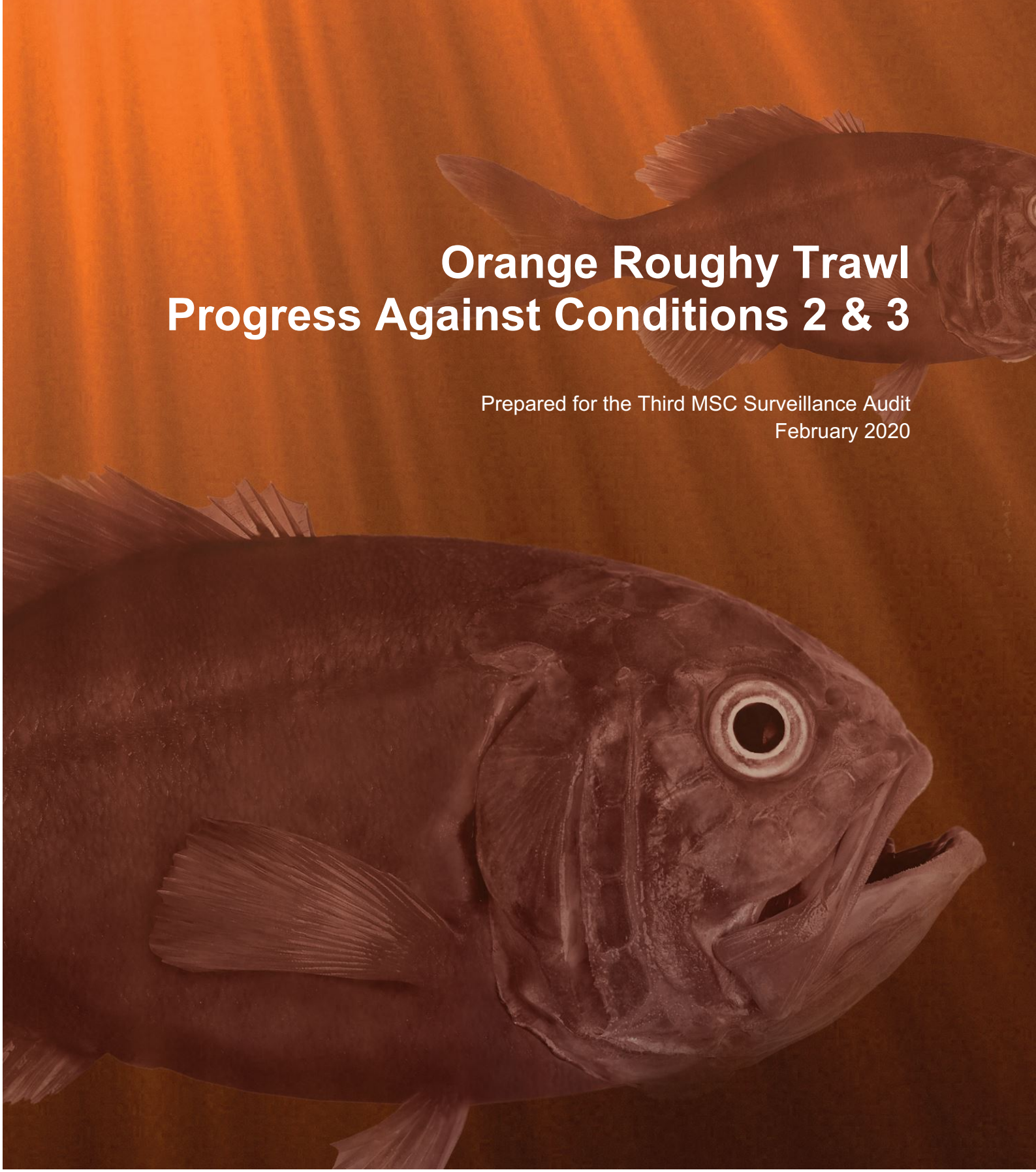

Orange Roughy Trawl
Progress Against Conditions 2 & 3

Prepared for the Third MSC Surveillance Audit
February 2020

deepwater group

Condition 2: The direct effects of ORH fishing must be highly unlikely to create unacceptable impacts to ETP coral species.

The table below is copied from the Year 2 surveillance audit for reference.

	Insert relevant PI number(s)	Insert relevant scoring issue/ scoring guidepost text	Score
Performance Indicator(s) & Score(s)	**2.3.1**	**2.3.1 The fishery meets national and international requirements for the protection of ETP species. The fishery does not pose a risk of serious or irreversible harm to ETP species and does not hinder recovery of ETP species.**	**75**
Condition	SI b. For ORH3B NWCR and ORH3B ESCR, by the end of the certification period, the direct effects of ORH fishing must be highly unlikely to create unacceptable impacts to ETP coral species.		
Milestones	Year 1: Present a plan to increase certainty regarding the impact of ORH fishing in the two UoAs on ETP coral groups. Years 2 - 3: Carry out the plan developed for the Year 1 milestone. Year 4: Demonstrate that the fishery is highly unlikely to create unacceptable impacts to ETP coral species in the NWCR and ESCR UoA areas. This will result in a score ≥80.		
Client action plan	Year 1: The client will review the outcome status of ETP coral and develop a plan to increase our understanding of the direct effects of fishing on ETP coral so as to reduce uncertainty in relation to the impacts of fishing on ETP coral. Years 2 - 3: The client will develop, conduct and begin reporting on studies to deliver the plan developed in Year 1. Year 4: Using the outputs from the studies conducted during years 2 and 3, plus any additional management actions implemented to protect corals, the client will report with improved certainty the likelihood of unacceptable impacts of the ORH3B NWCR and ORH3B ESCR fisheries on ETP coral such that the SG 80 will be met for each fishery.		
Progress on Condition [Year 1]	By the first surveillance audit, the client was required to review the outcome status of ETP coral and develop a plan to increase understanding of the direct effects of fishing on ETP coral, so as to reduce uncertainty in relation to the impacts of fishing on ETP coral. Ahead of the first surveillance audit, the client produced such a plan (Update on the Conditions of Certification 2 and 3 (ETP Corals), published here: http://deepwatergroup.org/update-on-conditions-2-3-corals/. This plan has three objectives initially relevant to this condition: 1. To improve understanding of predicted coral distribution; 2. To improve understanding of gear impacts on protected coral species; and 3. To improve confidence in predicted coral distribution models. The resulting work from these three objectives is designed to enable the client to eventually be able to demonstrate that the fishery is meeting the 80 scoring guidepost for this performance indicator. According to this plan, reports will be produced, fulfilling the three objectives listed above, during subsequent surveillance audits.		
Progress on Condition [Year 2]	The Conservation Services Plan 2018/2019 lists three industry/government co-funded projects related to the client action for years 2 and 3 of this condition: 1. The age and growth of New Zealand protected corals at high risk (Project Code: POP 2017-07); 2. Improved habitat suitability modelling for protected corals in New Zealand waters (Project Code: POP 2018-01); and 3. Protected coral connectivity in New Zealand (Project code: POP2018-06). The first of these projects was completed in June 2018 and resulted in a methodology to determine the age and growth characteristics of key, high-risk New Zealand cold-water coral species which is needed to better understand the productivity inputs for an Ecological Risk Assessment on these protected species (Tracey et. al. 2018).		

