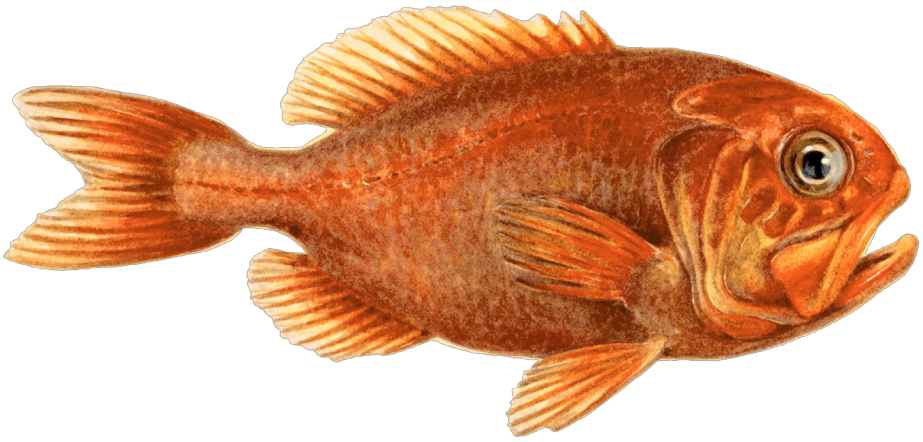
Monterey Bay Aquarium
Seafood Watch

Environmental sustainability assessment of wild-caught orange roughy (*Hoplostethus atlanticus*) from New Zealand caught using bottom trawls



Species: Orange roughy (*Hoplostethus atlanticus*)

Location: New Zealand: Southwest Pacific
Gear: Bottom trawls
Type: Wild Caught
Author: Seafood Watch
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Assessed using Seafood Watch Fisheries Standard v3

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About the Monterey Bay Aquarium Seafood Watch Program

The mission of the Monterey Bay Aquarium is to inspire conservation of the ocean and enable a future where the ocean flourishes and people thrive in a just and equitable world. To do this, the Aquarium is focused on creating extraordinary experiences that inspire awe and wonder, championing science-based solutions, and connecting people across the planet to protect and restore the ocean. We know that healthy ocean ecosystems are critical to enabling life on Earth to exist, and that our very survival depends on them. As such, our conservation objectives are to mobilize climate action, improve the sustainability of global fisheries and aquaculture, reduce sources of plastic pollution, and restore and protect ocean wildlife and ecosystems.

The aquarium is focused on improving the sustainability of fisheries and aquaculture given the role seafood plays in providing essential nutrition for 3 billion people globally, and in supporting hundreds of millions of livelihoods. Approximately 180 million metric tons of wild and farmed seafood is harvested each year (excluding seaweeds). Unfortunately, not all current harvest practices are sustainable and poorly managed fisheries and aquaculture pose the greatest immediate threat to the health of the ocean and the economic survival and food security of billions of people.

The Seafood Watch program was started 25 years ago as a small exhibit in the Monterey Bay Aquarium highlighting better fishing practices and grew into one of the leading sources of information on seafood sustainability, harnessing the power of consumer choice to mobilize change. The program's comprehensive open-source information and public outreach raises awareness about global sustainability issues, identifies areas for improvement, recognizes and rewards best practices and empowers individuals and businesses to make informed decisions when purchasing seafood.

We define sustainable seafood as seafood from sources, whether fished or farmed, that can maintain or increase production without jeopardizing the structure and function of affected ecosystems, minimize harmful environmental impacts, assure good and fair working conditions, and support livelihoods and economic benefits throughout the entire supply chain. As one aspect of this vision, Seafood Watch has developed trusted, rigorous standards for assessing the environmental impacts of fishing and aquaculture practices worldwide. Built on a solid foundation of science and collaboration, our standards reflect our guiding principles for defining environmental sustainability in seafood.

Seafood Watch Ratings

The Seafood Watch Standard for Fisheries is used to produce assessments for wild-capture fisheries resulting in a Seafood Watch rating of green, yellow, or red. Seafood Watch uses the assessment criteria to determine a final numerical score as well as numerical subscores and colors for each criterion. These scores are translated to a final Seafood Watch color rating according to the methodology described in the table below. The table also describes how Seafood Watch defines each of these categories. The narrative descriptions of each Seafood Watch rating, and the guiding principles listed below, compose the framework on which the criteria are based.

Green	Final Score >3.2, and either criterion 1 or criterion 3 (or both) is green, and no red criteria, and no critical scores	Wild-caught and farm-raised seafood rated green are environmentally sustainable, well managed and caught or farmed in ways that cause little or no harm to habitats or other wildlife. These operations align with all of our guiding principles.
Yellow	Final score >2.2, and no more than one red criterion, and no critical scores, and does not meet the criteria for green (above)	Wild-caught and farm-raised seafood rated yellow cannot be considered fully environmentally sustainable at this time. They align with most of our guiding principles, but there is either one conservation concern needing substantial improvement, or there is significant uncertainty associated with the impacts of the fishery or aquaculture operations.
Red	Final Score ≤2.2, or two or more red criteria, or one or more critical scores.	Wild-caught and farm-raised seafood rated red are caught or farmed in ways that have a high risk of causing significant harm to the environment. They do not align with our guiding principles and are considered environmentally unsustainable due to either a critical conservation concern, or multiple areas where improvement is needed.

