, 2021).**

| Category | ORH7A - WB | ORH3B NWCR | ORH3B ESCR |
|---|---|---|---|
| Average annual coral catch (kg) | 15.36 | 33.58 | 511.13 |
| Annual average no. coral tows | 25 | 12 | 43 |
| % of tows that caught coral | 6% | 4% | 3% |
| Annual average coral catch on UTFs (kg) | 2.95 | 3.33 | 349.25 |
| % of coral catch on UTFs | 19% | 10% | 68% |
| Annual average no. coral tows on UTFs | 3 | 1 | 19 |
| % of tows that caught coral on UTFs | 7% | 2% | 3% |
| Annual average coral catch on flat (kg) | 12.41 | 30.24 | 161.88 |
| % of coral catch on flat | 81% | 90% | 32% |
| Average annual no. coral tows on flat | 22 | 11 | 24 |
| % of tows that caught coral on flat | 6% | 5% | 4% |

### Assessment of trawling interactions

A key tool for assessing the probable effects of trawl fishing on ETP coral communities has been to assess the extent of overlap between the fishery footprint and areas where corals are known to occur (i.e. the observed coral distribution). Bottom trawl records for all tows that targeted ORH, OEO and HOK within the UoA areas over the recent three-year period 2017-18 to 2019-20 were plotted against Observer-reported, vessel-reported and Research coral datasets (the 'observed' coral distribution), using GIS to determine the overlap within the ORH habitat depth range of 800 – 1,600 m.

The method involves coral capture localities being expressed as areas of 1 km x 1 km in extent, which are then overlaid with the recent trawl footprint to provide an indication of probable fishery impact. However, the 'observed' coral dataset is not representative of the overall distribution of corals because the majority of the records originated from the fishing grounds.

The Research dataset, while not restricted to the trawl grounds, cannot be assumed to be representative of the distribution over the entire extent of the Chatham Rise UoAs, either by area or depth, as it is predominantly based on trawl survey records, which have the objective of assessing the biomass of fished stocks and not the nature and extent of epibenthic fauna. These are strong reasons not to rely solely on the 'observed' coral distribution as a basis for assessing the impact of UoA fisheries on corals.

There is evidence that many of New Zealand's deepwater protected corals occur deeper than the maximum depths currently fished (i.e. ~1,400 m), with maximum depth records as follows (Finucci et al., 2019):

- Black corals – 2,440 m
- Gorgonian octocorals - ~2,990 m
- Scleractinian stony corals - 2,860 m
- Hydrocorals - ~2,530 m.

Global databases show depth distributions down to 5,000 m for coral genera that occur in the New Zealand region (Cairns, 1991, 1995; Finucci et al., op. cit.). Given the comparatively narrow depth range used in the assessment of fishery impacts on protected New Zealand deepwater corals, the estimated fishery impact will be over-estimated in relation to their overall distribution.

The overlap between the ORH/OEO fisheries and coral habitat in the three UoAs was estimated by plotting the trawl footprint against modelled coral distributions.

The Observer-reported coral catch composition for the years 2013-14 to 2019-20 showed the following:

- NWCR – unspecified coral, stony coral and coral rubble were reported in roughly equal quantities and formed the bulk of the coral catch. Small quantities of gorgonian and black corals were recorded
- ESCR – by far the bulk of the coral catch was dead coral rubble. Small quantities of hydrocoral, gorgonian coral, stony coral and black coral and live coral rubble were recorded
- ORH7A-WB – Black coral, stony coral and gorgonian coral formed the bulk of the coral catch. Small quantities of hydrocorals and unspecified corals were recorded (Fig. 11).

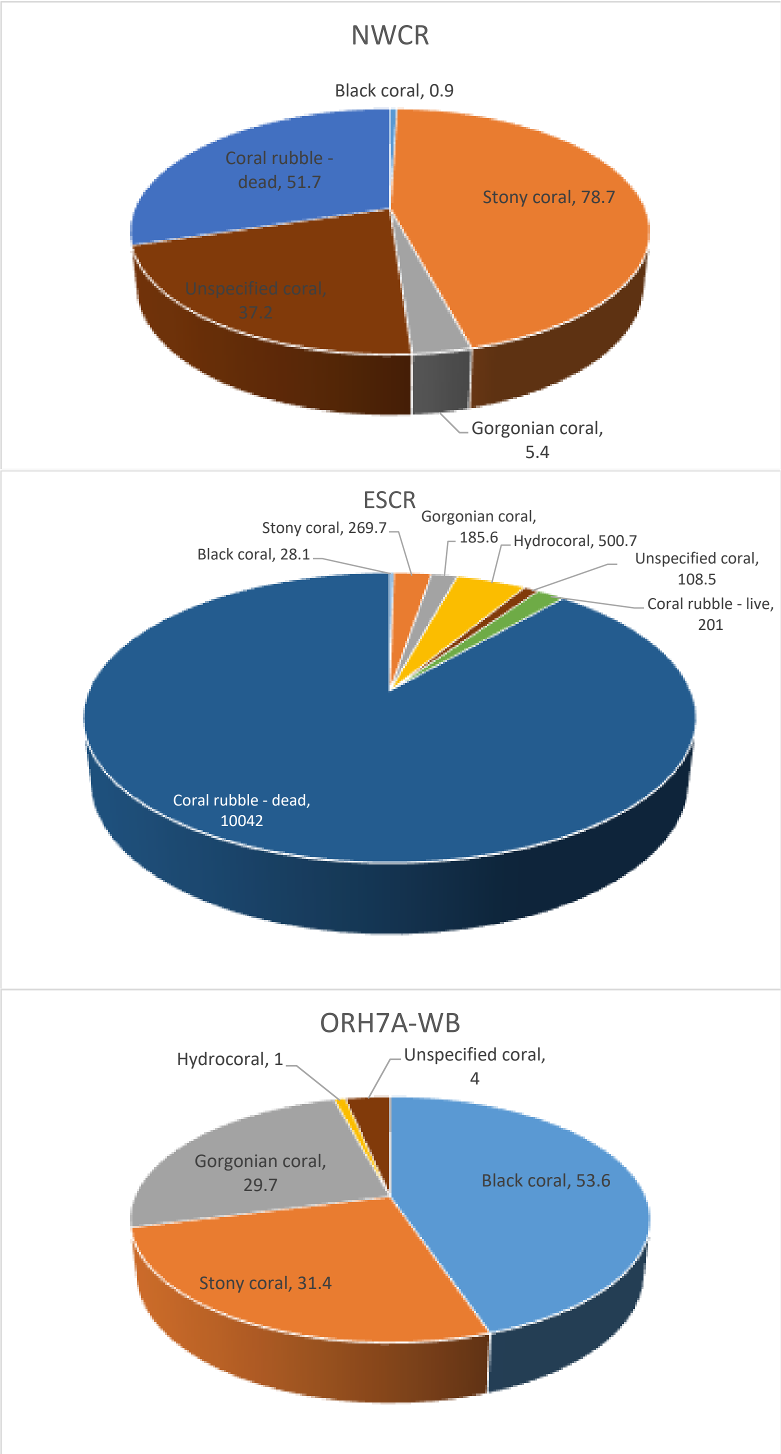



**Figure 11: Observer-reported coral catch composition (kg) in the NWCR, ESCR and ORH7A-WB UoAs for the years 2013-14 to 2019-20 combined.**

**Trawl footprint overlap against predicted distributions of corals and other VME indicator taxa**

In the knowledge of the deficiencies and biases of analyses based on the 'observed' coral distribution for assessing fishery impact, models have been developed to produce predicted coral habitat distributions (e.g. Anderson et al., 2014, 2015, 2019, 2020; Bowden et al., 2019, 2019a; Clark et al, 2015).

For a previous surveillance audit, predicted habitat distributions for protected coral groups (Anderson et al., 2014), were overlayed with the trawl footprint to estimate the potential fishery impact. The audit team determined that the model could not be relied upon as an indicator of true coral distribution and discounted the assessment of trawl footprint against the predicted coral distributions. Outputs from a revised and updated model were presented for the third surveillance audit in 2020, using the model of Anderson et al. (2015), which used slightly different methodology in consideration of real coral absence data, as opposed to 'pseudo-absence' data used in the 2014 study, and in interpolating the models to the resolution of the true sea floor topography rather than the modelled sea floor.

The trawl footprint for the 2017-18 and 2018-19 fishing years, plotted against the Anderson et al. (2015) predicted coral distributions at the >50th percentile level for each of the four protected coral groups, were suggestive of a very small overlap by the NWCR and ESCR fisheries on the coral distributions, ranging between 0.59% and 3.18% (Table 24).

**Table 24: Overlap of the combined 2017-18 and 2018-19 trawl footprint against the updated predicted habitat distribution of Anderson et al. (2015) for black, gorgonian and stony corals. Predicted distribution > 50th percentile occurrence (Black & Easterbrook-Clark, 2021).**

| Coral Group | UoA | Predicted coral distribution >50th percentile ($km^2$) | Overlap of 2017-19 footprint with predicted coral distribution ($km^2$) | % overlap with predicted coral distribution |
|---|---|---|---|---|
| Black corals – O. Antipatharia | ORH3B NWCR | 9,620 | 113 | 1.18% |
| Gorgonian corals – O. Alcyonacea | | 7,008 | 325 | 0.96% |
| Stony corals – O. Scleractinia | | 33,906 | 11 | 0.15% |
| Black corals – O. Antipatharia | ORH3B ESCR | 26,637 | 847 | 3.18% |
| Gorgonian corals – O. Alcyonacea | | 33,058 | 589 | 1.78% |
| Stony corals – O. Scleractinia | | 15,312 | 90 | 0.59% |

Predicted distribution modelling of benthic biodiversity in the New Zealand EEZ has developed rapidly over recent years. While earlier models used faunal distribution data to predict distributions in unsampled areas, they were deficient in that they used presence-only data from museum and trawl datasets and did not incorporate population density data. For these reasons their predictions were considered uncertain. In more recent modelling a new, merged benthic invertebrate occurrence dataset from five seabed photographic surveys has been used to inform development of improved predictive models at both single taxon levels, using Random Forest RF) and Boosted Regression Tree (BRT) decision-tree methods, and at community levels, using Gradient Forest (GF) and Regions of Common Profile (RCP) methods (Bowden et al., 2019). Georgian et al. (2019) used combinations of these approaches in ensemble models to similarly produce habitat suitability distributions for a suite of ten VME indicator taxa in the New Zealand region. The use of these new, quantitative datasets, incorporating environmental variables at a very fine scale of resolution of 1 $km^2$, represent a major refinement of the earlier models. The approach used in all of these modelling exercises is essentially to define relationships between point-sampled (i.e. observed) faunal data and environmental gradients to predict how individual benthic taxa and communities vary spatially over large areas (e.g. Chatham Rise).

The accuracy and spatial resolution of these models is dependent on the quality and consistency of fine-scale information on the sediment types and topography of the seabed. This is significant because the distribution of sessile fauna such as corals and other habitat-forming fauna is defined by the availability of hard substrata, which is highly patchy (Bowden et al., op cit.). The resolution of both the input data and the predicted outputs from the recent modelling are at a reasonably fine scale of 1 x 1 km cells and the predicted abundances of benthic taxa, for the depth range 300 – 3,000 m, are presented as the number of individuals per 1000 $m^{-2}$. The relative confidence in the predictions was assessed using a bootstrapping technique, at the scale of individual cells, to produce spatially explicit uncertainty measures. Model uncertainties were calculated as the coefficient of variation (CV) of the bootstrap output (Bowden et al., op cit.).

The combined trawl footprint for ORH/OEO-targeted tows, and HAK/HOK/LIN-targeted tows where at least part of the tow was ≥ 800 m depth, for the period 2017-18 to 2019-20 was mapped for NWCR and ESCR against the Bowden et al. (2019), and for ORH7A-WB against the Georgian et al. (2019) ensemble model distributions for the following ETP corals (Table 25; Appendix 3, Figs. B1 – B9),(Black & Easterbrook-Clark, 2021):

- 'Coral Reef' – a grouping of four common reef-forming stony corals (O. Scleractinia) comprising:
  - *Enallopsammia rostrata*
  - *Madrepora oculata*
  - *Solenosmilia variabilis*
  - *Goniocorella dumosa.*
- *Goniocorella dumosa* alone, as it is a dominant, thicket-forming stony coral on the Chatham Rise
- Family Stylasteridae, a group of hydrocorals (O. Anthoathecata).

**Table 25: Overlap of the combined ORH/OEO and HOK/HAK/LIN trawl footprints for the period 2017-18 to 2019-20 against the predicted distribution models of Bowden et al. (2019) in NWCR and ESCR, and against the ensemble model distributions of Georgian et al. (2019) in ORH7A-WB. Predicted distributions > 50th percentile occurrence (Black & Easterbrook-Clark, 2021).**

| UoA | Coral or Coral Group | Predicted coral distribution ($km^2$) | Trawl footprint in predicted coral area ($km^2$) | Overlap (%) |
|---|---|---|---|---|
| NWCR | Coral Reef | 38,738.39 | 587.40 | 1.52% |
| | *Goniocorella dumosa* | 20,184.11 | 18.27 | 0.09% |
| | Family Stylasteridae | 5,134.98 | 20.04 | 0.39% |
| ESCR | Coral Reef | 34,756.21 | 533.90 | 1.54% |
| | *Goniocorella dumosa* | 15,383.23 | 125.46 | 0.82% |
| | Family Stylasteridae | 42,698.81 | 1,079.65 | 2.53% |
| ORH7A - WB | Coral Reef | 102,038.41 | 2,654.66 | 2.60% |
| | *Goniocorella dumosa* | 104,559.05 | 2,208.21 | 2.11% |
| | Family Stylasteridae | 98,311.59 | 1,683.04 | 1.71% |

The overlaps of the trawl footprint with the modelled distributions from the above studies have all produced similar results: for stony corals the overlap ranged between 0.15% and 0.59% in the Anderson et al. (2015) study (Table 24), between 0.09% and 2.60% in the Bowden et al. (2019) study (Table 25), and 2.3% to 3.7% in the Georgian et al. (2019) study; for black corals and gorgonian corals the overlap ranged between 0.96% and 3.18% in the Anderson et al. (2015) study (Table 24) and between 2.2% and 3.7% in the Georgian et al. (2019) study; for sponges and sea pens between 2.3% and 3.5% (Georgian et al. (op cit.), (Table 26). These results suggest that the UoA fisheries are likely to have a very minor impact on coral habitat in each of the UoAs.

**Table 26 Overlap of the combined ORH/OEO and HOK/HAK/LIN trawl footprint for the period 2017-18 to 2019-20 against the ensemble model predicted distributions of Georgian et al. (2019), (GDU, Goniocorella dumosa; SVA, Solenosmilia variabilis; MOC, *Madrepora oculata*; ERO, *Enallopsammia rostrata*). Predicted distributions > 50th percentile occurrence (Black & Easterbrook-Clark, 2021).**

| UoA | Coral group & non corals | Predicted coral distribution ($km^2$) | 2005-06 to 2019-20 | | 2017-18 to 2019-20 | |
|---|---|---|---|---|---|---|
| | | | Trawl footprint in predicted coral area ($km^2$) | % overlap | Trawl footprint in predicted coral area ($km^2$) | % overlap |
| NWCR | Stony Corals (GDU, SVA, MOC & ERO) | 100,596 | 5,882.07 | 5.85% | 2,334.77 | 2.32% |
| | Black corals – Antipatharia | 101,523 | 5,932.02 | 5.84% | 2,356.26 | 2.32% |
| | Alcyonacea – soft corals | 106,552 | 5,948.72 | 5.58% | 2,366.70 | 2.22% |
| | Stylasteridae – hydrocorals | 101,910 | 5,941.28 | 5.83% | 2,363.43 | 2.32% |
| | Desmospongiae – desmosponges | 102,326 | 5,938.85 | 5.80% | 2,363.00 | 2.31% |
| | Hexactinellidae – glass sponges | 103,185 | 5,944.10 | 5.76% | 2,363.66 | 2.29% |
| | Pennatulacea – sea pens | 101,258 | 5,928.67 | 5.86% | 2,362.91 | 2.33% |
| ESCR | Stony Corals (GDU, SVA, MOC & ERO) | 81,986 | 7,643.61 | 9.32% | 2,466.34 | 3.01% |
| | Black corals – Antipatharia | 81,067 | 7,641.49 | 9.43% | 2,466.32 | 3.04% |
| | Alcyonacea – soft corals | 83,354 | 7,644.64 | 9.17% | 2,467.24 | 2.96% |
| | Stylasteridae – hydrocorals | 80,468 | 7,643.63 | 9.50% | 2,466.34 | 3.06% |
| | Desmospongiae – desmosponges | 80,660 | 7,639.84 | 9.47% | 2,465.88 | 3.06% |
| | Hexactinellidae – glass sponges | 78,658 | 7,642.92 | 9.72% | 2,466.52 | 3.14% |
| | Pennatulacea – sea pens | 88,926 | 7,602.47 | 8.55% | 2,443.10 | 2.75% |
| ORH7A - WB | Stony Corals (GDU, SVA, MOC & ERO) | 147,734 | 3,396 | 2.30% | 5,503 | 3.73% |
| | Black corals – Antipatharia | 155,758 | 3,396 | 2.18% | 5,503 | 3.53% |
| | Alcyonacea – soft corals | 156,225 | 3,396 | 2.17% | 5,503 | 3.52% |
| | Stylasteridae – hydrocorals | 154,910 | 3,341 | 2.16% | 5,446 | 3.52% |
| | Desmospongiae – desmosponges | 155,334 | 3,396 | 2.19% | 5,503 | 3.54% |
| | Hexactinellidae – glass sponges | 155,436 | 3,396 | 2.18% | 5,503 | 3.54% |
| | Pennatulacea – sea pens | 152,088 | 2,357 | 1.55% | 4,185 | 2.75% |

For the entire EEZ the ORH/OEO and HAK/HOK/LIN trawl footprint overlaps against the ensemble model predicted habitat suitability distributions for a suite of 10 VME indicator taxa (Georgian et al., 2019) are even lower, at between 0.84% to 0.9% for corals and 0.77% to 0.89% for sponges and sea pens (Table 27).

**Table 27 Overlap of the combined ORH/OEO and HOK/HAK/LIN trawl footprint against the ensemble model predicted distributions of Georgian et al. (2019) for the entire EEZ, 2017-18 to 2019-20 (GDU, *Goniocorella dumosa*; SVA, *Solenosmilia variabilis*; MOC, *Madrepora oculata*; ERO, *Enallopsammia rostrata*). Predicted distributions > 50th percentile occurrence (Black & Easterbrook-Clark, 2021).**

| UoA | Coral group & non corals | Predicted coral distribution (km²) | 2005-06 to 2019-20 | | 2017-18 to 2019-20 | |
|---|---|---|---|---|---|---|
| | | | Trawl footprint in predicted coral area (km²) | % overlap | Trawl footprint in predicted coral area (km²) | % overlap |
| EEZ | Stony Corals (GDU, SVA, MOC, ERO) | 1,324,412 | 37,607.58 | 2.84% | 11,878.32 | 0.90% |
| | Black corals – Antipatharia | 1,417,504 | 37,857.45 | 2.67% | 11,944.82 | 0.84% |
| | Alcyonacea – soft corals | 1,425,579 | 37,869.24 | 2.66% | 11,957.33 | 0.84% |
| | Stylasteridae – hydrocorals | 1,350,725 | 37,559.13 | 2.78% | 11,821.13 | 0.88% |
| | Desmospongiae – desmosponges | 1,343,035 | 37,778.40 | 2.81% | 11,942.22 | 0.89% |
| | Hexactinellidae – glass sponges | 1,355,578 | 37,671.18 | 2.78% | 11,941.79 | 0.88% |
| | Pennatulacea – sea pens | 1,268,087 | 33,057.85 | 2.61% | 9,724.78 | 0.77% |

The maps of the observed and predicted coral distributions, plotted against the 2017-18 to 2019-20 trawl footprints for ORH/OEO-targeted tows and for HAK/HOK/LIN-targeted tows within the 800 – 1,600 m habitat area, clearly illustrate that protected coral groups are distributed very widely in relation to the fishery footprints (Appendix 3, Figs. B1 – B9).