	The second project is intended to update the distribution modelling of protected corals initially carried out by Anderson et al. in 2014. This project will include updated datasets of observer presence records for protected corals, recent research and biodiversity trawl survey data for protected corals, revised and extensive regional environmental data layers, and the updated trawl footprint for the region. Catch effort data will be considered. The project is slated for completion in late June 2020, with the following planned outputs: a. Data on coral distribution in an electronic format suitable for use in risk assessment. b. A technical report describing the methods used along with maps of the presence and predicted distribution of protected corals in relation to commercial fishing effort. c. Recommendations for any future research required to further improve the estimation of risk to protected corals from commercial fishing. The third project will review connectivity information on deep water corals in New Zealand, based on existing genetics studies in the region. Following the information review, a genetic study investigating previously identified at risk coral species would be undertaken on a species of the protected black coral group, where genetic connectivity data in New Zealand is particularly limited. The analyses will be focused on archived specimens for which existing molecular markers are available. Analyses will assess connectivity at various temporal and spatial scales and, if possible, will address on contemporary vs. historical connectivity. The project is scheduled for completion in mid-2019 with the following outputs identified: a. A technical report summarizing coral genetic connectivity studies carried out to date in the New Zealand region, and methods applied and results obtained from a genetic connectivity assessment of a 'high-risk' coral species. b. Data obtained, suitable for use in further analyses such as fisheries risk assessment. In addition, observer coverage (funding for which is supplemented by the CSP) for Orange Roughy and Oreo deepwater bottom trawl fisheries will be focused on assessing the extent of protected coral landed on vessels (as well as monitoring and recording interactions with, and behaviours of, seabirds). Sub-samples of corals will be taken for identification when required. This directed observer sampling will support data collection for the second two projects listed above. Other efforts underway to address the three objectives outlined in the Year 1 plan by DWG include: • DOC contracted NIWA (in progress) to review current state of knowledge of deepwater corals: – Known species in NZ – Known/predicted distributions – Known reproduction/recruitment – Molecular studies – Known age/growth – Threats – Management • DWG contracted NIWA (in progress) to review international depth distributions

Year 3 Progress on Condition 2

Summary

Several analyses and studies have been undertaken to demonstrate that the direct effects of orange roughy fishing in the NWCR and ESCR UoAs are highly unlikely to create unacceptable impacts to ETP coral species. These include:

1. An update on the fishery footprint overlap with observed and predicted coral distributions using data on current fishing performance.
2. New evidence, based on swath mapping data, showing that only a small proportion of the hard benthic habitat that is considered very likely to be coral habitat in the UoAs, is contacted by trawls.
3. New evidence, based on an analysis of coral depth records for deepwater corals, both in New Zealand waters and internationally, which shows that the UoA fisheries impact only small components of the known depth distributions of these corals.
4. New evidence, based on an analysis of the proximity between known coral capture localities on Underwater Topographic Features (UTF) and slope habitat in the UoAs. This suggests there is likely to be a high degree of connectivity between recorded coral locations within each UoA and across the Chatham Rise.

Given the information and evidence provided, DWG considers it is highly unlikely that the UoA fisheries on the Chatham Rise create an adverse impact on ETP coral species.

Information from New Coral Studies:

1. **An update on the fishery footprint overlap with observed and predicted coral distributions**

   A key tool used for assessing the probable effects of trawl fishing on protected coral communities on the Chatham Rise has been to assess the extent of overlap between the fishery footprint and areas where coral is known to occur, using coral capture locality records collected by MPI's Scientific Observer Programme and using coral locality data from New Zealand's Research Database (MRAG, 2016).

   The method involves coral capture localities being expressed as areas of 1 km x 1 km extent which are then overlaid with the recent trawl footprint to provide an indication of probable fishery impact. However, the observer and research datasets are both deficient in areal coverage.

   The observer capture localities are collected entirely from within the fishing grounds, and as the NWCR and ESCR ORH/OEO fisheries have swept only 5% and 6% of these UoAs respectively over the 30-year period 1989-90 to 2018-19, the magnitude of the underestimation of coral distribution is evident (i.e. more than 94% has not been "sampled" for corals). This brings a very conservative bias to an analysis of the extent of overlap of the trawl fishery footprint against the observer coral dataset.

   The research dataset, while not restricted to the trawl grounds, similarly 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 observer or research coral datasets as a basis for assessing the impact of UoA fisheries on corals.

   The combined trawl footprint for the 2017-18 and 2018-19 fishing years was assessed against the updated observer and research coral locality datasets (the 'observed' distribution) for the period 2013-14 to 2017-18. The 2017-18 fishing year marked the commencement of catch locality reporting 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 should improve the precision of the trawl footprint estimate.

The overlap of the 2017-18 to 2018-19 trawl footprint with the updated observed coral distribution is very similar to that previously considered by the assessment team (Clark et al., 2015). For the NWCR UoA the assessed overlap with black corals has increased from 14.4% to 18.8% but has remained largely unchanged for gorgonian and stony corals at 5.4% and 8.0% respectively (Table 1). Note that a fourth protected coral group, hydrocorals (all species from family Stylasteridae in the order Anthoathecata) has been included in the analysis.

Table 1: Overlap of the combined 2017-18 and 2018-19 trawl footprint against the 'observed' distribution of the four protected coral groups based on the 2013-14 to 2017-18 observer and research datasets (Black, 2020).

Coral Group	UoA	Estimated coral distribution from observed records (km^2)	Overlap of 2017-19 footprint with observed coral distribution (km^2)	% overlap with observed coral distribution
Black corals – O. Antipatharia	ORH3B NWCR	5.00	0.94	18.8%
Gorgonian corals – O. Alcyonacea		11.00	0.59	5.4%
Stony corals – O. Scleractinia		65.00	5.23	8.0%
Hydrocorals – O. Anthoathecata		6.00	0.00	0.0%
Black corals – O. Antipatharia	ORH3B ESCR	15.00	3.63	24.2%
Gorgonian corals – O. Alcyonacea		26.00	6.31	24.3%
Stony corals – O. Scleractinia		34.00	6.18	18.2%
Hydrocorals – O. Anthoathecata		3.00	0.27	9.0%

In the knowledge of the deficiencies and biases of analyses based on the observed coral distribution for assessing fishery impact, a lot of time and effort has been applied to the development of models to produce predicted coral habitat distributions (e.g. Anderson et al., 2014, 2015, 2019).

While the MRAG assessment team determined that the Anderson et al. (2014) predicted habitat distribution 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 (MRAG, 2016), the predicted coral distributions have been subsequently twice revised and updated through incorporation of additional data and model types (Anderson et al., 2015, 2019). These revisions have advanced the methodologies used and have produced modified predicted coral distributions in the UoA areas.

The Anderson et al. (2015) predicted habitat distribution differed from the Anderson et al. (2014) outputs in that the methodology used was slightly different in consideration of real coral absence data from the benthic stations dataset (i.e. 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 predicted coral distributions were broadly similar to those in Anderson et al. (2014) but were more in alignment with sea floor bathymetry. The trawl footprint for the 2017-18 and 2018-19 fishing years was plotted against the Anderson et al. (2015) predicted coral distributions at the >50th percentile level for each of the four protected coral groups (Table 2).

Table 2: 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. Note: determination of 50th percentile occurrence is based on the predicted coral distribution across the entire New Zealand region (Black, 2020).

Coral Group	UoA	Predicted coral distribution >50th percentile (km²)	Overlap of 2017-19 footprint with predicted coral distribution (km²)	% 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%

DWG is of the view that this information is informative and should be considered in the assessment of UoA fisheries impacts on protected corals. The biases inherent in both the observed and predicted coral distributions need to be acknowledged and the 'truth' probably lies somewhere between the two.