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Guiding Principles

Monterey Bay Aquarium defines sustainable seafood as seafood from sources, whether fished or farmed, that can maintain or increase production without jeopardizing the structure and function of affected ecosystems, minimize harmful environmental impacts, assure good and fair working conditions, and support livelihoods and economic benefits throughout the entire supply chain.

As one aspect of this vision, Seafood Watch has developed trusted, rigorous standards for assessing the environmental impacts of fishing and aquaculture practices worldwide. Environmentally sustainable wild capture fisheries:

1. **Follow the principles of ecosystem-based fisheries management**

   The fishery is managed to ensure the integrity of the entire ecosystem, rather than solely focusing on maintenance of single species stock productivity. To the extent allowed by the current state of the science, ecological interactions affected by the fishery are understood and protected, and the structure and function of the ecosystem is maintained.

2. **Ensure all affected stocks[1] are healthy and abundant**

   Abundance, size, sex, age and genetic structure of the main species affected by the fishery (not limited to target species) is maintained at levels that do not impair recruitment or long-term productivity of the stocks or fulfillment of their role in the ecosystem and food web.

   Abundance of the main species affected by the fishery should be at, above, or fluctuating around levels that allow for the long-term production of maximum sustainable yield. Higher abundances are necessary in the case of forage species, in order to allow the species to fulfill its ecological role.

3. **Fish all affected stocks at sustainable levels**

   Fishing mortality for the main species affected by the fishery should be appropriate given current abundance and inherent resilience to fishing while accounting for scientific uncertainty, management uncertainty, and non-fishery impacts such as habitat degradation.

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[1]"Affected" stocks include all stocks affected by the fishery, no matter whether target or bycatch, or whether they are ultimately retained or discarded.

The cumulative fishing mortality experienced by affected species must be at or below the level that produces maximum sustainable yield for single-species fisheries on typical species that are at target levels.

Fishing mortality may need to be lower than the level that produces maximum sustainable yield in certain cases such as forage species, multispecies fisheries, highly vulnerable species, or fisheries with high uncertainty.

For species that are depleted below target levels, fishing mortality must be at or below a level that allows the species to recover to its target abundance.

4. **Minimize bycatch**

   Seafood Watch defines bycatch as all fisheries-related mortality or injury other than the retained catch. Examples include discards, endangered or threatened species catch, pre-catch mortality and ghost fishing. All discards, including those released alive, are considered bycatch unless there is valid scientific evidence of high post-release survival and there is no documented evidence of negative impacts at the population level.

   The fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss and by efficiently using marine and freshwater resources as bait.

5. **Have no more than a negligible impact on any threatened, endangered or protected species**

   The fishery avoids catch of any threatened, endangered or protected (ETP) species. If any ETP species are inadvertently caught, the fishery ensures and can demonstrate that it has no more than a negligible impact on these populations.

6. **Are managed to sustain the long-term productivity of all affected species**

   Management should be appropriate for the inherent resilience of affected marine and freshwater life and should incorporate data sufficient to assess the affected species and manage fishing mortality to ensure little risk of depletion. Measures should be implemented and enforced to ensure that fishery mortality does not threaten the long term productivity or ecological role of any species in the future.

   The management strategy has a high chance of preventing declines in stock productivity by taking into account the level of uncertainty, other impacts on the stock, and the potential for increased pressure in the future.

   The management strategy effectively prevents negative population impacts on bycatch species, particularly species of concern.

7. **Avoid negative impacts on the structure, function or associated biota of aquatic habitats where fishing occurs**

The fishery does not adversely affect the physical structure of the seafloor or associated biological communities.

If high-impact gears (e.g. trawls, dredges) are used, vulnerable seafloor habitats (e.g. corals, seamounts) are not fished, and potential damage to the seafloor is mitigated through substantial spatial protection, gear modifications and/or other highly effective methods.

8. **Maintain the trophic role of all aquatic life**

   All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web, as informed by the best available science.

9. **Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts**

   Fishing activities must not result in harmful changes such as depletion of dependent predators, trophic cascades, or phase shifts.

   This may require fishing certain species (e.g., forage species) well below maximum sustainable yield and maintaining populations of these species well above the biomass that produces maximum sustainable yield.

10. **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**

    Any enhancement activities are conducted at levels that do not negatively affect wild stocks by reducing diversity, abundance or genetic integrity.

    Management of fisheries targeting enhanced stocks ensures that there are no negative impacts on the wild stocks, in line with the guiding principles described above, as a result of the fisheries.

    Enhancement activities do not negatively affect the ecosystem through density dependent competition or any other means, as informed by the best available science.

