

# Monterey Bay Aquarium Seafood Watch®

## Orange Roughy



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## New Zealand: Southwest Pacific

## Bottom trawls

*July 6, 2020*

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### Disclaimer

Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch program or its recommendations on the part of the reviewing scientists. Seafood Watch is solely responsible for the conclusions reached in this report.

Seafood Watch Standard used in this assessment: Standard for Fisheries vF3

## **Table of Contents**

About Seafood Watch .....	3
Guiding Principles .....	4
Summary .....	5
Final Seafood Recommendations .....	6
Introduction .....	9
Assessment .....	14
<i>Criterion 1: Impacts on the Species Under Assessment</i> .....	14
<i>Criterion 2: Impacts on Other Species</i> .....	34
<i>Criterion 3: Management Effectiveness</i> .....	40
<i>Criterion 4: Impacts on the Habitat and Ecosystem</i> .....	49
Acknowledgements .....	57
References .....	58
Appendix A: Extra By Catch Species .....	62

## **About Seafood Watch**

Monterey Bay Aquarium's Seafood Watch program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from [www.seafoodwatch.org](http://www.seafoodwatch.org). The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Watch Assessment. Each assessment synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives" or "Avoid." This ethic is operationalized in the Seafood Watch standards, available on our website here. In producing the assessments, Seafood Watch seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch's sustainability recommendations and the underlying assessments will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Watch assessments in any way they find useful.

## **Guiding Principles**

Seafood Watch defines sustainable seafood as originating from sources, whether fished<sup>1</sup> or farmed that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.

These guiding principles are operationalized in the four criteria in this standard. Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and rating

Once a rating has been assigned to each criterion, we develop an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guide and online guide:

**Best Choice/Green:** Are well managed and caught in ways that cause little harm to habitats or other wildlife.

**Good Alternative/Yellow:** Buy, but be aware there are concerns with how they're caught.

**Avoid/Red** Take a pass on these for now. These items are overfished or caught in ways that harm other marine life or the environment.

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<sup>1</sup> "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates

## **Summary**

This report provides recommendations for orange roughy (*Hoplostethus atlanticus*), caught by bottom trawl in the New Zealand EEZ in the southwestern Pacific. Recommendations are provided for each of the following management areas and stocks: ORH1 Northern North Island - Mercury-Colville, ORH1 Northern North Island - Other, Cape Runaway to Banks Peninsula (ORH 2A, 2B, & 3A) - East Cape (2A North), Cape Runaway to Banks Peninsula (ORH 2A, 2B, & 3A) - Mid-East Coast (2A South, 2B, 3A), Chatham Rise and Puysegur (ORH 3B) - Northwest Chatham Rise, Chatham Rise and Puysegur (ORH 3B) - East and South Chatham Rise, Chatham Rise and Puysegur (ORH 3B) - Puysegur, Chatham Rise and Puysegur (ORH 3B) - Other, and Challenger Plateau (ORH 7A) - Challenger Plateau.

The impact on the species is a high concern for Mercury-Colville (ORH1), Northern North Island (ORH1) and ORH3B Other areas due to uncertainty in abundance and lack of reference points for fishing mortality. There is also high concern for the Mid-East Coast (2A South, 2B, 3A) stock as it is likely overfished and uncertain if overfishing is occurring. For East Cape (ORH2A North) there is moderate concern due to uncertain stock status and lack of limit reference points. There is a low concern of impact on the species for Northwest Chatham Rise (ORH 3B), East and South Chatham Rise (ORH 3B), Challenger Plateau (ORH 7A) and Puysegur (ORH 3B) areas which are above target reference points for biomass and below limit reference points for fishing mortality.

Discards are low in the orange roughy fishery with 96% of the catch comprising orange roughy and other QMS managed species. Smooth oreo is the only other species exceeding 5% of catch composition, however, the proportion caught in the orange roughy fishery is small relative to the directed oreo fishery. Due to their high vulnerability, slow growing long-lived corals are the species of greatest concern caught in the orange roughy fishery.

Management is considered moderately effective in the data poor fisheries (ORH1 Northern North Island, ORH1 Mercury-Colville, ORH3B Other and ORH2A north - East Cape) and the ORH2A south, ORH2B, ORH3A - Mid East Coast fishery where the stock is overfished and overfishing may be occurring. Measures are in place, including annual catch limits, to protect species sustainability but with some uncertainty. Management is considered highly effective in the data rich fisheries (Northwest Chatham Rise (ORH 3B), East and South Chatham Rise (ORH 3B), Challenger Plateau (ORH 7A) and Puysegur (ORH 3B)) with recent stock assessments based on biomass estimates utilizing acoustic monitoring data. Logbook requirements, vessel monitoring systems and an observer program are included in bycatch management for all regions. Management has robust enforcement systems in place and is highly effective in stakeholder inclusion partnering with the Deepwater Group which comprises industry stakeholders.

Impacts on the habitat and ecosystem are considered a high concern. The orange roughy fishery uses trawl gear known to reduce biogenic habitat and while Benthic Protection Areas mitigate gear impacts, more data are required for a comprehensive understanding of the scale and distribution of biogenic habitat in trawled areas and the effects of removal on the ecosystem. Although some ecosystem models have been attempted, data are lacking to fully inform the overall ecosystem effects of the orange roughy fishery.

## **Final Seafood Recommendations**

<b>SPECIES   FISHERY</b>	<b>CRITERION 1: Impacts on the Species</b>	<b>CRITERION 2: Impacts on Other Species</b>	<b>CRITERION 3: Management Effectiveness</b>	<b>CRITERION 4: Habitat and Ecosystem</b>	<b>OVERALL RECOMMENDATION</b>
<b>Orange roughy</b> New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH1 Northern North Island   ORH1 Northern North Island	Red (1.732)	Red (1.000)	Yellow (3.000)	Red (1.414)	<b>Avoid (1.646)</b>
<b>Orange roughy</b> New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH2A north - East Cape   ORH2A north - East Cape	Yellow (2.644)	Red (1.000)	Yellow (3.000)	Red (1.414)	<b>Avoid (1.830)</b>
<b>Orange roughy</b> New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH2A south, ORH2B, ORH3A - Mid East Coast   ORH2A south, ORH2B, ORH3A - Mid East Coast	Red (1.732)	Red (1.000)	Yellow (3.000)	Red (1.414)	<b>Avoid (1.646)</b>
<b>Orange roughy</b> New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH3B East and South Chatham Rise   ORH3B East and South Chatham Rise	Green (4.284)	Red (1.000)	Green (4.000)	Red (1.414)	<b>Avoid (2.218)</b>

<b>Orange roughy</b> New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH3B Northwest Chatham Rise   ORH3B Northwest Chatham Rise	Green (4.284)	Red (1.000)	Green (4.000)	Red (1.414)	<b>Avoid (2.218)</b>
<b>Orange roughy</b> New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH3B Other   ORH3B Other	Red (1.732)	Red (1.000)	Yellow (3.000)	Red (1.414)	<b>Avoid (1.646)</b>
<b>Orange roughy</b> New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH3B Puysegur   ORH3B Puysegur	Green (4.284)	Red (1.000)	Green (4.000)	Red (1.414)	<b>Avoid (2.218)</b>
<b>Orange roughy</b> New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH7A Challenger Plateau   ORH7A Challenger Plateau	Green (4.284)	Red (1.000)	Green (4.000)	Red (1.414)	<b>Avoid (2.218)</b>
<b>Orange roughy</b> New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH1 Mercury-Colville	Red (1.732)	Red (1.000)	Yellow (3.000)	Red (1.414)	<b>Avoid (1.646)</b>

## Summary

Orange roughy fisheries in New Zealand are rated Avoid in all regions due to concerns regarding impacts on vulnerable corals and biogenic habitats both as direct effects on species' population health and as indirect effects on the habitat and ecosystem.

## Eco-Certification Information

Orange roughy from management areas ORH3B Northwest Chatham Rise, ORH3B East & South Chatham Rise and ORH7A are Marine Stewardship Council (MSC) certified.

## Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

- **Best Choice/Green** = Final Score  $>3.2$ , and no Red Criteria, and no Critical scores
- **Good Alternative/Yellow** = Final score  $>2.2$ - $3.2$ , and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern<sup>2</sup>, and no more than one Red Criterion, and no Critical scores
- **Avoid/Red** = Final Score  $\leq 2.2$ , or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

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<sup>2</sup> Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).



## **Introduction**

### **Scope of the analysis and ensuing recommendation**

This report provides recommendations for orange roughy (*Hoplostethus atlanticus*), caught by bottom trawl in the New Zealand EEZ in the southwestern Pacific. Recommendations are provided for each of 9 stocks from the following management areas:

<b>Management Area</b>	<b>Stock</b>
Northern North Island (ORH 1)	Mercury-Colville
Northern North Island (ORH 1)	Other
Cape Runaway to Banks Peninsula (ORH 2A, 2B, & 3A)	East Cape (2A North)
Cape Runaway to Banks Peninsula (ORH 2A, 2B, & 3A)	Mid-East Coast (2A South, 2B, 3A)
Chatham Rise and Puysegur (ORH 3B)	Northwest Chatham Rise
Chatham Rise and Puysegur (ORH 3B)	East and South Chatham Rise
Chatham Rise and Puysegur (ORH 3B)	Puysegur
Chatham Rise and Puysegur (ORH 3B)	Other
Challenger Plateau (ORH 7A)	Challenger Plateau

### **Species Overview**

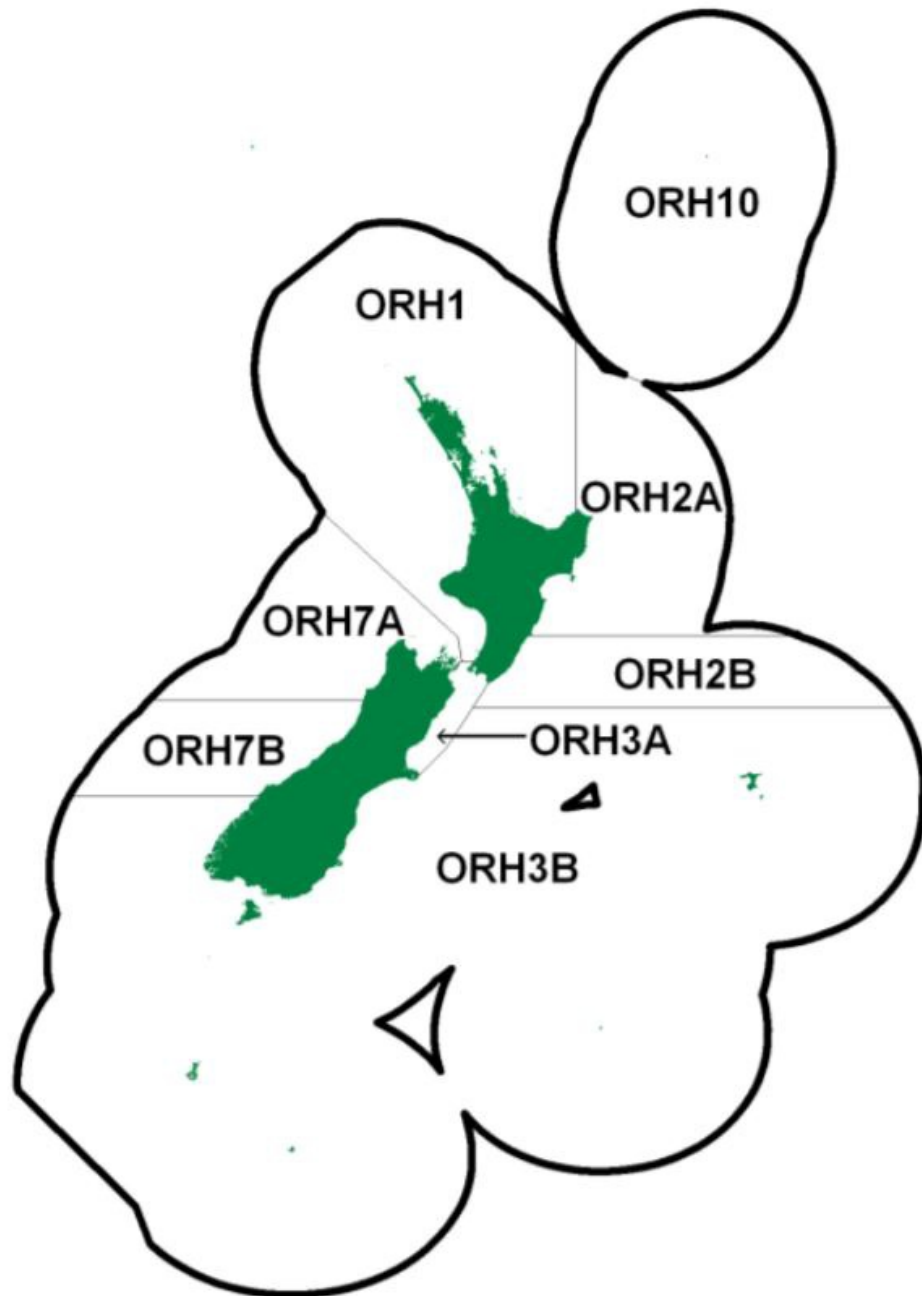


Figure 1 Orange roughy management areas in New Zealand (Fisheries New Zealand 2019).

Orange roughy are distributed in temperate waters in the Western Atlantic (off northern Nova Scotia), Eastern Atlantic (Iceland to Morocco, Walvis Bay, Namibia to off Durban, South Africa), Indo-Pacific (south-central Indian Ocean and New Zealand), and Eastern Pacific (Chile) (Froese & Pauly 2019). They inhabit deep-waters (range 700-1500 m, typically 800-1200 m in the New Zealand EEZ) over rocky continental slopes, ridges and sea-mounts (Fisheries New Zealand 2019a). Orange roughy are long lived (>100 ys), slow growing, late to mature (>20 ys, 50% maturity is estimated at 32-41 ys) and as such are vulnerable to overfishing (Andrews et al. 2009)(Branch 2011)(Cordue 2014). They are broadcast spawners forming large spawning aggregations in winter (June/July) with relatively low fecundity (40-60 k eggs) (New Zealand Fisheries 2019a). Orange roughy also form feeding aggregations throughout the year, mainly preying on prawns, fishes and squids.

The New Zealand orange roughy trawl fishery was established in 1979, with additional fisheries developing in

the 1980s and 90s in Australia, Namibia, Ireland, the Faroe Islands and Chile (Branch 2001)(Foley et al. 2011). The orange roughy fishery in New Zealand is managed by Fisheries New Zealand (within the Ministry for Primary Industries (MPI)) in collaboration with the Deepwater Group (DWG, industry stakeholders) (Fisheries New Zealand 2019c). The partnership was developed under a Memorandum of Understanding (MOU, est. 2006) and the two parties devised and implemented the National Deepwater plan for managing New Zealand's deepwater fisheries.

Orange roughy from management areas ORH3B Northwest Chatham Rise, ORH3B East & South Chatham Rise and ORH7A are Marine Stewardship Council (MSC) certified, representing about 60% of New Zealand's orange roughy fisheries (MRAG Americas 2016).

## Production Statistics

Global production of orange roughy rose to a peak of over 90,000 mt in 1990 then fell steadily, in part due to implementation of catch quotas, and has remained consistently below 11,000 mt since 2011 (see figure 1). New Zealand is the largest global producer, with ten distinct orange roughy stock management units (though some are temporarily closed to fishing). In 2018 the majority of landings in New Zealand were in the ORH3B South East Chatham Rise (61%) and ORH7A Challenger North (20%) areas (see figure 2).