2. Swath mapping assessment of areas of hard benthic habitat (HBH)

The Orange Roughy Management Company conducted a side-scan sonar survey on the Chatham Rise in 1994 using the industry vessel FV *Arrow* (Figure 1) (Patchell, 2019). The purpose of the survey was to identify areas of interest for orange roughy fishing, primarily UTFs. The survey followed the 1,000 m depth contour around the Chatham Rise and provided coverage of depths between 800 and 1,400 m on average (i.e. the main orange roughy fishery depths). The survey system recorded digital bathymetry and acoustic backscatter data from which swath maps were generated (Figure 2).

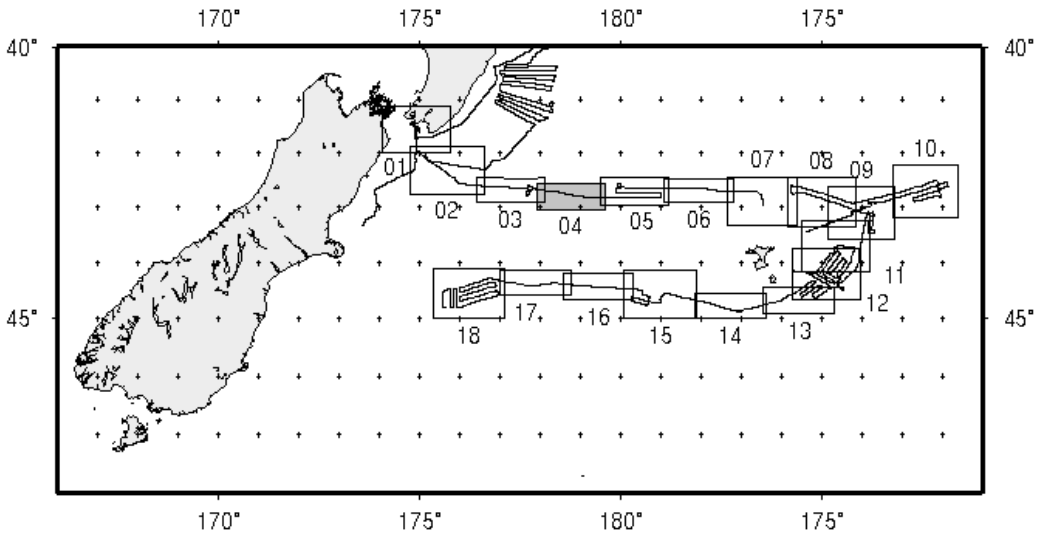

Figure 1: Side-scan survey tracks on the Chatham Rise from the 1994 survey aboard FV *Arrow*.

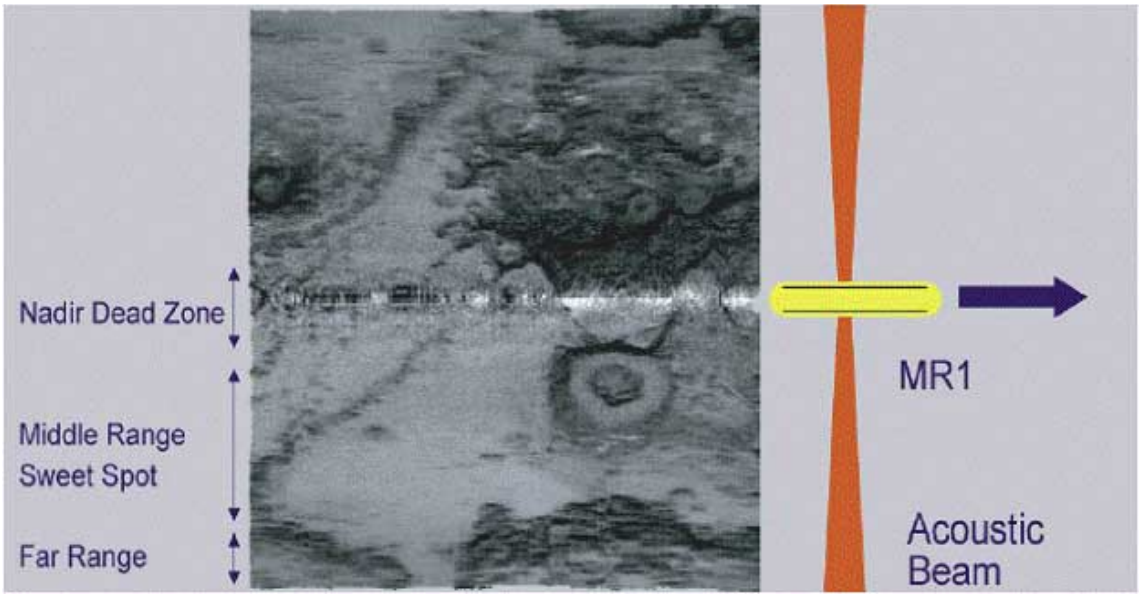

Figure 2: Swath image from side-scan sonar data showing volcanic cones and other bathymetric features. Harder benthic substrata have stronger acoustic reflectivity and show up as darker grey shades. Softer sediments (mud and sand) show up as lighter grey shades.

Interpretation of the swath imagery was supported using skippers' local knowledge of the grounds. In particular, knowledge of areas that had proven to be unfishable was used to ground-truth hard benthic habitat (HBH) areas identified from the swath maps. In combination, the bathymetry, swath maps and skippers' knowledge enabled the identification of large areas of rocky substratum interspersed within the broader sandy and muddy substrata that make up much of the Chatham Rise. Analysis of the swath-mapped acoustic data over the range of fishable depths enabled the characterisation of large areas of HBH, which are assumed likely to support coral growth.

A total of 772 km^2 of HBH was identified in the NWCR UoA and 3,517 km^2 in the ESCR UoA, amounting to 4.4% and 9.2% of the respective UoA areas. Less than 7% of this identified HBH area on the Chatham Rise has been traversed by trawl (Table 3, Figures 3 & 4). This, in combination with the fact that the survey covered only a small portion of the Chatham Rise, further reduces the uncertainty associated with the probability of unacceptable impacts of these fisheries on ETP corals.

Table 3: The extent of hard benthic habitat (HBH) area within the Chatham Rise UoA areas, the swept areas within the HBH areas during 2017-18 and 2018-19, and the proportion of UTF habitat that falls within HBH areas (GNS, 2020).

Metric	UoA NWCR		UoA ESCR	
	2017-18	2018-19	2017-18	2018-19
Fishable Area (800 - 1,600 m)	17,398		38,198	
Hard Benthic Habitat (HBH) (km^2)	772		3,517	
HBH as % of fishable area	4.4%		9.2%	
Swept area OHR/OEO (km^2 in HBH area)	44	25	239	220
% swept area in HBH area	5.7%	3.2%	6.8%	6.3%
UTF area within HBH areas (km^2)	20		230	
% UTF area within HBH areas	94%		87%	