Final Ratings

Ratings Details	C 1 Target Species	C 2 Other Species	C 3 Management	C 4 Habitat	Rating
Orange roughy New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH1 Northern North Island	1.732	1.000	3.000	0.000	Red (0.000)
Orange roughy New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH2A north - East Cape	1.732	1.000	3.000	0.000	Red (0.000)
Orange roughy New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast	3.413	1.000	3.000	0.000	Red (0.000)
Orange roughy New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B East and South Chatham Rise	1.732	1.000	3.000	0.000	Red (0.000)
Orange roughy New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Northwest Chatham Rise	3.413	1.000	4.000	0.000	Red (0.000)
Orange roughy New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Other	1.732	1.000	3.000	0.000	Red (0.000)
Orange roughy New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Puysegur	4.284	1.000	4.000	0.000	Red (0.000)
Orange roughy New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH7A Challenger Plateau	3.318	1.000	4.000	0.000	Red (0.000)
Orange roughy New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH1 Mercury-Colville	1.732	1.000	3.000	0.000	Red (0.000)

Summary

This report provides recommendations for orange roughy (*Hoplostethus atlanticus*) caught by bottom trawl in the New Zealand EEZ in the southwestern Pacific Ocean. Recommendations are provided for each of the following management areas and stocks: ORH1 Northern North Island; ORH1 Mercury-Colville; ORH2A North—East Cape; ORH2A South, ORH2B, and ORH3A Mid-East Coast; ORH3B East and South Chatham Rise; ORH3B Northwest Chatham Rise; ORH3B Other; ORH3B Puysegur; and ORH7A Challenger Plateau.

The impact on the species is a high concern for the areas ORH1 Mercury-Colville, ORH1 Northern North Island, ORH3B East and South Chatham Rise, and ORH3B Other because of uncertainty in abundance and a lack of reference points for fishing mortality. Abundance in ORH3B East and South Chatham Rise is considered a high concern because the 2020 stock assessment was rejected for model concerns; therefore, the stock status and fishing mortality (moderately effective) are considered unknown. There is also a high concern for the Mid-East Coast stock (areas ORH2A South, ORH2B, and ORH3A) because it is deemed by the management body as overfished, with overfishing not occurring. For the East Cape stock (ORH2A North), there is a moderate concern as a result of the outdated stock assessment, uncertain stock status, and lack of limit reference points. There is a low concern of impact on the species for the areas Northwest Chatham ORH3B Rise, ORH7A Challenger Plateau, and ORH3B Puysegur, which are above the target reference points for biomass and below the limit reference points for fishing mortality.

Discards are low in the orange roughy fishery, with 96% of the catch comprising orange roughy and other quota management system (QMS) species. All vertebrate/invertebrate species or groups of bycatch composed less than 5% of the catch; however, slow-growing, long-lived corals are the species of greatest concern caught in the orange roughy fishery, because of their high vulnerability, and are considered a main species.

Management is considered moderately effective in the ORH1 Northern North Island, ORH1 Mercury-Colville, ORH3B East and South Chatham Rise, ORH3B Other, ORH2A North—East Cape, and ORH2A South, ORH2B, and ORH3A Mid-East Coast fisheries, where the stock is overfished. Measures are in place (including annual catch limits) to protect the species' sustainability, but with some uncertainty. Management is considered highly effective in the ORH3B Northwest Chatham Rise, ORH7A Challenger Plateau, and ORH3B Puysegur fisheries, with recent stock assessments based on biomass estimates utilizing acoustic monitoring data. Logbook requirements, vessel monitoring systems (VMS), 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 that comprises industry stakeholders.

Impacts on the habitat and ecosystem are considered a high concern. The orange roughy fishery uses trawl gear that is known to reduce biogenic habitat, and though 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.

Introduction

Scope of the analysis and ensuing rating

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

Table 1

Management Area	**Stock**
Northern North Island (ORH1)	Mercury-Colville
Northern North Island (ORH1)	Other
Cape Runaway to Banks Peninsula (ORH2A, 2B, & 3A)	East Cape (2A North)
Cape Runaway to Banks Peninsula (ORH2A, 2B, & 3A)	Mid-East Coast (2A South, 2B, 3A)
Chatham Rise and Puysegur (ORH3B)	Northwest Chatham Rise
Chatham Rise and Puysegur (ORH3B)	East and South Chatham Rise
Chatham Rise and Puysegur (ORH3B)	Puysegur
Chatham Rise and Puysegur (ORH3B)	Other
Challenger Plateau (ORH7A)	Challenger Plateau