The predicted distribution/habitat suitability models have evolved and improved over recent years and DWG is of the view that they are informative and much more likely to reflect the scale of the impacts by the UoA fisheries on protected corals and other VME indicator taxa than are distributions based on observer-reported and research survey data, for which sampling occurs largely within the fishery areas.

### Coral recovery

A towed camera study conducted on a group of fished and unfished UTFs on the Chatham Rise, involving surveys in 2001, 2006, 2009 and 2015, showed very little evidence of stony coral recovery on any of these UTFs, notably one that had been closed to trawling for 15 years (Morgue Hill), (Clark et al., 2019). A more recent survey in 2020 did, however, find evidence of new clumps of stony coral polyps growing on coral rubble near the summit, and on a rocky outcrop below the summit, of a heavily fished UTF (Graveyard Hill). New polyps were also found on the adjacent Morgue Hill (Clark et al., in press). This study has produced evidence that corals do recover from the effects of trawling, albeit on a decadal scale.

Coral diversity will be maintained on fished UTFs in areas that are too rough or too steep to trawl or in gullies and crags where trawl nets cannot reach them, providing a potential source for coral recovery should trawling cease (Consalvey et al., 2006). While around 80% of UTFs in the EEZ within fishable depths (i.e. 0 – 1,600 m) have been fished by trawl (Clark & O'Driscoll, 2003), far fewer are currently fished due to TACCs having been considerably reduced from a peak during the early 1980s. There is, therefore, considerable scope for corals to recover on many previously fished UTFs, the majority of which are found on the Chatham Rise.

Corals on isolated UTFs have in the past often been associated with high levels of endemism, but it is now becoming evident that this impression may have been the result of a limited amount of sampling effort on these features. A growing number of studies has shown that seamounts, and smaller UTFs, are generally not ecologically isolated and often share species assemblages with those in adjacent deepsea areas or on continental slopes and banks. Recent studies have indicated that rates of endemism may not be elevated on seamounts/UTFs (see review in Clark et al., 2012).

There is currently insufficient data to conclude that New Zealand UTFs harbour endemism to any large degree and, given the connectedness of the oceanic environment at these depths, the best hypothesis might be one based on uniformity of biodiversity. Studies around the world, where sampling has been more detailed, have moved away from the hypothesis of high degrees of endemicity on individual UTFs in similar oceanographic locations (e.g. McClain et al., 2009).

Consalvey et al. (2006) indicated that around 24% of deepwater corals in New Zealand were considered to be endemic. However, estimates of endemicity tend to change according to the scale and extent of research and benthic sampling undertaken and the level of coral endemicity in New Zealand waters may well be lower than current estimates.

Connectivity between UTF coral assemblages is thought to be highly variable, but studies have shown that there are considerable genetic linkages between corals on UTFs distant from one another (Clark et al., 2012). It has been postulated that dispersal distances of deepwater coral species may be related to oocyte size, with larger, energy-rich oocytes giving rise to larvae with greater dispersal potential (Zeng, et al., 2017). Genetic connectivity between sessile invertebrates on the Chatham Rise is suggestive of dispersal distances of the order of 200 – 400 km (Bors et al., 2012). Recent experiments in aquaria have demonstrated that the commonly occurring stony coral *Goniocorella dumosa* is a brooder with the capability of incubating gametes for extended periods and for larvae to be released and 'free-swimming' for up to 88 days in the water column prior to settling (Tracey et al., 2021), supporting the contention that dispersal may be possible over considerable distances given favourable currents. With the exception of a single UTF in ESCR, all UTFs in the two Chatham Rise UoAs are separated by distances of considerably less than 100 km, which given potential coral dispersal capabilities, may point to considerable genetic connectivity between them, particularly as corals are additionally distributed patchily on flat habitat between UTFs (DWG, 2020).

**Indirect effects**

Potential indirect effects include sedimentation from trawling operations, which it is speculated could potentially smother coral colonies. A recent study by NIWA on the Chatham Rise has involved an experiment in which vast clouds of sediment were created using a towed plough-like apparatus in the vicinity of known coral beds, with the intention of monitoring any adverse effects on the corals. Although results from the study have yet to be published, it cannot be assumed that corals are mortally susceptible to the effects of sedimentation. By way of example, a large reef system on the shelf break off the mouth of the Amazon River has been found to support a range of cnidarians including stony corals, black corals and octocorals, which live in an environment of high suspended sediment (Moura, et al., 2016). Corals clearly have some ability to cleanse themselves of sediments. Trawling on UTFs will produce variable levels of sedimentation depending on the nature of the substratum, while elevated currents associated with these topographic features will serve to move the sediment along fairly rapidly. The effects of sedimentation will likely be greater on flat habitat where clumps of coral occur on rocky patches within otherwise sandy or muddy habitat.

**Management strategy**

The management of ETP species in New Zealand falls under the Wildlife Act 1953. The Wildlife Act provides for partial protection of all species of corals in the orders Antipatharia (black corals), Gorgonacea (gorgonian corals), Scleractinia (stony corals) and of all species in the family Stylasteridae (hydrocorals). It is, however, not an offence to catch these corals in areas outside of designated protected areas (i.e. MPAs, BPAs, SCAs), and no catch limits are prescribed. Captures are required to be reported and are not allowed to be retained.

The purpose of the Fisheries Act 1996 (s8) is 'to provide for the utilisation of fisheries resources while ensuring sustainability', where ensuring sustainability entails 'avoiding, remedying, or mitigating any adverse effects of fishing on the aquatic environment'. The environmental principles of the Act require that 'associated and dependent species should be maintained at a level that ensures their long-term viability' and that the 'biological diversity of the aquatic environment should be maintained'.

When impacts of fishing are such that they are causing an adverse effect on the Marine Environment (Fisheries Act s2, s8), measures are to be taken pursuant to the Conservation Act 1987 and the Director-General of where the Department of Conservation will implement measures, including:

- Research relating to those effects on protected species
- Research on measures to mitigate the adverse effects of commercial fishing on protected species
- The development of population management plans under the Wildlife Act 1953 and the Marine Mammals Protection Act 1978.

While Government policy is not well developed to determine when adverse impacts might collectively constitute adverse effects, effective policy has been implemented for some ETP species, such as seabirds and marine mammals, to manage impacts on a population basis, not on the basis of impacts to individual animals. DWG has urged the development of effective policies on this basis for ETP corals and similar epibenthic organisms, to manage any adverse impacts on their populations, rather than a focus on zero captures (DWG, 2021).

Recognising that the need to allow for the utilisation of fisheries resources will entail interactions between bottom fisheries and corals, given the scattered and widespread coral distribution of corals, and given the susceptibility of corals to damage by trawl gear, New Zealand has opted to introduce area closures to provide protection to corals and similar sessile benthic fauna. Over 31% of the seabed within the Territorial Sea and EEZ is protected from bottom trawling and dredging (Helson et al., 2010; Spear & Cannon, 2012), (Fig. 12).

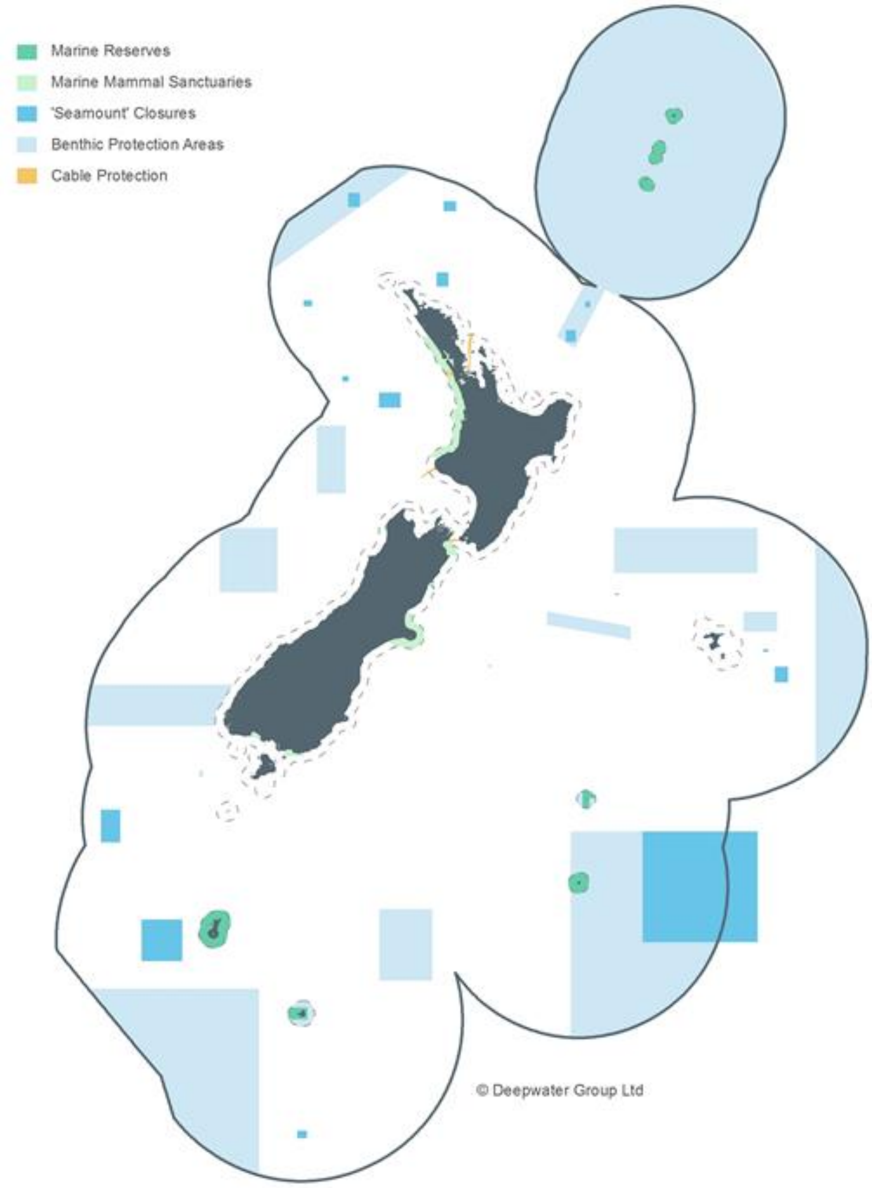



**Figure 12: New Zealand's Marine Protected Areas. Dark blue = Seamount Closures, Light blue = Benthic Protection Areas, Green = Marine Protected Areas.**

### Management strategy implementation

Fishing vessel locality is electronically monitored by the Ministry on a 24/7 basis and any transgressions by bottom trawlers into protected areas draw large penalties and automatic vessel forfeiture. Three such transgressions by orange roughy trawlers in recent years have resulted in prosecutions, none of them in the UoAs, providing evidence that the management strategy is being implemented successfully.

### Management effectiveness

Assessments of fishery performance are undertaken regularly and published in the Annual Review Reports for Deepwater Fisheries (FNZ, 2020a), while fishery performance against environmental considerations is assessed and reported in Aquatic Environment & Biodiversity

Annual Reviews (FNZ, 2020e). These reports, which provide metrics on rates of observer coverage, ETP captures and trawl footprint trends, show that the fishery impacts are not increasing and that the level of observer coverage is consistent and adequate to provide for monitoring. The Corals Medium Term Research Plan (DoC, 2020a) updates research requirements annually, while Compliance reviews are undertaken to assess any regulation transgressions by the UoA fisheries.

**Information**

DWG has recently completed an agreement to purchase $4.4 m of science from Australia's Commonwealth Science and Industrial Research Organisation (CSIRO) over the next five years (funded one third by CSIRO and two thirds by industry) to further our understanding of the deepwater benthic biodiversity and biogenic habitats. There are two main themes to give effect to this:

4. **Habitat mapping of the benthic biodiversity within selected areas**

   Mapping in detail the benthic habitats of selected Underwater Topographic Features (UTFs) using CSIRO's underwater towed video system (with real-time connectivity to the survey vessel). The objective is to quantitatively map and assess the habitat types and the benthic biodiversity within each survey area (e.g., mud, sand, rock, biogenic) and to quantify species' occurrences within biogenic habitats (i.e., areas containing corals, sponges and other epibenthic invertebrate communities) using CSIRO's Artificial Intelligence (AI) capabilities.

   Over five years, the plan is to survey the benthic habitats of up to 25 of the key UTFs. The survey information will then be analysed with other data, such as trawl paths, enabling assessments of any risks posed by trawling and the extent of areas untouched by trawling.

5. **Industry trawl camera systems**

   DWG and vessel owners have contracted CSIRO to develop and deploy bespoke SMART-cam technology (Seafloor Monitoring, Automated Recording of Trawls). This robust underwater hardware and software will be routinely deployed during commercial trawling to collect high-resolution digital imagery of the seabed along trawl pathways that will be analysed to identify and quantify the benthic habitat types and their biodiversity. We will apply CSIRO's proven solutions for deepwater engineering, automated data download, data management and analyses using their proven Artificial Intelligence capabilities in New Zealand waters.

   It is anticipated that the results from this project will provide a basis for an informed strategy for assessing and managing risks to ETP corals and to benthic communities from deepwater trawling.

**Research projects**

The Department of Conservation's Conservation Services Programme (CSP) has ongoing projects aimed at improved understanding of fishery impacts on protected corals (Weaver, 2020). These include:

- Project INT2015-03 - identifying corals collected by observers aboard trawlers to species level to better understand coral diversity and distribution
- Project INT2018-01 – purchase of observer services from FNZ to ensure ongoing monitoring of protected species interactions, including with corals, towards developing and improving mitigation methods

- Project POP2018-01 - modelling of habitat suitability for protected corals to estimate the probable distribution of coral groups in poorly sampled areas beyond the trawl grounds
- Project POP2018-06 - investigating the nature of reproduction and dispersal by corals to estimate connectivity between coral populations within and between geographic regions.

In 2020-21, a new project has been developed aimed at identifying gaps in mitigation technology/practice towards achieving reductions of protected coral species bycatch (DOC, 2020):

- Project MIT2020-03 – mitigation gaps analysis towards reducing protected species bycatch.

For 2021-22, two new protected coral-related projects are planned (DOC, 2021). These are:

- Project INT2021-02 – characterisation of protected coral interactions towards an improved understanding of coral bycatch across multiple fisheries and fishing methods and to inform the development of a risk assessment for protected corals
- Project POP2021-02 – identification of protected coral hotspots based on analysis of towed camera transects and application of these data in species distribution models towards an improved understanding of the historical effects of fishing on coral distribution and relative abundance.

**Monitoring**

Information collected through observers, vessel monitoring systems, research surveys and other research projects, such as analyses making use of existing datasets to understand fishery interactions with protected species or sensitive habitats, is sufficient to measure trends and support the above-described strategy for managing impacts on ETP species. Regular monitoring and reporting of the ORH/OEO and HAK/HOK/LIN trawl footprints in relation to coral habitat provides trend data relevant for evaluation of the likely impact of the fishery on these protected species. In addition, ongoing and new research projects, as described above, provide for improved knowledge as a basis for assessing and managing the effects of fishing on ETP corals.

## Habitats

### Habitats impacted by the UoA fisheries

Orange roughy and oreo are distributed throughout the New Zealand EEZ at depths of between 800 – 1,600 m. The two main habitat types encountered through bottom trawling for orange roughy are flat habitat and Underwater Topographic Features (UTFs).

In ORH 7A-WB and NWCR most fishing effort and catch occurs on flat habitat, while in ESCR effort is equally distributed between flat and UTF habitat, but a higher proportion of the catch is taken on UTFs than on flat. The median tow depth of ORH-targeted trawls ranges from 895 m in ORH7A-WB, to 1,100 m in NWCR and to 1,042 m in ESCR. The average number of tows per annum in each of the UoAs ranges from 269 in NWCR, to 411 in ORH7A-WB and to 1,369 in ESCR. (Table 28).

Table 28: **Median tow start depths, fishing effort and ORH/OEO catch on flat and UTF habitat in each of the three UoAs over the period 2017-18 to 2019-20 (Black & Easterbrook-Clark, 2021).**

| Parameter | ORH7A - WB | ORH3B NWCR | ORH3B ESCR |
|---|---|---|---|
| Tow start depth - median | 895 | 1,100 | 1,042 |
| ORH/OEO catch (kg) | 4,735,961 | 1,860,356 | 17,484,674 |
| No. tows | 1,234 | 808 | 4,106 |
| No. tows on flat | 1,127 | 618 | 2,053 |
| % Tows on flat | 91% | 76% | 50% |
| ORH/OEO catch on flat (kg) | 4,450,186 | 1,600,128 | 11,639,190 |
| ORH/OEO catch on flat (%) | 94% | 86% | 67% |
| No. tows on UTFs | 107 | 190 | 2,053 |
| % Tows on UTFs | 9% | 24% | 50% |
| ORH/OEO catch on UTFs (kg) | 285,775 | 260,228 | 5,845,484 |
| ORH/OEO catch on UTFs (%) | 6% | 14% | 33% |

There has been a trend in recent years to fewer tows being undertaken on UTFs in NWCR and ESCR and greater fishing effort being directed on to the flats.

### Trawl footprint analysis

The trawl footprint of orange roughy and oreo fisheries is monitored annually to assess the extent of their interactions with the benthic habitat (Baird & Mules, 2021, 2021a). The 2017-18 fishing year marked the commencement of catch locality reporting by vessels at a finer resolution (i.e. longitude and latitude to 4 decimal places, or less than 20 m), (FNZ, 2019), than previously (i.e. to the nearest minute of arc, or about 1.852 nm). This new reporting regulation has negated the requirement for random jittering of tow start and finish positions, which was previously applied to trawl datasets to provide a more realistic spread of effort and has improved the precision of the trawl footprint estimate. The outcome for orange roughy and oreo fisheries has been a slightly reduced estimated trawl footprint.

Baird & Mules (2021a) estimated that in 2018-19, all New Zealand OEO and ORH fisheries traversed 0.2% and 1.2% respectively of the EEZ fishable area between 800 - 1,600 m.

Within the three UoAs, ORH/OEO-targeted trawl footprint analyses indicate that the fisheries have traversed between 4.2% and 7.6% of the of the 800 – 1,600 m habitat area in the three UoAs over the most recent three-year period 2017-18 to 2019-20. These are considerably smaller areas than were fished during the period of peak orange roughy fishing in the late 1980s and early 1990s, and for the period from the baseline year (i.e. 2005-06 for habitats assessment in terms of FCR v2.01), for which the trawl footprint ranged between 7.7% and 19.5% of the 800 – 1,600 m fishable area. During the recent three-year period, new areas trawled amounted to 3.5% in NWCR, 2.4% in ESCR and 3.0% in ORH7A-WB, of the respective fishable grounds (Table 29), (Figs. A1 – A6).