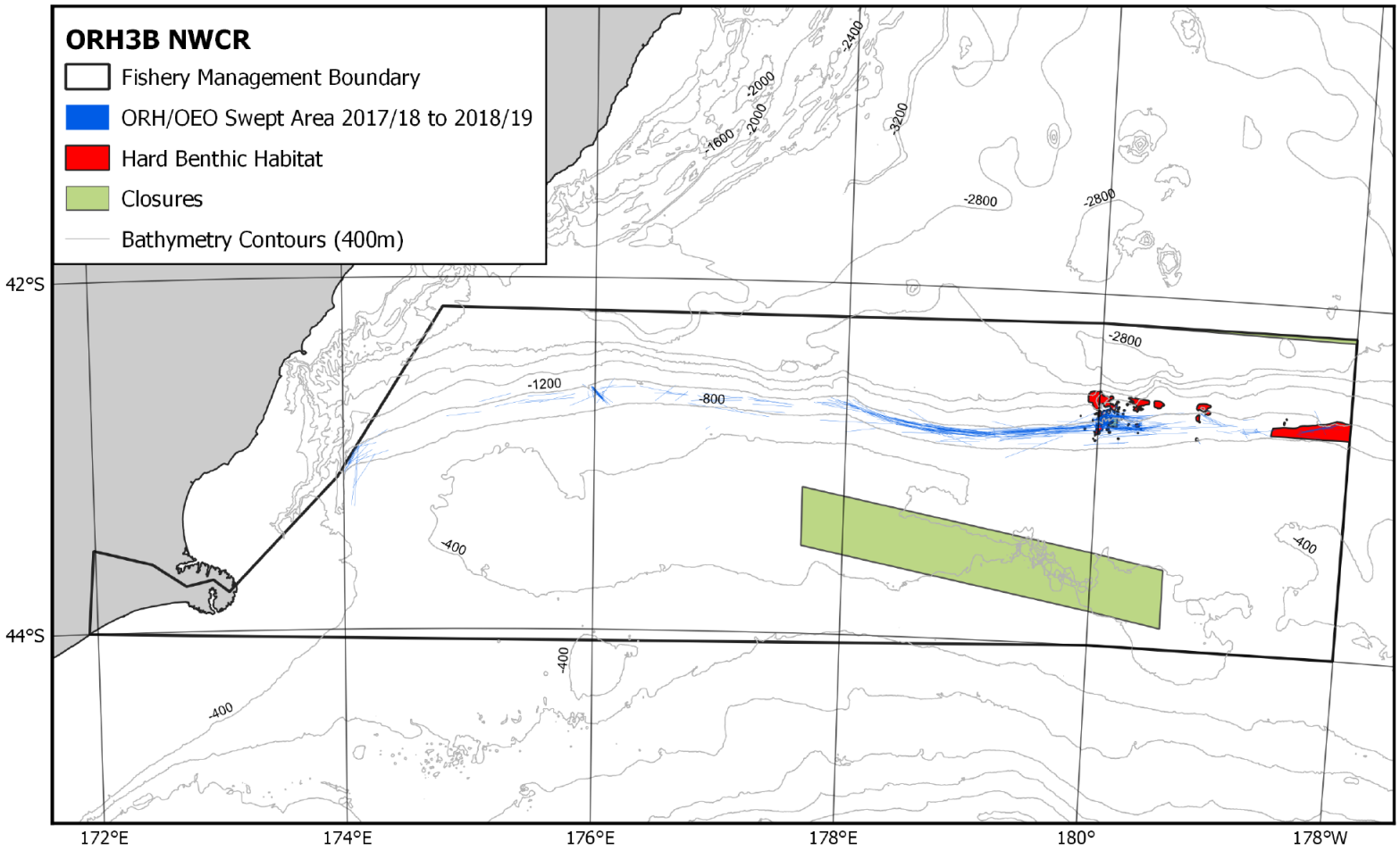

Figure 3: Areas of hard benthic habitat (red) within the NWCR UoA as determined from swath mapping surveys, and trawl footprint for the 2017-18 and 2018-19 fishing years combined (GNS, 2020).

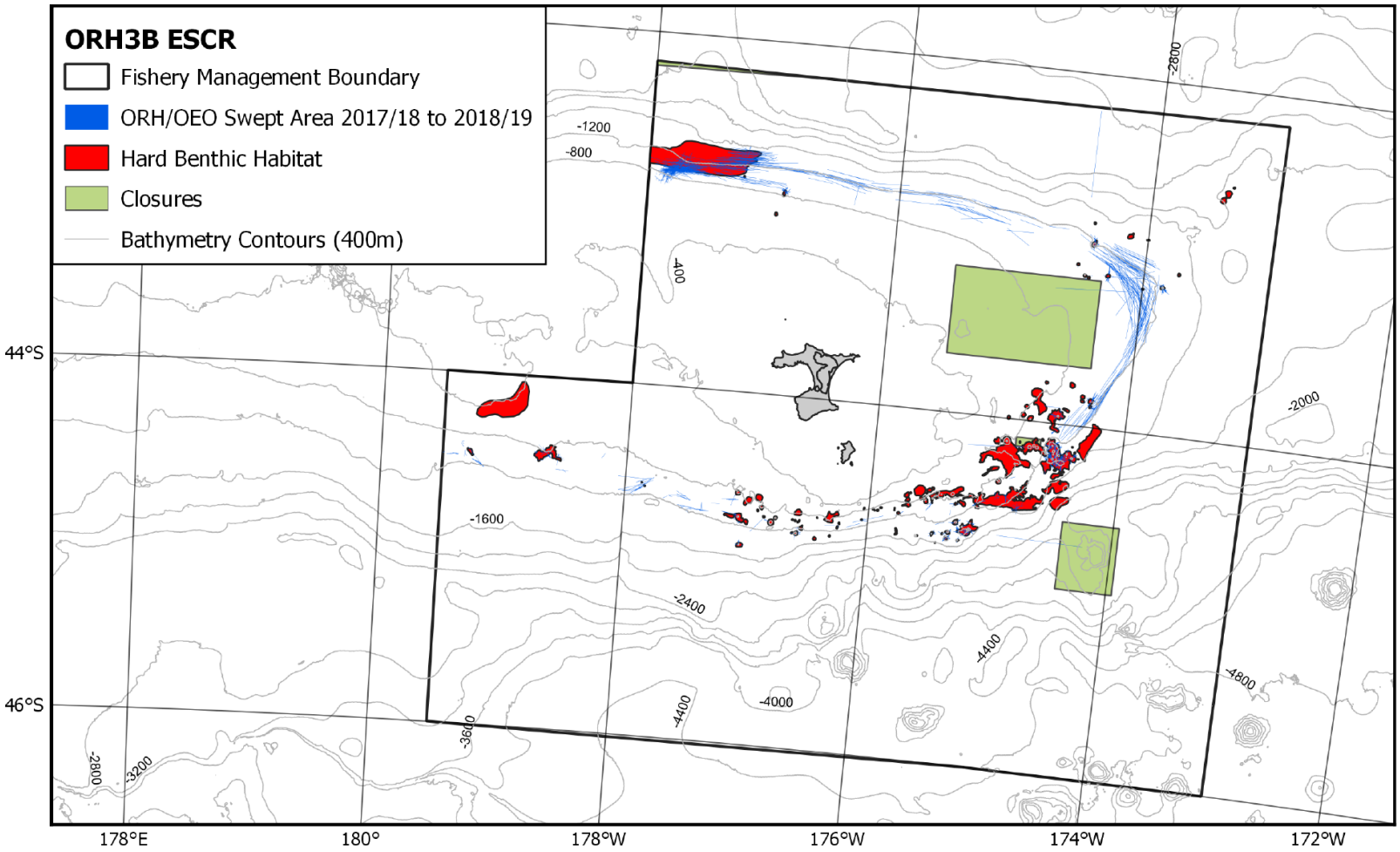

Figure 4: Areas of hard benthic habitat (red) within the ESCR UoA as determined from swath mapping surveys, and recent trawl footprint for the 2017-18 and 2018-19 fishing years combined (GNS, 2020).