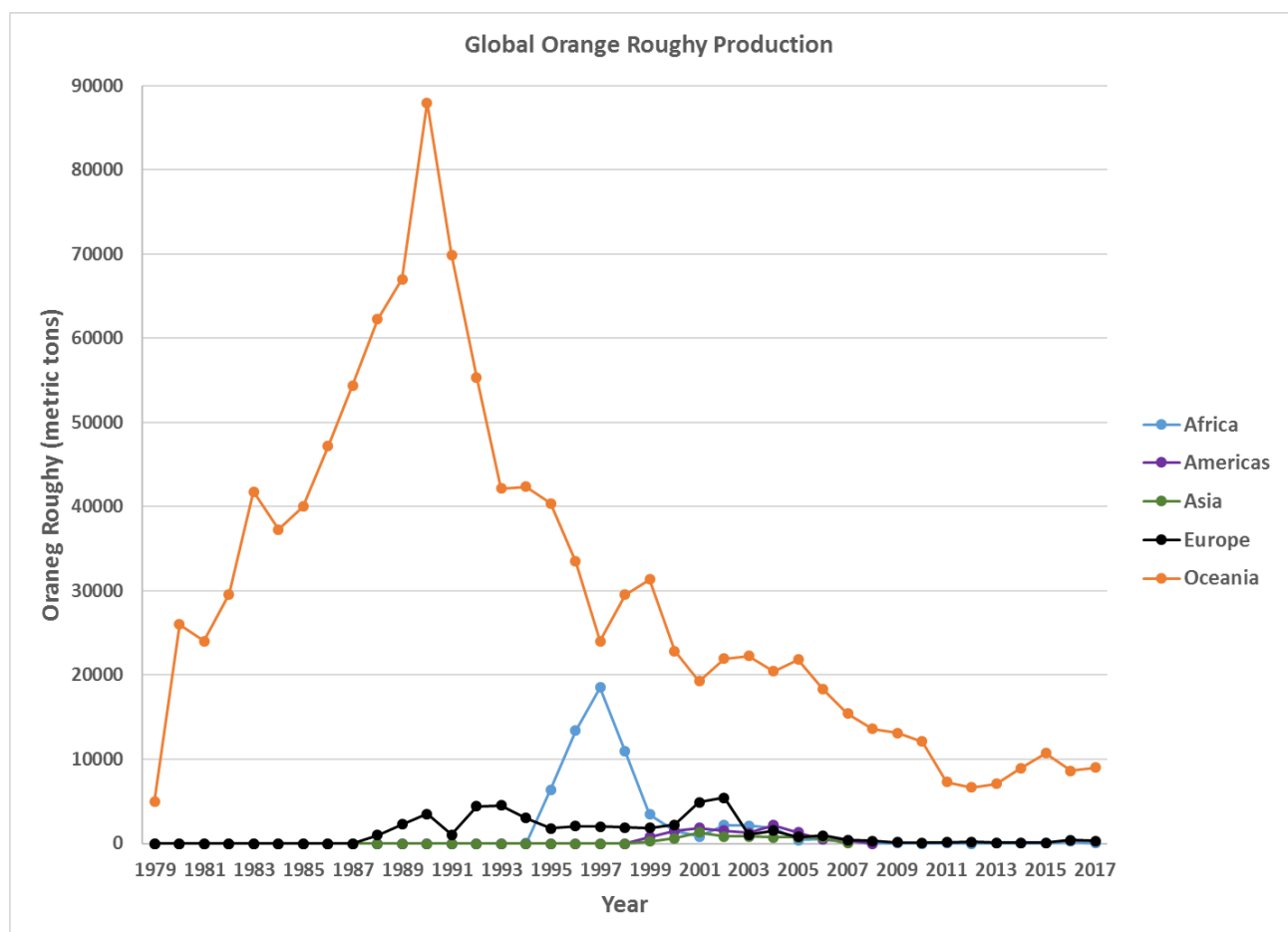


Figure 2 Global orange roughy production (data source: FAO 2019).

Fishstock Code	Management Area	Reported Commercial Catch (kg)	TACC (kg)
ORH3B	Orange Roughy South East (Chatham Rise)	4,942,104	5,197,000
ORH7A	Orange Roughy Challenger (North)	1,601,069	1,600,000
ORH1	Orange Roughy Auckland (East)	881,364	1,400,000
ORH2A	Orange Roughy Central (Gisbourne)	484,836	488,000
ORH3A	Orange Roughy South East (Cook Strait / Kaikoura)	116,926	177,000
ORH2B	Orange Roughy Central (Wairarapa)	45,701	60,000
ORH7B	Orange Roughy Challenger (South)	1,415	1,000
ORHSTR	Orange Roughy South Tasman Rise	-	-

Figure 3 2018 Orange roughy catch by New Zealand management area (data source: Fisheries New Zealand 2019b).

### Importance to the US/North American market.

Global imports of frozen orange roughy fillets to the United States reached a peak in 1997 at ~13k mt but have steadily declined and remained ~1400-2000 mt since 2011 (see figure 3). In 2018 New Zealand was the primary source of orange roughy imports to the United States (83%, 1567 mt) followed by China (9%, 165 mt), Australia (6%, 121 mt), Taiwan (1%, 20 mt) & Vietnam (1%, 17 mt see figure 4)(NOAA 2019). Imports from China, Taiwan and Vietnam are likely re-exports from New Zealand.

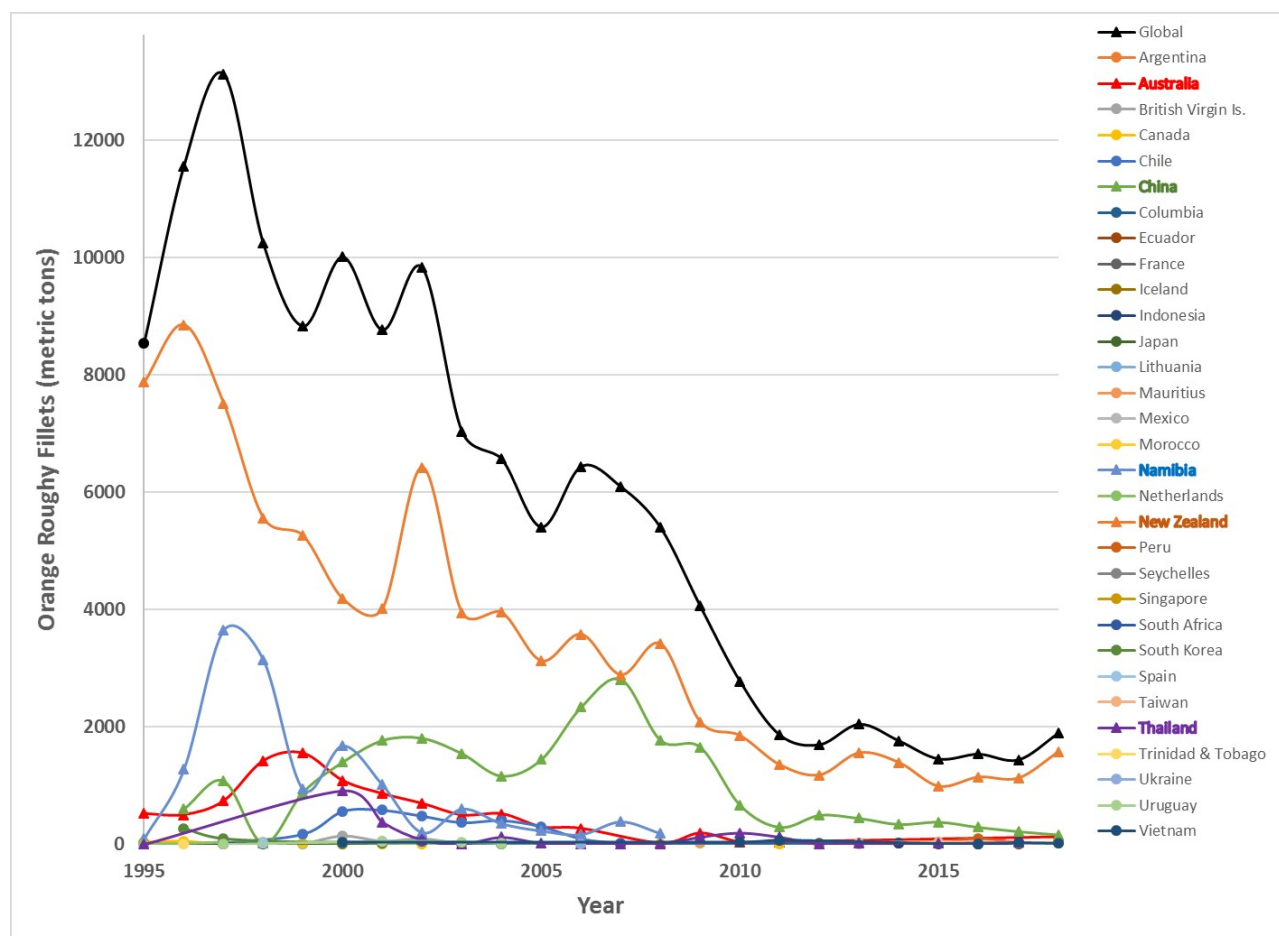


Figure 4 Orange roughy imports to the United States 1995-2018 global (in black) and by country (data source: NMFS 2019).

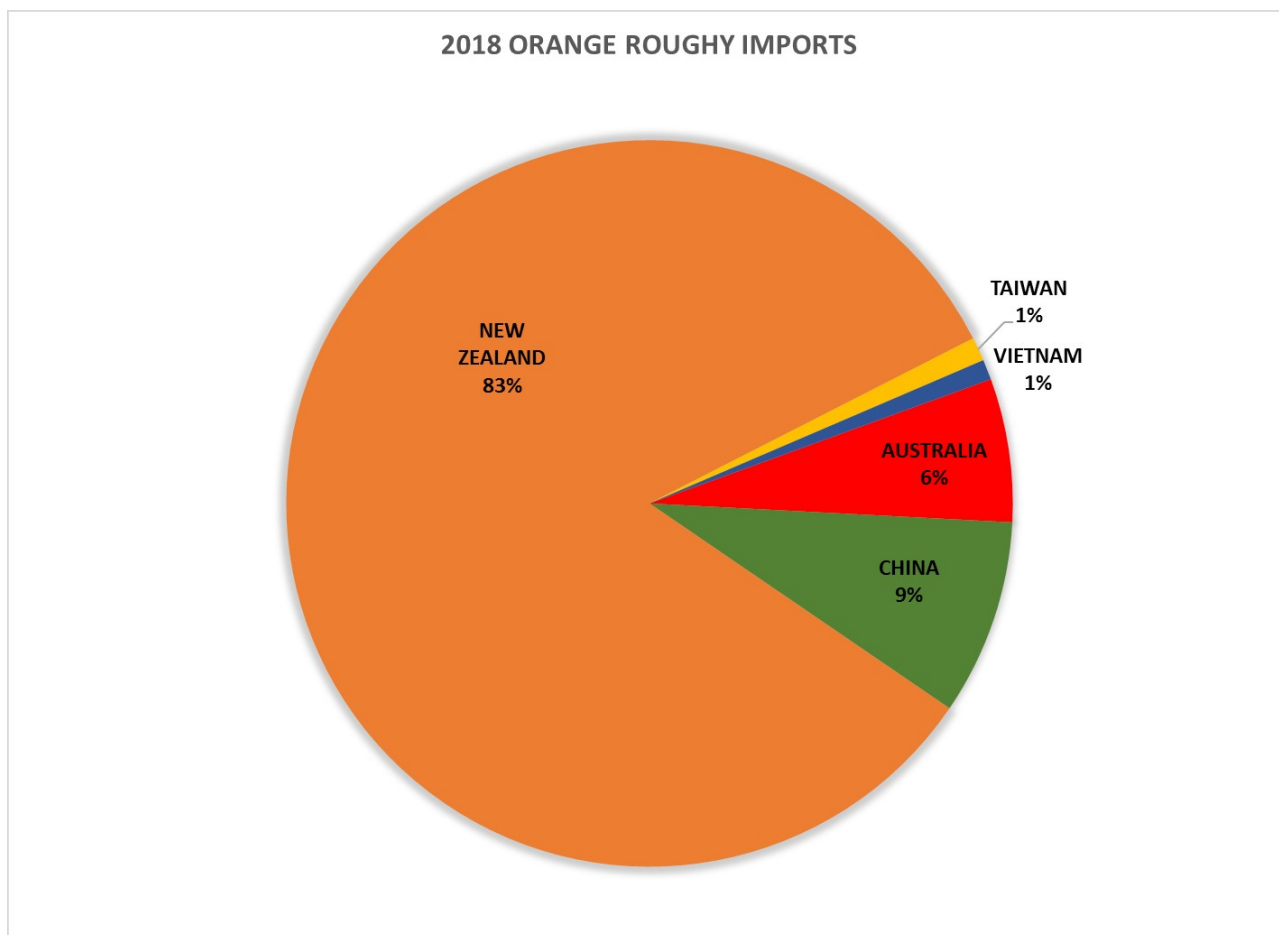


Figure 5 Orange roughy imports to the United States in the form of frozen fillets in 2018 (data source: NMFS 2019).

### **Common and market names.**

Common name: Orange Roughy. FDA market name: Roughy, Orange. Vernacular name: Red Roughy (FDA 2019).

### **Primary product forms**

Fresh: Fillets (skinless/boneless)

Frozen (most common): Fillets (skinless/boneless)

Value-added: Blocks, Breaded

(Seafood Source 2014).

## Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at [www.seafoodwatch.org](http://www.seafoodwatch.org). The specific standard used is referenced on the title page of all Seafood Watch assessments.

### Criterion 1: Impacts on the Species Under Assessment

*This criterion evaluates the impact of fishing mortality on the species, given its current abundance. When abundance is unknown, abundance is scored based on the species' inherent vulnerability, which is calculated using a Productivity-Susceptibility Analysis. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:*

- Score  $>3.2$ =Green or Low Concern
- Score  $>2.2$  and  $\leq 3.2$ =Yellow or Moderate Concern
- Score  $\leq 2.2$ =Red or High Concern

*Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical*

#### Guiding Principles

- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable level.

#### Criterion 1 Summary

ORANGE ROUGHY			
Region   Method	Abundance	Fishing Mortality	Score
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH1 Northern North Island	1.00: High Concern	3.00: Moderate Concern	Red (1.732)
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH2A north - East Cape	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.644)
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH2A south, ORH2B, ORH3A - Mid East Coast	1.00: High Concern	3.00: Moderate Concern	Red (1.732)

<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH3B East and South Chatham Rise	3.67: Low Concern	5.00: Low Concern	Green (4.284)
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH3B Northwest Chatham Rise	3.67: Low Concern	5.00: Low Concern	Green (4.284)
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH3B Other	1.00: High Concern	3.00: Moderate Concern	Red (1.732)
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH3B Puysegur	3.67: Low Concern	5.00: Low Concern	Green (4.284)
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH7A Challenger Plateau	3.67: Low Concern	5.00: Low Concern	Green (4.284)
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH1 Mercury-Colville	1.00: High Concern	3.00: Moderate Concern	Red (1.732)

## Criterion 1 Assessment

### SCORING GUIDELINES

#### Factor 1.1 - Abundance

Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*
- *3.67 (Low Concern) — Population may be below target abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.*
- *2.33 (Moderate Concern) — Population is not overfished but may be below 75% of the target abundance*

level, OR abundance is unknown and the species is not highly vulnerable.

- 1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.

## Factor 1.2 - Fishing Mortality

Goal: Fishing mortality is appropriate for current state of the stock.

- 5 (Low Concern) — Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is low enough to not adversely affect its population.
- 3 (Moderate Concern) — Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.
- 1 (High Concern) — Probable that fishing mortality from all source is above a sustainable level.

## ORANGE ROUGHY

### Factor 1.1 - Abundance

#### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

#### High Concern

There are no stock assessments for the ORH1 (Northern North Island and Mercury-Colville stocks) or ORH3B (Other stock) management areas, no biomass estimates are available. As biomass relative to limit reference points is unknown and the species is highly vulnerable (PSA = 3.54, see table below), stock status is considered a high concern.