**Table 29: ORH/OEO trawl footprint by UoA for the periods 2005-06 to 2019-20 and 2017-18 to 2019-20, new footprint area and area closures ($km^2$ and %), (Black & Easterbrook-Clark, 2021).**

| UoA | UoA Habitat 800-1,600 m | Footprint 2005-06 to 2019-20 | | Footprint 2017-18 to 2019-20 | | New Footprint 2017-18 to 2019-20 | | UoA Closed Area | |
|---|---|---|---|---|---|---|---|---|---|
| NWCR | 17,398 | 3,267 | 18.8% | 1,326 | 7.6% | 617 | 3.5% | 52 | 0.3% |
| ESCR | 38,155 | 7,440 | 19.5% | 2,439 | 6.4% | 920 | 2.4% | 1,755 | 4.6% |
| ORH7A-WB | 78,871 | 6,110 | 7.7% | 3,332 | 4.2% | 2,329 | 3.0% | 12,304 | 15.6% |

Large areas of seabed between approximately 800 – 1,400 m in the NWCR and ESCR UoAs are untrawlable ‘hard grounds’. The extent of this hard benthic habitat (HBH) was estimated from data recorded during side-scan sonar surveys in combination with feedback from skippers on where they had encountered untrawlable grounds (Figs. A1 – A4), (Patchell, 2019). A total of 772 $km^2$ of HBH was identified in NWCR and 3,517 $km^2$ in ESCR, amounting to 4.4% and 9.2% of the fishable area (i.e. less than 1,600 m depth) in the two UoAs. Trawl footprint analysis revealed that only 4% – 6% of the HBH in NWCR and ESCR were contacted by trawl during the period 2017-18 to 2018-19. These HBH areas are in effect natural refuges from the effects of bottom trawling and are likely to be prime habitat for benthic invertebrate fauna.

The major bottom trawl fishery in New Zealand targets hoki, hake and ling at depths between 250 – 750 m. A small proportion of tows occur at depths greater than 800 m (i.e., within the ORH/OEO fishery areas). Including the HOK/HAK/LIN trawl fishery footprint in the analyses results in only small increases to the overall trawl footprints within the 800-1,600 m fishable grounds under consideration.

Within the three UoAs, the combined ORH/OEO- and HAK/HOK/LIN-targeted trawls traversed 10.4%, 6.5% and 4.2% of the 800 – 1,600 m habitat area in the NWCR, ESCR and ORH7A-WB UoAs respectively over the three-year period 2017-18 to 2019-20 (Table 30), (Figs. A1, A3, A5).

**Table 30: ORH/OEO and HAK/HOK/LIN trawl footprint combined by UoA for depths > 800 m for the periods 2005-06 to 2019-20 and 2017-18 to 2019-20, new footprint and area closures ($km^2$ and %), (Black & Easterbrook-Clark, 2021).**

| UoA | UoA Habitat 800-1,600 m | Footprint 2005-06 to 2019-20 | | Footprint 2017-18 to 2019-20 | | New Footprint 2017-18 to 2019-20 | | UoA Closed Area | |
|---|---|---|---|---|---|---|---|---|---|
| NWCR | 17,398 | 4,547 | 26.1% | 1,805 | 10.4% | 719 | 4.1% | 52 | 0.3% |
| ESCR | 38,155 | 7,543 | 19.8% | 2,475 | 6.5% | 933 | 2.4% | 1,755 | 4.6% |
| ORH 7A-WB | 78,871 | 6,185 | 7.8% | 3,332 | 4.2% | 2,329 | 3.0% | 12,304 | 15.6% |

Maps showing the extent of the trawl footprints in relation to the orange roughy habitat areas for each of the UoAs are provided in Appendix 2.

- In NWCR, most fishing has occurred on flat habitat to the south and west of the 180˚ hills in recent years and much of the ‘new area’ traversed has involved in-filling between existing trawl tracks within the traditional fishing grounds, as acknowledged by Baird & Mules (2021a), (Figs. A1 & A2).

- In ESCR, the fishery has remained spread between UTF and flats habitat and much of the ‘new area’ traversed has involved in-filling between existing trawl tracks within the traditional fishing grounds (Figs. A3 & A4).
- In ORH 7A-WB, there has been an expansion of the fishery towards the south-east, reflective of the fishery increasingly operating outside of the spawn as abundance has increased (the spawning area is in the extreme western part of ORH7A-WB), (Figs. A5 & A6).

**Flat habitat**

The Chatham Rise is approximately 1,290 km long and 390 km wide, with an area of 476,000 $km^2$. The depth range is from 400 m at the top of the Rise to more than 4,000 m on the northern and southern flanks, with a mean depth of 1,645 m. The substrate is a mixture of mud, sand and gravel, with organic-rich, low carbonate muds dominating on the western and south-central parts and sand and gravel dominating on the Mernoo Bank area and on the north-eastern flank around the Chatham Islands (Nodder, et al., 2011; Pinkerton, 2011).

The Challenger Plateau has a diameter of approximately 500 km and an area of about 280,000 $km^2$. The water depth ranges between 500 m on the crest to 1,500 m on the flanks. The central crest is dominated by sandy sediments, while the deeper areas on the flanks are dominated by muddy sediments (Nodder, et al., 2011).

An extensive study based on analyses of samples from epibenthic sled and deep-towed imaging system transecting on soft flat habitat on the Chatham Rise and Challenger plateau (Ocean Survey 20/20), revealed that while there was some evidence of both positive and negative correlations of individual species abundances with fishing, the overall effects of fishing appeared to be weak, a result that aligns with expectations in relation to life histories of the encountered species (Tuck et al, 2017).

**UTF habitat**

**Fishery contact with UTF benthic habitat**

There are over 530 known UTFs in the New Zealand EEZ, representing approximately 103,000 $km^2$ of seafloor, and over 812 known UTFs including the broader New Zealand region, representing approximately 250,000 $km^2$ of sea floor in total. Within the EEZ, the latitude band with the greatest concentration of UTFs occurs between 44˚ – 46˚S, which includes the Chatham Rise (Rowden et al., 2005), (Figure 13).

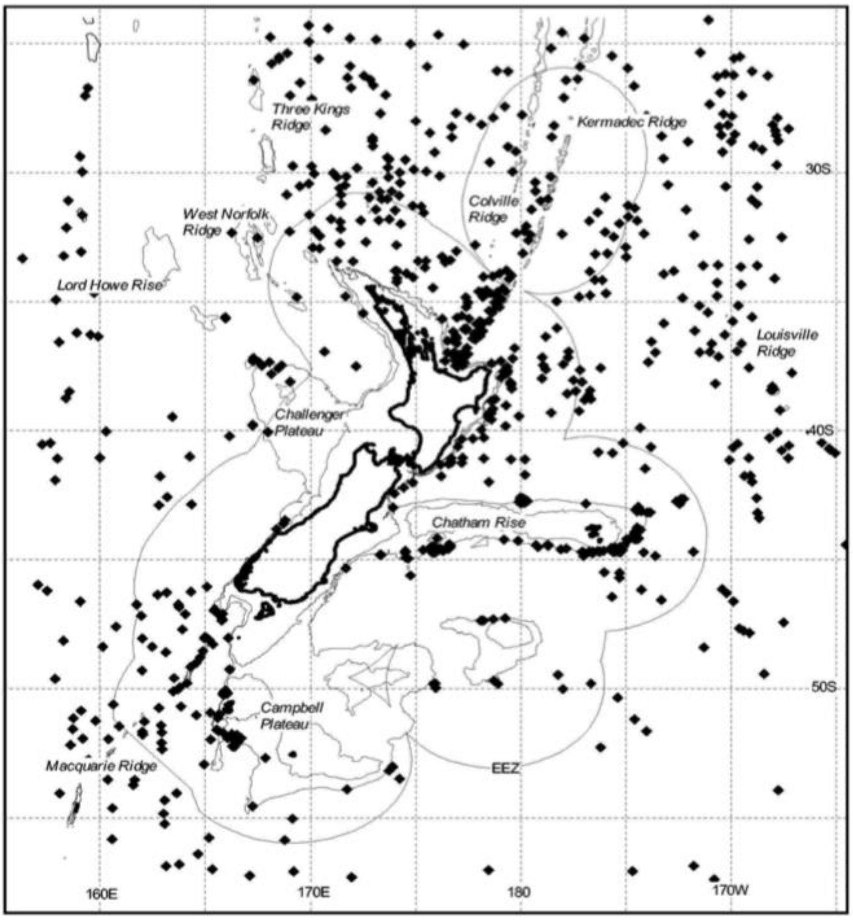



**Figure 13: Known UTFs in the New Zealand region (from Rowden et al., 2005).**

This serves to illustrate the very substantial amount of UTF habitat that exists within the New Zealand region, of which orange roughy- and oreo-targeted fishing contacts only a very small proportion. On the reasonable assumption that much of the UTF area in the EEZ is likely to support coral assemblages, the overall impact of trawling must be very slight.

Not all of the UTFs in the UoAs are contacted by trawl. For the period 2008-09 to 2012-13, 72 out of 116 known UTFs in the three UoAs were fished; about one-third of UTFs in NWCR were fished and about two-thirds of UTFs in ESCR were fished. Four of the five UTFs in ORH7A-WB were fished (Table 31).

**Table 31: Numbers of known and fished UTFs in the three UoAs, 2008-09 to 2012-13 (Roux et al., 2014, 2014a).**

| Parameter | ORH7A - WB | ORH3B NWCR | ORH3B ESCR |
|---|---|---|---|
| No. known UTFs | 5 | 26 | 85 |
| No. UTFs with tows | 4 | 10 | 58 |
| % UTFs with tows | 80% | 38% | 68% |

Over the recent three-year period, 2017-18 to 2019-20, 73 of 130 known UTFs were fished; just under half of the 26 UTFs in NWCR were fished and just over half of the 99 known UTFs in ESCR were fished. Of the five known UTFs in ORH7A-WB, four have been fished (Table 32). This illustrates that the numbers of fished UTFs has remained constant over the last 12 years.

**Table 32: Numbers of known and fished UTFs in the three UoAs, 2017-18 to 2019-20 (Black & Easterbrook-Clark, 2021).**

| Parameter | ORH7A - WB | ORH3B NWCR | ORH3B ESCR |
|---|---|---|---|
| No. known UTFs | 5 | 26 | 99 |
| No. UTFs with tows | 4 | 12 | 57 |
| % UTFs with tows | 80% | 46% | 58% |

Trawling on UTFs involves the trawl gear being landed just beyond the summit of the hill and then being towed down to the base and sometimes onto the surrounding flats. The trawl doors usually do not contact the seabed on hill tows, meaning that the area of impact is considerably reduced (i.e. ~20 – 25 m between wingtips) relative to tows on flat/sloping ground where contact with the seafloor includes the footrope, the sweeps between the wings of the trawl net and the trawl doors, and the trawl doors themselves. The door-to-door width of orange roughy trawl nets is generally ~150 m and this is assumed to be the width of the trawl track for analyses of trawl footprint.

Trawl footprint on UTFs varies depending on the topography, with UTFs accessible to bottom trawling typically having gradients of less than 20˚. Steeper UTFs, or steep areas on UTFs, are not fished. Areas with steep drop-offs or rocky, rough bottom are avoided because they cannot be effectively trawled and usually result in gear damage. On these steeper UTFs, trawling typically occurs only along particular, accessible towlines, with the rest of the feature remaining untouched by trawl gear. UTFs with gentle gradients may have towlines in multiple directions and these are often 'mud hills' which have little or no coral cover.

**Fished UTFs are hills and knolls, not seamounts**

All of the fished UTFs in NWCR and ORH 7A-WB are hills (i.e. with elevation ≤ 500 m). In ESCR, three of the fished UTFs have elevations greater than 500 m which places them in the category of knolls (i.e. with elevation > 500 m and < 1,000 m). No seamounts are fished in any of the UoAs (i.e. UTFs with elevation ≥ 1,000 m).

There are 142 known true seamounts (i.e. with elevation ≥ 1,000 m) in the EEZ (Clark, 2021), of which only 15 have ever been fished (i.e. 10.5%) and of which only nine have been fished over the most recent 10-year period 2009-10 to 2018-19 (i.e. 6.3%), (T. Northern, FNZ, pers. comm.).

**Vulnerable Marine Ecosystem taxa**

Not all of the fished UTFs are known to support corals and other sensitive, sessile epibenthic fauna. Roux et al. (2014, 2014a) reported that only 67 of the 116 known UTFs in the three

UoAs (i.e. 58%), had known coral presence (Table 33). This information is supported by records of observed, nil coral captures by the UoA fisheries, on multiple UTFs.

Corals also occur in areas of hard benthic habitat on flat habitat (i.e. rocky outcrops and fissures), as evidenced by research surveys and trawl catches, and are highly likely to also occur in canyons and on steep, rocky drop-offs where no trawling occurs.

**Table 33: Numbers of known UTFs in the three UoAs and the numbers known to support corals (Roux et al., 2014, 2014a).**

| Parameter | ORH7A - WB | ORH3B NWCR | ORH3B ESCR |
|---|---|---|---|
| Number of UTFs | 5 | 26 | 85 |
| No. UTFs known to have coral | 0* | 19 | 48 |
| % of UTFs known to have coral | 0% | 73% | 56% |

*Note: coral captures have subsequently been recorded from two UTFs in ORH7A-WB.

During the period 2008-09 to 2012-13, there were no reported coral captures on UTFs in ORH7A-WB, nine with reported coral captures in NWCR and 37 in ESCR.

During the recent period, 2017-18 to 2019-20, two UTFs in each of ORH7A-WB and NWCR had reported coral catches and 26 UTFs in ESCR had coral captures. For the three UoAs combined, 56% of all known UTFs were fished and of these, 41% had coral captures (Table 34). This information provides evidence that for the three UTFs combined, 59% do not support corals. They are likely 'mud hills', a colloquial term used by skippers.

**Table 34: Numbers of known UTFs, numbers of fished UTFs and numbers of UTFs with coral capture records in the NWCR, ESCR and ORH7A-WB UoAs over the period 2017-18 to 2019-20 (Black & Easterbrook-Clark, 2021).**

| Parameter | ORH7A - WB | | ORH3B NWCR | | ORH3B ESCR | |
|---|---|---|---|---|---|---|
| | 2009 - 2013 | 2018 - 2020 | 2009 - 2013 | 2018 - 2020 | 2009 - 2013 | 2018 - 2020 |
| No. known UTFs | 5 | 5 | 26 | 26 | 85 | 99 |
| No. UTFs with tows | 4 | 4 | 10 | 12 | 58 | 57 |
| % UTFs with tows | 80% | 80% | 38% | 46% | 68% | 58% |
| No. UTFs with coral tows | 0 | 2 | 9 | 2 | 37 | 26 |
| % towed UTFs with coral catch | 0% | 50% | 90% | 17% | 64% | 46% |

For UTFs that do support coral, not all of the UTF surface will be suited to coral growth. A study on the 180˚ hills complex in NWCR has revealed that on unfished hills, the mean overall coral coverage amounts to around 17% of the surface (Consalvey et al., 2006).

**Scale of UTF habitat in UoAs**

UTF habitat, expressed as the sum of their estimated basal areas (i.e. a conservative, two-dimensional estimate), in each of the NWCR, ESCR and ORH7A-WB UoAs amount to 99 $km^2$, 3,890 $km^2$ and 15 $km^2$ respectively, which in aggregate accounts for only 4% of the UTF area in the EEZ. Clearly, the UoA fisheries have a very minor impact on the overall UTF habitat within the New Zealand region.

Of the UTFs that have been fished over the last three years, the aggregate of the contacted areas ranges from 14% in NWCR, to 29% in ESCR and to 38% in ORH7A-WB (Black, in prep). The areas contacted by trawl gear, as a proportion of total UTF habitat in each of the UoAs, ranges from 2% in ESCR, to 7% in NWCR and to 26% in ORH7A-WB (Table 35). It is noted that there are a large number of UTFs that are closed to fishing in the SPRFMO management area, of which the Westpac Bank is a component.

**Table 35: Basal areas of UTF habitat and proportions of UTF habitat contacted by ORH/OEO-targeted trawls in each of the UoAs over the period 2017-18 to 2019-20 (Black & Easterbrook-Clark, 2021).**

| Parameter | ORH7A - WB | ORH3B NWCR | ORH3B ESCR |
|---|---|---|---|
| Basal area of all known UTFs ($km^2$) | 15.44 | 98.93 | 3,889.93 |
| Basal area of UTFs with tows ($km^2$) | 10.40 | 47.87 | 306.98 |
| Footprint of tows on UTFs ($km^2$) | 3.94 | 6.49 | 88.54 |
| Footprint on UTFs (%) | 38% | 14% | 29% |
| Footprint as % of basal area of all known UTFs | 26% | 7% | 2% |

**Vulnerable benthic species**

It has been well-documented that bottom trawling may change the relative abundance of structurally fragile benthic species, particularly those that are long-lived and with slow turn-over rates, such as corals.

Taking a harmonisation approach and using spatial scales from other jurisdictions (including those used in MSC fishery certification reports) and applying their outcomes in a New Zealand context, it is clear that vulnerable marine ecosystems (VME) should not only meet the UNGA and *International Guidelines for the Management of Deep-Sea Fisheries in the High Seas* (FAO Guidelines) (as they are incorporated into the MSC Standard), but they must also be of sufficient scale so as to comprise a defined habitat structure and to provide an ecosystem function.

The guidelines do not explicitly define the distinction between a VME and a VME indicator species/taxon, although it is clear that a single occurrence (e.g. a single coral clump) does not constitute a VME, nor does the full distribution of a species/taxon (i.e. patchy distribution over a large geographic area such as the Chatham Rise does not render the entire Chatham Rise as a VME).

International VME type habitat classifications (e.g. OSPAR Convention, Baltic Marine Environment Protection Commission (HELCOM)) and applications of VMEs in other MSC fishery assessment jurisdictions, have yielded VME scales that rely on more significant aggregations of the representative taxa or species (e.g. reefs, gardens, beds) (with a scale of 100s metres to kilometres) often in associated with "VME indicator elements" that refer to topographical, hydrophysical or geological features which potentially support VMEs, such as seamounts; steep-slopes and peaks on mid-ocean ridges

A recent paper broadly differentiated coral communities into three categories based on the nature of their structure (Anderson et al., 2019):

- Coral clumps – dispersed and solitary individual colonies, not forming extensive coral beds. Includes 'tree-like' habit of growth and some may exceed 1-2 metres in height (e.g. *Paragorgia* spp., bubblegum corals and *Bathypathes* black coral)
- Coral beds/thickets – colonies of structure-forming, stony corals in extensive beds up to 1 metre in height and hundreds of square metres in extent (e.g. many stony corals in the order Scleractinia)
- Coral reefs – forming large structures up to 40 m high and 700 m wide (described from Campbell Plateau).

In the UoAs, coral clumps would appear to be the main category encountered by orange roughy trawl gear in recent years, judging by the small capture quantities (i.e. estimated live coral captures, based on raised observer data for the period 2013-14 to 2019-20, of about 213 kg, 1,250 kg and 116 kg per annum in each of NWCR, ESCR and ORH7A (see Tables 18, 19 & 20).