3. Analysis of depth records for deep water corals in New Zealand

DWG commissioned analyses to determine the depth distributions for the four protected coral groups both in New Zealand waters and internationally (Finucci et al., 2019). The analysis for the New Zealand region revealed that they had a wide depth distribution ranging from very shallow depths down to 2,500 m and beyond. Antipatharia (black corals), Alcyonacea (gorgonian corals) and Scleractinia (stony corals) were frequently encountered at orange roughy fishery depths (800 – 1,200 m), with the latter also prevalent at shallower depths. Anthoathecata (hydrocorals) were less abundant at orange roughy depths and more abundant in shallower waters. Note that these records are largely from commercial trawl and research trawl and dredge catches and that there has been very little sampling at depths greater than ~1,600 m. Our knowledge of the relative coral abundance deeper than this in New Zealand waters is poor. The analysis of the international databases revealed broadly similar overall depth distributions but with differences in abundance of records by depth compared to New Zealand. The international databases showed a higher abundance of records at depths greater than 1,000 m for Antipatharia (black corals) and Alcyonacea (gorgonian corals), and fewer for Scleractinia (stony corals) and Anthoathecata (hydrocorals) (Figure 5).

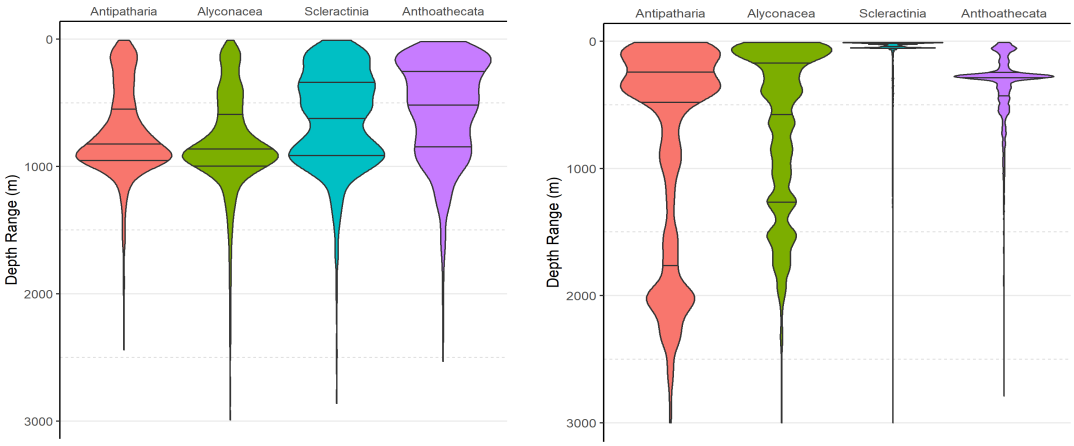

Figure 5: Violin plots illustrating coral capture records by 10 m depth bins for the four ETP coral groups from the New Zealand database (left) and the international database (right). Widths are representative of the numbers of coral records at each depth interval. Horizontal lines represent inter-quartile ranges. Note that these shapes are indicative rather than determinative as there will be sampling biases in the source data.

The analysis from the New Zealand database show that all four ETP coral groups occur both shallower and deeper than the depths prosecuted by Chatham Rise orange roughy fisheries and may well prove to be more abundant at depths greater than the depths fished in the NWCR and ESCR UoAs than (Figure 6).

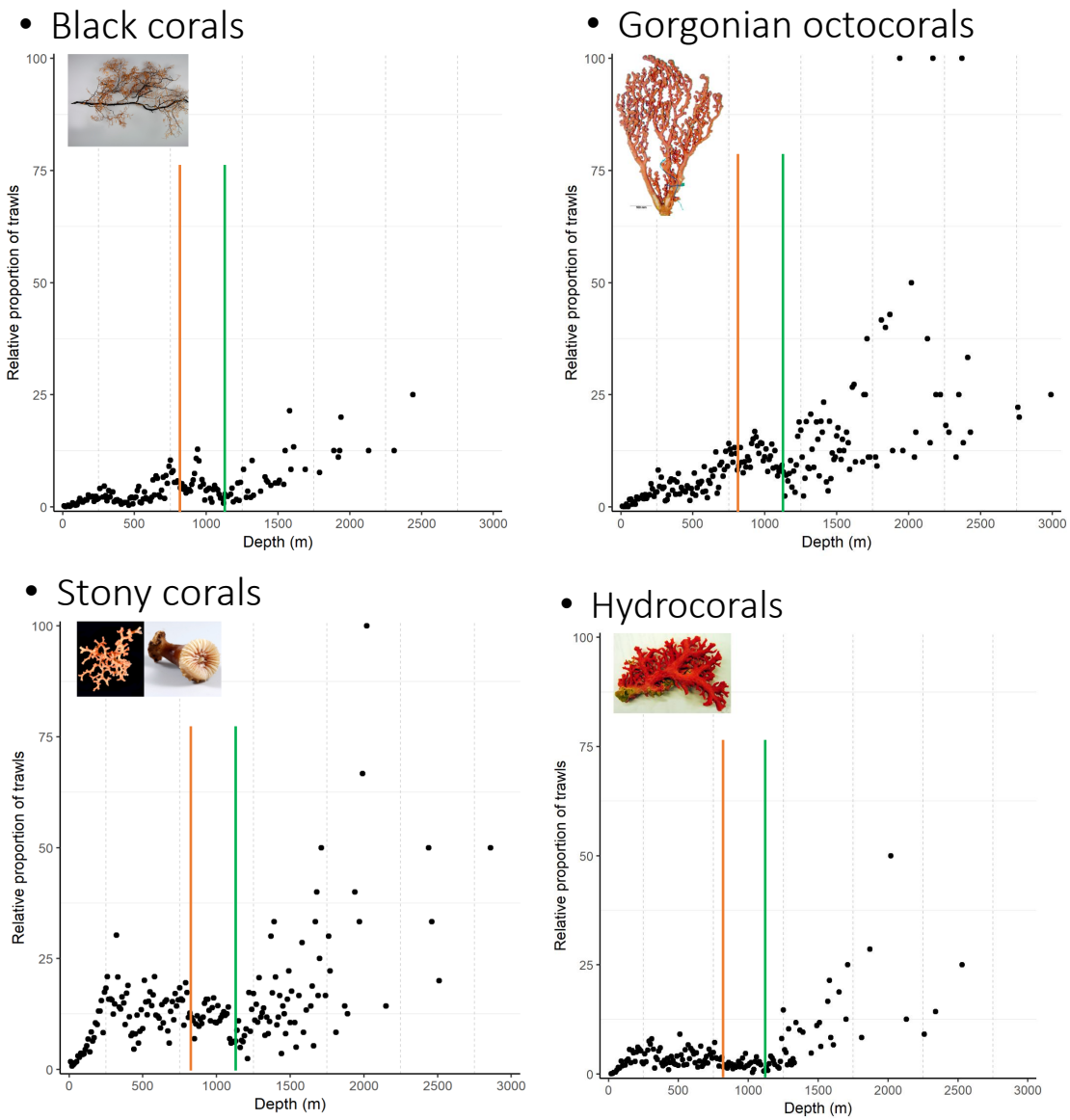

Figure 6: Proportional frequency of coral records by depth interval from the New Zealand database for the four protected groups. Vertical lines illustrate the median trawl tow depths by the ESCR (~840 m, orange) and NWCR (~1,035 m, green) UoA fisheries. Most orange roughy fishing occurs between approximately 800 m and 1,200 m in the two UoAs.

It is apparent from these analyses that the depth distribution of protected corals, in New Zealand waters and internationally, extends well beyond, both shallower and deeper, than the ~800 m to 1,200 m operational depths of the two UoA fisheries on the Chatham Rise and that trawling in each of the two UoAs will have only limited overlap with the known habitat ranges of these four coral groups in New Zealand.