Species Overview

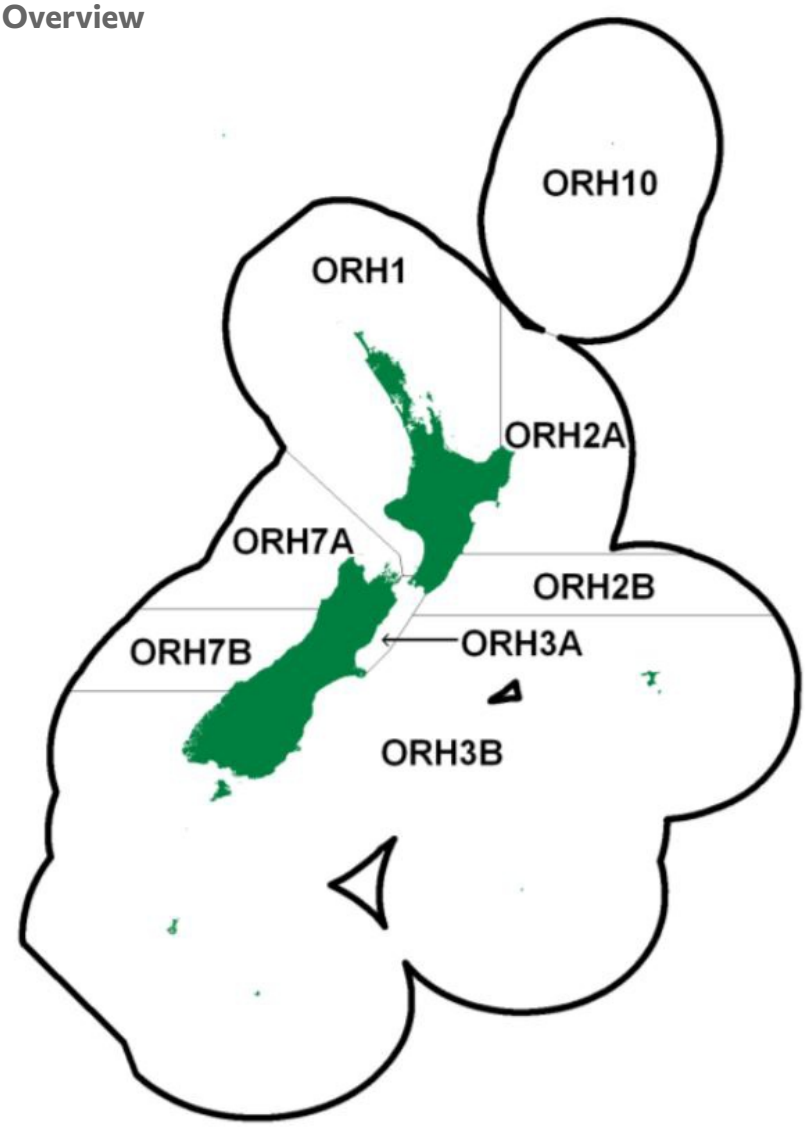

Figure 1: Orange roughy management areas in New Zealand (Fisheries New Zealand 2019a).

Orange roughy is distributed in temperate waters in the Western Atlantic Ocean (off northern Nova Scotia), Eastern Atlantic (Iceland to Morocco, Walvis Bay, Namibia to off Durban, South Africa), Indo-Pacific Ocean (south-central Indian Ocean and New Zealand), and Eastern Pacific Ocean (Chile) (Froese & Pauly 2019). It inhabits deep waters (range of 700 to 1,500 m; typically 800 to 1,497 m in the New Zealand EEZ) over rocky continental slopes, ridges, and seamounts (Fisheries New Zealand 2019a; Dunn et al. 2009). Orange roughy is long-lived (> 100 yr), slow growing, and late to mature (> 20 yr; 50% maturity is estimated at 32–41 yr), so it is vulnerable to overfishing {Andrews et al. 2009; Branch 2011; Cordue 2014). It is a broadcast spawner that forms large spawning aggregations in the winter (June/July), with relatively low fecundity (40,000 to 60,000 eggs) (MPI 2024c). Orange roughy also forms 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 1990s 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 (signed off by the Minister of Fisheries) for managing New Zealand's deepwater fisheries. In addition, there are high seas fisheries for orange roughy in the southeast Atlantic Ocean, Indian Ocean, and southwest Pacific Ocean.

Production Statistics

Global production of orange roughy rose to a peak of over 90,000 kg (90 MT) in 1990 then fell steadily, partly because of the implementation of catch quotas, and has remained consistently below 12,500 kg (12.5 MT) since 2010 (Figure 2) (FAO 2024). New Zealand is the largest global producer, with 10 distinct orange roughy stock management units (though some are temporarily closed to fishing). In the 2023 fishing year (12-month period to 9/30/2023), the majority of landings in New Zealand were from the areas ORH3B East and South Chatham Rise (71.1%) and ORH7A Challenger Plateau (8.61%) (Figure 3).

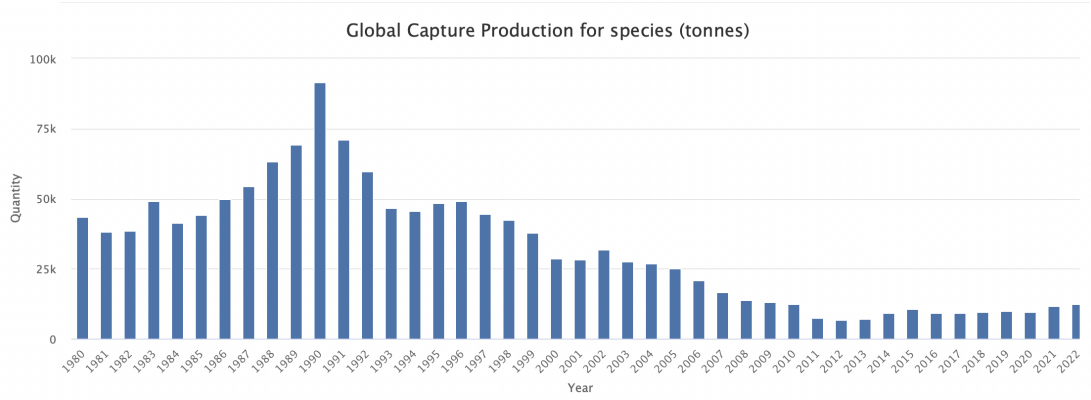

Figure 2: Global orange roughy production in kg from 1980 to 2022. Data source: (FAO 2024).