It is conceivable that coral beds/thickets may have been prevalent in the UoAs during the years prior to commencement of bottom trawling, but as the greatest effects on coral habitats are caused by the first few fishing events (Rice, 2006), these will have been greatly reduced on flat habitat in the fishing grounds by the early 1980s and on UTF habitat by the mid-1990s. Based on coral capture records it is evident that very few, if any, encounters of coral beds/thickets have will occurred in recent years.

Records of vulnerable benthic species captures, other than corals, reported by observers in 2018-19 and 2019-20 indicate that taxa such as sea pens and deepsea anemones are vulnerable to the effects of trawling in ESCR and ORH7A-WB. The anemones occur on hard substrate, while sea pens are found on soft substrates (Tables 36 & 37). There was no observer-reported capture of non-coral benthos in NWCR during this period.

**Table 36: Observer-reported and estimated non-coral benthic taxa captured in ESCR, 2018-19 and 2019-20 (kg), (R. Tinkler, FNZ, pers. comm.).**

| Non-coral benthos | 2018-19 | 2019-20 |
|---|---|---|
| Coral-like anemones | 1 | 4 |
| Deepsea anemone | | 1 |
| *Epizoanthus* spp. | 4 | 2 |
| Feathery sea pens | | 1 |
| Purple sea pen | | 1 |
| Smooth deepsea anemones | 4 | 25 |
| **Non-coral benthos totals (kg)** | **9** | **34** |
| **No. observed tows** | **411** | **472** |
| **Observer coverage (% of tows)** | **33%** | **35%** |
| **No. tows** | **1247** | **1358** |
| **Estimated non-coral benthos catch (kg)** | **27.3** | **97.8** |
| **Estimated non-coral benthos catch /tow (kg)** | **0.007** | **0.025** |

**Table 37: Observer-reported and estimated non-coral benthic taxa captured in ORH7A-WB, 2018-19 and 2019-20 (kg), (R. Tinkler, FNZ, pers. comm.).**

| Non-coral benthos | 2018-19 | 2019-20 |
|---|---|---|
| Coral-like anemones | | 1 |
| Deepsea anemone | | 1 |
| *Epizoanthus* spp. | 2 | 1 |
| Smooth deepsea anemones | 7 | 9 |
| **Non-coral benthos totals (kg)** | **9** | **12** |
| **No. observed tows** | **108** | **193** |
| **Observer coverage (% of tows)** | **23%** | **35%** |
| **No. tows** | **478** | **555** |
| **Estimated non-coral benthos catch (kg)** | **39.1** | **34.3** |
| **Estimated non-coral benthos catch /tow (kg)** | **0.082** | **0.062** |

### Benthic habitat protection

Approximately 34% of the New Zealand EEZ is considered 'fishable', meaning seabed areas shallower than 1,600 metres and open to fishing (i.e. not within a Benthic Protection Area (BPA) or a Seamount Closure Area (SCA)).

New Zealand’s strategy to guard against adverse effects on the benthic environment, as is required by the Fisheries Act 1996, includes multiple area closures in the EEZ. A total of 17

BPAs, representatively distributed around the EEZ (Helson et al., 2010), and 19 SCAs, collectively close 31% of the EEZ to bottom trawling (FNZ, 2019b). These closures protect:

- 28 percent of underwater topographic features (including seamounts)
- 50 percent of true seamounts (i.e. UTFs over 1,000 metres in elevation)
- 88 percent of known active hydrothermal vents.

Area closures provide habitat protection to over 31% of the EEZ and to 14% of the fishable area shallower than 1,600 m within the EEZ (Table 38), (Baird & Mules, 2021, 2021a).

**Table 38: The EEZ area, the fishable area less than 1,600 m, and the proportions of these areas protected from bottom trawling (Baird & Mules, 2021).**

| Category | EEZ | EEZ Fishable Area |
|---|---|---|
| Total area ($km^2$) | 3,924,602 | 1,435,765 |
| Protected area (%) | 31% | 14% |

It is noted that there are additionally extensive bottom trawl closures in the SPRFMO area on the Challenger Plateau north of Westpac Bank, which is effectively an extension of the ORH7A-WB habitat area.

**BPAs and Seamount Closure Areas as refugia for corals and other VME indicator taxa**

Analysis of predicted habitat suitability distributions for a range of corals, sponges and sea pens (Georgian et al. 2019) in the BPAs and SCAs within each of the UoAs suggests that these closures may serve an important role as refuges for these VME indicator taxa. The analysis for the entire New Zealand EEZ shows that between 19.5% and 23.2% of the predicted distributions of these taxa fall within area closures (Table 39).

**Table 39: The extent of the overall predicted distributions of key corals, sponges and sea pens in the New Zealand EEZ that fall within BPAs and SCAs (GDU, *Goniocorella dumosa*; SVA, *Solenosmilia variabilis*; MOC, *Madrepora oculata*; ERO, *Enallopsammia rostrata*). Predicted distributions > 50th percentile occurrence (Black & Easterbrook-Clark, 2021).**

| Coral groups & non corals | Total Area of BPAs and SCAs in EEZ ($km^2$) | Predicted Distribution in BPAs and SCAs ($km^2$) | Overlap (%) |
|---|---|---|---|
| Stony Corals (GDU, SVA, MOC & ERO) | 1,213,811.59 | 281,567 | 23.20% |
| Black corals – Antipatharia | | 258,831 | 19.54% |
| Alcyonacea – soft corals | | 266,672 | 20.14% |
| Stylasteridae – hydrocorals | | 268,381 | 20.26% |
| Desmospongiae – desmosponges | | 264,181 | 19.95% |
| Hexactinellidae – glass sponges | | 283,165 | 21.38% |
| Pennatulacea – sea pens | | 294,557 | 22.24% |

Applying this analysis to the individual UoAs shows that BPAs and SCAs may provide significant protection to these VME indicator taxa, with the predicted distributions occupying between 95% and 98% of the closure areas in NWCR, between 79% and 85% in ESCR and between 72% and 81% in ORH7A-WB (Table 40). This, in combination with the small trawl footprint overlap with the protected species distributions of key coral groups, of between 0.09% and 2.6% (see Table 25), suggests that the UoA fisheries are likely to have a very minor impact on these VME indicator taxa.

**Table 40: The extent of the predicted distributions of key corals, sponges and sea pens that fall within BPAs and SCAs in each of the UoAs (GDU, *Goniocorella dumosa*; SVA, *Solenosmilia variabilis*; MOC, *Madrepora oculata*; ERO, *Enallopsammia rostrata*). Predicted distributions > 50th percentile occurrence (Black & Easterbrook-Clark, 2021).**

| UoA | Coral group & non corals | Area of BPAs and SCAs ($km^2$) | Predicted Distribution in BPAs and SCAs ($km^2$) | Overlap (%) |
|---|---|---|---|---|
| NWCR | Stony Corals (GDU, SVA, MOC & ERO) | 8,997.5 | 8,776 | 97.54% |
| | Black corals – Antipatharia | | 8,776 | 97.54% |
| | Alcyonacea – soft corals | | 8,776 | 97.54% |
| | Stylasteridae – hydrocorals | | 8,776 | 97.54% |
| | Desmospongiae – desmosponges | | 8,776 | 97.54% |
| | Hexactinellidae – glass sponges | | 8,776 | 97.54% |
| | Pennatulacea – sea pens | | 8,601 | 95.59% |
| ESCR | Stony Corals (GDU, SVA, MOC & ERO) | 7,092.0 | 5,796 | 81.73% |
| | Black corals – Antipatharia | | 5,699 | 80.36% |
| | Alcyonacea – soft corals | | 5,655 | 79.73% |
| | Stylasteridae – hydrocorals | | 5,717 | 80.61% |
| | Desmospongiae – desmosponges | | 5,778 | 81.47% |
| | Hexactinellidae – glass sponges | | 5,822 | 82.09% |
| | Pennatulacea – sea pens | | 6,069 | 85.58% |
| ORH7A - WB | Stony Corals (GDU, SVA, MOC & ERO) | 36,114.4 | 26,537 | 73.48% |
| | Black corals – Antipatharia | | 26,241 | 72.66% |
| | Alcyonacea – soft corals | | 27,070 | 74.96% |
| | Stylasteridae – hydrocorals | | 26,399 | 73.10% |
| | Desmospongiae – desmosponges | | 26,461 | 73.27% |
| | Hexactinellidae – glass sponges | | 26,319 | 72.88% |
| | Pennatulacea – sea pens | | 29,365 | 81.31% |

**Management of benthic effects**

Observer monitoring of around 30% of trawl tows in the UoAs provides a good estimation of the impact of the fisheries on vulnerable habitats and mandatory Global Position Reporting by vessels enables the Ministry to monitor vessel compliance with regard to area closures on a 24/7 basis.

DWG's Benthic Operational Procedures, implemented from 1 October 2021 (DWG, 2021b, 2021c), apply to all trawlers over 28 m and ensure that vessels are cognisant of the requirement to accurately measure, record and report all captures of benthic biota to the Ministry and to their shore managers. The objectives of the Benthic OPs are to:

- Ensure correct reporting of benthos, both protected and non-protected
- Enable avoidance or mitigation of catches of benthos.

DWG's Environmental Liaison Officer is at hand to assist in providing response management advice to vessels for implementation in near-real-time.

**Reducing our Catches of Corals and other Epi-Benthic Species**

Our current our benthic habitat management strategies (non-fish by-catch reporting, Seamount Closures, and Benthic Protection Areas) goes some way towards protecting assemblages and communities of corals and other epi-benthic species.

It is clear that in order to meet our objective to reduce our catches of live corals to as near as zero as possible we will need to implement further measures.

However, adopting the VMEs, which were developed by the UN rules for application to high seas fisheries is problematic, not only because they lack a clear definition, but also because under UN rules it is difficult to find a distinction between a VME and VME indicator species/taxa; even though the UN FAO Guidelines also notes that "merely detecting the presence of [a species] itself is not sufficient to identify a VME."

In New Zealand's deepwater fisheries, sessile (non-mobile) epi-benthic organisms (e.g., corals, sponges, bryozoans etc.) are vulnerable to bottom trawl gear. Many of these species which are outlined in the Deepwater Trawl Benthic Operational Procedures, create habitats for fish and other mobile animals. However, the defining criteria for VMEs do not provide guidance around the extent to which these organisms are habitat forming.

Because our objective is to reduce our catches of live epi-benthic organisms (e.g., corals) to as near to zero as practicable within these ORH fisheries, we need to implement management procedures that not only meet the requirements of the New Zealand orange roughy fisheries, in terms of minimising gear interactions with benthic organisms, but also apply a clear spatial scale or area so that these organisms can be quantified and protected (where required).

In the absence of any explicit scale component by MSC, the quantification of VME type habitat health and integrity and the demonstration of the effectiveness of management strategies is challenging.

Applying VME habitat requirements in other international organisations and in other MSC fishery assessments, has yielded VME scales that rely upon significant aggregations of the representative taxa or species with scales of 100s metres to kilometres, often associated with physical elements such as "seamounts."

**MPSA (Monitor, Pause, Survey and Assess) management strategy**

This MPSA strategy implements our own criteria and terminology to reduce our interactions with "VME" taxa:

- MPSA (Monitor, Pause, Survey and Assess) Management Strategy: This strategy outlines the process by which VBAs are identified, surveyed and assessed (see below).
- Benthic Management Areas (BMAs): These are areas that contain extensive aggregations or communities of epi-benthic organisms to the extent that they conform to BMA criteria:

The proposed MPSA (Monitor, Pause, Survey and Assess) management strategy, is based on a specific set of operational procedures that use current information and infrastructure to management interactions with epi-benthic habitat areas.

- **Monitor**: Regular reporting of non-fish catch by observers and industry.
    - Training key crew members in epi-benthic species identification to, differentiate between live and dead coral, and improved use of reporting codes)
    - Trigger point reporting to DWG if designated VBA indicator taxa reach agreed triggers (e.g., 50kg of any VBA Indicator species).
    - Annually review each towline to assess if catches of designated VBA indicator taxa reach agreed triggers (e.g., 50kg of any VBA Indicator species).
- **Pause**: Fishing on a towline would be paused if a pre-set trigger point is met,
    - DWG will notify the fleet that a trigger was met, the coordinates of the towline and will request that fishing ceases along this towline can be surveyed, and the VBA characteristics can be assessed.
- **Survey**: The towline and the area adjacent to the paused towline is prioritised for benthic biodiversity survey under the five-year research programme contracted to CSIRO.
- **Assess:** Survey results are assessed to determine any BMA characteristics in the vicinity of the paused towline, consider and implement appropriate management measures (e.g., reopening of the towline, or determining the level of protection including designation as a MBA, should the area conform with the definition of a VBA)

### Pause

Move-on rules produce unpredictable changes in effort and impacts overall and may be better considered as secondary to other measures for reducing trawling impacts on sensitive biota (McConnaughey et al (2019) p9), other commentors have said that nets are poor samplers of epi-benthic taxa or that move-on rules are two clunky to be used as a benthic management strategy.

For this reason, the MPSA procedures are not a move on rule, but simple a pause in fishing until the epi-benthic habitat area is surveyed and/or assessed for a management response. This enable the MPSA to readily incorporate other benethic management components such as closures, reporting, footprint analysis and benthic predictive modelling – to form a more comprehensive strategy.

In the pause phase an encounter with a significant epi-benthic habitat area that results in a single tow trigger of ≥50kg as outlined in Appendix 1 of the DWG Benthic Operational Procedure

While the DWG threshold of ≥50kg as outlined in the OP is higher in comparison with other MSC certified fisheries, it is sufficient as a pause trigger for a single tow encounter. As stipulated in the OP, the inbuilt precaution within the MPSA strategy comes from the annual cumulative towline threshold of ≥50kg and the ability to survey and assess towlines with real world indicative information against Benthic Management Area (BMA) criteria (which define BMAs in terms of a science-based and operationally applicable scale that enables the ability to quantify ecosystem structure and function). This cumulative analysis and subsequent survey/assessment is not a feature in other strategies.

Survey:

Owners of deepwater quota have recently completed an agreement to purchase science from CSIRO over the next five years (funded one third by CSIRO and two thirds by industry) to further our understanding of the deepwater benthic biodiversity and fisheries interactions with biogenic habitats. This work will have 2 main themes:

- **Habitat mapping of the benthic biodiversity within selected areas:** Detailed surveying and mapping of the benthic habitats of selected Underwater Topographic Features (UTFs) using CSIRO's underwater towed video system (with real- time connectivity to the survey vessel). Over a five-year period, the plan is to survey the benthic habitats of up to 25 of the key UTFs. The objective is to quantitatively survey and assess the habitat types and the benthic biodiversity on each of these UTFs (e.g., mud, sand, rock, biogenic) and the VME indicator taxa within biogenic habitats encountered (i.e., areas containing corals, sponges and other epibenthic invertebrate communities). The video imagery from these surveys will be analysed by CSIRO using their Artificial Intelligence (AI) capabilities. The survey information will then be analysed in relation to other data, such as trawl paths, enabling assessments of any risks posed by trawling and the extent of areas untouched by trawling.
- **Industry trawl camera systems**: progressively surveys will employ SMART-cam technology. DWG and vessel owners have contracted CSIRO to develop and deploy bespoke SMART-cam technology (Seafloor Monitoring, Automated Recording of Trawls). This robust underwater hardware and software will be routinely deployed during commercial trawling to collect high resolution digital imagery of the seabed along trawl pathways that will be analysed to identify and quantify the benthic habitat types and their biodiversity. We will apply CSIRO's proven solutions for deepwater engineering, automated data download, data management and analyses using their proven AI capabilities in New Zealand waters. This project will deliver a unique seafloor monitoring programme, the results from which will provide a basis for an informed strategy for assessing and managing risks to benthic communities from deepwater trawling.

Under the MPSA Strategy paused tows and towlines will be prioritised for surveying and mapping.

Assess:

McConnaughey et al (2019) noted that the best strategy is to have within any management system, an adaptive process to monitor performance and allow for future refinements. The Assessment phase of the MPSA strategy because it is both responsive and adaptive, to both the needs of the ORH fisheries and of the benthic habitat.

During the assessment phase of the strategy, best available information is assessed, including:

- Trawl footprint information
- Trawl tow analysis
- Epi-benthic taxa catch analysis
- Catch analysis
- CSIRO underwater towed video survey results
- Smart-Cam data

The analysis of this information will enable assessments of any risks posed by trawling and the extent of areas untouched by trawling, and will provide valuable information on requisite levels of management and protection, including the designation of Benthic Management Areas BMAs) , which will provide localised protection of significant epi-benthic habitat areas, which in turn will integrate with other extant benthic protections such as BPAs and Seamount Closures.

**Summary on ETP corals & habitats**

The updated information provided here on the small footprint by the UoA fisheries in relation to the 800 – 1,600 m habitat area and in relation to the predicted coral distributions, the small trawl footprint on UTFs in relation to the overall UTF habitat, and the extensive protected areas, in combination with the information provided for Surveillance Audit 3 (i.e. analyses on the distribution of corals at depths both shallower and deeper than orange roughy fishery depths, the extent of untrawled hard benthic habitat in the NWCR and ESCR UoAs, and on the proximity and likely connectivity between known coral habitats), (DWG, 2020, 2020a), all point to a minor fishery impact on the overall distribution of protected corals and on habitats of vulnerable sessile benthic fauna.

The fishing-related risk to corals within New Zealand's EEZ is very low. Stony corals and hydrocorals occur over wide depth ranges, most of which are outside of the depth ranges being trawled. Of the depth range that has been trawled for orange roughy (i.e. 800-1,400 metres) 92.6% remains untouched by bottom trawls. In addition, corals and other benthic organism are afforded protection provided by the Benthic Protection Areas (BPAs) and the Seamount Closure Areas (SCAs).

DWG is of the view that the above, together with the recently introduced Benthic Operational Procedures and MPSA management framework currently under development, in combination meet the requirements of MSC FS v2.01 for ETP corals and Habitats.