4. Analysis of proximity between coral capture localities on the Chatham Rise

MRAG's Public Certification Report on the orange roughy MSC assessment determined that fishery impacts on protected corals in New Zealand should be considered at the scale

of the UoAs, while the scale at which to determine population impacts is of the order of 100 km.

DWG commissioned an analysis to determine the degree of spatial connectivity between individual UTFs known to have coral in the NWCR and ESCR UoAs. The analysis showed that coral-bearing UTFs in the NWCR UoA are separated by a few tens of km at most. In the ESCR UoA there is only one UTF (Mt Muck), which is more than 100 km from the nearest coral-bearing UTF. There is, however, a very large area of slope habitat known to support coral just to the west of Mt Muck, as well as in areas to the east of it (Figure 7), (B. de Jong, pers. comm.). All of the rest of the ESCR UTFs are well clustered and interspersed with known areas of coral on slope habitat between them. This information on the distances between known coral locations on UTF and slope habitat within the UoAs is suggestive of reasonably good connectivity between them and leads to the assumption that coral larval dispersal between the identified coral habitat may be possible given favourable ocean current conditions.

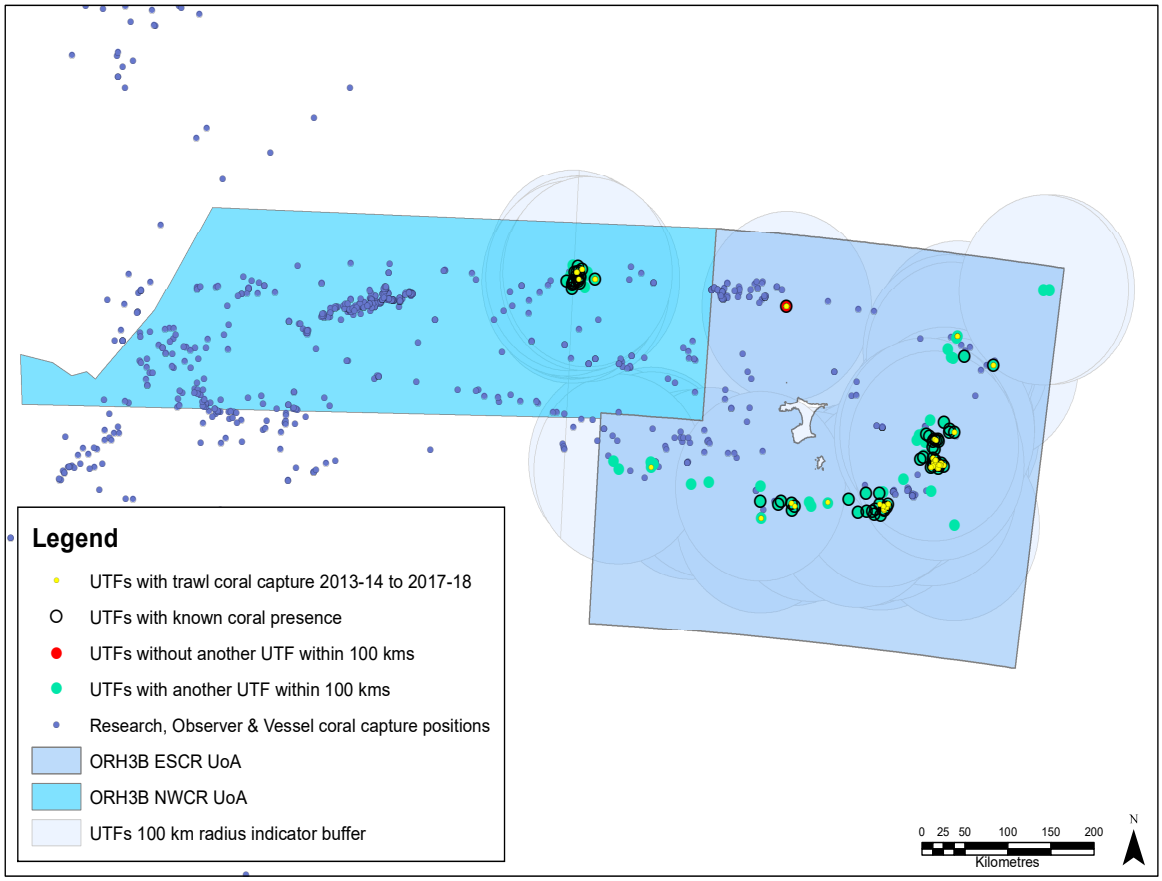

Figure 7: UTF localities (small circles), 100 km radius buffer areas around UTFs (large circles) and coral capture positions (blue dots) within the NWCR and ESCR UoA areas. The red dot in ESCR indicates the Mt Muck UTF.

Dunn & Devine (2010) showed that there was a general, eastward current flow along the north-west Chatham Rise at 900 m depth and postulated that a gyre situated to the north of the Graveyard UTF complex at ~180^0 longitude could help to retain orange roughy eggs and larvae spawned there.

It is not unreasonable to suggest that these currents could have a similar effect on coral propagules. In the NWCR UoA, they would likely be dispersed from west to east along the north Rise until they encountered the gyre, and then be retained. Further to the east, in the ESCR UoA, coral propagules could similarly be dispersed by these deep currents in an easterly and then southerly direction around the eastern edge of the Rise (Figure 8).

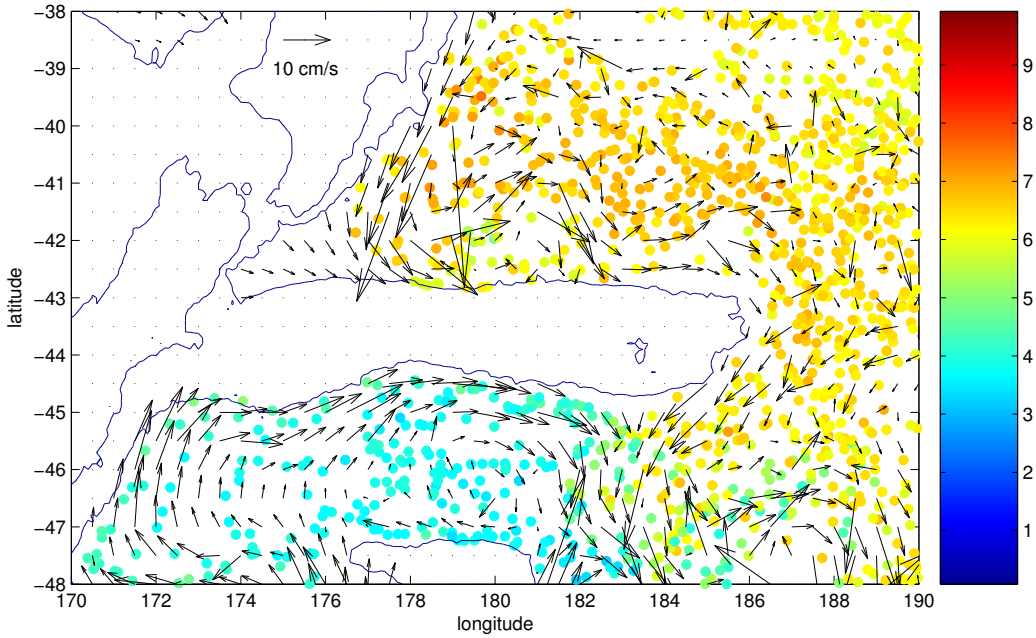

Figure 8: The Chatham Rise showing sea temperature (°C) measured at 900 m from Argo profiles (dots) with estimates of current velocity at 900 m overlaid (arrows). A gyre is evident on the northern edge of the Rise at ~180^{0}E. Further eastwards the currents are easterly and then southerly around the eastern edge of the Rise. A cold, easterly current flows along the southern edge of the Chatham Rise (After Dunn & Devine, 2010).