Fishstock Code	Management Area	Reported Commercial Catch (kg)	TACC (kg)
ORH3B	Orange Roughy South East (Chatham Rise)	6,763,590	7,967,000
ORH7A	Orange Roughy Challenger (North)	1,770,938	2,058,000
ORH2A	Orange Roughy Central (Gisbourne)	495,447	488,000
ORH1	Orange Roughy Auckland (East)	331,596	1,400,000
ORH3A	Orange Roughy Southeast (Cook Strait/Kaikura)	85,270	177,000
ORH2B	Orange Roughy (Waiararpa)	60,634	60,000
ORH7B	Orange Roughy Challenger (South)	301	1,000
ORHSTR	Orange Roughy South Tasman Rise	-	-

Figure 3: Orange roughy catch by New Zealand management area for the 2023 fishing year (12-month period to 9/30/2023) (FNZ 2024a).

Importance to the US/North American market

Global imports of frozen orange roughy fillets in the United States reached a peak in 1997 at ≈13 million kg (≈13,000 MT), but have steadily declined and remained between 1.4 million and 2.1 million kg (1,400 and 2,100 MT) since 2011 (Figure 4) (NMFS 2024). In 2023, New Zealand was the primary source of orange roughy imports in the United States (95%; 1,274,229 kg, 1,274.2 MT), followed by Vietnam (3%; 38,120 kg, 38.1 MT) and Australia (2%; 33,340 kg, 33.3 MT) (Figure 5) (NMFS 2024). Imports from Vietnam are likely re-exports from New Zealand.

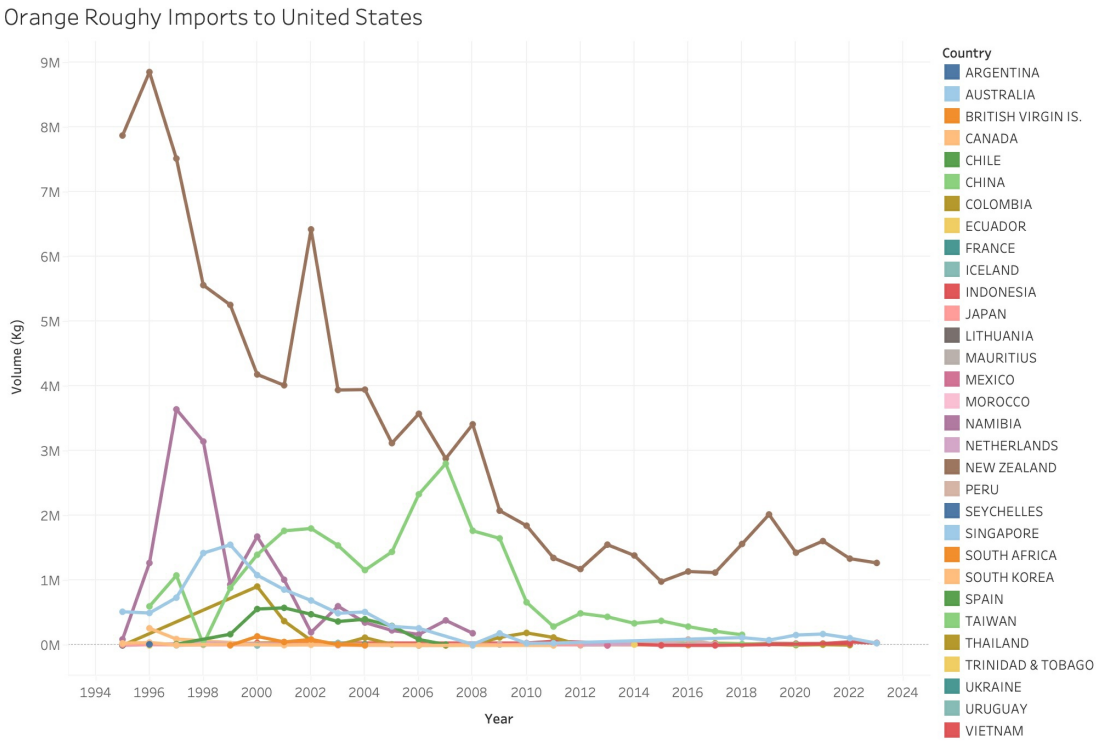

Figure 4: Orange roughy imports to the United States, 1995–2023, by country. Data source: (NMFS 2024).