**Research projects:**

Aquatic environment and biodiversity research initiatives related to the benthic effects of fishing are detailed in the Annual Operational Plan for Deepwater Fisheries. Projects to monitor seabed contact by bottom trawling are ongoing (FNZ, 2020, p. 34). These include:

- BEN2019-04 A spatially explicit benthic impact assessment for inshore and deepwater fisheries New Zealand to describe and quantify the likely nature and extent of impacts to benthic taxa or communities by mobile bottom fishing methods in New Zealand
- BEN2019-05 Towards the development of a spatial decision support tool for managing the impacts of bottom fishing on in-zone, particularly vulnerable or sensitive habitats.
- BEN2020-07 Extent and intensity of trawl effort on or near underwater topographic features in New Zealand's Exclusive Economic Zone

- BEN2020-21 Extent and intensity of seabed contact by mobile bottom fishing in the New Zealand Territorial Sea and Exclusive Economic Zone (trawl footprint)
- ENV2020-20 Temporal and spatial distribution on non-target catch, and non-target species, in deepwater fisheries

ZBD2019-01 Quantifying Benthic Biodiversity Across Environmental Gradients - To expand and develop initiatives to improve confidence in predictive models of seabed fauna and habitat distributions

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## Appendix 1 – Bycatch trends in all EEZ ORH/OEO trawl fisheries 1990-91 to 2016-17

**No Bycatch Trend**

| Code | Species/Species Group |
|---|---|
| ANT | Generic code anemones |
| APR | Catchark |
| ASR | Asteroid starfish |
| BAC | Cod-headed rattail |
| BBE | Banded bellowsfish |
| BEL | Bellowsfish |
| BJA | Black javelin fish |
| BSK | Basking shark |
| BSL | Black slickhead |
| BTH | Generic code deepsea skates |
| BTS | Prickly deepsea skate |
| CAN | Brown brotula |
| CAR | Carpet shark |
| CBB | Coral rubble |
| CBD | Coral rubble dead |
| CEN | Generic code seepsea sharks |
| CHI | Chimaera spp. |
| CHP | Brown chimaera |
| COD | Generic code cod |
| COL | Oliver's rattail |
| CON | Conger eel |
| COU | Coral unspecified |
| CRB | Rough shovelnose dogfish |
| CSE | Serrulate rattail |
| CSH | Catchark |
| CUB | Cubehead |
| DEA | Dealfish |
| DEQ | *Deania quadrispinosum* dogfish |
| DWE | Generic code deepwater eel |
| EPR | Robust cardinal fish |
| ERA | Electric ray |
| ETP | *Etmopterus pusillus* dogfish |
| FRO | Frost fish |
| GDU | *Goniocorella dumosa* |
| GIZ | Giant stargazer |
| GLS | Glass sponges |
| GRC | Grenadier cod |
| GSQ | *Architeuthis* spp. squid |
| HAK | Hake |
| HOK | Hoki |
| HTH | Generic code sea cucumber |
| HYD | *Hydrolagus* sp. Chimaera |
| IBR | Cookie cutter shark |
| JAV | Javelin fish |
| JMA | Jack mackerel |
| KIC | King crab |
| LAG | *Laetmogone* spp. Sea cucumber |
| LCH | Long-nosed chimaera |
| LDO | Lookdown dory |
| LEG | Giant lepidion |
| LIN | Ling |
| LPS | Giant lepidion |
| LUC | *Luciosudus* sp. wary fishes |
| MAK | Mako shark |

**Positive Bycatch Trend**

| Code | Species/Species Group |
|---|---|
| ACS | Deepsea anemone |
| BRG | Armless starfish |
| CHG | Giant chimaera |
| CSQ | Leafscale gulper shark |
| CYL | Portuguese dogfish |
| CYO | Smooth skin dogfish |
| CYP | Longnose velved dogfish |
| ETB | Baxter's lantern dogfish |
| GSP | Pale ghost shark |
| HJO | Johnson's cod |
| MCA | Ridge-scaled rattail |
| PSK | Longnosed deepsea skate |
| PSY | Blobfish |
| RCH | Widenosed chimaera |
| SLK | Slickhead |
| SSM | Small-scaled brown slickhead |
| TAM | Tam O' Shanter urchin |
| TSQ | *Todarodes filippovae* squid |
| WSQ | Warty squid |

**Negative Bycatch Trend**

| Code | Species/Species Group |
|---|---|
| BEE | Basketwork eel |
| BNS | Bluenose |
| BOE | Black oreo |
| BSH | Seal shark |
| BSQ | Broad squid |
| BYS | Alfonsino |
| BYX | Alfonsino |
| CDL | Black cardinal fish |
| EPL | Bigeye cardinal fish |
| ETL | Lucifer dogfish |
| ETM | Etmopterus dogfish spp. |
| GSH | Dark ghost shark |
| OCT | Generic code octopus |
| OEO | Generic code oreo |
| OFH | Oilfish |
| PDG | Prickly dogfish |
| RAG | Ragfish |
| RAT | Generic code rattails |
| RIB | Ribaldo |
| RUD | Rudder fish |
| SHA | Generic code sharks |
| SKA | Generic code skates |
| SNR | Rough shovelnose dogfish |
| SOP | Pacific sleeper shark |
| SOR | Spiky oreo |
| SPD | Spiny dogfish |
| SQU | Arrow squids |
| SSO | Smooth oreo |
| SWA | Silver warehou |

**No Bycatch Trend** (continued)

| Code | Species/Species Group |
|---|---|
| MDO | Mirror dory |
| MIQ | Warty squid |
| MOD | Generic code morid cods |
| MOR | Moray eel |
| MST | Black dragonfish |
| MUR | Moray cod |
| NEB | Brodie's king crab |
| ONG | Generic code sponges |
| OPE | Orange perch |
| OPH | Brittle star |
| OSK | Generic code skates |
| PAB | *Bubblegum coral* |
| PLS | Plunket's shark |
| PMO | *Pseudostichopus mollis* sea cucumber |
| PSE | *Pseudechinus* spp. Sea urchin |
| RBM | Ray's bream |
| RHY | Common roughy |
| ROC | Rock cod |
| RSK | Rough skate |
| RSQ | Ommastrephes bartrami squid |
| SBI | Big-scaled brown slickhead |
| SBK | Spineback |
| SBR | Southern bastard cod |
| SCM | Large spine velvet dogfish |
| SFN | Spiny fin |
| SHE | Sherwood's dogfish |
| SIA | Stony corals |
| SLC | Antarctic arm squid |
| SMC | Small-headed cod |
| SNA | Snapper |
| SND | Shovelnose dogfish |
| SPE | Sea perch |
| SPI | Spider crab |
| SQA | Generic code dogfishes |
| SQX | Generic code squid |
| SRH | Silver roughy |
| SRI | Sleeper shark |
| SSH | Slender smooth-hound |
| SSK | Smooth skate |
| SVA | Solenosmilia variabilis |
| SWR | Sandager's wrasse |
| SYN | Cut-throat eel |
| TAL | *Talismania longifilis* slickhead |
| TOA | Toadfish |
| TOP | Pale toadfish |
| VCO | Violet cod |
| VIT | Deepsea spider crab |
| VSQ | Violet squid |
| WHR | Unicorn rattail |
| WHX | White rattail |
| WIT | Witch flounder |
| WOE | Worty oreo |
| WWA | White warehou |
| ZAS | Velvet dogfish |

| Legend |
|---|
| Corals |
| Sponge/anemone/echinoderm |
| Crustaceans |
| Cephalopods |
| Sharks/chimaeras |
| Rattails |
| Johnson's cods |
| Non-QMS teleosts |
| QMS species/groups |

## Appendix 2 – UoA Trawl Footprint Maps

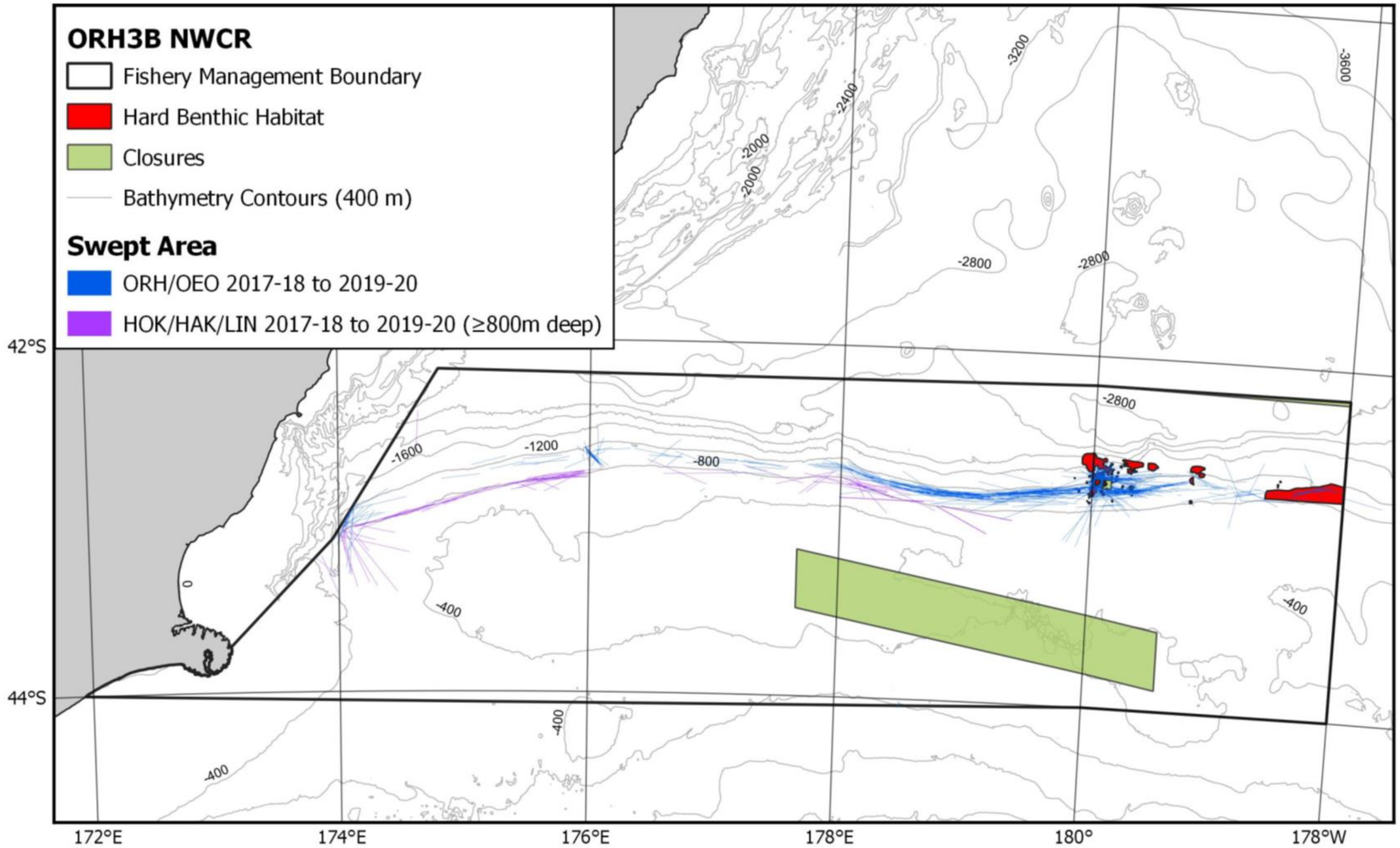


**Figure A1: NWCR UoA trawl footprint for ORH/OEO targeted tows and for HAK/HOK/LIN targeted tows with starting depths ≥ 800 m, 2017-18 to 2019-20.**

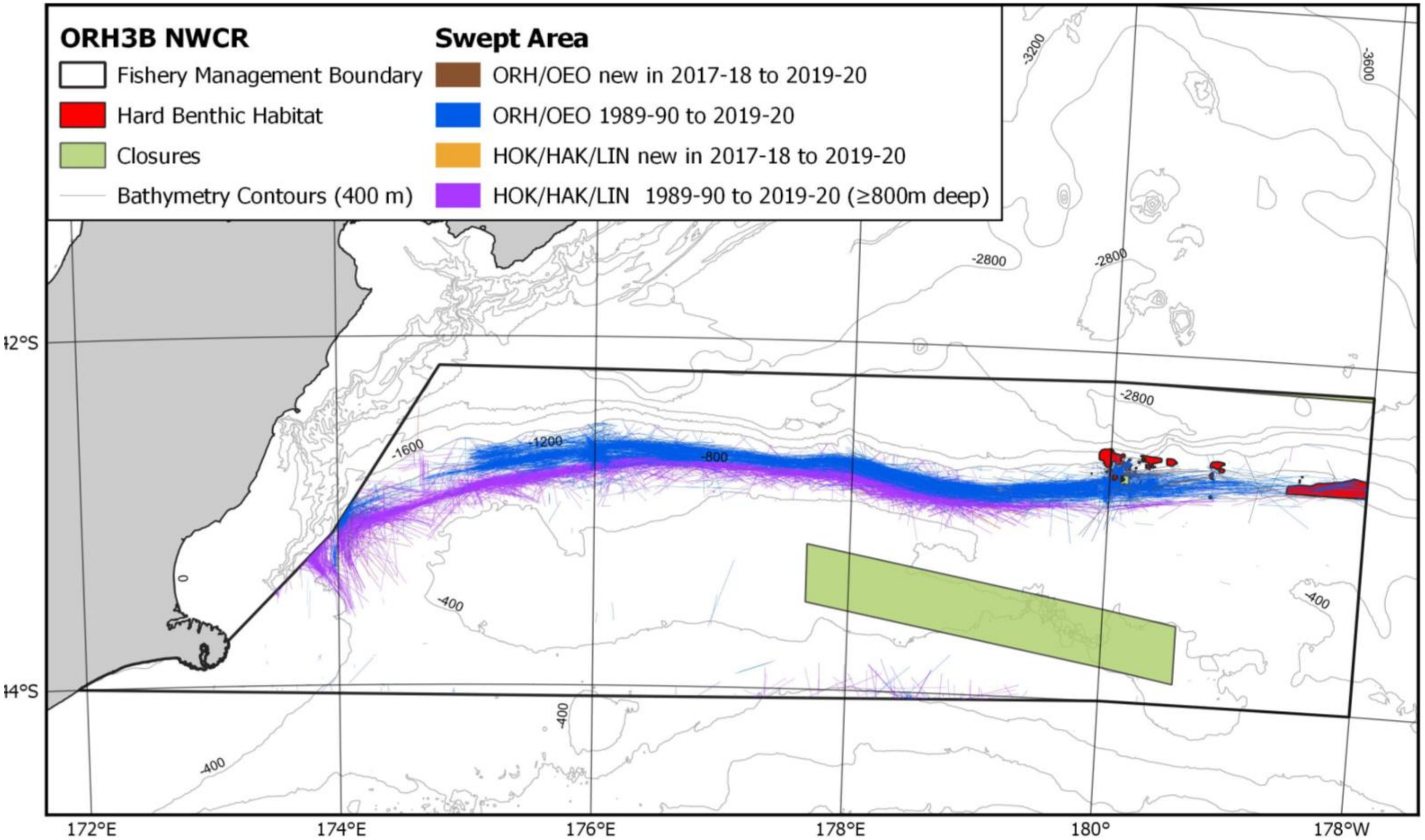


**Figure A2: NWCR UoA trawl footprint for ORH/OEO targeted tows and for HAK/HOK/LIN targeted tows with starting depths ≥ 800 m, 1989-90 to 2019-20.**

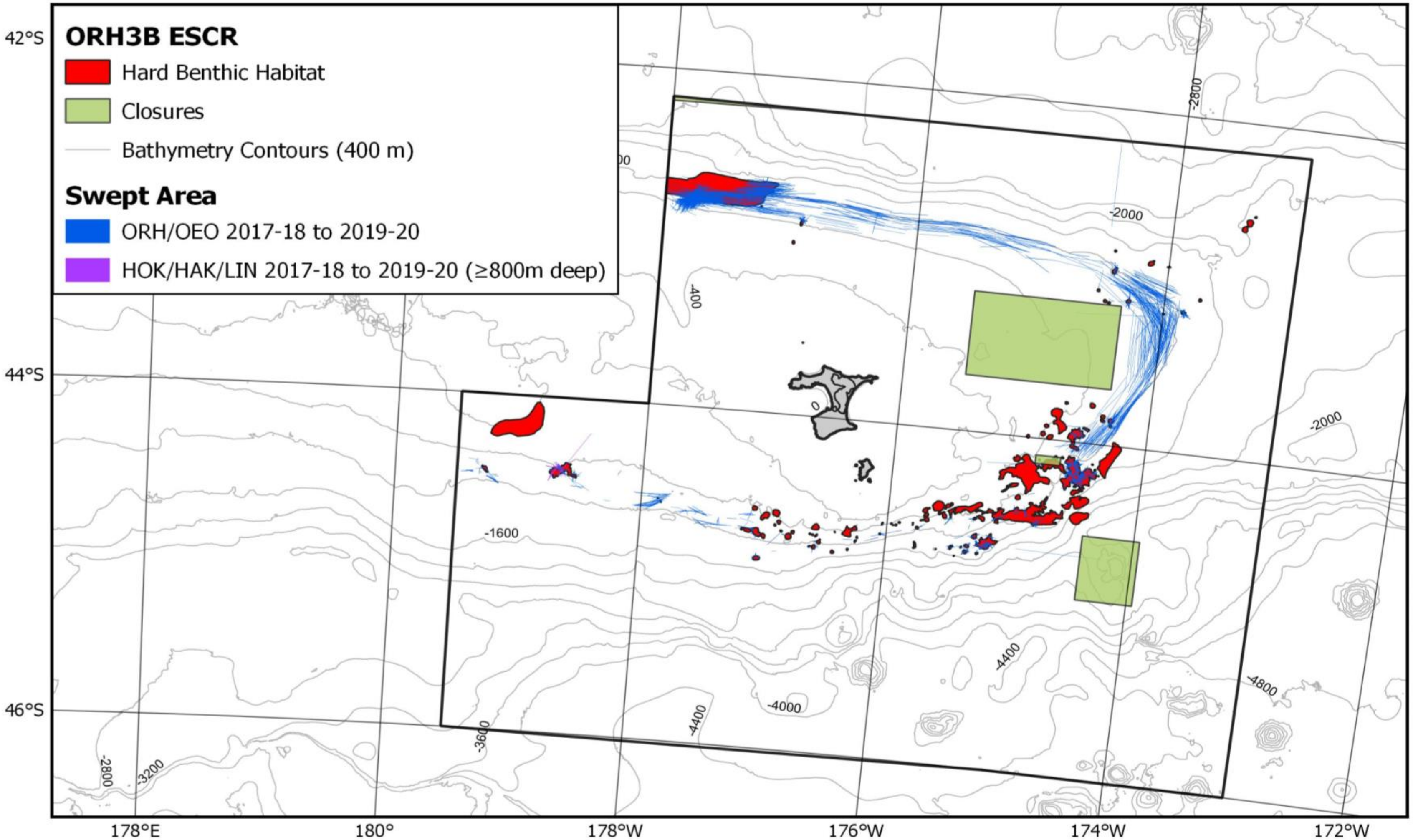


**Figure A3: ESCR UoA trawl footprint for ORH/OEO targeted tows and for HAK/HOK/LIN targeted tows with starting depths ≥ 800 m, 2017-18 to 2019-20.**