#### Justification:

#### PSA Table: Orange Roughy, New Zealand trawl fisheries

Productivity Attributes	Value	Score (1 = low risk; 2 = medium risk; 5 = high risk)	Reference
Average age at maturity (years)	36.5	3	Fisheries New Zealand 2019a
Average maximum age (years)	120	3	Fisheries New Zealand 2019a
Fecundity (eggs/yr)	50,000	1	Fisheries New Zealand 2019a
Average maximum size (cm) (not to be used when scoring invertebrate species)	50	1	Fisheries New Zealand 2019a



Average size at maturity (cm) (not to be used when scoring invertebrate species)		37	1	Fisheries New Zealand 2019a
Reproductive strategy		Broadcast spawner	1	Fisheries New Zealand 2019a
Trophic level		4.3	3	Froese & Pauly 2019
Density dependence (invertebrates only)		NA		
Quality of Habitat		Moderately altered	2	Fisheries New Zealand 2019a
Productivity Subscore			1.88	
Susceptibility Attribute	Information	Score (1 = low risk; 2 = medium risk; 5 = high risk)		Reference
Areal overlap	default	3		
Vertical overlap	> 33% (most abundant in depth range 800-1,200 m, fishing depth most commonly 700-1,100 m)	3		Kailola et al. 1993, MRAG 2016
Selectivity of fishery	fishing in aggregations	3		Fisheries New Zealand 2019a
Post-capture mortality	default	3		
Selectivity of fishery		3		
Susceptibility Subscore		3		
Productivity-Susceptibility Score		3.54		
Vulnerability Rating (high, medium or low)		High		

## Factor 1.2 - Fishing Mortality

## NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

### Moderate Concern

The ORH1 Mercury-Colville and Northern North Island stocks and the ORH3B Other stock are not recently assessed and there are no plans yet for future stock assessment due to lack of reliable abundance indices. Efforts are ongoing to find appropriate methodology for designing and executing surveys to provide the necessary data to index abundance of the stocks. The ORH1 Mercury-Colville stock was restricted to an annual catch of 30t in 2001 (Fisheries New Zealand 2019a). The TACC for ORH1 Northern North Island has been set to 1400t since 2000 and catch has not exceeded this limit. As ORH1 is likely to include multiple stocks a working group determined that estimation of  $B_{MSY}$  is not possible and adequate data required for estimation are not expected in the near future (Fisheries New Zealand 2019a). The Deepwater Working Group reviewed data the on ORH3B Other management area in 2006 and concluded that data were not sufficient for CPUE analyses. Without indicators of current abundance it is not possible to determine if fishing levels are sustainable. Fishing mortality relative to appropriate limit reference points is unknown and thus considered a moderate concern.

## ORANGE ROUGHY

### Factor 1.1 - Abundance

## NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

### Moderate Concern

Based on biomass estimates (utilizing CPUE indices) from the 2003 stock assessment, it is unlikely ( $B_{2003} = 24\% B_0$ , <40% probability) that the orange roughy stock in management area ORH2A is above target levels (30%  $B_0$ ) or below the soft limit (overfished or depleted, 20%  $B_0$ ) (Fisheries New Zealand 2019a). It is very unlikely (probability <10%) that the stock is below the hard limit (collapsed, 10%  $B_0$ ). There is concern regarding the suitability of the model used in the stock assessment as it assumes deterministic recruitment which may not be ecologically realistic. As the stock assessment is over ten years old, with biomass estimated to be over the soft limit reference point but with uncertainty regarding the estimate, and orange roughy are considered highly vulnerable (PSA = 3.54), abundance is considered a moderate concern.

### Factor 1.2 - Fishing Mortality

## NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

### Moderate Concern

Due to implementation of reduced catch limits in 2000, fishing mortality remains at ~200 t (Fisheries New Zealand 2019a). An overfishing threshold has not been established for ORH2A north - East Cape. As fishing mortality relative to limit reference points is unknown it is rated a moderate concern.

## ORANGE ROUGHY

### Factor 1.1 - Abundance

## NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

### High Concern

Based on biomass estimates from the 2014 stock assessment, it is very unlikely ( $B_{2014} = 14\% B_0$ ,  $<10\%$  probability) that the orange roughy stock in management areas ORH2A South, ORH2B, ORH3A is at or above target levels (30–40%  $B_0$ ) (see figure below for estimated SSB trajectory) (Fisheries New Zealand 2019a). It is likely (probability  $>60\%$ ) biomass is below the soft limit (overfished or depleted, 20%  $B_0$ ) and unlikely (probability  $<40\%$ ) that the stock is below the hard limit (collapsed, 10%  $B_0$ ). The minimum time projected to rebuild the stock to target levels with no catch is estimated at 21 years (70% probability). As the stock is considered to likely be overfished, abundance is a high concern.

### Justification:

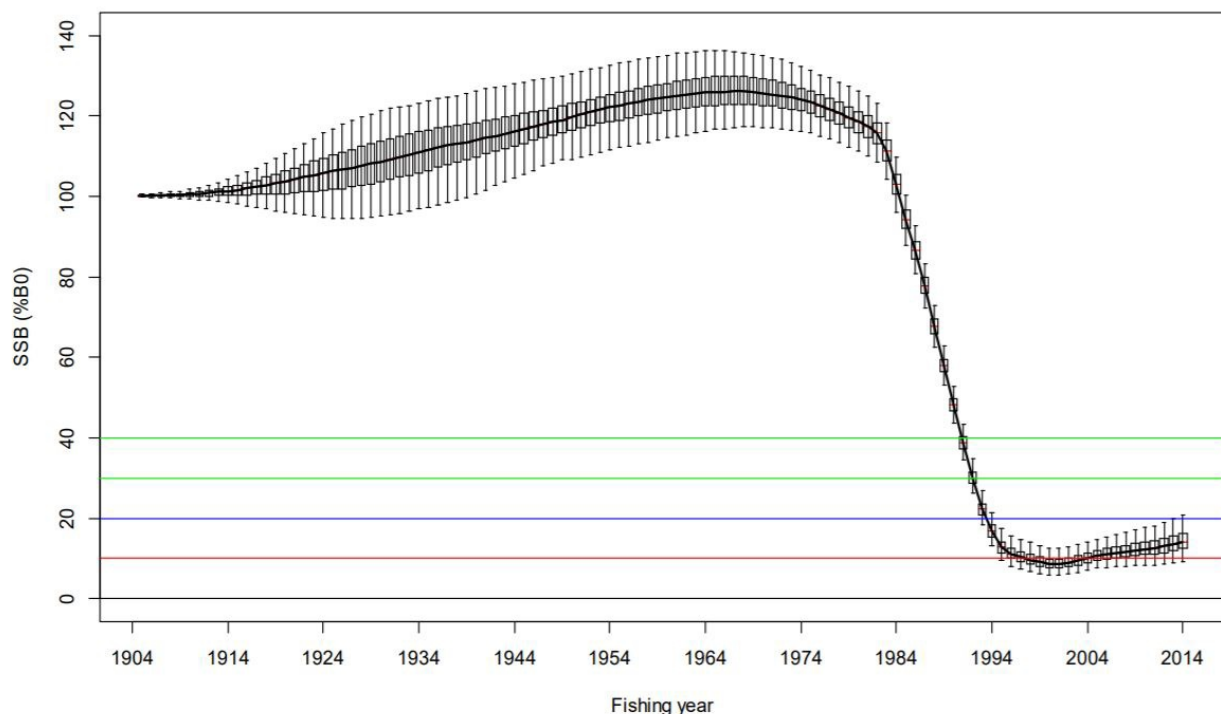


Figure 6 Estimated spawning-stock biomass trajectory for the Mid-East Coast stock ORH2A, ORH2B, ORH3A (Fisheries New Zealand 2019a). The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. The hard limit, 10%  $B_0$  (red), soft limit, 20%  $B_0$  (blue), and biomass target range, 30–40%  $B_0$  (green) are marked by horizontal lines. There is a steep decline in the stock status trajectory from the start of fishery through 2000 (biomass reached 10%  $B_0$ ), after which there was a slow increase.

## Factor 1.2 - Fishing Mortality

## NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

### Moderate Concern

It is considered about as likely as not (40-60% probability) that overfishing is occurring in management areas ORH2A South, ORH2B, ORH3A (see figure below for estimated fishing-intensity trajectory)(Fisheries New Zealand 2019a). The overfishing threshold is considered to be a fishing intensity range of  $U_{30\%B_0}$ –  $U_{40\%B_0}$  and fishing intensity for 2014 was estimated to be  $U_{35\%B_0}$ . As it is unknown if overfishing is occurring, fishing mortality is considered a moderate concern.

### Justification:

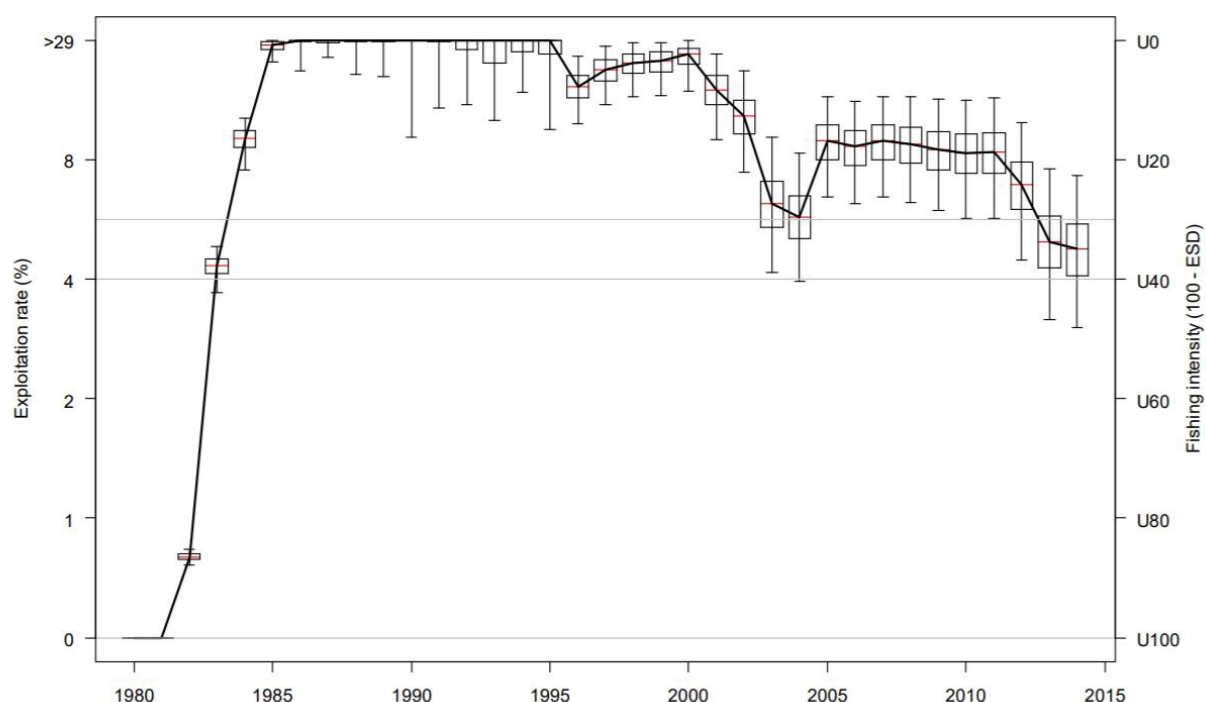


Figure 7 Estimated (MCMC) fishing intensity trajectory for Mid-East Coast stock ORH2A, ORH2B, ORH3A (Fisheries New Zealand 2019). The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. The fishing-intensity range associated with the biomass target of 30–40%  $B_0$  is marked by horizontal lines. Estimated fishing intensity was above the target range ( $U_{30\%B_0}$ – $U_{40\%B_0}$ ) from 1984 to 2012. Fishing intensity in the last two years of the time series decreased to within the target range.

## ORANGE ROUGHY

### Factor 1.1 - Abundance

#### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

#### Low Concern

Based on biomass estimates from the 2017 stock assessment, it is likely ( $B_{2017} = 33\% B_0$ , >60% probability) that the orange roughy stock in management area ORH3B East and South Chatham is at or above target levels (30-50%  $B_0$ ) (see figure on estimated SSB trajectory below)(Fisheries New Zealand 2019a). It is very unlikely (probability <10%) biomass is below the soft limit (overfished or depleted, 20%  $B_0$ ) and exceptionally unlikely (probability <1%) that the stock is below the hard limit (collapsed, 10%  $B_0$ ). As a recent quantitative stock assessment reflects that biomass is above a target reference point, but with some uncertainty regarding the biomass estimate (see Justification section), abundance is considered a low concern.

## Justification:

New Zealand Fisheries ranks the stock assessment for this region as high quality but with uncertainty in biomass estimation due to limited age composition data (3 yrs) used in determining year class strength and not knowing the proportion of the spawning stock indexed by the acoustic survey or the timing of the Rekohu spawning plume on which stock status is dependent (Fisheries New Zealand 2019a).

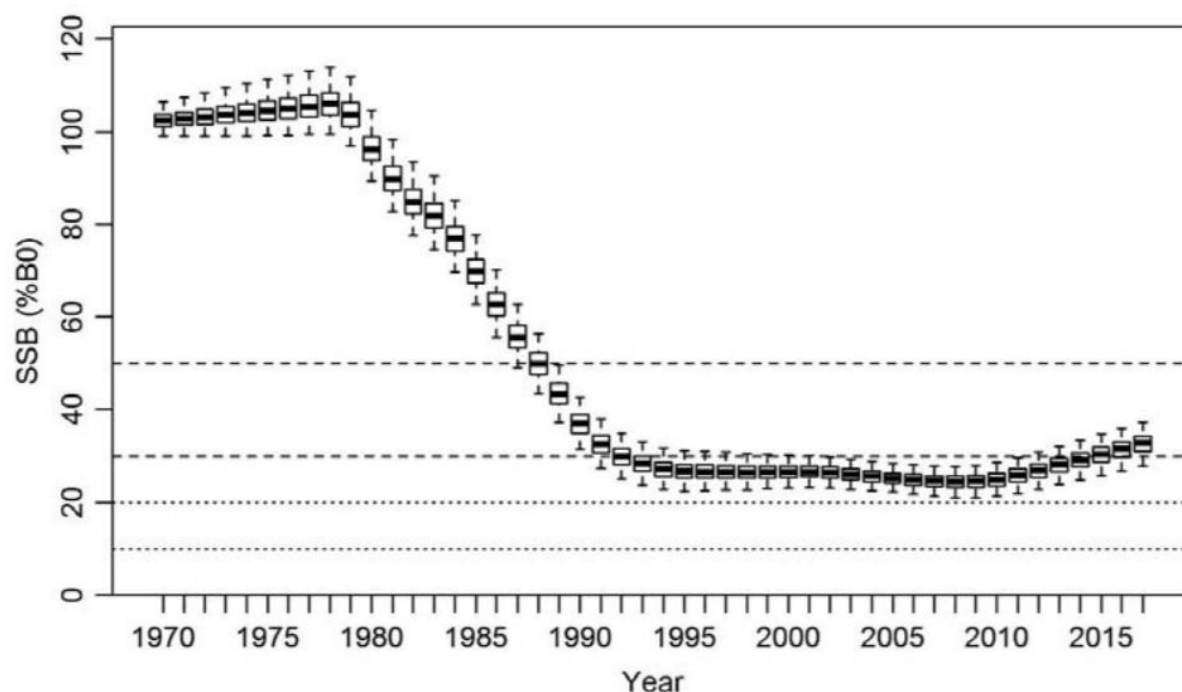


Figure 8 Markov Chain Monte Carlo (MCMC) estimated spawning-stock biomass trajectory for East and South Chatham Rise ORH3B (Fisheries New Zealand 2019a). The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. Dotted lines indicate the hard limit (10% B0) and soft limit (20% B0), dashed lines the biomass target range (30–50% B0). There was a steady decline in SSB from when the fishery began until the mid-1990s, where it remained in the 20–30% range until increasing in 2010.

## Factor 1.2 - Fishing Mortality

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

#### Low Concern

Overfishing is considered to be exceptionally unlikely (<1%) to be occurring in management area ORH3B East and South Chatham (see estimated fishing trajectory figure below) (Fisheries New Zealand 2019a). The overfishing threshold is considered to be a fishing intensity range of  $U_{30\%B0}$ – $U_{50\%B0}$  and the exploitation rate has remained at the low end of the target range for the past 7 years. As it is probable that fishing mortality from all sources is at or below a sustainable level, fishing mortality is considered a low concern.