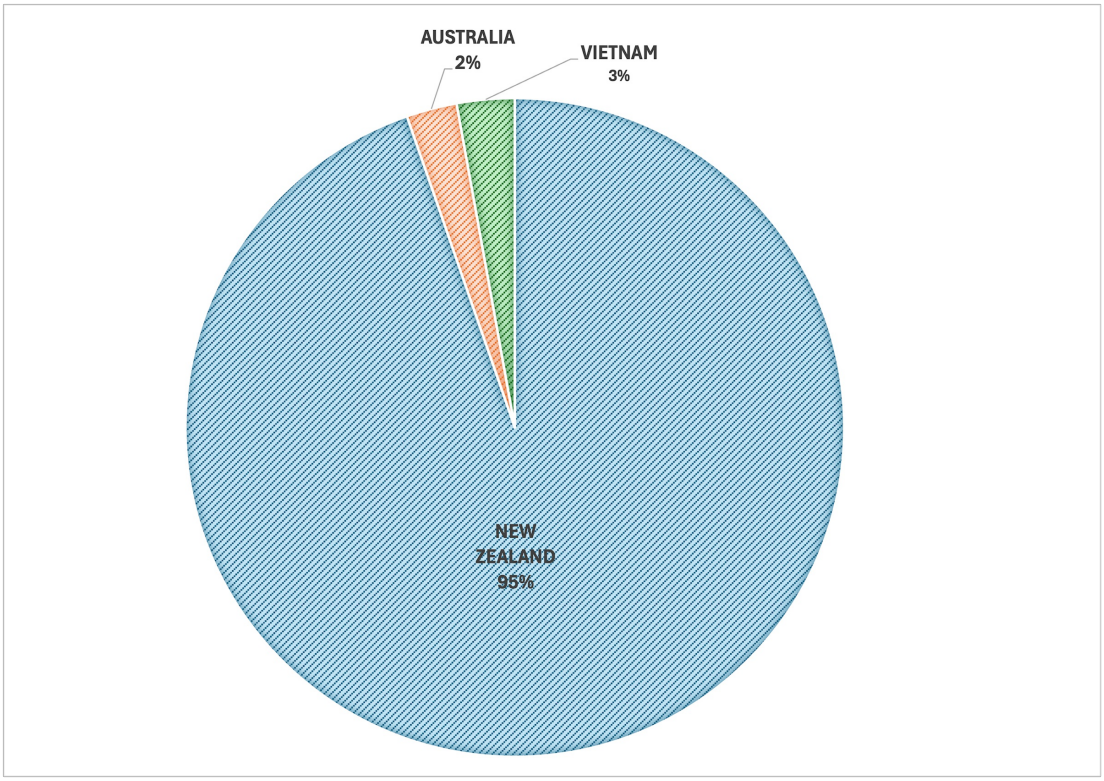

Figure 5: Orange roughy imports to the United States in the form of frozen fillets in 2023. Data source: (NMFS 2024).

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): whole fish, fillets (skinless/boneless); and value-added: blocks, breaded (Seafood Source 2014; MSC 2021).

Summary

Orange roughy fisheries in New Zealand are rated red in all regions because of concerns regarding the 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 and ORH7A are certified as sustainable against the Marine Stewardship Council standards for sustainable seafood, representing about 35% of landings of New Zealand's orange roughy fisheries (MSC 2023).

Assessments

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at 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 ≤3.2 = **Yellow** or Moderate Concern
- Score ≤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**
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH1 Northern North Island	1.000 High Concern	3.000 Moderate Concern	**Red (1.732)**
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH2A north - East Cape	1.000 High Concern	3.000 Moderate Concern	**Red (1.732)**
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast	2.330 Moderate Concern	5.000 Low Concern	**Green (3.413)**
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B East and South Chatham Rise	1.000 High Concern	3.000 Moderate Concern	**Red (1.732)**
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Northwest Chatham Rise	2.330 Moderate Concern	5.000 Low Concern	**Green (3.413)**
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Other	1.000 High Concern	3.000 Moderate Concern	**Red (1.732)**
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Puysegur	3.670 Low Concern	5.000 Low Concern	**Green (4.284)**
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH7A Challenger Plateau	3.670 Low Concern	3.000 Moderate Concern	**Green (3.318)**
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH1 Mercury-Colville	1.000 High Concern	3.000 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 *(Hoplostethus atlanticus)*

1.1 Abundance

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH1 Northern North Island

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Other

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH1 Mercury-Colville

High Concern

There are no stock assessments for the ORH1 stocks (Northern North Island and Mercury-Colville) except the small area of the Mercury-Colville box, which has an outdated assessment (2001). In addition, there is no stock assessment for the ORH3B Other management area. Therefore, no biomass estimates are available. Because biomass relative to reference points is unknown and the species is highly vulnerable (PSA = 3.54; Tables 2–3), stock status is considered a "high concern."

Supplementary Information

The amount of fishing in some areas of ORH1 appears to be low, but without any indication of current abundance, there is no way to determine if this level of fishing is sustainable or if current feature limits will avoid overexploitation of localized areas (MPI 2024a).

Table 2

Productivity-Susceptibility Analysis: Orange Roughy, New Zealand trawl fisheries			
Productivity Attribute	**Value**	**Score (1 = low risk; 2 = medium risk; 3 = high risk)**	**Reference**
Average age at maturity (years)	36.5	3	(MPI 2024c)
Average maximum age (years)	120	3	(MPI 2024c)
Fecundity (eggs/yr)	50,000	1	(MPI 2024c)

Average maximum size (cm) (not to be used when scoring invertebrate species)	50	1	(MPI 2024c)
Average size at maturity (cm) (not to be used when scoring invertebrate species)	37	1	(MPI 2024c)
Reproductive strategy	Broadcast spawner	1	(MPI 2024c)
Trophic level	4.3	3	(Froese & Pauly 2019)
Density dependence (invertebrates only)	NA		
Quality of habitat	Moderately altered	2	(MPI 2024c)
Productivity Subscore		**1.88**	

Table 3

Susceptibility Attribute	**Information**	**Score (1 = low risk; 2 = medium risk; 3 = high risk)**	**Reference**
Areal overlap	default	3	
Vertical overlap	> 33% (most abundant in depth range 560–1,496 m, fishing depth most commonly 750–1,500 m)	3	(Dunn et al. 2009; MRAG 2016; FIsheries New Zealand 2019a}
Selectivity of fishery	fishing in aggregations	3	(MPI 2024c)
Post-capture mortality	default	3	
Susceptibility Subscore		**3**	
Productivity-Susceptibility Score		**3.54**	

Vulnerability Rating (high, medium or low)	**High**	

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH2A north - East Cape

High Concern

The most recent stock assessment for ORH2A is from 2003. Because the stock assessment is > 10 years old and orange roughy is considered highly vulnerable (PSA = 3.54; see Tables 4–5), abundance is considered a "high concern."