Potential evidence for dispersal distances for propagules of sessile invertebrates on the Chatham Rise is provided by a genetic study on a non-planktotrophic, benthic quill worm *Hyalinoecia longibranchiata*. A high degree of genetic connectivity was detected between samples taken from individuals on the northeast Chatham Rise approximately 240 km apart, and between samples taken from individuals on the southwest Chatham rise up to 400 km apart, but samples from the northeastern and southwestern areas, separated by an average distance of approximately 750 km, were genetically distinct. It was noted that the Sub-Tropical Front current system may have presented a barrier to genetic connectivity between the two sampling sites (Bors et al., 2012).

Zeng et al. (2017), suggested that dispersal distances of deepwater stony coral species may be related to oocyte size, where species with larger oocytes may have greater dispersal capability due to their greater energy resources resulting in longer larval stages. In a study involving three Scleractinian corals they found that *Madrepora oculata*, which has the largest mean oocyte size (2-3 times larger than other two species), was the only species for which significant differentiation amongst populations on large geomorphic features such as the Chatham Rise was not observed. The two other species, *Goniocorella dumosa* and *Solenosmilia variabilis*, which have smaller mean oocyte diameter, exhibited less connectivity on individual geomorphic features.

While coral connectivity is a complex issue, being dependent on a number of factors such as reproductive mode, current patterns and the scale of geographic separation, indications are that at the scale of the Chatham Rise UoAs there is a high likelihood of reasonably good connectivity for corals exhibiting sexual reproduction.

A project aimed at investigating the extent of genetic connectivity for New Zealand deep water corals is currently underway (POP 2018-06). The project will review the literature on genetic connectivity focussing on species highlighted by the pilot ERA (Clark et al., 2014) as being 'high risk'. The information will be used to inform and support the identification of coral populations for management purposes should this prove necessary. It is envisaged that the data and information from the project will be used in a benthic risk assessment for trawl fisheries (CSP, 2018).

5. Predicted habitat suitability modelling

In addition to the above studies, NIWA has been contracted by the Department of Conservation to further develop their studies on predicted habitat suitability modelling for protected corals in New Zealand waters (POP 2018-01).

The methodology for this study (Anderson et al., 2019) uses models which:

- Account for spatial autocorrelation in the sampling data
- Estimate precision of the predicted distributions
- Combine multiple model types
- Assess model performance.

In a change from previous studies, the environmental predictors used were derived primarily from outputs of the New Zealand Earth System Model. Other predictors such as recently revised and updated sediment data layers, seafloor slope and seamount distribution, were also incorporated. It is expected that the outputs from this project will provide for greatly improved and more accurate predicted habitat distributions for protected corals that will have greater utility for management purposes.

The draft report will be presented to a meeting of the CSP Technical Working Group on 5 March 2020. When available, the GIS shapefiles from this project will be used to overlay the UoA area trawl footprints in order to quantitatively estimate the fishery impact on predicted coral distributions.

Summary

The new information provided here, from four separate analyses combined, convincingly demonstrates that the UoA fisheries contact only a small proportion of the potential ETP coral habitat on the Chatham Rise. It is, therefore, highly unlikely that the direct effects of orange roughy fishing create unacceptable impacts to ETP coral species in either the NWCR or ESCR fisheries. The reasons include results from:

1. The updated trawl footprint overlap with the observed and predicted coral distributions.
2. The areas of untrawled, hard benthic habitat identified from swath mapping data.
3. The distribution of protected corals both shallower and deeper than orange roughy fishery depths.
4. The proximity between known coral habitats and the demonstrated genetic connectivity between benthic invertebrates at a scale of 200 - 400 km on the Chatham Rise.

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Condition 3: Information must be sufficient to determine whether the fishery may be a threat to protection and recovery of ETP coral species.

The table below is copied from the Year 2 surveillance audit for reference.

Performance Indicator(s) & Score(s)	Insert relevant PI number(s)	Insert relevant scoring issue/ scoring guidepost text	Score
	2.3.3	**Relevant information is collected to support the management of the fishery impacts on ETP species, including: -information for the development of the management strategy;-information to assess the effectiveness of the management strategy; and –information to determine the outcome status of ETP species.**	**75**
Condition	SI b. By the end of the certification period information must be sufficient to determine whether the fishery may be a threat to protection and recovery of ETP coral species.		
Milestones	Year 1: Present a plan to reduce uncertainty regarding the threat of ORH fishing to the two UoAs on ETP coral groups. Years 2- 3: Carry out the plan developed for the Year 1 milestone. Year 4: Provide information sufficient to determine whether the fishery may be a threat to the protection and recovery of ETP coral species. This will result in a score ≥80.		
Client action plan	Year 1: The client will supply a plan that establishes a sequence of analyses of existing data related to reducing uncertainty of the impacts of ORH fishing on ETP coral groups. Years 2 - 3: The client will develop, conduct and begin reporting on analyses to deliver the plan developed in Year 1. Year 4: Using the outputs from the studies conducted during years 2 and 3, plus any additional management actions implemented to protect corals, the client will report with improved certainty the information necessary to determine the likelihood of unacceptable impacts of the ORH3B NWCR and ORH3B ESCR fisheries on ETP coral such that the SG 80 will be met for each fishery.		
Progress on Condition [Year 1]	According to the Client action plan, in year 1, the client was to supply a plan that establishes a sequence of analyses of existing data related to reducing uncertainty of the impacts of ORH fishing on ETP coral groups. Ahead of the first surveillance audit, the client produced such a plan (Update on the Conditions of Certification 2 and 3 (ETP Corals), published here: http://deepwatergroup.org/update-on-conditions-2-3-corals/. This plan has three objectives initially relevant to this condition: 1. To improve understanding of predicted coral distribution; 2. To improve understanding of gear impacts on protected coral species; and 3. To improve confidence in predicted coral distribution models. The resulting work from these three objectives is designed to enable the client to eventually be able to demonstrate that the fishery is meeting the 80 scoring guidepost for this performance indicator. According to this plan, reports will be produced, fulfilling the three objectives listed above, during subsequent surveillance audits.		
Progress on Condition [Year 2]	The Conservation Services Plan 2018/2019 lists three industry/government co-funded projects related to the client action for years 2 and 3 of this condition: 1. The age and growth of New Zealand protected corals at high risk (Project Code: POP 2017-07); 2. Improved habitat suitability modelling for protected corals in New Zealand waters (Project Code: POP 2018-01); and 3. Protected coral connectivity in New Zealand (Project code: POP2018-06). The first of these projects was completed in June of 2018 and resulted in a methodology to determine the age and growth characteristics of key high-risk New Zealand cold-water		