## Justification:

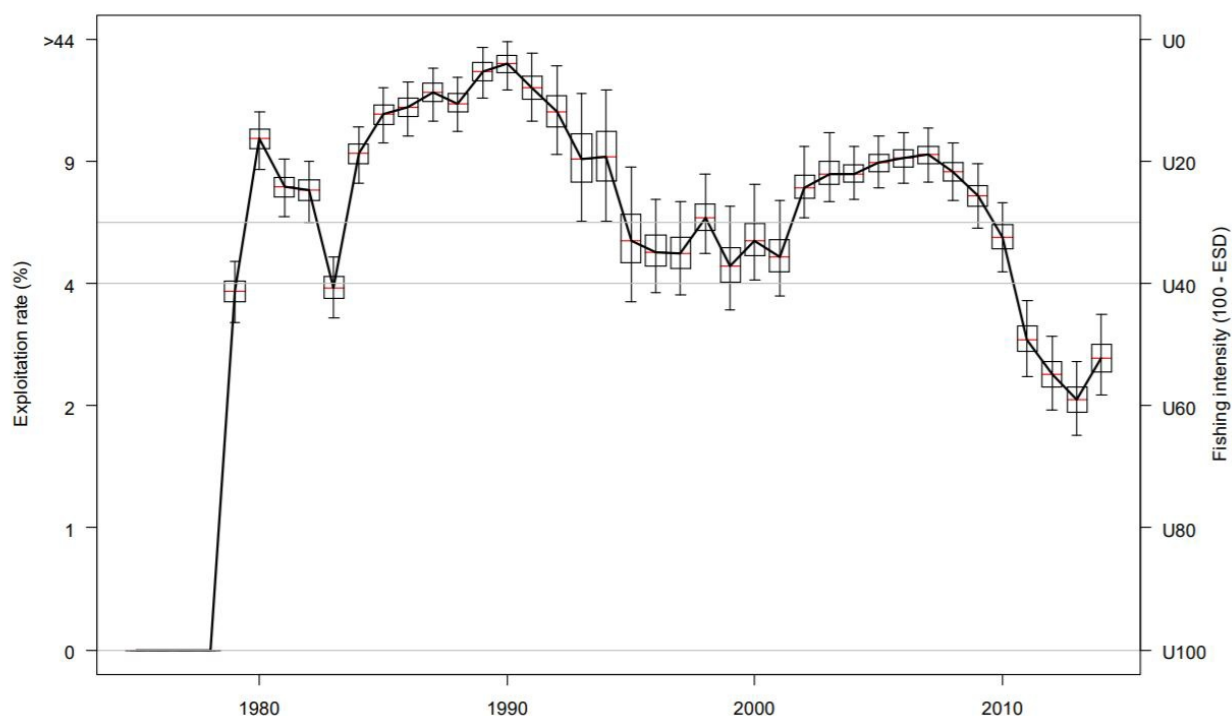


Figure 9 Estimated (MCMC) fishing intensity trajectory for East and South Chatham Rise ORH3B (Fisheries New Zealand 2019a). The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. The fishing-intensity range associated with the biomass target of 30–50%  $B_0$  is marked by horizontal lines. Estimated fishing intensity was within or above the target range (U30% $B_0$ –U50% $B_0$ ) for most years of the fishery. After 2009–10 fishing intensity was below the target range.

## ORANGE ROUGHY

### Factor 1.1 - Abundance

#### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

#### Low Concern

Based on biomass estimates from the 2018 stock assessment, it is very likely ( $B_{2018} = 38\% B_0$ , >90% probability) that the orange roughy stock in management area ORH3B Northwest Chatham Rise is at or above the lower end of target levels (30–50%  $B_0$ ) thus the stock is considered to be fully rebuilt (see figure below for estimated SSB trajectory) (Fisheries New Zealand 2019a). It is exceptionally unlikely (probability <1%) biomass is below the soft limit (overfished or depleted, 20%  $B_0$ ) or hard limit (collapsed, 10%  $B_0$ ). As a recent quantitative stock assessment reflects that biomass is above a target reference point, but with some uncertainty regarding the biomass estimate (see Justification section), abundance is considered a low concern.

#### Justification:

New Zealand Fisheries considers the quantitative stock assessment to be high quality but uncertainty exists regarding biomass estimates due to not knowing the proportion of the spawning stock indexed by the acoustic survey and lack of data availability in age composition (year class strength based on 1 year of data) and abundance indices (time series restricted to period of lower stock status) (Fisheries New Zealand 2019a).

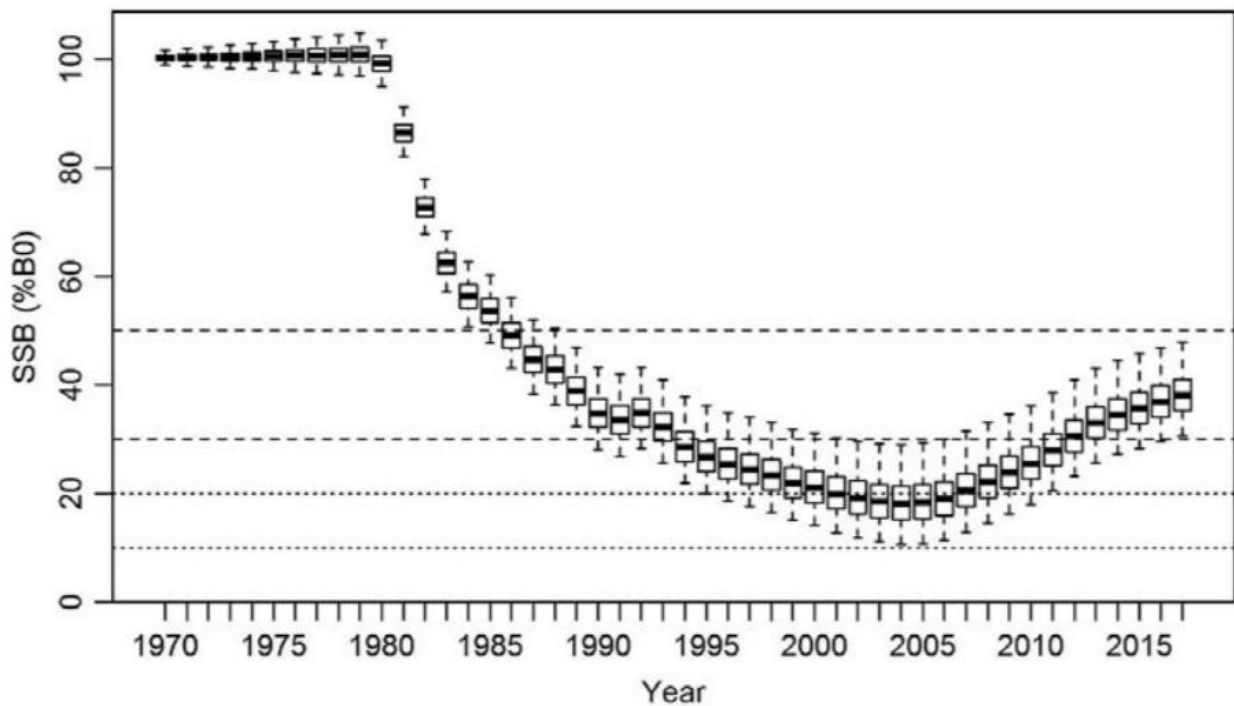


Figure 10 Northwest Chatham Rise ORH3B estimated (MCMC) SSB trajectory (Fisheries New Zealand 2019a). The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. Dotted lines indicate the hard limit (10% B0) and soft limit (20% B0), dashed lines the management target range (30–50% B0). There was a declining trend from when the fishery started in 1980 through to 2004 when the biomass was About as Likely as Not (40–60%) to be below the soft limit. Biomass has increased steadily since 2005.

## Factor 1.2 - Fishing Mortality

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

#### Low Concern

Overfishing is considered to be exceptionally unlikely (<1%) to be occurring in management area ORH3B Northwest Chatham Rise (see figure below for estimated fishing-intensity trajectory)(Fisheries New Zealand 2019a). The overfishing threshold is considered to be a fishing intensity range of  $U_{30\%B_0}$ –  $U_{50\%B_0}$  and exploitation rates have remained below the threshold since 2007. As it is probable that fishing mortality from all sources is at or below a sustainable level, fishing mortality is considered a low concern.

#### Justification:

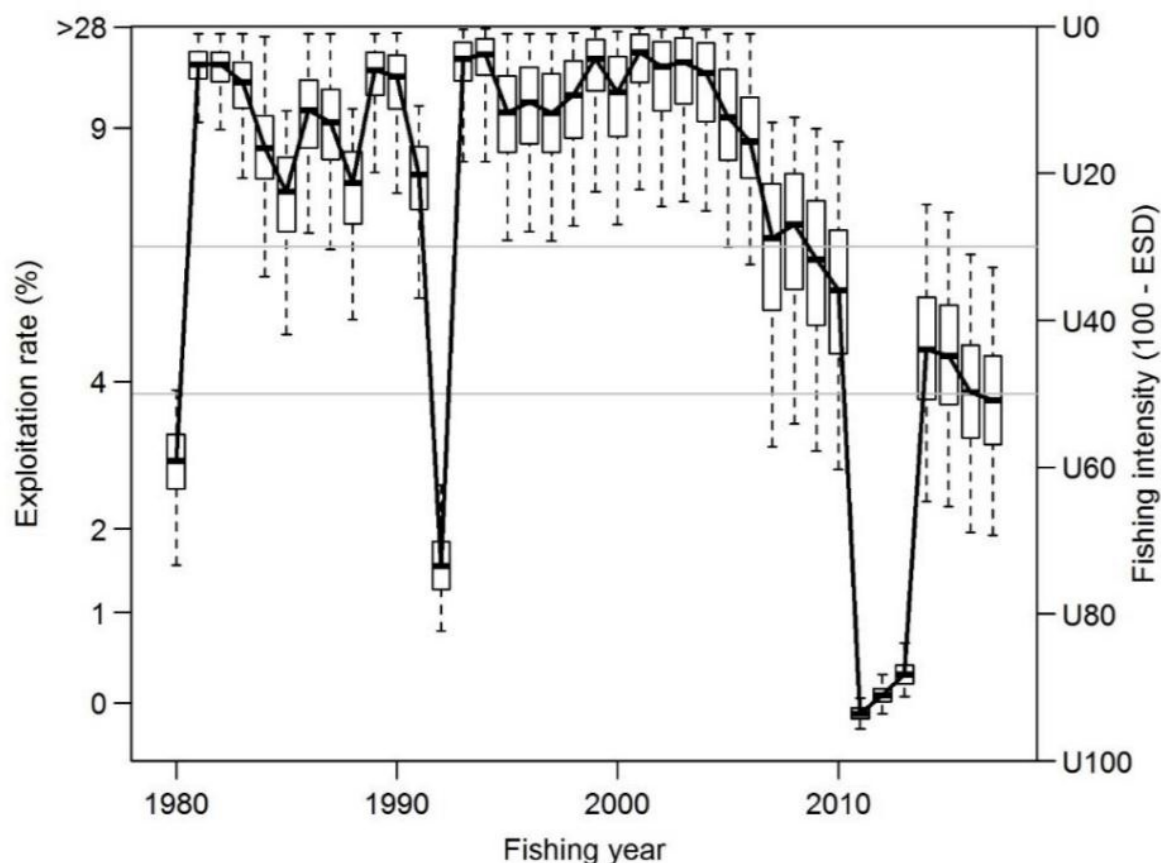


Figure 11 Estimated (MCMC) fishing-intensity trajectory for Northwest Chatham Rise ORH3B (Fisheries New Zealand 2019a). The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. The fishing-intensity range associated with the biomass target of 30–50%  $B_0$  is marked by horizontal lines. Estimated fishing intensity was above U20% $B_0$  for most of the history of the fishery, in the target range from 2009–2010 and dropped substantially in 2011 (due to industry fishing curtailment). Fishing intensity has been in or just below the target range since 2014.

## ORANGE ROUGHY

### Factor 1.1 - Abundance

#### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

#### High Concern

There are no stock assessments for the ORH1 (Northern North Island and Mercury-Colville stocks) or ORH3B (Other stock) management areas, no biomass estimates are available. As biomass relative to limit reference points is unknown and the species is highly vulnerable ( $PSA = 3.54$ , see table below), stock status is considered a high concern.

#### Justification:

#### PSA Table: Orange Roughy, New Zealand trawl fisheries



Productivity Attributes		Value	Score (1 = low risk; 2 = medium risk; 5 = high risk)	Reference
Average age at maturity (years)		36.5	3	Fisheries New Zealand 2019a
Average maximum age (years)		120	3	Fisheries New Zealand 2019a
Fecundity (eggs/yr)		50,000	1	Fisheries New Zealand 2019a
Average maximum size (cm) (not to be used when scoring invertebrate species)		50	1	Fisheries New Zealand 2019a
Average size at maturity (cm) (not to be used when scoring invertebrate species)		37	1	Fisheries New Zealand 2019a
Reproductive strategy		Broadcast spawner	1	Fisheries New Zealand 2019a
Trophic level		4.3	3	Froese & Pauly 2019
Density dependence (invertebrates only)		NA		
Quality of Habitat		Moderately altered	2	Fisheries New Zealand 2019a
Productivity Subscore			1.88	
Susceptibility Attribute	Information	Score (1 = low risk; 2 = medium risk; 5 = high risk)		Reference
Areal overlap	default	3		
Vertical overlap	> 33% (most abundant in depth range 800-1,200 m, fishing depth most commonly 700-1,100 m)	3		Kailola et al. 1993, MRAG 2016
Selectivity of fishery	fishing in aggregations	3		Fisheries New Zealand 2019a
Post-capture mortality	default	3		

<b>Selectivity of fishery</b>	3
<b>Susceptibility Subscore</b>	3
<b>Productivity-Susceptibility Score</b>	3.54
<b>Vulnerability Rating (high, medium or low)</b>	High

## Factor 1.2 - Fishing Mortality

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

#### Moderate Concern

The ORH1 Mercury-Colville and Northern North Island stocks and the ORH3B Other stock are not recently assessed and there are no plans yet for future stock assessment due to lack of reliable abundance indices. Efforts are ongoing to find appropriate methodology for designing and executing surveys to provide the necessary data to index abundance of the stocks. The ORH1 Mercury-Colville stock was restricted to an annual catch of 30t in 2001 (Fisheries New Zealand 2019a). The TACC for ORH1 Northern North Island has been set to 1400t since 2000 and catch has not exceeded this limit. As ORH1 is likely to include multiple stocks a working group determined that estimation of  $B_{MSY}$  is not possible and adequate data required for estimation are not expected in the near future (Fisheries New Zealand 2019a). The Deepwater Working Group reviewed data the on ORH3B Other management area in 2006 and concluded that data were not sufficient for CPUE analyses. Without indicators of current abundance it is not possible to determine if fishing levels are sustainable. Fishing mortality relative to appropriate limit reference points is unknown and thus considered a moderate concern.

## ORANGE ROUGHY

### Factor 1.1 - Abundance

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

#### Low Concern

Based on biomass estimates from the 2017 stock assessment, it is very likely ( $B_{2017} = 49\% B_0$ , >90% probability) that the orange roughy stock in management area ORH3B Puysegur is at or above the lower end of target levels (30-50%  $B_0$ ) (see estimated SSB trajectory figure below)(Fisheries New Zealand 2019a). Biomass reached a historic low in 1998 (when the fishery was closed) but abundance has steadily increased since and the stock is currently considered to be fully rebuilt (and reopened in 2017). It is exceptionally unlikely (probability <1%) biomass is below the soft limit (overfished or depleted, 20%  $B_0$ ) or hard limit (collapsed, 10%  $B_0$ ). As a recent quantitative stock assessment reflects that biomass is above a target reference point, but with some uncertainty regarding the biomass estimate (see Justification section),

abundance is considered a low concern.

#### Justification:

New Zealand Fisheries considers the quantitative stock assessment to be high quality but uncertainty exists regarding biomass estimates due to not knowing the proportion of the spawning stock indexed by the acoustic survey and lack of data availability regarding acoustic surveys (biomass index based on only one acoustic estimate) and age frequency (year class strength based on two years of data) (Fisheries New Zealand 2019a).