Supplementary Information

Table 4

Productivity-Susceptibility Analysis: Orange Roughy, New Zealand trawl fisheries			
Productivity Attribute	**Value**	**Score (1 = low risk; 2 = medium risk; 3 = high risk)**	**Reference**
Average age at maturity (years)	36.5	3	(MPI 2024c)
Average maximum age (years)	120	3	(MPI 2024c)
Fecundity (eggs/yr)	50,000	1	(MPI 2024c)
Average maximum size (cm) (not to be used when scoring invertebrate species)	50	1	(MPI 2024c)
Average size at maturity (cm) (not to be used when scoring invertebrate species)	37	1	(MPI 2024c)
Reproductive strategy	Broadcast spawner	1	(MPI 2024c)
Trophic level	4.3	3	(Froese & Pauly 2019)

Density dependence (invertebrates only)	NA		
Quality of habitat	Moderately altered	2	(MPI 2024c)
Productivity Subscore		**1.88**	

Table 5

Susceptibility Attribute	**Information**	**Score (1 = low risk; 2 = medium risk; 3 = high risk)**	**Reference**
Areal overlap	default	3	
Vertical overlap	> 33% (most abundant in depth range 560–1,496 m, fishing depth most commonly 750–1,500 m)	3	(Dunn et al. 2009; MRAG 2016; Fisheries New Zealand 2019a)
Selectivity of fishery	fishing in aggregations	3	(MPI 2024c)
Post-capture mortality	default	3	
Susceptibility Subscore		**3**	
Productivity-Susceptibility Score		**3.54**	
Vulnerability Rating (high, medium or low)		**High**	

An attempt to update the assessment with a new set of CPUE indices was made in 2006, but was rejected by the Working Group because of changes in the fishery, which invalidated the utility of the CPUE series as an index of abundance. With no other abundance estimates available, an updated stock assessment was not possible (MPI 2024). 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) (MPI 2024; MPI 2024c). 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 because it assumes deterministic recruitment, which may not be ecologically realistic.

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast

Moderate Concern

The most recent stock assessment for Mid-East Coast orange roughy (ORH2A South, ORH2B, ORH3A) was completed in 2022, using fisheries data to the end of the 2020–21 fishing year. The virgin spawning stock size (B_0) in the base case model run was estimated to be 53,350 MT (95% CI; 46,550–63,670 MT), and the stock status (B_{2022}/B_0) was estimated to be 22.4% (16.7–29.2%) (Dunn et al. 2022). Based on these estimates, current stock biomass is Very Unlikely (< 10%) to be at or above the lower end of the management target range. B_{2022} is About as Likely as Not (40–60%) to be below the Soft Limit, and Unlikely (< 40%) to be below the Hard Limit.

The stock is estimated to have been slowly and steadily rebuilding since 1994–95. At recent catch levels, the stock is expected to continue to slowly rebuild, with spawning stock biomass estimated to be greater than the lower bound of the target zone (30% B_0) with at least 70% probability by 2037 (ibid). Because the stock is above a limit reference point but below 75% of the target reference point, abundance is considered a “moderate concern.”

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B East and South Chatham Rise

High Concern

Research in 2023 raised some concerns about the results of the most recent stock assessment models of the Northwest Chatham Rise (2018) and East and South Chatham Rise (2020), which estimated both stocks to be in the target zone of 30–50% B_0 (MPI 2024c). The concerns stemmed from inconsistencies between the stock biomass and trends estimated by the models, and observational data such as local estimates of (unstandardized) CPUE and acoustic time series (ibid). MSC certification for ORH3B was self-suspended by the Deepwater Group because of these inconsistencies. The consensus of the Working Group was that the previously accepted assessment model for the (2020) East and South Chatham Rise can no longer be considered to accurately reflect stock status, and the Status of the Stocks table has been removed. Because the stock assessment for ORH3B was rejected, the stock status is considered unknown and the PSA (score of 3.54; Tables 6–7) is used. Thus, abundance is considered a “high concern.”

There has been insufficient time to develop a credible new assessment, so the current stock status is unable to be determined. There is a plan to undertake further research assessment to be completed by 2025, at which time the Status of the Stocks table will be updated (MPI 2024c).