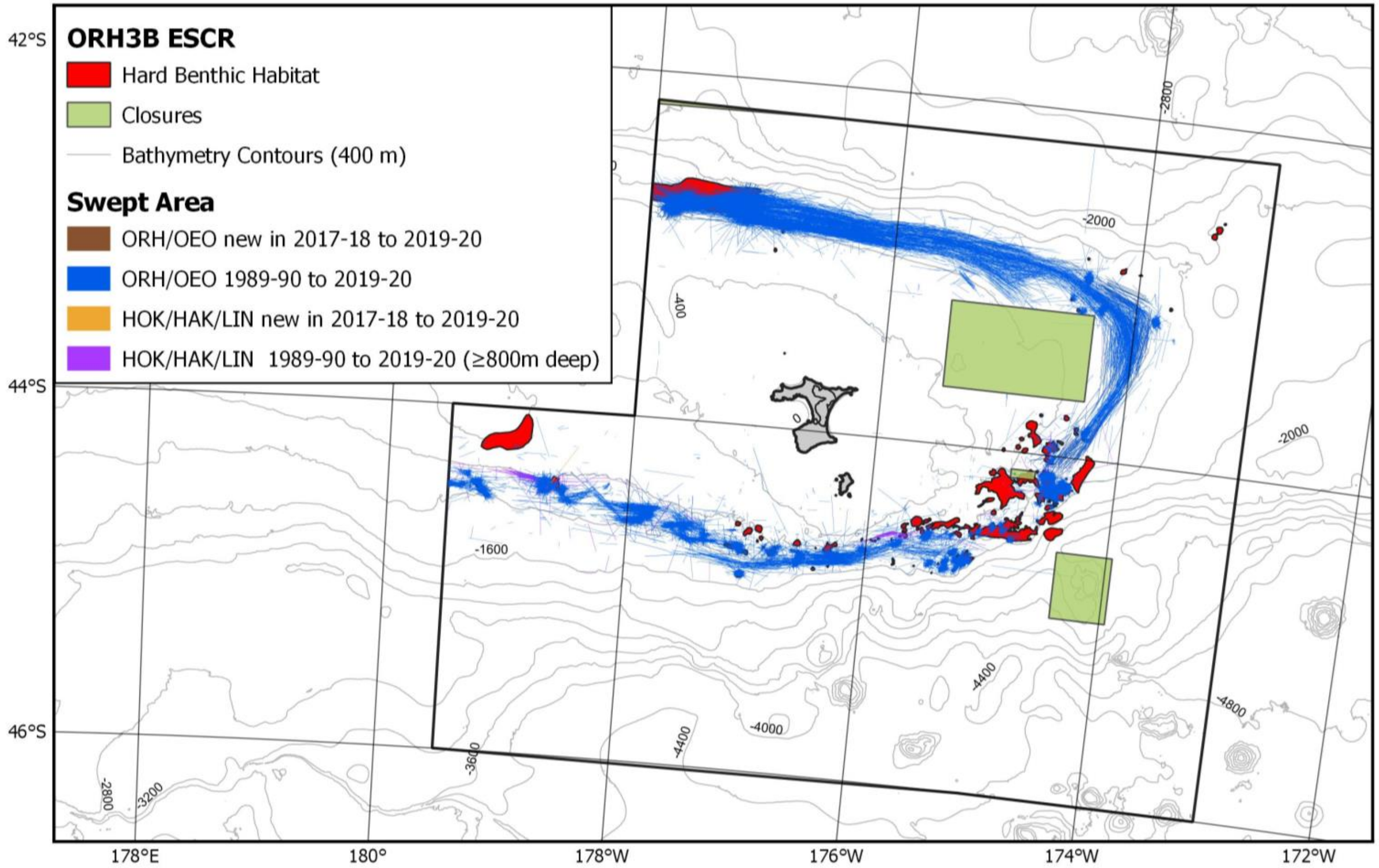


**Figure A4: ESCR UoA trawl footprint for ORH/OEO targeted tows and for HAK/HOK/LIN targeted tows with starting depths ≥ 800 m, 1989-90 to 2019-20.**

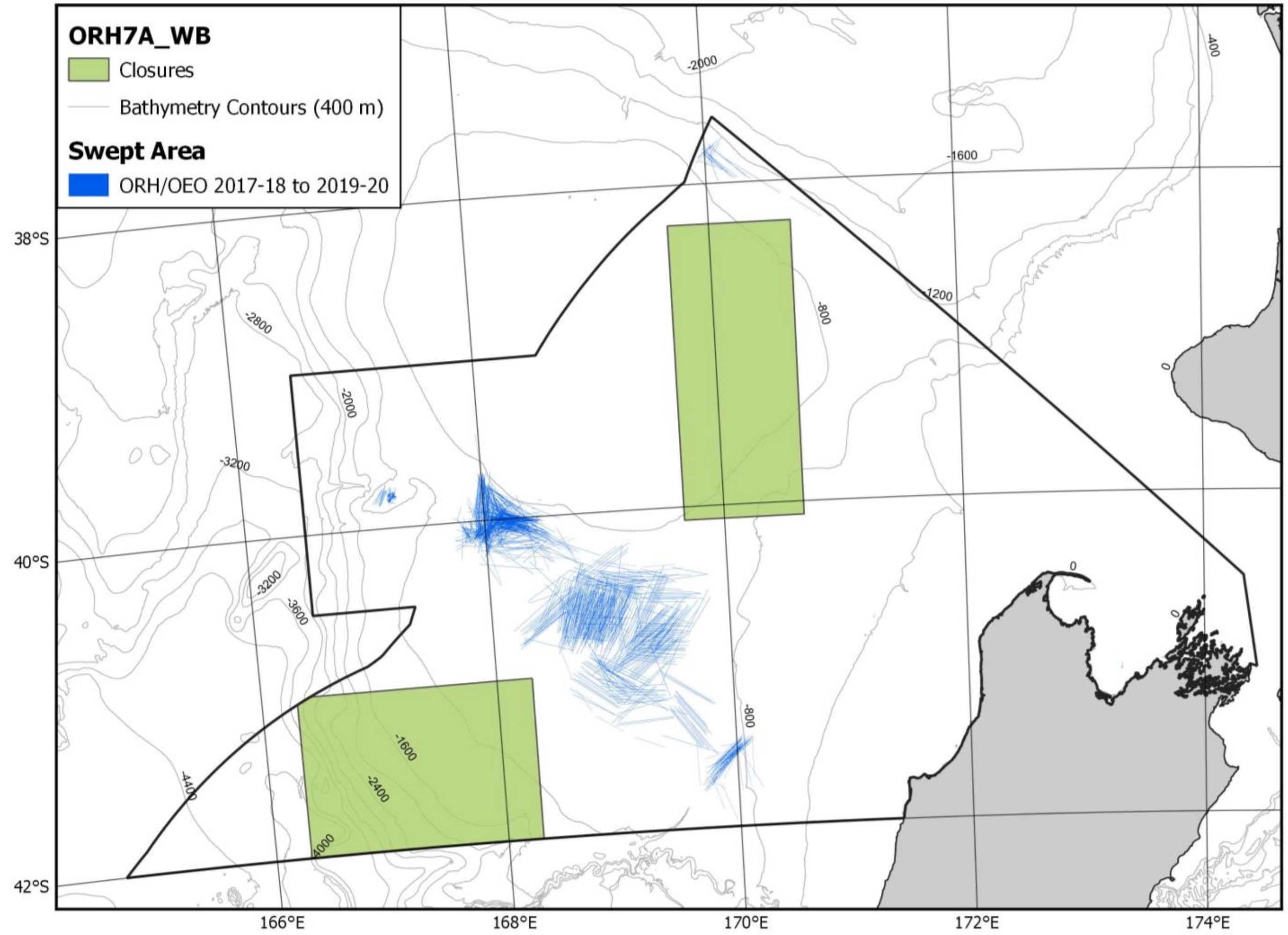


**Figure A5: ORH7A-WB UoA trawl footprint for ORH/OEO targeted tows and for HAK/HOK/LIN targeted tows with starting depths ≥ 800 m, 2017-18 to 2019-20.**

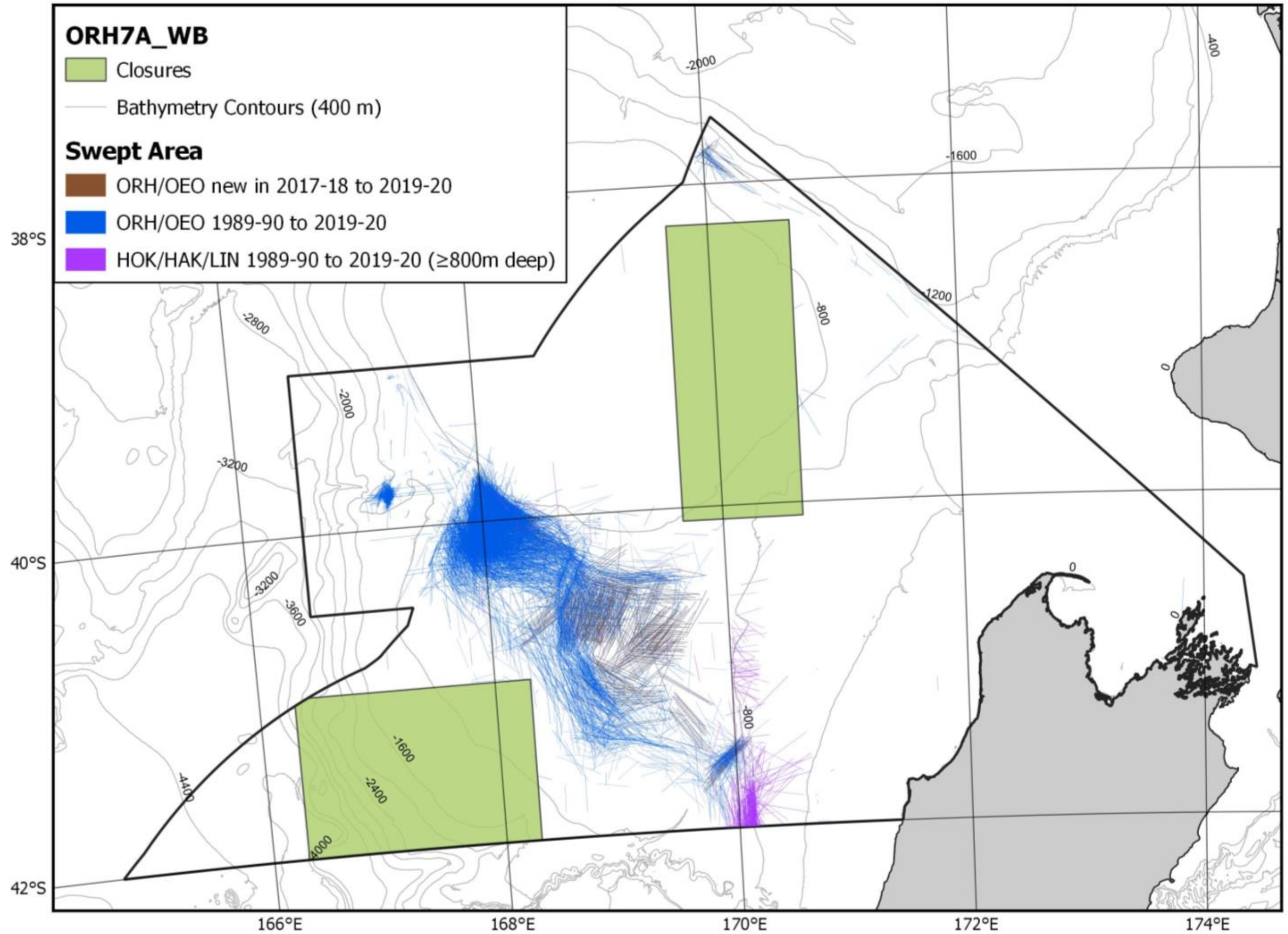


**Figure A6: ORH7A-WB UoA trawl footprint for ORH/OEO targeted tows and for HAK/HOK/LIN targeted tows with starting depths ≥ 800 m, 1989-90 to 2019-20.**

## Appendix 3 – UoA Trawl footprint overlaps with observed and predicted coral distributions

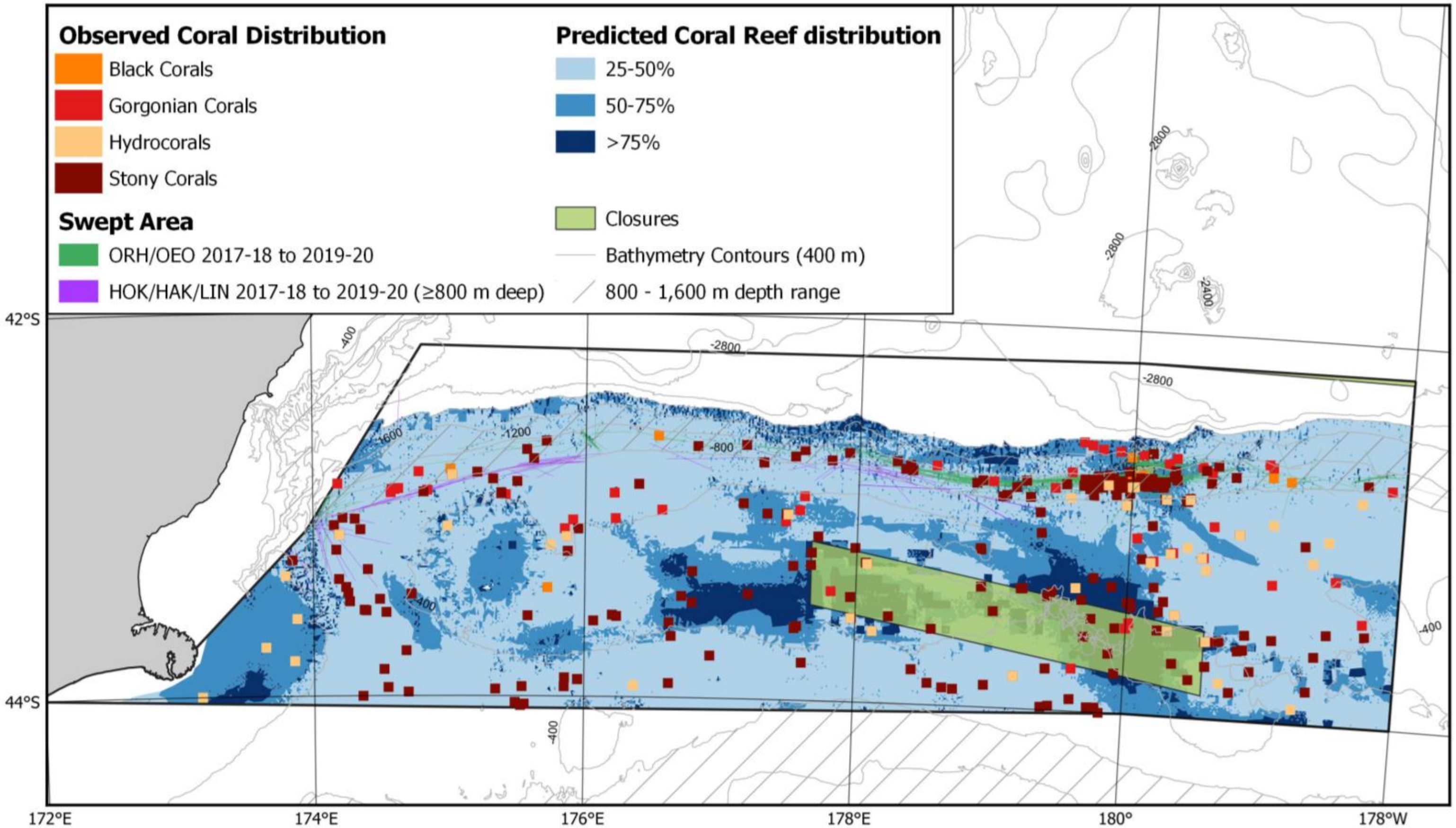


**Figure B1: NWCR UoA observed distributions for black, gorgonian, stony and hydrocorals (coloured squares), ensemble model weighted habitat suitability distributions for 'Coral Reef' and the ORH/OEO and HAK/HOK/LIN trawl footprints for the period 2017-18 to 2019-20. Note: (a) predicted habitat suitability indicated by intensity of blue shading (b) observed coral distribution squares exaggerated in size for clarity.**

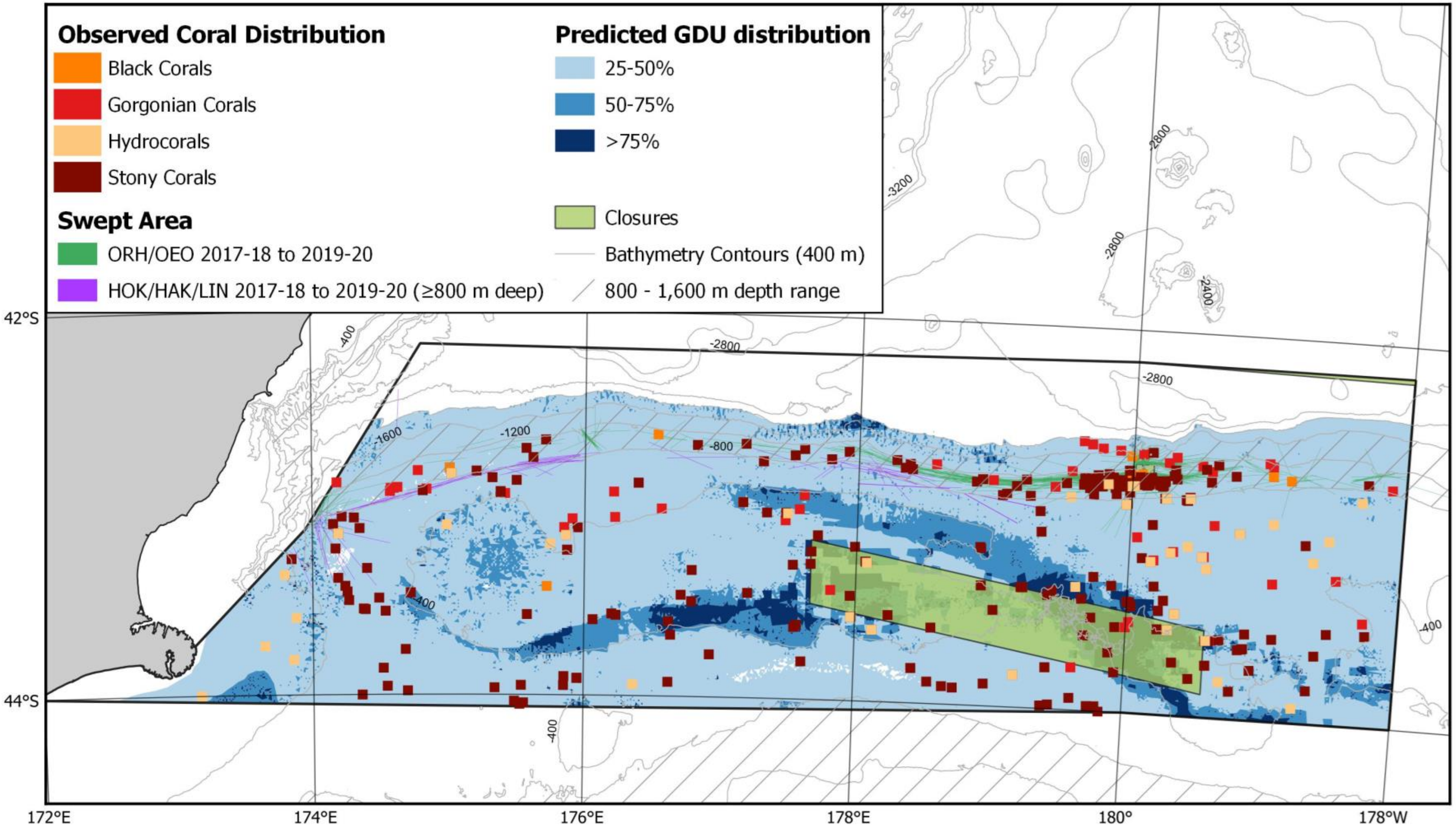


**Figure B2: NWCR UoA observed distributions for black, gorgonian, stony and hydrocorals (coloured squares), ensemble model weighted habitat suitability distributions for the stony coral *Goniocorella dumosa* (GDU) and the ORH/OEO and HAK/HOK/LIN trawl footprints for the period 2017-18 to 2019-20. Note: (a) predicted habitat suitability indicated by intensity of blue shading (b) observed coral distribution squares exaggerated in size for clarity.**