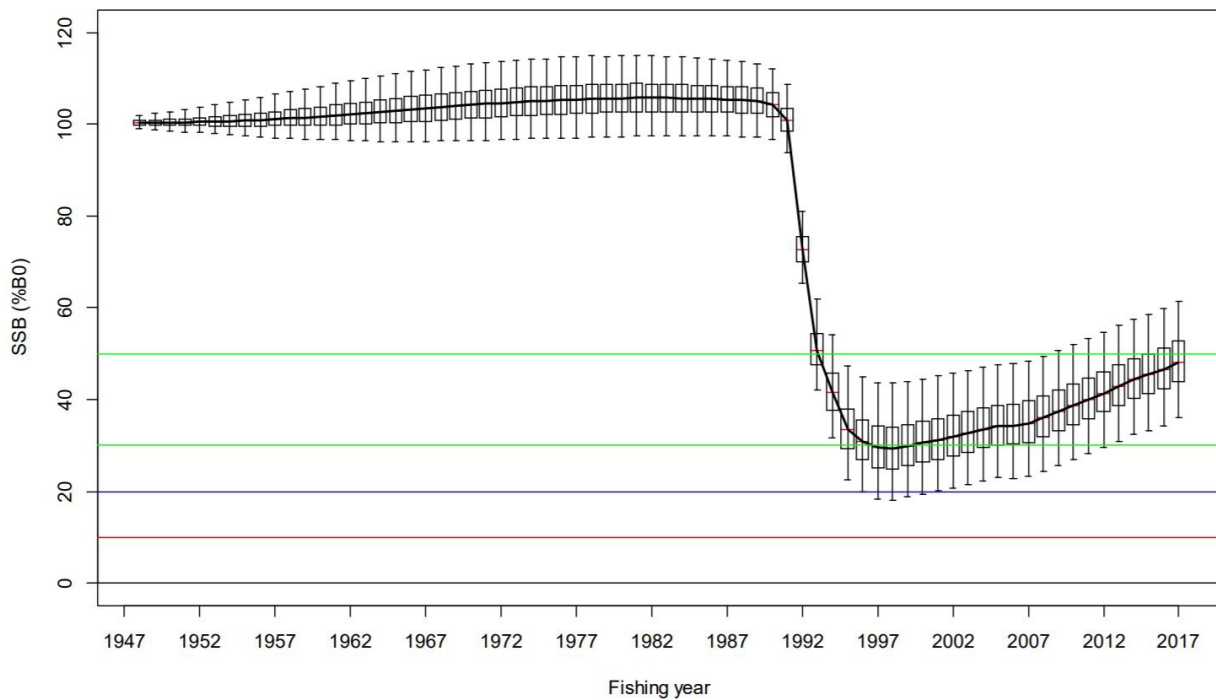


Figure 12 Estimated (MCMC) spawning-stock biomass trajectory for Puysegur ORH3B (Fisheries New Zealand 2019a). The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. The hard limit (red), soft limit (blue), and biomass target range (green) are marked by horizontal lines. From the beginning of the fishery in 1990, SSB declined until the fishery was closed in 1998. SSB has increased steadily since the closure and has been within target for the past decade.

## Factor 1.2 - Fishing Mortality

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

#### Low Concern

Overfishing is considered to be exceptionally unlikely (<1%) to be occurring in the ORH3B Puysegur management area (see estimated fishing intensity trajectory figure below)(Fisheries New Zealand 2019a). The overfishing threshold is considered to be fishing intensity of  $U_{30\%B_0}$ . A commercial catch limit was set to 347t when the fishery was considered rebuilt and reopened (after a 19 year closure) in October 2017. As it is probable that fishing mortality from all sources is at or below a sustainable level, fishing mortality is considered a low concern.

## Justification:

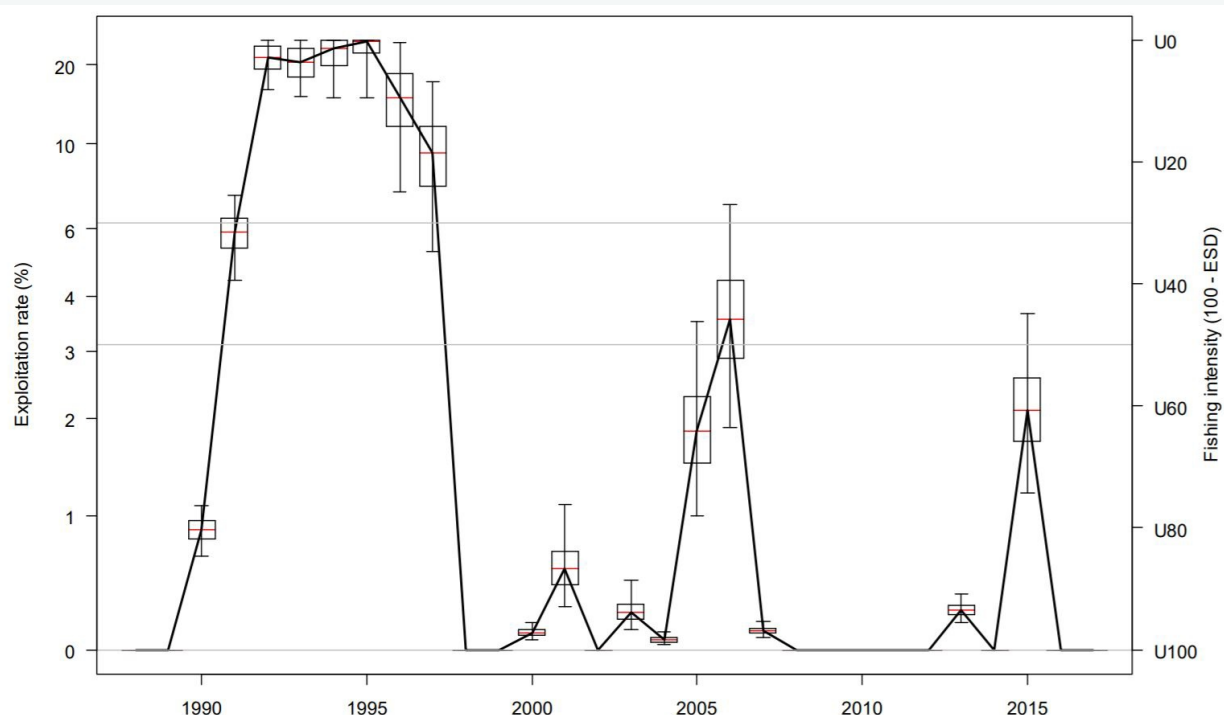


Figure 13 Puysegur ORH3B estimated (MCMC) fishing-intensity trajectory (Fisheries New Zealand 2019a). The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. The fishing-intensity range associated with the biomass target of 30–50%  $B_0$  is marked by horizontal lines. The fishery was closed in 1998 and was briefly in the target range (U30%B0–U50%B0) in 2006 when there was a combined acoustic and trawl survey, the fishery recently reopened at the end of 2017.

## ORANGE ROUGHY

### Factor 1.1 - Abundance

#### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

#### Low Concern

Based on biomass estimates from the 2019 stock assessment, it is very likely ( $B_{2014} = 47\% B_0$ , >90% probability) that the orange roughy stock in the ORH7A Challenger Plateau management area is at or above the lower range of target levels (30-50%  $B_0$ ) and about as likely as not (probability 40-60%) that the stock is at or above the upper end of the target range (see estimated SSB trajectory figure below)(Fisheries New Zealand 2019a). It is exceptionally unlikely (probability <1%) biomass is below the soft limit (overfished or depleted, 20%  $B_0$ ) or hard limit (collapsed, 10%  $B_0$ ). As a recent quantitative stock assessment reflects that biomass is above a target reference point, but with some uncertainty regarding the biomass estimate (see Justification section), abundance is considered a low concern.

#### Justification:

The stock assessment is considered to be high quality by Fisheries New Zealand but a major source of uncertainty to biomass estimation is the proportion of the stock that is indexed by the acoustic and trawl

surveys (Fisheries New Zealand 2019a).

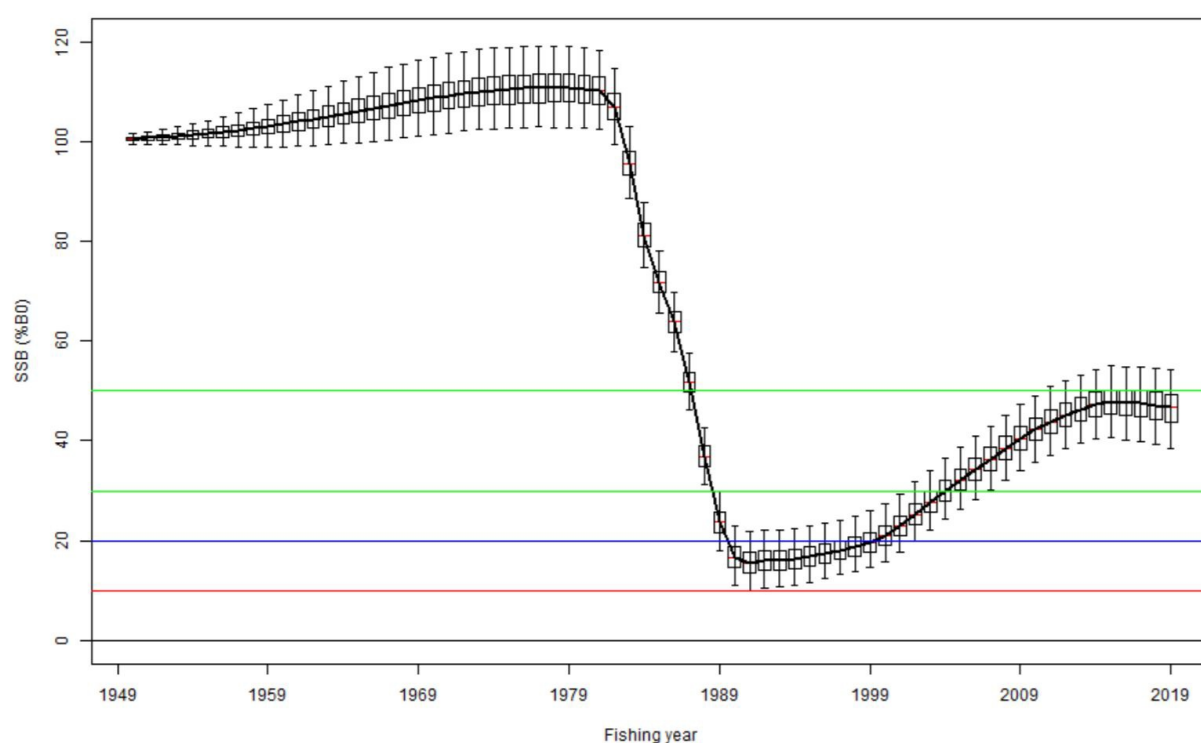


Figure 14 Estimated (MCMC) spawning-stock biomass trajectory for Challenger Plateau ORH7A (Fisheries New Zealand 2019a). The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. The hard limit 10% B0 (red), soft limit 20% B0 (blue), and biomass target range 30–50% B0 (green) are marked by horizontal lines. The stock was fished down to 15% of B0 after the fishery opened and remained there until the late 1990s. Biomass gradually increased from the late 1990s until peaking in 2015 and then leveling out in recent years (due to an increase in TACC).

## Factor 1.2 - Fishing Mortality

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

#### Low Concern

Overfishing is considered to be very unlikely (<10%) to be occurring in the ORH7A Challenger Plateau management area (see estimated fishing-intensity trajectory figure below)(Fisheries New Zealand 2019a). The overfishing threshold is considered to be a fishing intensity range of  $U_{30\%B0}$ –  $U_{50\%B0}$  and exploitation rates have remained near the bottom of the target range since 2014-15. As it is probable that fishing mortality from all sources is at or below a sustainable level, fishing mortality is considered a low concern.

#### Justification:

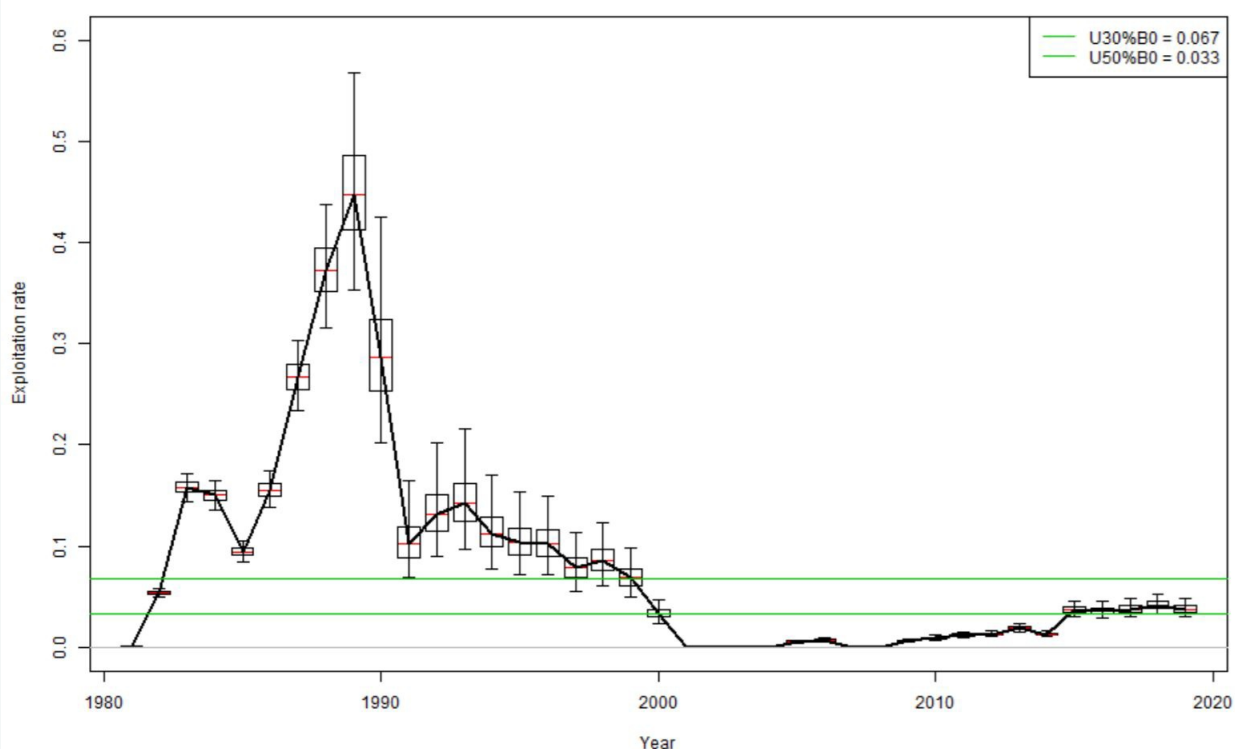


Figure 15 Estimated (MCMC) fishing-intensity trajectory for Challenger Plateau ORH7A (Fisheries New Zealand 2019a). The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. The fishing-intensity range associated with the biomass target of 30–50%  $B_0$  is marked by horizontal lines. Until the closure in 2001, estimated fishing intensity was generally well above the target range ( $U_{30\%B_0}$ – $U_{50\%B_0}$ ). Post-closure it was well below the target range through 2014 when it reopened and has since remained at the lower end of the target range.

## ORANGE ROUGHY

### Factor 1.1 - Abundance

#### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

#### High Concern

There are no stock assessments for the ORH1 (Northern North Island and Mercury-Colville stocks) or ORH3B (Other stock) management areas, no biomass estimates are available. As biomass relative to limit reference points is unknown and the species is highly vulnerable ( $PSA = 3.54$ , see table below), stock status is considered a high concern.