	coral species which is needed to better understand the productivity inputs for an Ecological Risk Assessment on these protected species (Tracey *et. al* 2018). The second project is intended to update the distribution modelling of protected corals initially carried out by Anderson et al. in 2014. This project will include updated datasets of observer presence records for protected corals, recent research and biodiversity trawl survey data for protected corals, revised and extensive regional environmental data layers, and the updated trawl footprint for the region. Catch effort data will be considered. The project is slated for completion in late June 2020 with the following planned outputs: a. Data on coral distribution in an electronic format suitable for use in risk assessment. b. A technical report describing the methods used along with maps of the presence and predicted distribution of protected corals in relation to commercial fishing effort. c. Recommendations for any future research required to further improve the estimation of risk to protected corals from commercial fishing. The third project will review connectivity information on deep sea corals in New Zealand, based on existing genetics studies in the region. Following the information review, a genetic study investigating previously identified at risk coral species would be undertaken on a species of the protected black coral group, where genetic connectivity data in New Zealand is particularly limited. The analyses will be focused on archived specimens for which existing molecular markers are available. Analyses will assess connectivity at various temporal and spatial scales and, if possible, will address on contemporary vs. historical connectivity. The project is scheduled for completion in mid-2019 with the following outputs identified: 4. A technical report summarizing coral genetic connectivity studies carried out to date in the New Zealand region, and methods applied and results obtained from a genetic connectivity assessment of a 'high-risk' coral species. 5. Data obtained, suitable for use in further analyses such as fisheries risk assessment. In addition, observer coverage (funding for which is supplemented by the CSP) for Orange Roughy and Oreo deepwater bottom trawl fisheries will be focused on assessing the extent of protected coral landed on vessels (as well as monitoring and recording interactions with, and behaviours of, seabirds). Sub-samples of corals will be taken for identification when required. This directed observer sampling will support data collection for the second two projects listed above. Other efforts underway to address the three objectives outlined in the Year 1 plan by DWG include: • DOC contracted NIWA (in progress) to review current state of knowledge of deepwater corals: – Known species in NZ – Known/predicted distributions – Known reproduction/recruitment – Molecular studies – Known age/growth – Threats – Management • DWG contracted NIWA (in progress) to review international depth distributions

Year 3 Progress on Condition 3

Summary:

A number of projects have been undertaken, are currently underway, or are planned, towards achieving an increased understanding of the impacts of orange roughy trawl fisheries on ETP corals. This information from these projects will collectively lead to a better

understanding of the effects of bottom trawling on coral habitats and inform the effectiveness of the current management strategy for the protection of protected deep water corals. These projects are described below.

Coral projects recently completed:

1. Identification and storage of cold-water coral bycatch specimens (Tracey et al., 2020):

   The project identified, photographed and catalogued samples from 178 protected coral taxa collected by observers on commercial fishing vessels. A total of 169 records were georeferenced to their capture localities. The data from this project provide important baseline information to better inform research underpinning marine protection planning, such as predictive modelling (Anderson et al., 2014, 2015, 2019; Georgian et al., 2019), benthic risk assessments (Clark et al., 2014), and management of benthic ETP species.

2. Benthic community resilience to bottom trawling on seamounts (Clark et al., 2019):

   Camera transect surveys undertaken on a selection of UTFs with varying exposures to trawling at four time-periods over 15 years, were analysed to determine rates and extents of coral taxa regeneration. It was concluded that a previously heavily fished UTF (Morgue), that had been closed to trawling for 15 years, showed little evidence of coral regeneration in terms of abundance or species richness. Increases in coral abundance and taxa that were noted were attributed to the effects of improved photographic resolution over the 15-year period. The authors noted that an important consideration affecting recolonization was the nature of coral reproduction; broadcast spawners being more likely to effect colony recovery than those exhibiting asexual reproduction and for which dispersal distances are greatly reduced. Coral species exhibiting both types of reproduction were present in the study area. They concluded that spatial closures were likely to be the most effective management strategy for conserving coral communities occurring within fishery depths.

Coral projects underway:

3. Resilience of deep-sea benthic communities to the effects of sedimentation (Clark et al., 2019a, 2019b):

   Research voyages aboard RV *Tangaroa* were undertaken in June 2018 and 2019 to undertake sediment disturbance experiments on the central Chatham Rise. The experiments involved generating a sediment cloud using a towed ploughing apparatus and then monitoring the dispersal and settlement of the sediment cloud and its effect on the functioning of ecologically significant benthic communities and species at depths of 400 – 500 m. A third voyage is planned during 2020 to assess the recovery/resilience of the affected seabed communities.

4. Improved habitat suitability modelling for protected corals in New Zealand waters (POP 2018-01):

   To carry out improved habitat suitability modelling for ETP corals to identify areas of risk from interactions with commercial fishing gear (as presented in progress against Condition 2), (CSP, 2018, 2019).

5. Protected coral connectivity in New Zealand (POP 2018-06):

   To review existing literature on genetic connectivity for New Zealand corals and to asses genetic connectivity of a key coral species highlighted by the pilot ecological risk

assessment (ERA) as 'high risk' (e.g. one of the black corals). This project has been delayed. A final report is due by the end of June 2020 (D. Tracey, NIWA, pers. comm.)

6. Medium-Term Research Plan for Protected Corals (CSP, 2019):

   The Conservation Services Programme (CSP) of the Department of Conservation has developed a draft Medium-Term Research Plan (MTRP) for deep water ETP corals. The draft has been consulted on and is due to be finalised during 2020. The purpose of the MTRP is to act as an interim guiding framework until such time as a National Plan of Action for protected corals is in place.

   The CSP's objectives in regard to deep water corals include:

   - Proven mitigation strategies are in place to avoid or minimise the adverse effects of commercial fishing on protected species across the range of fisheries with known interactions
   - The nature of direct adverse effects of commercial fishing on protected species is described
   - The extent of known direct adverse effects of commercial fishing on protected species is adequately understood
   - The nature and extent of indirect adverse effects of commercial fishing are identified and described for protected species that are at particular risk to such effects
   - Adequate information on population level and susceptibility to fisheries effects exists for protected species populations identified as at medium or higher risk from fisheries (Freeman et al., 2014).

   The MTRP will identify projects for development and implementation to address data and information deficiencies on the direct and indirect impacts of trawling on ETP coral taxa, which are required as a basis for informing a quantitative ecological risk assessment on the vulnerability of coral species to fishing impacts. In particular, projects aimed at:

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

Projects planned to commence in 2019/20:

7. Identification and storage of cold-water coral bycatch specimens (INT 2019-04):

   To identify coral bycatch specimens to the finest taxonomic level possible and update coral identification information for use by fisheries observers (CSP, 2019).

8. Coral biodiversity in deepwater fisheries bycatch (INT 2019-05):

   To use DNA sequencing of observer-sampled octocoral specimens to genetically quantify the species-level diversity contained within deepwater fisheries bycatch, to improve understanding of fishery impacts (CSP, 2019).

9. Review of mitigation techniques to reduce benthic impacts of trawling (MIT 2019-02):

To review modified trawl fishing gear applicable to the New Zealand inshore trawl fleet with a view to reducing the harmful effects of trawling on seafloor communities (CSP, 2019).

10. A spatially explicit benthic impact assessment for inshore and deepwater fisheries in New Zealand (BEN 2019-04):

    To provide a spatially explicit estimation of fishing impact to key benthic taxa or communities within New Zealand's TS and EEZ. The project outputs will be used to inform a spatially explicit, quantitative risk assessment for benthic habitats to support meeting the objectives of inshore and deepwater Fisheries Management Plans (MPI, 2019).

11. Monitor the extent and intensity of bottom contact by trawl and dredge fishing in the Territorial Sea and Exclusive Economic Zone (BEN 2019-01):

    To continue the annual analysis of benthic contact by trawl and dredge fisheries in the TS and EEZ (MPI, 2019).

Conclusion:

Data collection on protected coral species captures is ongoing, MPI's scientific observers are trained in coral reporting requirements and are provided with updated coral identification guides as and when produced. The Department of Conservation and MPI report annually on deep water trawl fishing effort, observer coverage and coral captures. The Aquatic Environment Research Advisory Group assesses annually what additional information may be required to inform the management of deep water benthic communities and appropriate research projects are implemented to provide the required information.

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