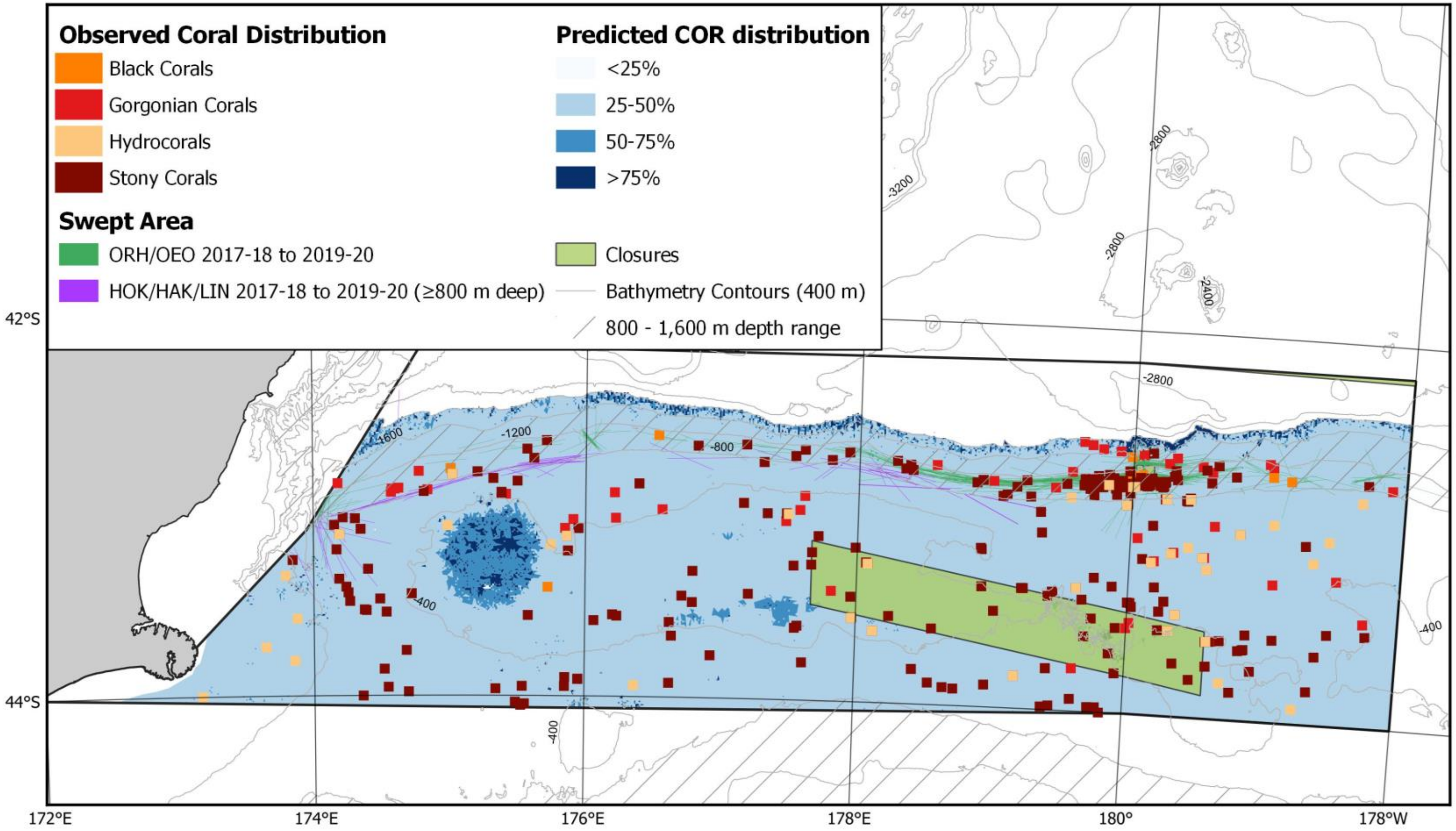


**Figure B3: NWCR UoA observed distributions for black, gorgonian, stony and hydrocorals (coloured squares), ensemble model weighted habitat suitability distributions for the Family Stylasteridae (COR, a group of protected hydrocorals in the O. Anthoathecata), and the ORH/OEO and HAK/HOK/LIN trawl footprints for the period 2017-18 to 2019-20. Note: (a) predicted habitat suitability indicated by intensity of blue shading (b) observed coral distribution squares exaggerated in size for clarity.**

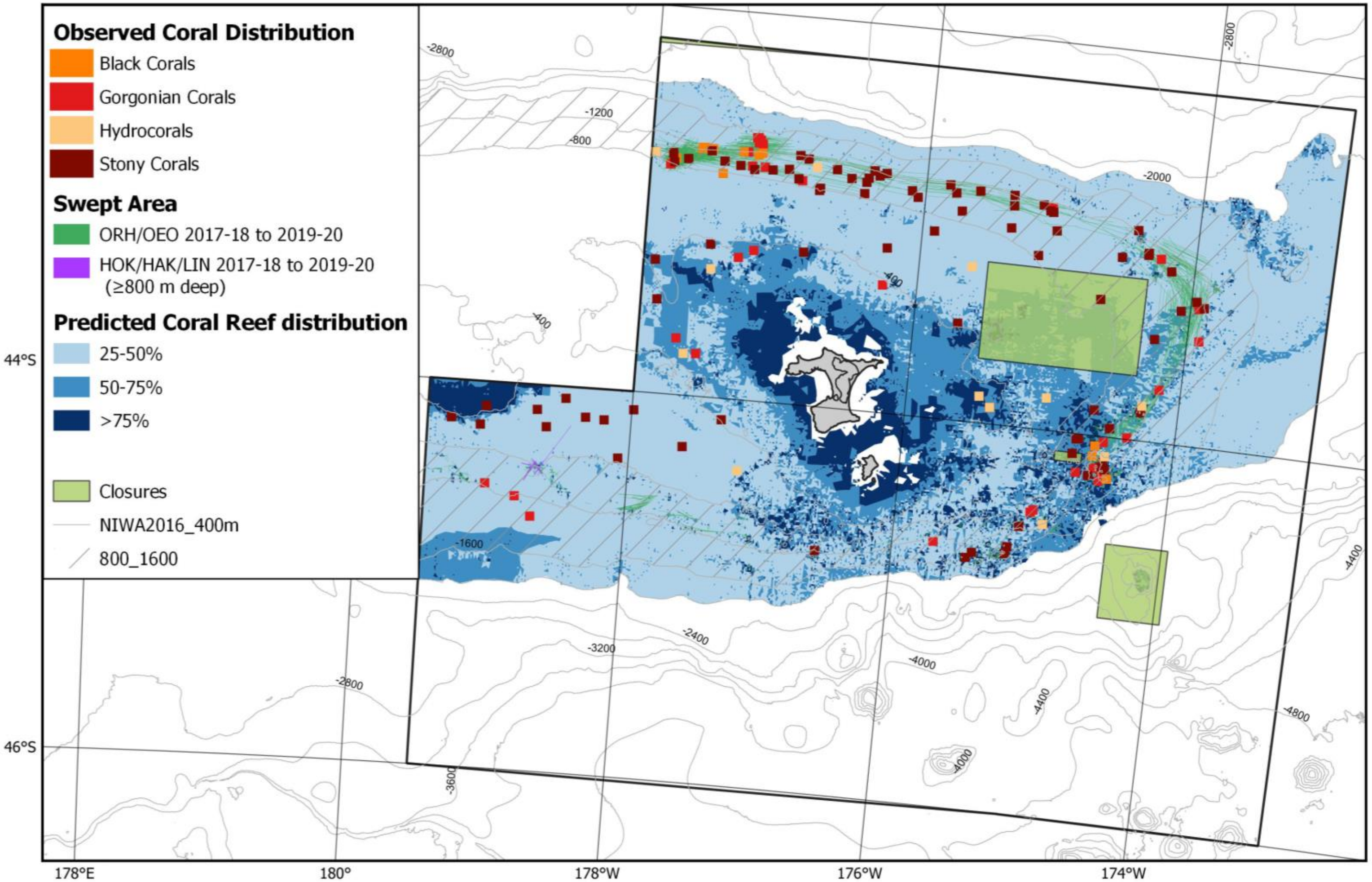


**Figure B4: ESCR UoA observed distributions for black, gorgonian, stony and hydrocorals (coloured squares), ensemble model weighted habitat suitability distributions for 'Coral Reef' and the ORH/OEO and HAK/HOK/LIN trawl footprints for the period 2017-18 to 2019-20. Note: (a) predicted habitat suitability indicated by intensity of blue shading (b) observed coral distribution squares exaggerated in size for clarity.**

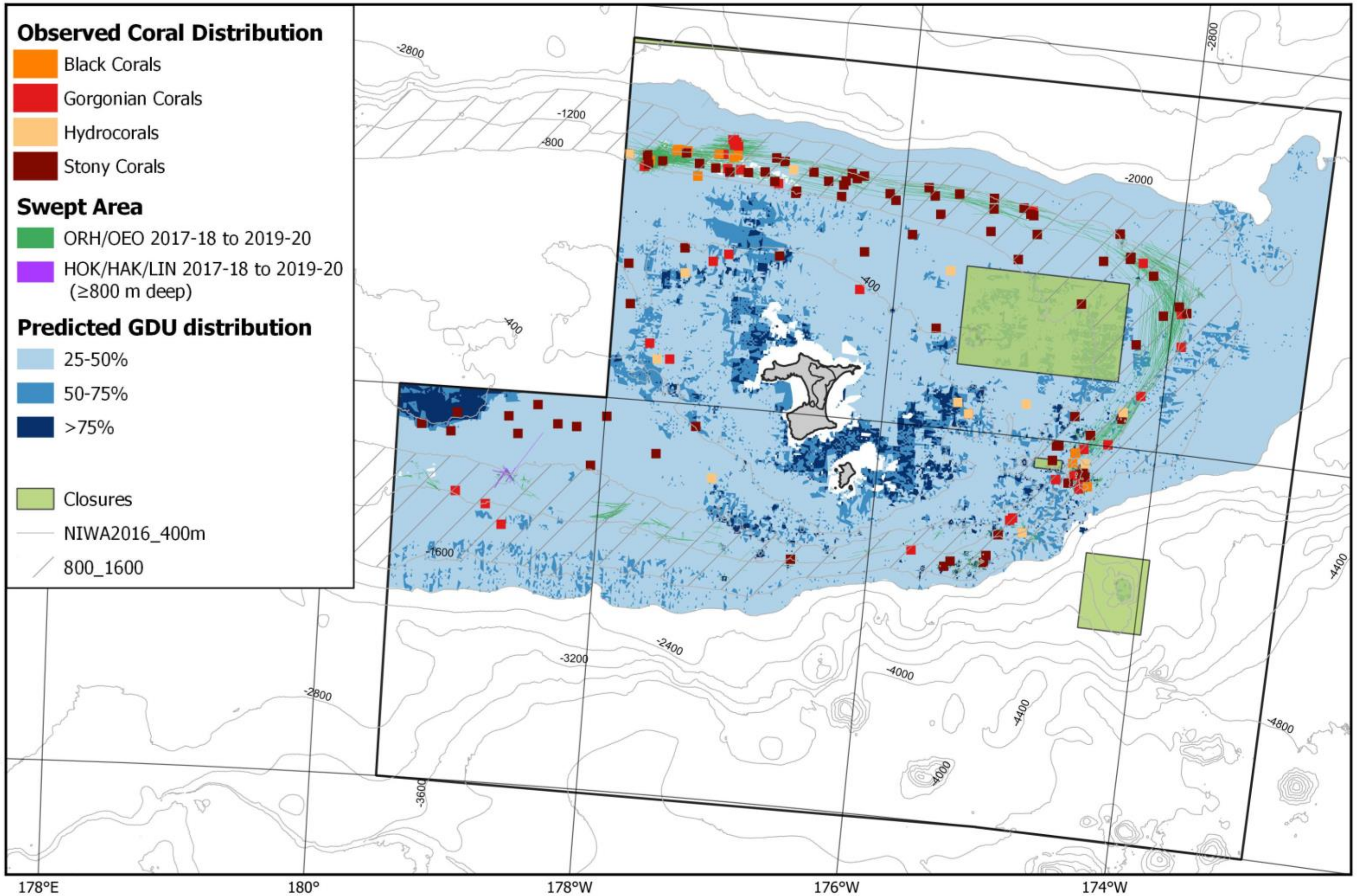


**Figure B5: ESCR UoA observed distributions for black, gorgonian, stony and hydrocorals (coloured squares), ensemble model weighted habitat suitability distributions for the stony coral *Goniocorella dumosa* (GDU) and the ORH/OEO and HAK/HOK/LIN trawl footprints for the period 2017-18 to 2019-20. Note: (a) predicted habitat suitability indicated by intensity of blue shading (b) observed coral distribution squares exaggerated in size for clarity.**

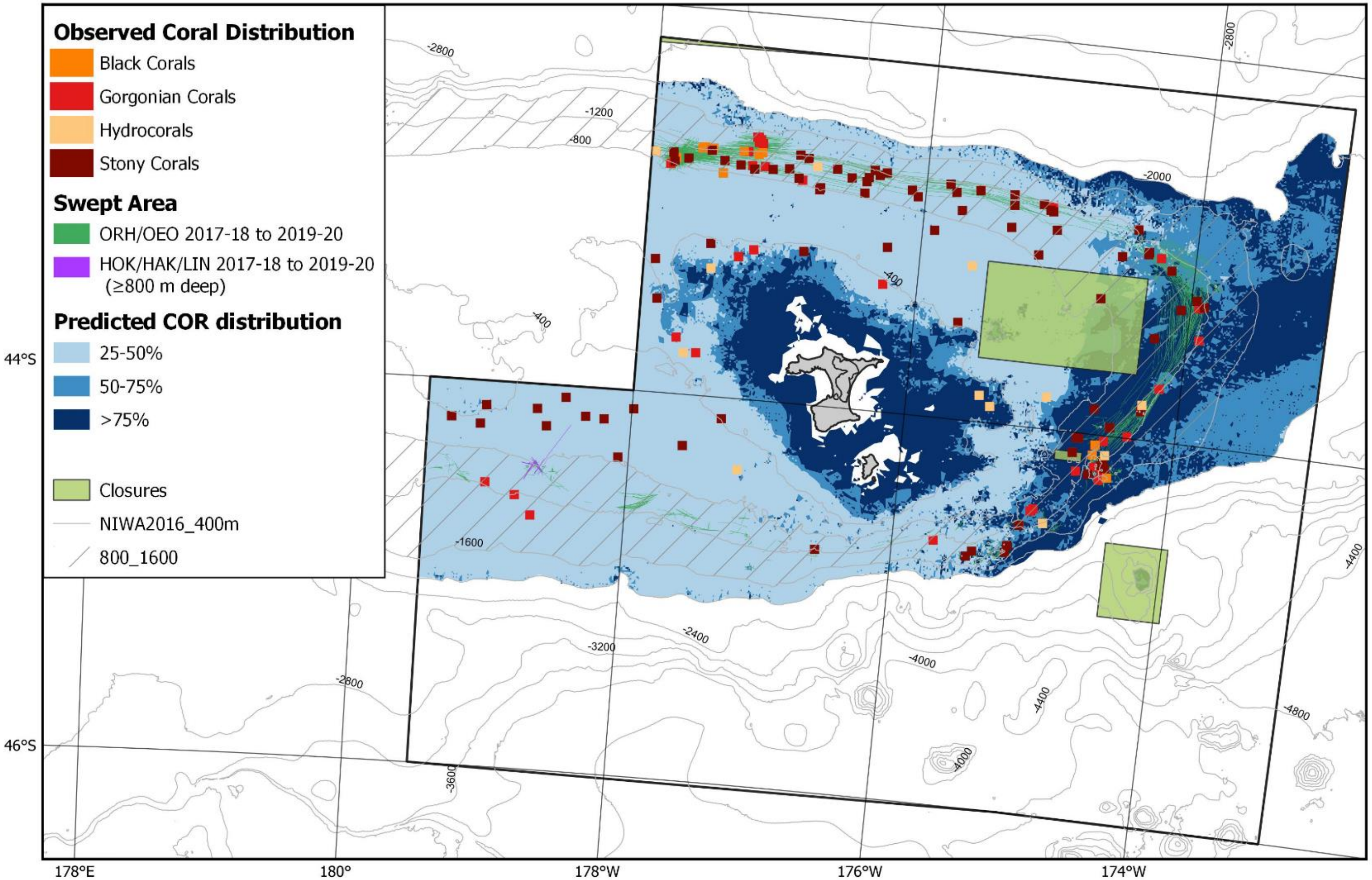


**Figure B6: ESCR UoA observed distributions for black, gorgonian, stony and hydrocorals (coloured squares), ensemble model weighted habitat suitability distributions for the Family Stylasteridae (COR, a group of protected hydrocorals in the O. Anthoathecata), and the ORH/OEO and HAK/HOK/LIN trawl footprints for the period 2017-18 to 2019-20. Note: (a) predicted habitat suitability indicated by intensity of blue shading (b) observed coral distribution squares exaggerated in size for clarity.**

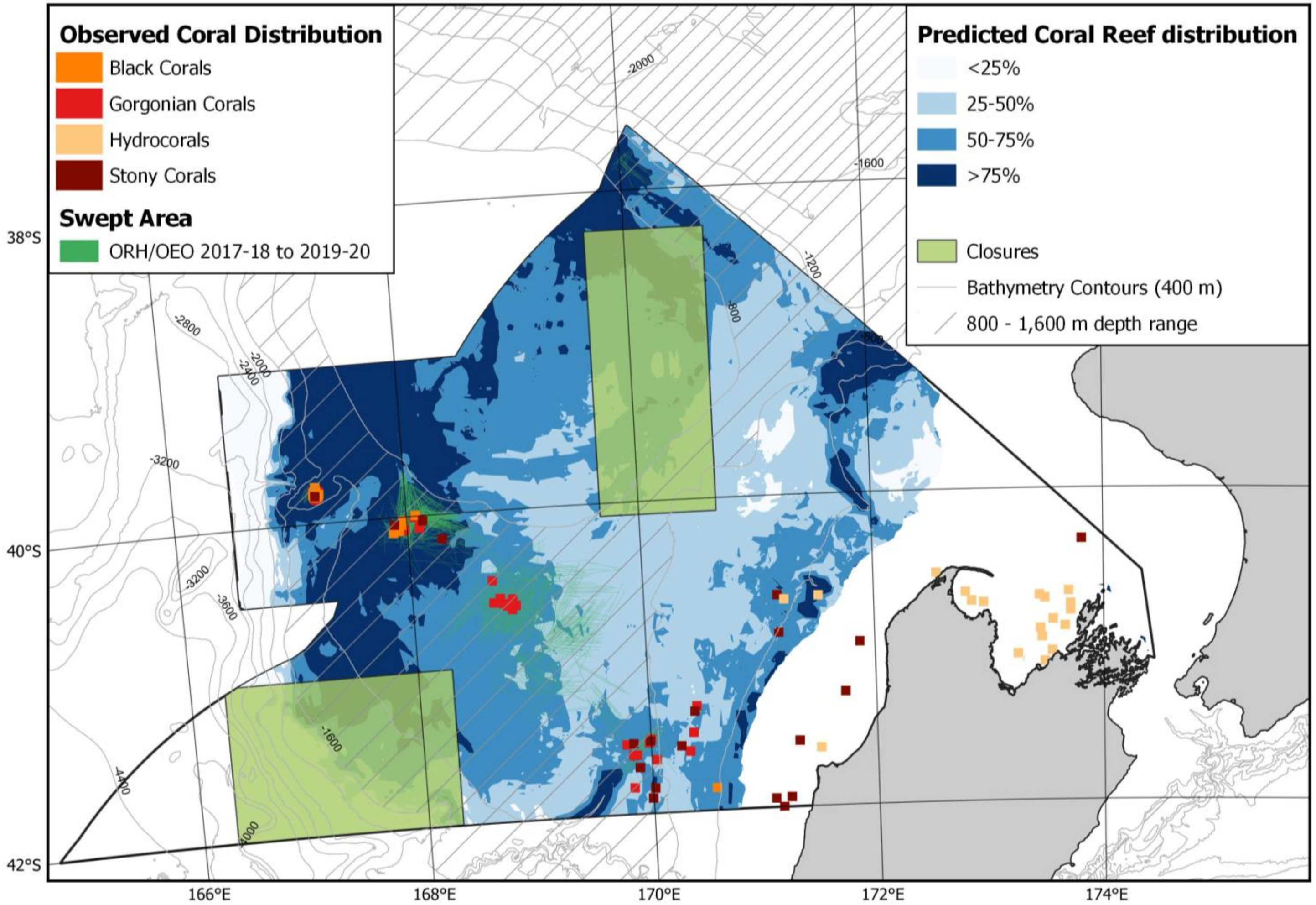


**Figure B7: ORH7A-WB UoA observed distributions for black, gorgonian, stony and hydrocorals (coloured squares), ensemble model relative predicted suitability distributions for 'Coral Reef' and the ORH/OEO and HAK/HOK/LIN trawl footprints for the period 2017-18 to 2019-20. Note: (a) predicted habitat suitability indicated by intensity of blue shading (b) observed coral distribution squares exaggerated in size for clarity.**