#### Justification:

#### PSA Table: Orange Roughy, New Zealand trawl fisheries

Productivity Attributes	Value	Score (1 = low risk; 2 = medium risk; 5 = high risk)	Reference
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<b>Average age at maturity (years)</b>	36.5	3	Fisheries New Zealand 2019a
<b>Average maximum age (years)</b>	120	3	Fisheries New Zealand 2019a
<b>Fecundity (eggs/yr)</b>	50,000	1	Fisheries New Zealand 2019a
<b>Average maximum size (cm) (not to be used when scoring invertebrate species)</b>	50	1	Fisheries New Zealand 2019a
<b>Average size at maturity (cm) (not to be used when scoring invertebrate species)</b>	37	1	Fisheries New Zealand 2019a
<b>Reproductive strategy</b>	Broadcast spawner	1	Fisheries New Zealand 2019a
<b>Trophic level</b>	4.3	3	Froese & Pauly 2019
<b>Density dependence (invertebrates only)</b>	NA		
<b>Quality of Habitat</b>	Moderately altered	2	Fisheries New Zealand 2019a
<b>Productivity Subscore</b>		<b>1.88</b>	
<b>Susceptibility Attribute</b>	<b>Information</b>	<b>Score (1 = low risk; 2 = medium risk; 5 = high risk)</b>	<b>Reference</b>
<b>Areal overlap</b>	default	3	
<b>Vertical overlap</b>	> 33% (most abundant in depth range 800-1,200 m, fishing depth most commonly 700-1,100 m)	3	Kailola et al. 1993, MRAG 2016
<b>Selectivity of fishery</b>	fishing in aggregations	3	Fisheries New Zealand 2019a
<b>Post-capture mortality</b>	default	3	
<b>Selectivity of fishery</b>		3	

<b>Susceptibility Subscore</b>	3
<b>Productivity-Susceptibility Score</b>	3.54
<b>Vulnerability Rating (high, medium or low)</b>	High

## Factor 1.2 - Fishing Mortality

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

#### Moderate Concern

The ORH1 Mercury-Colville and Northern North Island stocks and the ORH3B Other stock are not recently assessed and there are no plans yet for future stock assessment due to lack of reliable abundance indices. Efforts are ongoing to find appropriate methodology for designing and executing surveys to provide the necessary data to index abundance of the stocks. The ORH1 Mercury-Colville stock was restricted to an annual catch of 30t in 2001 (Fisheries New Zealand 2019a). The TACC for ORH1 Northern North Island has been set to 1400t since 2000 and catch has not exceeded this limit. As ORH1 is likely to include multiple stocks a working group determined that estimation of  $B_{MSY}$  is not possible and adequate data required for estimation are not expected in the near future (Fisheries New Zealand 2019a). The Deepwater Working Group reviewed data the on ORH3B Other management area in 2006 and concluded that data were not sufficient for CPUE analyses. Without indicators of current abundance it is not possible to determine if fishing levels are sustainable. Fishing mortality relative to appropriate limit reference points is unknown and thus considered a moderate concern.



## Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. Seafood Watch defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait score. The Criterion 2 rating is determined as follows:

- Score  $>3.2$ =Green or Low Concern
- Score  $>2.2$  and  $\leq 3.2$ =Yellow or Moderate Concern
- Score  $\leq 2.2$ =Red or High Concern

Rating is Critical if Factor 2.3 (Fishing Mortality) is Critical

### Guiding Principles

- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable level.
- Minimize bycatch.

### Criterion 2 Summary

Only the lowest scoring main species is/are listed in the table and text in this Criterion 2 section; a full list and assessment of the main species can be found in Appendix A.

ORANGE ROUGHY					
New Zealand/Southwest Pacific   Bottom Trawls   New Zealand   ORH1 Mercury-Colville					
Subscore:	1.000	Discard Rate:	1.00	C2 Rate:	1.000
Species   Stock	Abundance	Fishing Mortality	Subscore		
Corals and other biogenic habitats	1.00:High Concern	1.00:High Concern	Red (1.000)		
Seabirds	1.00:High Concern	5.00:Low Concern	Yellow (2.236)		
Smooth oreo dory	2.33:Moderate Concern	5.00:Low Concern	Green (3.413)		

ORANGE ROUGHY					
New Zealand/Southwest Pacific   Bottom Trawls   New Zealand   ORH1 Northern North Island   ORH1 Northern North Island					
Subscore:	1.000	Discard Rate:	1.00	C2 Rate:	1.000
Species   Stock	Abundance	Fishing Mortality	Subscore		
Corals and other biogenic habitats	1.00:High Concern	1.00:High Concern	Red (1.000)		

Seabirds	1.00:High Concern	5.00:Low Concern	Yellow (2.236)
Smooth oreo dory	2.33:Moderate Concern	5.00:Low Concern	Green (3.413)

#### ORANGE ROUGHY

New Zealand/Southwest Pacific | Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

<b>Subscore:</b>	<b>1.000</b>	<b>Discard Rate:</b>	<b>1.00</b>	<b>C2 Rate:</b>	<b>1.000</b>
Species   Stock	Abundance	Fishing Mortality	Subscore		
Corals and other biogenic habitats	1.00:High Concern	1.00:High Concern	Red (1.000)		
Seabirds	1.00:High Concern	5.00:Low Concern	Yellow (2.236)		
Smooth oreo dory	2.33:Moderate Concern	5.00:Low Concern	Green (3.413)		

#### ORANGE ROUGHY

New Zealand/Southwest Pacific | Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

<b>Subscore:</b>	<b>1.000</b>	<b>Discard Rate:</b>	<b>1.00</b>	<b>C2 Rate:</b>	<b>1.000</b>
Species   Stock	Abundance	Fishing Mortality	Subscore		
Corals and other biogenic habitats	1.00:High Concern	1.00:High Concern	Red (1.000)		
Seabirds	1.00:High Concern	5.00:Low Concern	Yellow (2.236)		
Smooth oreo dory	2.33:Moderate Concern	5.00:Low Concern	Green (3.413)		

#### ORANGE ROUGHY

New Zealand/Southwest Pacific | Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

<b>Subscore:</b>	<b>1.000</b>	<b>Discard Rate:</b>	<b>1.00</b>	<b>C2 Rate:</b>	<b>1.000</b>
Species   Stock	Abundance	Fishing Mortality	Subscore		
Corals and other biogenic habitats	1.00:High Concern	1.00:High Concern	Red (1.000)		
Seabirds	1.00:High Concern	5.00:Low Concern	Yellow (2.236)		
Smooth oreo dory	2.33:Moderate Concern	5.00:Low Concern	Green (3.413)		

#### ORANGE ROUGHY

New Zealand/Southwest Pacific | Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

<b>Subscore:</b>	<b>1.000</b>	<b>Discard Rate:</b>	<b>1.00</b>	<b>C2 Rate:</b>	<b>1.000</b>
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Species   Stock	Abundance	Fishing Mortality	Subscore
Corals and other biogenic habitats	1.00:High Concern	1.00:High Concern	Red (1.000)
Seabirds	1.00:High Concern	5.00:Low Concern	Yellow (2.236)
Smooth oreo dory	2.33:Moderate Concern	5.00:Low Concern	Green (3.413)

ORANGE ROUGHY					
New Zealand/Southwest Pacific   Bottom Trawls   New Zealand   ORH3B Other   ORH3B Other					
<b>Subscore:</b>	<b>1.000</b>	<b>Discard Rate:</b>	<b>1.00</b>	<b>C2 Rate:</b>	<b>1.000</b>
Species   Stock	Abundance	Fishing Mortality	Subscore		
Corals and other biogenic habitats	1.00:High Concern	1.00:High Concern	Red (1.000)		
Seabirds	1.00:High Concern	5.00:Low Concern	Yellow (2.236)		
Smooth oreo dory	2.33:Moderate Concern	5.00:Low Concern	Green (3.413)		

ORANGE ROUGHY					
New Zealand/Southwest Pacific   Bottom Trawls   New Zealand   ORH3B Puysegur   ORH3B Puysegur					
<b>Subscore:</b>	<b>1.000</b>	<b>Discard Rate:</b>	<b>1.00</b>	<b>C2 Rate:</b>	<b>1.000</b>
Species   Stock	Abundance	Fishing Mortality	Subscore		
Corals and other biogenic habitats	1.00:High Concern	1.00:High Concern	Red (1.000)		
Seabirds	1.00:High Concern	5.00:Low Concern	Yellow (2.236)		
Smooth oreo dory	2.33:Moderate Concern	5.00:Low Concern	Green (3.413)		

ORANGE ROUGHY					
New Zealand/Southwest Pacific   Bottom Trawls   New Zealand   ORH7A Challenger Plateau   ORH7A Challenger Plateau					
<b>Subscore:</b>	<b>1.000</b>	<b>Discard Rate:</b>	<b>1.00</b>	<b>C2 Rate:</b>	<b>1.000</b>
Species   Stock	Abundance	Fishing Mortality	Subscore		
Corals and other biogenic habitats	1.00:High Concern	1.00:High Concern	Red (1.000)		
Seabirds	1.00:High Concern	5.00:Low Concern	Yellow (2.236)		
Smooth oreo dory	2.33:Moderate Concern	5.00:Low Concern	Green (3.413)		

Bycatch composition for Criterion 2 was informed by an average of 38% observer coverage over a 14-year time series (2001-02 through 2014-15) (Anderson et al. 2017). Although over 700 species were documented as bycatch, only the smooth oreo (7% of catch) exceeded 5% of catch composition followed in frequency by black oreo (1.6%), hoki (0.6%) and cardinalfish (0.3%). For non-QMS (Quota Management System) fishes deepwater

dogfishes, rattails, morid cods and slickheads were the most common bycatch but none exceeded 1% of the catch. Warty squid and corals were the most commonly caught non-QMS invertebrate bycatch but not exceeding 0.01% of the catch. Overall a low proportion of the catch is bycatch with 96% of the catch comprising orange roughy and other QMS managed species (MRAG Americas 2016). Improved fishing gear and techniques have reduced discards from 3400t in the 1990s to <500t since 2007/08 (MPI 2017).

Corals and biogenic habitat were included as a main species under Criterion 2 as all deepwater black corals, gorgonians, stony corals, and some hydrocorals in New Zealand are listed as protected species and deepwater trawl fisheries pose the greatest risk to coral species (Baird et al. 2013). Due to their high vulnerability corals are the species of highest concern interacting with the orange roughy trawl fisheries.

Orange roughy trawls occasionally catch seabirds (0-0.29 per 100 tows) which is considered low relative to other trawl fisheries (Fisheries New Zealand 2019a). The fishery is thought to pose the most risk to the Salvin's albatross and Chatham Island albatross (Fisheries New Zealand 2019a)(Robertson et al. 2017).

Sharks were not included as main species assessed as the level of interaction per shark species is low (<1%) and there is lack of evidence that this interaction level impacts these species (Anderson et al. 2017).

## Criterion 2 Assessment

### SCORING GUIDELINES

#### **Factor 2.1 - Abundance**

*(same as Factor 1.1 above)*

#### **Factor 2.2 - Fishing Mortality**

*(same as Factor 1.2 above)*

### CORALS AND OTHER BIOGENIC HABITATS

#### **Factor 2.1 - Abundance**

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

### High Concern

The orange roughy trawl fishery impacts biogenic habitat considered to have low resilience including corals and sponges (Clark et al. 2016). Due to their vulnerability, all deepwater black corals, gorgonians, stony corals and some hydrocorals were listed as protected species in New Zealand in 2010 (Baird et al. 2013). As abundance is scored based solely on the health of the assessed species, and corals are considered to be highly vulnerable with no evidence that the stocks are above or below reference points, abundance is considered a high concern.

## Factor 2.2 - Fishing Mortality

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

### High Concern

The orange roughy fisheries trawl over biogenic habitat including corals and sponges (Clark et al. 2019). Protected corals are one of the main non-QMS invertebrate species caught in the orange roughy fishery (Anderson et al. 2017). The proportion of total catch comprising corals is low with 0.11% (76 tons, 37.49% discarded) of the orange roughy catch from 2001 to 2015 consisting of protected corals. The orange roughy fishery, along with other deepwater trawl fisheries such as the oreo, black cardinalfish and alfonsino fisheries, are considered to be the fisheries that pose the most risk to protected corals (Baird et al. 2013). As there is no assessment of the impacts of the orange roughy fisheries on coral or sponge populations with no reference point for a sustainable level of mortality for corals, the Unknown Bycatch Matrix was used to score fishing mortality. Fishing mortality is rated a high concern (UBM score = 1).

### Justification:

Criterion 2 is focused on the direct population level impacts on corals caught as bycatch, while Criterion 4 considers the indirect effects of habitat damage on fish communities and ecosystems.

## Factor 2.3 - Modifying Factor: Discards and Bait Use

Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

*Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.*

RATIO OF BAIT + DISCARDS/LANDINGS	FACTOR 2.3 SCORE
<100%	1
>=100	0.75

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

#### **< 100%**

Annual discards/landings ratio ranged from 0.02 to 0.13 (from 2001-2002 to 2014-15) with an overall value of 0.07 and a decreasing trend in recent years (Anderson et al. 2017). The majority of orange roughy and QMS species are retained. The main species discarded in recent years are rattails and shovelnose spiny dogfish (0.7%, 0.6% of catch respectively) at a rate of 50% or more.

## Criterion 3: Management Effectiveness

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective', or 'critical'. The final Criterion 3 score is determined as follows:

- 5 (Very Low Concern) — Meets the standards of 'highly effective' for all five factors considered.
- 4 (Low Concern) — Meets the standards of 'highly effective' for 'management strategy and implementation' and at least 'moderately effective' for all other factors.
- 3 (Moderate Concern) — Meets the standards for at least 'moderately effective' for all five factors.
- 2 (High Concern) — At a minimum, meets standards for 'moderately effective' for Management Strategy and Implementation and Bycatch Strategy, but at least one other factor is rated 'ineffective.'
- 1 (Very High Concern) — Management Strategy and Implementation and/or Bycatch Management are 'ineffective.'
- 0 (Critical) — Management Strategy and Implementation is 'critical'.

The Criterion 3 rating is determined as follows:

- Score  $>3.2$  = Green or Low Concern
- Score  $>2.2$  and  $\leq 3.2$  = Yellow or Moderate Concern
- Score  $\leq 2.2$  = Red or High Concern

Rating is Critical if Management Strategy and Implementation is Critical.

### GUIDING PRINCIPLE

- The fishery is managed to sustain the long-term productivity of all impacted species.

### Criterion 3 Summary

Fishery	Management Strategy	Bycatch Strategy	Research and Monitoring	Enforcement	Stakeholder Inclusion	Score
Fishery 1: New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH1 Mercury-Colville	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Yellow (3.000)
Fishery 2: New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH1 Northern North Island   ORH1 Northern North Island	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Yellow (3.000)
Fishery 3: New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH2A north - East Cape   ORH2A north - East Cape	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Yellow (3.000)

Fishery 4: New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH2A south, ORH2B, ORH3A - Mid East Coast   ORH2A south, ORH2B, ORH3A - Mid East Coast	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Yellow (3.000)
Fishery 5: New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH3B East and South Chatham Rise   ORH3B East and South Chatham Rise	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Highly Effective	Green (4.000)
Fishery 6: New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH3B Northwest Chatham Rise   ORH3B Northwest Chatham Rise	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Highly Effective	Green (4.000)
Fishery 7: New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH3B Other   ORH3B Other	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Yellow (3.000)
Fishery 8: New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH3B Puysegur   ORH3B Puysegur	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Highly Effective	Green (4.000)
Fishery 9: New Zealand/Southwest Pacific   Bottom trawls   New Zealand   ORH7A Challenger Plateau   ORH7A Challenger Plateau	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Highly Effective	Green (4.000)

### Criterion 3 Assessment

#### Factor 3.1 - Management Strategy and Implementation

*Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? Do managers follow scientific advice? To achieve a highly effective rating, there must be appropriately defined management goals, precautionary policies that are based on scientific advice, and evidence that the measures in place have been successful at maintaining/rebuilding species.*



**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

**Moderately Effective**

Historically, New Zealand orange roughy fisheries have been considered poorly managed with stock assessments based on inconsistent or uncertain data (trawl survey data that was not representative of stock-wide abundance and ageing data with low precision) (Tingley & Dunn 2018). Management has responded to stock depletion (below  $B_{MSY}$ ) by implementing TAC reductions and fishery closures to facilitate rebuilding. In the 1980s TACs were based on biomass estimates from trawl surveys that required assumptions about catchability. This was complicated by uneven distribution of an aggregating species (sometimes with highly variable sex ratios) and difficulty in comparing vessels and surveys leading to high coefficients of variation in biomass estimates. CPUE data have been rejected from orange roughy stock assessments and evaluations since 2014 in most management regions but are still used in some regions (East Cape, areas of ORH1 and Sub-Antarctic areas of ORB 3B). Recent developments in acoustic technology (multifrequency systems allowing for species identification) have allowed for more robust data availability to estimate spawning stock biomass. Advances in ageing orange roughy have also allowed for incorporation of age composition data into recent stock assessments (post 2011) although some imprecision still remains, leading to uncertainty. The accuracy of  $M$  used in the stock assessments (0.045) is also uncertain, driven by assuming average recruitment for cohorts that are poorly represented in the age data (MRAG Americas 2016). Recruitment dynamics are poorly understood as related to spawning stock biomass and complicated by long lag times between spawning and recruitment to the fishery. Stock assessments assume a Beverton-Holt stock-recruit relationship with high inter-annual variability to account for recruitment uncertainty.

The ORH1 Northern North Island, ORH1 Mercury-Colville and ORH3B Other orange roughy fisheries are data poor with no stock assessments or limit reference points based on biological data. For the ORH2A north - East Cape orange roughy fishery data are outdated with the last stock assessment in 2003 and fishing mortality relative to limit reference points based on biological data unknown. The ORH2A south, ORH2B, ORH3A - Mid East Coast stock is overfished with minimum projection time to rebuild 21 years and uncertainty exists as to if overfishing may be occurring. As management measures are in place to minimize mortality of stocks of concern and for >70% of the fishery's primary target but with concern regarding data uncertainty, management is rated a moderate concern.

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

### Highly Effective

Historically, New Zealand orange roughy fisheries have been considered poorly managed with stock assessments based on inconsistent or uncertain data (trawl survey data that was not representative of stock-wide abundance and ageing data with low precision) (Tingley & Dunn 2018). Management has responded to stock depletion (below  $B_{MSY}$ ) by implementing TAC reductions and fishery closures to facilitate rebuilding. In the 1980s TACs were based on biomass estimates from trawl surveys that required assumptions about catchability. This was complicated by uneven distribution of an aggregating species (sometimes with highly variable sex ratios) and difficulty in comparing vessels and surveys leading to high coefficients of variation in biomass estimates. CPUE data have been rejected from orange roughy stock assessments and evaluations since 2014 in most management regions but are still used in some regions (East Cape, areas of ORH1 and Sub-Antarctic areas of ORB 3B). Recent developments in acoustic technology (multifrequency systems allowing for species identification) have allowed for more robust data availability to estimate spawning stock biomass. Advances in ageing orange roughy have also allowed for incorporation of age composition data into recent stock assessments (post 2011) although some imprecision still remains, leading to uncertainty. The accuracy of  $M$  used in the stock assessments (0.045) is also uncertain, driven by assuming average recruitment for cohorts that are poorly represented in the age data (MRAG Americas 2016). Recruitment dynamics are poorly understood as related to spawning stock biomass and complicated by long lag times between spawning and recruitment to the fishery. Stock assessments assume a Beverton-Holt stock-recruit relationship with high inter-annual variability to account for recruitment uncertainty.

Since 2013, higher data-quality thresholds have been required for assessment and relative spawning stock biomass was used rather than the previously utilized absolute spawning stock biomass estimates which required assumptions that introduce bias (Fisheries New Zealand 2019a). Stock assessments reflect that recruitment may have historically fallen below average for several decades. As management measures are in place with appropriate reference points for >70% of the fishery's primary target, and management implements precautionary measures inclusive of scientific advice and incorporating uncertainty, management is rated highly effective.

### Factor 3.2 - Bycatch Strategy

*Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.*

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

**Moderately Effective**

Trawl gear is not selective, however, bycatch is relatively low with 4% of the catch being discards (not orange roughy or other QMS species) (MRAG Americas 2016). Deepwater corals are species of concern caught in the fishery. Spatial management measures are in place to protect habitat from trawling. Benthic Protection Areas, covering 32% of habitat in the New Zealand EEZ, were designed to protect a range of habitat types rather than specifically for coral protection (MPI 2015). It is uncertain if the proportion and distribution of habitat protected is suitable for sustainability of these vulnerable deepwater coral species as little is known about their dispersal capabilities and requirements for population connectivity (Clark et al. 2011). Currently 82% of the BPAs are in depths greater than fishing operations. The design of the BPAs could be improved upon to both optimize protection of marine biodiversity and benefit the fishing industry (Leathwick et al. 2008). As species of concern are caught, with some bycatch management measures in place, bycatch strategy is rated moderately effective.

**Justification:**

To reduce incidental catch in fisheries, New Zealand has National Plans of Action for sharks and seabirds in place with regulations to require reporting, mitigation measures and gear restrictions (MPI 2013a) (MPI 2013b). Scare devices are required on vessels >28m to keep seabirds away from interacting with fisheries gear (Fisheries New Zealand 2019a). There are also regulations in place to manage disposal of fish discards such that they minimize attracting foraging seabirds.

**Factor 3.3 - Scientific Research and Monitoring**

*Considerations: How much and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.*

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

**Moderately Effective**

The Deep Water Fisheries Assessment Working Group (DWFAWG), an open scientific forum including MPI scientists, independent scientists, fishery managers, industry and environmental NGOs, provides technical guidance and peer review on stock assessments (Clement et al. 2013)(Fisheries New Zealand 2019a). Assessments are further reviewed through MPI's scientific plenary process. All stocks are not monitored with equal frequency - those which are most heavily targeted or require rebuilding (70% of annual catch) are the most regularly monitored and assessed. Uncertainty in recruitment, due to high interannual recruitment variability leads to complications in use of predictive population models based on observational data (Doonan et al. 2015). Harvest Control Rules (HCRs) are used for determining Total Allowable Commercial Catches (TACCs) for each Quota Management Area (QMA) or biological stock within QMA based on stock size where data are available for size estimation (such as biomass estimates from acoustic surveys). The current HCRs are considered likely to lead to sustainable fisheries, even when considering uncertainty in recruitment variability, but could be improved upon by utilizing an alternative HCR that is more robust to uncertainty (Doonan et al. 2015). Bycatch is monitored through an observer program (average of 38% observer coverage, (Anderson et al. 2017)), mandatory logbooks and electronic monitoring through onboard Vessel Monitoring Systems (VMS) with landings reported electronically to MPI (FAO 2010)(MRAG Americas 2016). Research is limited in the ORH1 Northern North Island, ORH1 Mercury-Colville, ORH3B Other and ORH2A north - East Cape orange roughy fisheries, with no recent stock assessments available or limit reference points based on biological data. A stock assessment is available for the ORH2A south, ORH2B, ORH3A - Mid East Coast stock. This stock is considered overfished with a minimum projection time to rebuild of 21 years and uncertainty exists as to if overfishing may be occurring. As bycatch is monitored and some data related to stock abundance and health are collected and analyzed to maintain the stock, but with data uncertainty and lacking recent stock assessments, scientific research and monitoring are rated as moderately effective.

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

**Highly Effective**

The Deep Water Fisheries Assessment Working Group (DWFAWG), an open scientific forum including MPI scientists, independent scientists, fishery managers, industry and environmental NGOs, provides technical guidance and peer review on stock assessments (Clement et al. 2013)(Fisheries New Zealand 2019a).

Assessments are further reviewed through MPI's scientific plenary process. All stocks are not monitored with equal frequency - those which are most heavily targeted or require rebuilding (70% of annual catch) are the most regularly monitored and assessed. Uncertainty in recruitment, due to high interannual recruitment variability leads to complications in use of predictive population models based on observational data (Doonan et al. 2015). Harvest Control Rules (HCRs) are used for determining Total Allowable Commercial Catches (TACCs) for each Quota Management Area (QMA) or biological stock within QMA based on stock size where data are available for size estimation (such as biomass estimates from acoustic surveys). The current HCRs are considered likely to lead to sustainable fisheries, even when considering uncertainty in recruitment variability, but could be improved upon by utilizing an alternative HCR that is more robust to uncertainty (Doonan et al. 2015). Bycatch is monitored through an observer program (average of 38% observer coverage, (Anderson et al. 2017)), mandatory logbooks and electronic monitoring through onboard Vessel Monitoring Systems (VMS) with landings reported electronically to MPI (FAO 2010)(MRAG Americas 2016). As bycatch is monitored with adequate coverage and management utilizes peer-reviewed stock assessment based on fishery-dependent and -independent data, scientific research and monitoring is rated highly effective.

### Factor 3.4 - Enforcement of Management Regulations

*Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.*

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

#### **Highly Effective**

Fisheries New Zealand has developed a VADE (Voluntary, Assisted, Directed, Enforced) model of compliance (Fisheries New Zealand 2019c)(Fisheries New Zealand 2019d) that includes education, monitoring, surveillance, audit, enforcement and prosecution of offenses. The drivers of non-compliance are examined before executing enforcement and the model is designed to facilitate communication between government and industry. In the first tier, fishers are informed of management regulations and comply voluntarily (voluntary compliance) while others may require specific information and education (assisted compliance). Enforcement and monitoring measures include vessel monitoring systems (VMS), aerial patrols and patrol boats which address lower end non-compliance through infringement notices or lower end penalties (directed compliance). When fraud and criminal activity is discovered they are prosecuted in the court system (enforced compliance)

and penalties can include vessel forfeiture, imprisonment and/or large monetary penalties. All vessels are required to have VMS with an onboard automatic location communicator (ALC). There is also an observer program that provides data to verify catch quantity and composition. As the appropriate permits and regulations are regularly enforced and independently verified, including VMS, logbook reports, air and at-sea monitoring, and the capacity to control compliance is appropriate to the scale of the fishery, enforcement is rated highly effective.

### Factor 3.5 - Stakeholder Inclusion

*Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.*

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

### **Highly Effective**

The orange roughy fishery in New Zealand is managed by the Fisheries New Zealand (within the Ministry for Primary Industries (MPI)) in collaboration with the Deepwater Group (DWG, industry stakeholders) (Fisheries New Zealand 2019c). The partnership was developed under a Memorandum of Understanding (MOU, est. 2006 and subsequently updated) and the two parties devised and implemented the National Deepwater plan for managing New Zealand's deepwater fisheries. Management is inclusive of input from Treaty Partners (Maori), stakeholders and the public. As part of the National Deepwater Fisheries Plan, there is regular engagement with stakeholders through the Fisheries Plan Advisory Group which includes representatives from the fishing industry, environmental groups, iwi, and other government agencies. Working groups, stock assessment Plenary meetings and their records are open to the public. Guidelines for MPI have been established for required consultation with stakeholders prior to providing advice to the Minister. Stakeholders include groups those that represent diverse interests such as the Fisheries Plan Advisory Group, the National Plan of Action for Conservation and Management of Sharks Advisory Group, the New Zealand Sea Lion Advisory Group and the Seabird Advisory Group. MPI provides a discussion document for stakeholders to inform them of potential management changes and solicits stakeholder input. Stakeholder comments are

summarized and provided to the Minister with MPI's recommendations for decision making. Final decisions are posted publicly on the MPI website. As the management process and decision making is transparent with participation encouraged from all major user groups, guidelines to facilitate stakeholder communication, and an effective constructive relationship between managers, scientists, and fishermen, stakeholder inclusion is rated highly effective.

## Criterion 4: Impacts on the Habitat and Ecosystem

*This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment. The final score is the geometric mean of the impact of fishing gear on habitat score (factor 4.1 + factor 4.2) and the Ecosystem Based Fishery Management score. The Criterion 4 rating is determined as follows:*

- Score >3.2=Green or Low Concern
- Score >2.2 and ≤3.2=Yellow or Moderate Concern
- Score ≤2.2=Red or High Concern

### GUIDING PRINCIPLES

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.
- Follow the principles of ecosystem-based fisheries management.

*Rating cannot be Critical for Criterion 4.*

### Criterion 4 Summary

Region   Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Score
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH1 Mercury-Colville	0	+0.5	Low Concern	Red (1.414)
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH1 Northern North Island	0	+0.5	Low Concern	Red (1.414)
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH2A north - East Cape	0	+0.5	Low Concern	Red (1.414)
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH2A south, ORH2B, ORH3A - Mid East Coast	0	+0.5	Low Concern	Red (1.414)
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH3B East and South Chatham Rise	0	+0.5	Low Concern	Red (1.414)



<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH3B Northwest Chatham Rise	0	+0.5	Low Concern	Red (1.414)
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH3B Other	0	+0.5	Low Concern	Red (1.414)
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH3B Puysegur	0	+0.5	Low Concern	Red (1.414)
<b>New Zealand/Southwest Pacific   Bottom trawls</b> New Zealand   ORH7A Challenger Plateau	0	+0.5	Low Concern	Red (1.414)

## Criterion 4 Assessment

### SCORING GUIDELINES

#### Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate

Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- 5 - Fishing gear does not contact the bottom
- 4 - Vertical line gear
- 3 - Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.
- 2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.
- 1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)
- 0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)  
Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

#### Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

- +1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.
- +0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl

*fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.*

- *0 — No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

### **Factor 4.3 - Ecosystem-Based Fisheries Management**

Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

- *5 — Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.*
- *4 — Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.*
- *3 — Policies are not in place to protect species' ecological roles and ecosystem functioning but detrimental food web impacts are not likely or policies in place may not be sufficient to protect species' ecological roles and ecosystem functioning.*
- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.*
- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

### **Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate**

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

**0**

As the fishery uses trawl gear, known to reduce biogenic habitat and impact slow growing long-lived corals (Clark et al. 2014) sponges and structure forming tube-worms (Anderson et al. 2019), the impact of fishing gear on the substrate is rated 0.

**Justification:**

While the population level impacts on coral species caught as bycatch are considered under Criterion 2, the indirect, community-wide impact of damaging these structure-forming organisms is considered under Criterion 4.

The New Zealand orange roughy fisheries trawl over a range of habitats including flat seabeds, vulnerable seep and vent areas inclusive of structure forming tube-worms, and near underwater topographical features (UTFs) such as canyons, knolls, hills and seamounts where fish aggregate and trawls interact with deep-sea corals and sponges (Clark & O'Driscoll 2003)(Clark & Rowden 2009)(Clark et al. 2016)(MRAG 2016)(Tingley & Dunn 2018)(Anderson et al. 2019). More data are required to understand the scale and distribution of biogenic habitat especially in the upper continental slope region where there is less benthic biomass overall relative to UTFs and distribution of biogenic habitat is more heterogenous.

Benthic community resilience to bottom trawling on seamounts can be very low evidenced by long-term monitoring studies displaying minimal recovery 15 years after closure on Chatham Rise seamounts (Clark et al. 2019). Coral cover was observed to be reduced by 90% on trawled seamounts compared to similar untrawled seamounts after as few as tens of trawl passes (Clark et al. 2010). Corals have also been observed persisting in flank areas around heavily trawled regions (>2000 passes) (Clark et al. 2014). Although in some regions the habitat trawled over is less sensitive is not possible to determine when non-biogenic habitat is trawled over exclusively due to high heterogeneity leading to uncertainty in distribution. There are on-going efforts to expand knowledge of the fisheries' impacts through data collection from vessel monitoring and observer programs on trawl footprint and monitoring impacts on the benthos (comparing 15 environmental classes based on a Benthic Optimised Marine Environmental Classification (BOMECE) (MPI 2015).

**Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts**

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

**+0.5**

Over 12% (22,000 km<sup>2</sup>) of New Zealand's territorial sea is protected with the majority in remote areas, however, an analysis of New Zealand's existing MPAs determined they could be designed more efficiently to protect a greater range of biodiversity (Geange et al. 2017). Benthic Protection Areas (BPAs), established in 2007, protect 32% of habitat (52% of seamounts) in the New Zealand EEZ from bottom trawling (see figure below), inclusive of high relief areas around Underwater Topographic Features (UTFs) which are protected from trawling due to their extreme slopes preventing gear contact (MPI 2015). Based on orange roughy depth range, the protected habitat represents 16% of orange roughy habitat (MPI 2010). Distribution of vulnerable coral habitat with the footprint of the fishery is considered to range between 0.2-40% (MRAG 2016). As a substantial proportion of habitat (>20%) is protected from gear contact, and trawl footprint is limited due to BPAs, with vulnerable habitats protected, mitigation of gear impacts is rated +0.5.