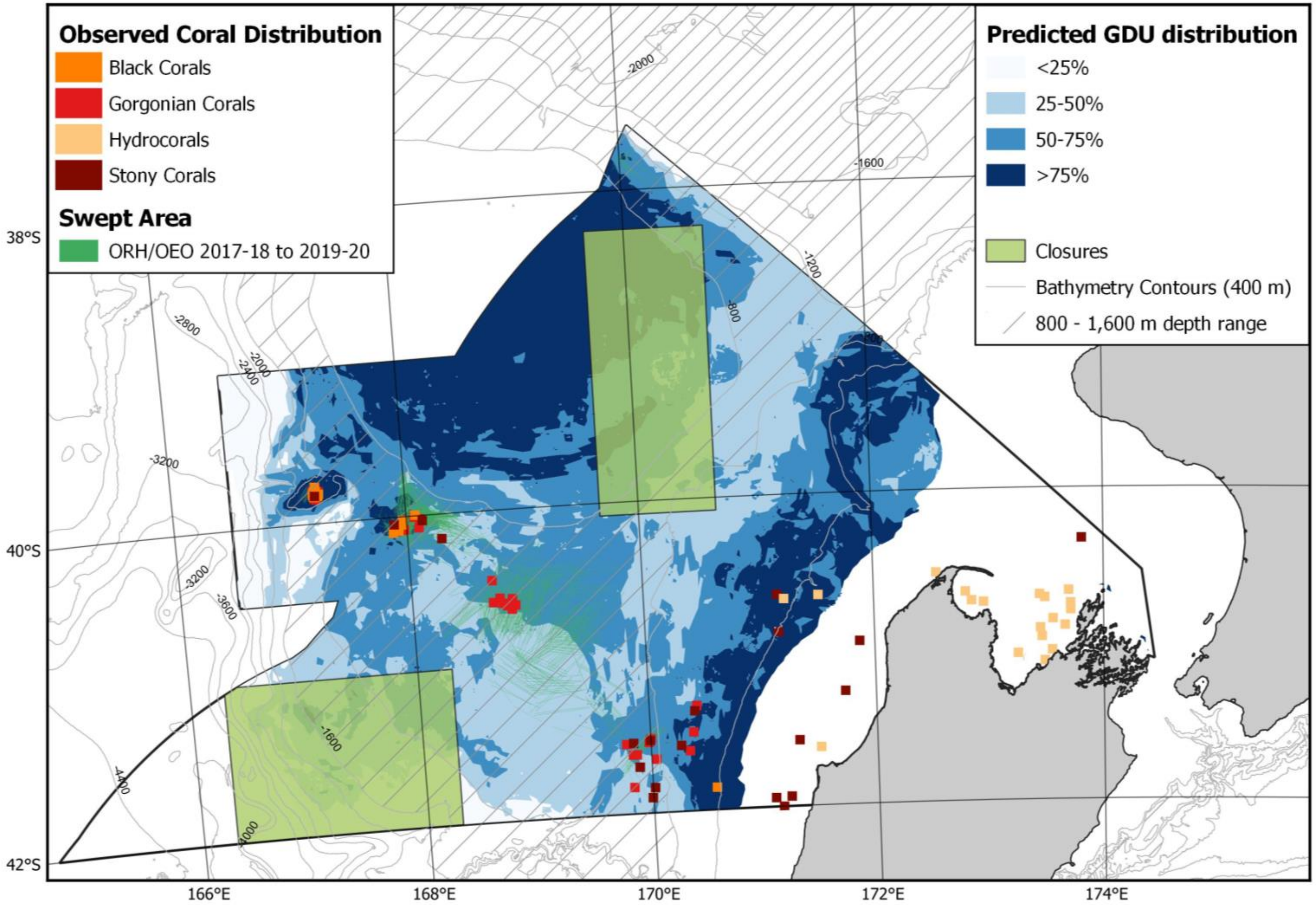


**Figure B8: ORH7A-WB UoA observed distributions for black, gorgonian, stony and hydrocorals (coloured squares), ensemble model relative predicted suitability distributions for the stony coral *Goniocorella dumosa* (GDU) and the ORH/OEO and HAK/HOK/LIN trawl footprints for the period 2017-18 to 2019-20. Note: (a) predicted habitat suitability indicated by intensity of blue shading (b) observed coral distribution squares exaggerated in size for clarity.**

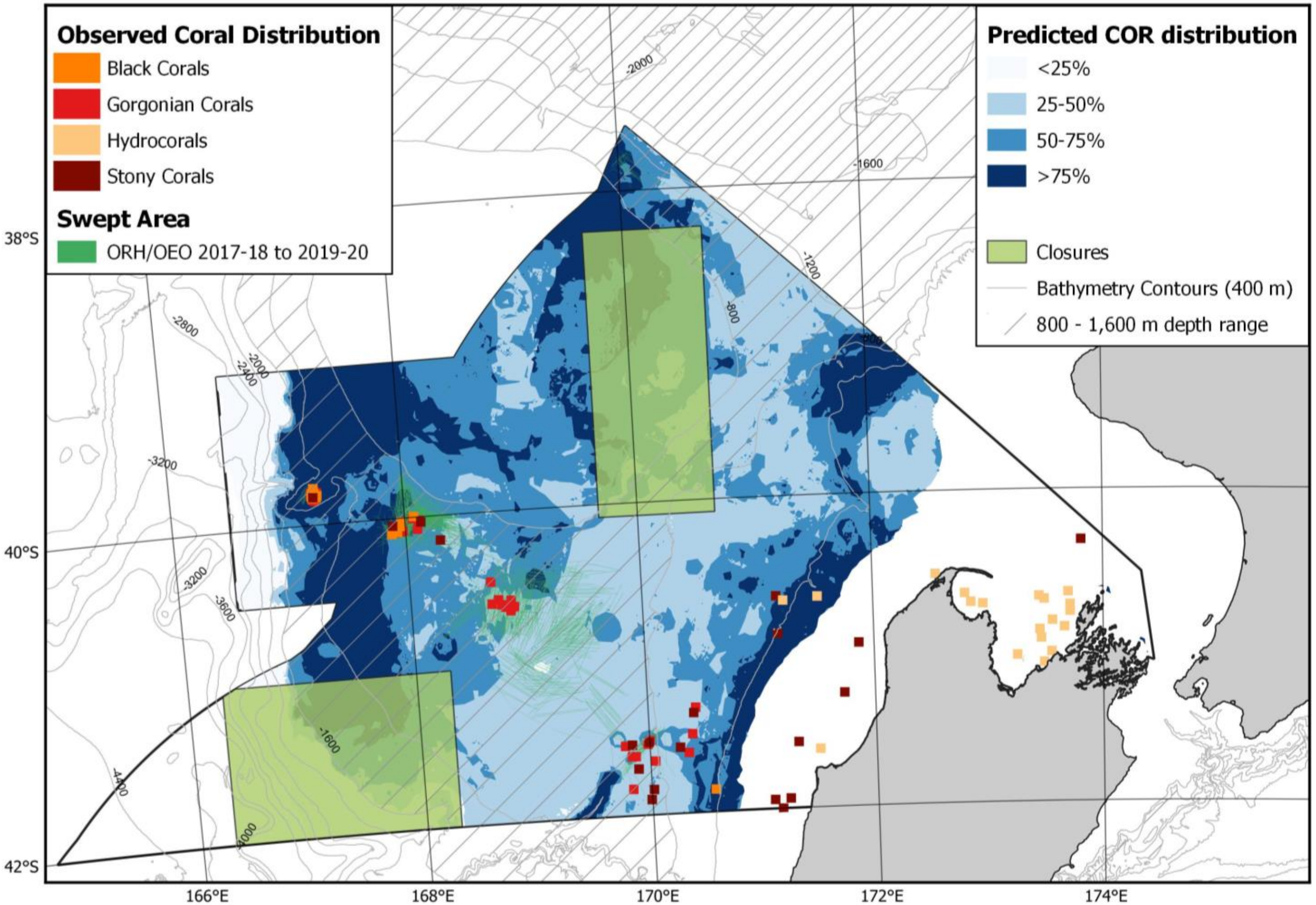


**Figure B9: ORH7A-WB UoA observed distributions for black, gorgonian, stony and hydrocorals (coloured squares), ensemble model relative predicted suitability distributions for the Family Stylasteridae (COR, a group of protected hydrocorals in the O. Anthoathecata), and the ORH/OEO and HAK/HOK/LIN trawl footprints for the period 2017-18 to 2019-20. Note: (a) predicted habitat suitability indicated by intensity of blue shading (b) observed coral distribution squares exaggerated in size for clarity.**

# PRINCIPLE 3: OVERVIEW OF MANAGEMENT INFORMATION

## Overview of Management Information

### Changes to management system & regulations

Electronic reporting and geo-positional reporting (VMS) for all New Zealand trawlers was phased in during 2019.

The South Pacific Regional Fisheries Management Organisation (SPRFMO) agreed to a new management measure for bottom fishing in the Convention Area, which includes the Westpac Bank portion of the ORH 7A-WB UoA (SPRFMO, 2021). The measure defines areas open to bottom trawling and implements requirements for move-on rules should vulnerable species be encountered. A catch limit for the NW Challenger (which includes the Westpac Bank area) was considered by the Commission in February 2021 on the basis of a 2020 stock assessment. The catch limit remained unchanged at 396 t (SPRFMO, 2020).

### Changes to personnel involved in science or management

Aaron Irving was appointed as Deputy CEO of Deepwater Group in January 2021. FNZ have appointed a new senior scientist, Dr Gretchen Skea, in the Fisheries Science and Information team. She currently Chairs the meetings of the Deep Water Working Group.

### Legal & customary framework

New Zealand's fisheries management is centred on the Quota Management System (QMS), a system introduced in 1986 based on Individual Transferrable Quota (quota), Total Allowable Catch (TAC) limits and Total Allowable Commercial Catch (TACC) limits.

Quota provides a property right to access commercial fisheries and has been allocated to Māori as part of the Treaty of Waitangi Settlements that acknowledge the Treaty guaranteed Māori *"full exclusive and undisturbed possession of their…fisheries."*

Quota is a tradable property right that entitles the owner to a share of the TACC. At the commencement of each fishing year, quota gives rise to Annual Catch Entitlements (ACE) which are tradable, expressed in weight, and entitle the holder to land catch against them. The QMS enables sustainable utilisation of fisheries resources through the direct control of harvest levels based on the best available science. The QMS is administered by MPI through the Fisheries Act 1996.

New Zealand has implemented one of the most extensive quota-based fisheries management systems in the world, with over a 100 species or species-complexes of fish, shellfish and seaweed now being managed within this framework. Almost all commercially targeted fish species within New Zealand's waters are now managed within the QMS.

At an operational level, these fisheries are managed in accordance with the National Fisheries Plans.

The National Fisheries Plan for Deepwater Fisheries has been revised and implemented as of May 2019 (MPI, 2019). It is a statutory document, approved by the Minister, which provides an enabling framework outlining agreed management objectives, timelines, performance criteria and review processes. There is a species-specific chapter for orange roughy within this plan (MPI, 2010).

The National Deepwater Plan consists of three parts:

- Fisheries management framework and objectives:

- Part 1A - strategic direction for deep water fisheries
- Part 1B - fishery-specific chapters and management objectives at the fishery level

- Annual Operational Plan (AOP) – detailing the management actions for delivery that relate to deep water fisheries during 2020-21 (see Table 2 (pp. 10-18)), research projects (see Tables 8-12, pp. 33-34), and observer coverage (see Table 12, pp. 35-36), (FNZ, 2020).
- Annual Review Report (ARR) – reporting on progress towards meeting the five-year plan and on the annual performance of the deep water fisheries against the AOP. For example, a comparison of planned and achieved observer coverage in orange fisheries during the 2018-19 fishing year showed that targets were exceeded in ORH 3B Chatham Rise fisheries but were under-delivered in ORH 7A (see Table 7, pp. 34), (FNZ, 2020a).

### Collaboration

In 2006, DWG and FNZ (then MPI), entered into a formal partnership to enable collaboration in the management of New Zealand's deep water fisheries. This partnership (MPI, 2010a) was updated in 2008 and 2010 and has directly facilitated improved management of the orange roughy trawl fisheries through:

- A close working relationship under a shared and agreed vision, objectives and collaborative work plans
- Real-time, open communication between DWG and FNZ on information relevant to management measures, particularly from the FNZ Observer Programme and commercial catching operations.

FNZ and DOC actively consult with interested parties to inform management decisions through their open scientific working groups and public consultation processes.

### Compliance & enforcement

FNZ maintains a comprehensive compliance programme, which includes both encouraging compliance through support and creating effective deterrents. This strategy is underpinned by the VADE model, which focuses on all elements of the compliance spectrum as follows:

9. Voluntary compliance – outcomes are achieved through education, engagement and communicating expectations and obligations
10. Assisted compliance – reinforces obligations and provides confidence that these are being achieved through monitoring, inspection, responsive actions and feedback loops
11. Directed compliance – directs behavioural change and may include official sanctions and warnings
12. Enforced compliance – uses the full extent of the law and recognises that some individuals may deliberately choose to break the law and require formal investigation and prosecution.

Since 1994, all vessels over 28 m have been required by law to be part of the Vessel Monitoring System (VMS) which, through satellite telemetry, enables FNZ to monitor all orange roughy vessel locations at all times. Paper based catch reporting was also required by all fishing vessels operating in NZ's EEZ. These systems have now been replaced by near real time Geospatial Position Reporting and daily Electronic Catch Reporting. FNZ still combines this functionality with at-sea and aerial surveillance, supported by the New Zealand Defence Force. This independently provides surveillance of activities of deep-water vessels through inspection and visual capability to ensure these vessels are fully monitored and verified to ensure compliance with both regulations and with industry-agreed Operational Procedures.

All commercial catches from QMS stocks must be reported and balanced against ACE at the end of the month. It is illegal to discard or not to report catches of QMS species. Catches may only be landed at designated ports and sold to Licensed Fish Receivers (LFRs). Reporting requirements for orange roughy vessels include logging the location, depth, main species caught for each tow, and total landed catch for each trip.

MPI Fishery Officers carried out two in port inspections during the 2019/2020 fishing year. The two vessels inspected had completed fishing trips targeting orange roughy in ORH7A.

Areas monitored included one or more of the following:

- ER reporting and landing documentation
- Monitored unload
- Compliance checks of seabird mitigation devices

No breaches were detected in relation to the areas examined.

There were no in port inspections carried out on vessels that had been engaged in fishing for orange roughy in ORH3B NWCR, ORH3B ESCR, and Westpac Bank Fisheries for the 2019/2020 fishing year.

There were no at sea inspections of vessels engaged in fishing for orange roughy in ORH3B NWCR, ORH3B ESCR, ORH7A or Westpac Bank for the 2019/2020 fishing year.

An RNZAF routine flight to monitor the West Coast South Island Hoki fishery obtained imagery relating to a vessel targeting orange roughy in ORH7A at the time of the flight. This was a highly overt flight utilised to gather basic information of vessel activity. The vessel was sighted with warps out the back and bird bafflers deployed. No breaches were detected.

Compliance activity is summarised in Table 1.

**Table 1: Number of inspections undertaken in UoC fisheries during 2019-20**

| Fishing year | Inspection type | ORH 3B NWCR | ORH 3B ESCR | ORH 7A | Westpac Bank |
|---|---|---|---|---|---|
| 2019-20 | In port | - | - | 2 | - |
| | At sea | - | - | | - |
| | Aerial | - | - | 1 | - |
| | Total | - | - | 3 | - |

Orange roughy was not a national priority for compliance, hence the small number of inspections undertaken in the 2019/20 fishing year. It is also important to note that port restrictions, due to COVID, resulted in a significant drop in the number of inspections during the 2019/20 fishing year particularly during the months of February 2020 through to June 2020 (MPI Compliance, pers. comm.).

Commercial fishermen face prosecution and risk severe penalties, which include automatic forfeiture of vessel and quota upon conviction of breaches of the fisheries regulations (unless the court rules otherwise). Financial penalties are also imposed in the form of deemed values to discourage fishermen from over-catching their ACE holdings.

The extensive regulations governing these fisheries are complemented by additional industry-agreed non-regulatory measures, known as the New Zealand Deepwater Fisheries Operational Procedures. The Minister for Fisheries relies on the effectiveness of both regulatory and non-regulatory measures to ensure the sustainable management of these fisheries.

As part of DWG's Operational Procedures, DWG has an Environmental Liaison Officer whose role is to liaise with vessel operators, skippers and FNZ to assist with the effective implementation of these Operational Procedures (Cleal, 2019, Cleal, 2020).

DWG personnel and vessel operators meet with MPI's Management and Compliance teams annually to discuss and evaluate any issues that may have arisen (DWG, 2020, 2020a, MPI, 2019a). Any identified risks are communicated to the fleet along with proposed remedial action to be undertaken (DWG, 2019).

### Research plans

Research needs for deep water fisheries are driven by the objectives of the National Fisheries Plan for Deepwater Fisheries and delivered through the Medium-Term Research Plan for deep water fisheries (MTRP), (MPI, 2017). The MTRP provides a five-year schedule of science and monitoring projects (e.g., biomass surveys and stock assessments), required to support the sustainable management of deepwater fisheries. The schedule of surveys and stock assessments for the orange roughy UoA fisheries is being adhered to, although the 2020 acoustic biomass survey of ORH 3B NWCR and ESCR was re-scheduled and is being undertaken during June-July 2021 (Ryan & Tilney, 2021). Revised stock assessments of these two UoAs will follow in 2022.

All research projects are reviewed by FNZ's Science Working Groups and assessed against FNZ's Research and Science Information Standard for New Zealand Fisheries (MFish, 2011).

FNZ's Annual Operational Plan 2020/21 and 2021/22 provide details of the research projects relating to deepwater fisheries to be undertaken during 2020/21 (see Tables 8-12, pp. 33-34 (FNZ, 2020) and Tables 8-11, pp. 29-30 (FNZ, 2020a)).

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