**Justification:**

## Locations of Benthic Protection Areas and Seamount closures

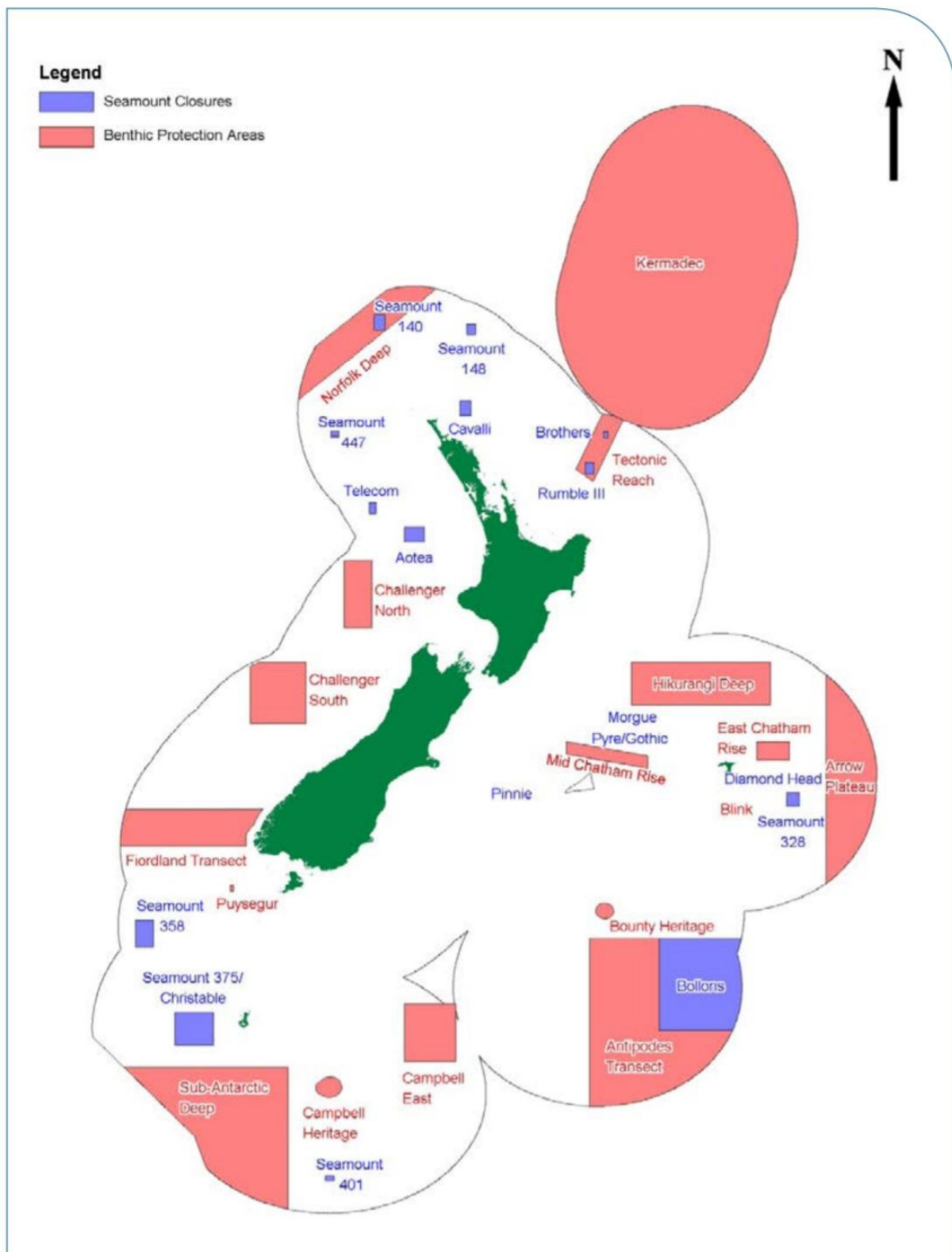


Figure 18 Benthic Protection Areas (MPI 2015).

### Factor 4.3 - Ecosystem-Based Fisheries Management

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

**Low Concern**

Orange roughy are opportunistic feeders consuming benthopelagic and mesopelagic prey with crustaceans, fishes and squids dominating the adult diet (Rosecchi et al. 1988)(Stevens et al. 2011)(Forman et al. 2016). The ecosystem implications of orange roughy commercial fishery removals are largely unknown (Fisheries New Zealand 2019a). It is unclear if orange roughy have a unique role in the ecosystem, other species in the system consume similar prey types however orange roughy are the most frequently occurring species in the mid-slope assemblage (Francis et al. 2002). A model of the foodweb in Chatham Rise was developed (trophic level of orange roughy 5.1) providing information on species, biomass, energetics and diets but uncertainties exist due to lacking some data for each group (Pinkerton 2013). The model indicated mesopelagic groups provided most of the food (82-99%) to demersal fishes and air-breathing predators. Orange roughy ranked 18-19th out of 32 in trophic importance, a measure of the importance of a group on the structure and function of the ecosystem. An end-to-end ecosystem model of Chatham Rise was also developed to include oceanography, nutrient data, species groups and fishing effects (McGregor et al. 2019). In this model, orange roughy was one of the top four groups (along with hoki, small pelagic fishes and spiny dogfish) for keystone-ness, having a high effect on the rest of the system. It has been demonstrated that trawls in the orange roughy fishery can reduce biogenic habitat diversity (Clark et al. 2010)(Clark et al. 2019), however, little is known about the effects of benthic disturbance as related to ecosystem food webs and nutrient cycling. The fishery has some spatial management (see Criterion 4.2 for details) in place to protect ecosystem functioning and account for capture species' ecological role and detrimental food web impacts are not likely. As measures are in place but it is uncertain if the level of spatial management is adequate to effectively preserve ecosystem dynamics, ecosystem based fisheries management is rated a low concern.

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*Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.*

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## **Appendix A: Extra By Catch Species**

### **SMOOTH OREO DORY**

#### **Factor 2.1 - Abundance**

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

##### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

#### **Moderate Concern**

The OEO1 and OEO3A Southland smooth oreo stocks are unlikely (<40%) to be at or above target levels while it is about as likely as not (40-60%) that the OEO3A and OEO4 stocks are at or above target levels (see figure below for map of management regions) (Fisheries New Zealand 2019a). It is unlikely (<40%) that OEO1, OEO3A Southland and OEO3A stocks are below the soft limit and very unlikely (<10%) that they are below the hard limit. It is very unlikely (<10%) that the OEO4 stock is below the soft limit and exceptionally unlikely (<1%) that it is below the hard limit. Stock status of smooth oreo in OEO6 is unknown. As biomass for smooth oreos is above limit reference points but may be below target reference points abundance is rated a moderate concern.

#### **Justification:**

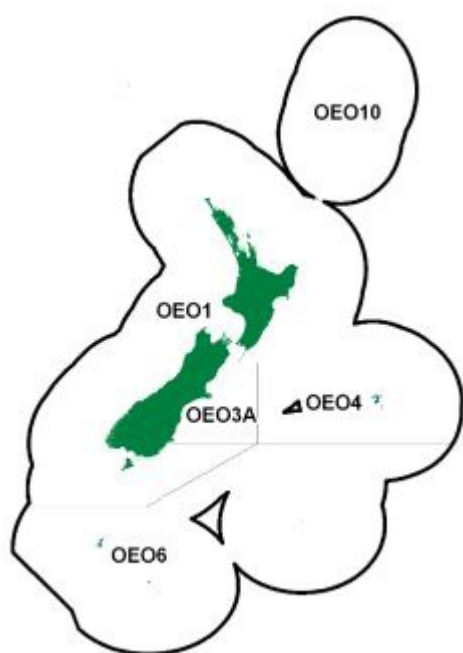


Figure 16 Map of oreo (OEO) management regions (Fisheries New Zealand 2019a).

## Factor 2.2 - Fishing Mortality

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

### NEW ZEALAND/SOUTHWEST PACIFIC

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

### Low Concern

It is likely (>60%) that overfishing is occurring for the OEO1 & OEO3A Southland smooth oreo stocks and unlikely (<40%) that overfishing is occurring for the OEO3A and OEO4 smooth oreo stocks (Fisheries New Zealand 2019a). In an observational study of the orange roughy fisheries over a 14 year time series (38% observer coverage, 2001-02 through 2014-15), smooth oreo comprised 7% of the catch (Anderson et al. 2017). Based on limited data, 2.4-9% the total smooth oreo catch is attributed to the orange roughy fishery

(data from 2006/07 and 2007/08 (MPI 2010)(Fisheries New Zealand 2012)). As the orange roughy fisheries are not a substantial contributor, fishing mortality is rated a low concern.

### Factor 2.3 - Discard Rate

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

#### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

#### **< 100%**

Annual discards/landings ratio ranged from 0.02 to 0.13 (from 2001-2002 to 2014-15) with an overall value of 0.07 and a decreasing trend in recent years (Anderson et al. 2017). The majority of orange roughy and QMS species are retained. The main species discarded in recent years are rattails and shovelnose spiny dogfish (0.7%, 0.6% of catch respectively) at a rate of 50% or more.

### SEABIRDS

### Factor 2.1 - Abundance

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

**High Concern**

There are over 80 species of seabirds that breed in New Zealand, several of which are reported as occasional bycatch in the orange roughy fisheries (Abraham & Thompson 2015). As some of these species such as Salvin's albatross (*Thalassarche salvinii*), the white-chinned petrel (*Procellaria aequinoctialis*) and the southern royal albatross (*Diomedea epomophora*) (all rated vulnerable (BirdLife International 2018a)(BirdLife International 2018b)(BirdLife International 2018c)) and the northern royal albatross (*Diomedea sanfordi*, rated endangered (BirdLife International 2018d)) are considered threatened or endangered, abundance is rated a high concern.

**Factor 2.2 - Fishing Mortality**

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

**NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

**Low Concern**

There were 43 observed captures of seabirds in orange roughy fisheries between 2002-2003 through 2017-18 (Abraham & Thompson 2015) (see figure on seabird interactions and percent observer coverage which ranged from 11.6-43.9% below). There were twelve interactions with vulnerable and endangered species (see table in Justification section below), from which the mortality rates ranged from 50-100%. As there is no assessment of the impacts of the orange roughy fisheries on seabird populations, and it is unknown whether the fishery is a substantial contributor to fishing mortality, the Unknown Bycatch Matrix was used to score fishing mortality. Fishing mortality is rated a low concern (UBM score = 5).

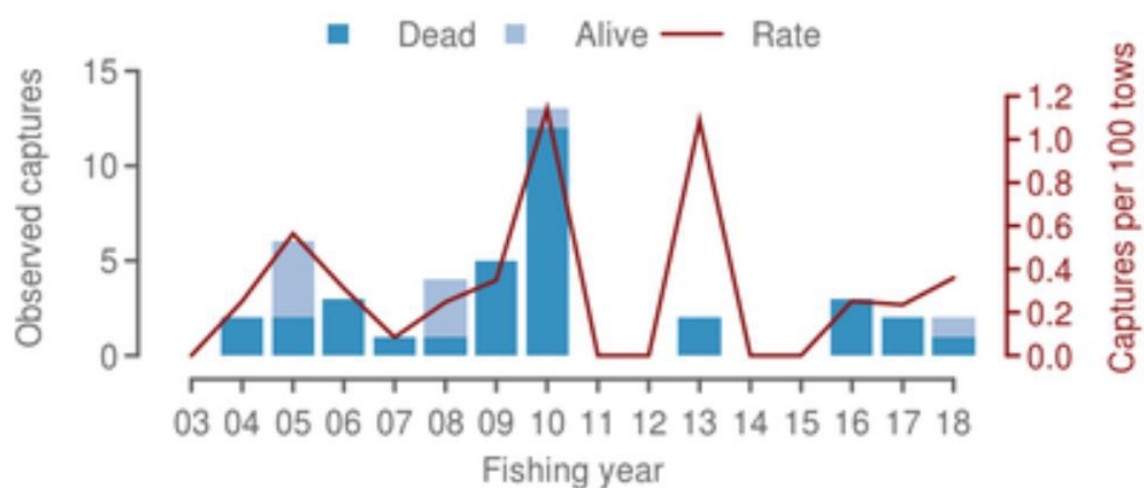
**Justification:**

Table below summarizes recorded seabird interactions with orange roughy fisheries from 2002/2003-2017/18 for vulnerable and endangered species (data from (Abraham & Thompson 2015)). Ranges in percent mortality are due to individuals recorded whose status (dead or alive) was recorded as unknown.

Seabird Species	Status	# of Interactions	% Mortality
Salvin's albatross ( <i>Thalassarche salvinii</i> )	Vulnerable	8	87.5-100%
white-chinned petrel ( <i>Procellaria aequinoctialis</i> )	Vulnerable	2	50-100%
southern royal albatross ( <i>Diomedea epomophora</i> )	Vulnerable	1	100%
northern royal albatross ( <i>Diomedea sanfordi</i> )	Endangered	1	100%



## Observed captures of all birds in orange roughy trawl fisheries



## Fishing effort and observations in orange roughy trawl fisheries

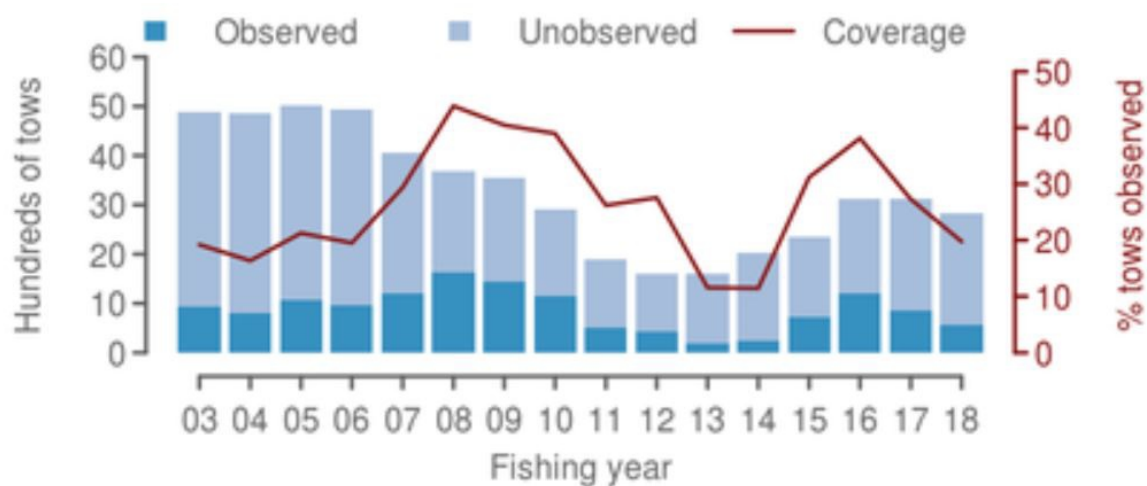


Figure 17 Observed seabird interactions with orange roughy fisheries from 2002/03-2017/18 and percent observer coverage (Abraham & Thompson 2015).

## Factor 2.3 - Discard Rate

### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Mercury-Colville

### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH1 Northern North Island | ORH1 Northern North Island

### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A North - East Cape | ORH2A North - East Cape

### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH2A South, ORH2B, ORH3A - Mid East Coast | ORH2A South, ORH2B, ORH3A - Mid East Coast

### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B East And South Chatham Rise | ORH3B East And South Chatham Rise

### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Northwest Chatham Rise | ORH3B Northwest Chatham Rise

### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Other | ORH3B Other

### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH3B Puysegur | ORH3B Puysegur

### **NEW ZEALAND/SOUTHWEST PACIFIC**

Bottom Trawls | New Zealand | ORH7A Challenger Plateau | ORH7A Challenger Plateau

### **< 100%**

Annual discards/landings ratio ranged from 0.02 to 0.13 (from 2001-2002 to 2014-15) with an overall value of 0.07 and a decreasing trend in recent years (Anderson et al. 2017). The majority of orange roughy and QMS species are retained. The main species discarded in recent years are rattails and shovelnose spiny dogfish (0.7%, 0.6% of catch respectively) at a rate of 50% or more.