Table 6

Productivity-Susceptibility Analysis: Orange Roughy, New Zealand trawl fisheries			
Productivity Attribute	**Value**	**Score (1 = low risk; 2 = medium risk; 3 = high risk)**	**Reference**
Average age at maturity (years)	36.5	3	(MPI 2024c)
Average maximum age (years)	120	3	(MPI 2024c)
Fecundity (eggs/yr)	50,000	1	(MPI 2024c)
Average maximum size (cm) (not to be used when scoring invertebrate species)	50	1	(MPI 2024c)
Average size at maturity (cm) (not to be used when scoring invertebrate species)	37	1	(MPI 2024c)
Reproductive strategy	Broadcast spawner	1	(MPI 2024c)
Trophic level	4.3	3	(Froese & Pauly 2019)
Density dependence (invertebrates only)	NA		
Quality of habitat	Moderately altered	2	(MPI 2024c)
Productivity Subscore		**1.88**	

Table 7

Susceptibility Attribute	Information	Score (1 = low risk; 2 = medium risk; 3 = high risk)	Reference
Areal overlap	Default	3	
Vertical overlap	> 33% (most abundant in depth range 560–1,496 m, fishing depth most commonly 750–1,500 m)	3	(Dunn et al. 2009; MRAG 2016; Fisheries New Zealand 2019a)
Selectivity of fishery	Fishing in aggregations	3	(MPI 2024c)
Post-capture mortality	Default	3	
Susceptibility Subscore		**3**	
Productivity-Susceptibility Score		**3.54**	
Vulnerability Rating (high, medium or low)		**High**	

A new assessment is being reviewed at the Plenary meeting in May 2025, which should inform stock status if it is accepted (Kevin Sullivan, March 2, 2025, pers comm).

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Northwest Chatham Rise

Moderate Concern

Work was undertaken during 2023 to produce a new stock assessment for ORH3B Northwest Chatham Rise, but the assessment could not be completed. New data considered included acoustic spawning biomass estimates and age frequencies from 2021 and 2022 (Dunn et al. 2022). Also, analyses to date provide reasons to consider the 2018 stock assessment to be more uncertain than originally thought (FNZ 2023c). But the most recent Northwest Chatham Rise stock assessment (2018) remains the best available information, with some qualifying statements.

The likelihoods of stock status were reevaluated: new status interpretations include that the substock is "unlikely to be below the soft and hard limits based on the 2022 acoustic survey results" (FNZ 2023c). Based on biomass estimates from the 2018 stock assessment, it is very likely (B_{2017} = 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 6 for estimated SSB trajectory) (Fisheries New Zealand 2019a). It is exceptionally unlikely (probability < 1%) that biomass is below the soft limit (overfished or depleted, 20% B_0) or the hard limit (collapsed, 10% B_0) (ibid). But the 2018 stock assessment relies on a single, dated age dataset from the 1990s (the same problematic age data flagged in 2023 for the ORH3B East and South Chatham Rise stock, and its biomass estimates were 40% higher than recent acoustic survey results {Dunn 2024}), prompting a reduction in confidence (FNZ 2023c). Therefore, continued reliance on this older, uncertain model may overstate stock health. Although the 2018 assessment provides the best available information, its reliance on an older model with known limitations lowers confidence in the stock status; therefore, abundance is considered a "moderate concern."

Supplementary Information

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 the lack of data availability in age composition (year class strength based on one year of data) and abundance indices (time series restricted to a period of lower stock status) (MPI 2024c).

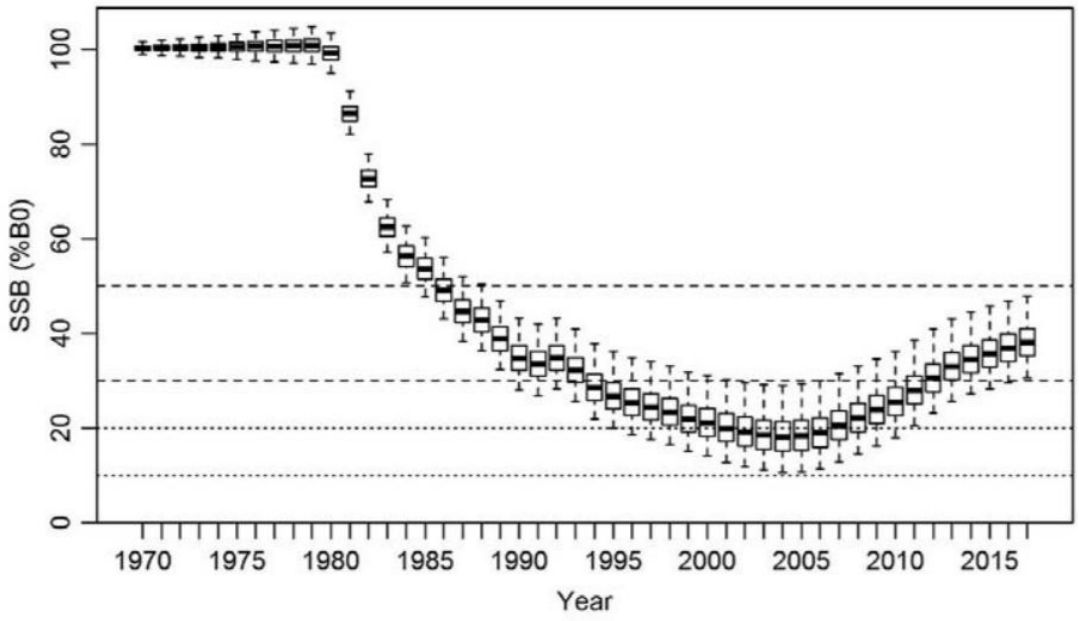

Figure 6: ORH3B Northwest Chatham Rise estimated (MCMC) SSB trajectory (MPI 2024c). The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution (ibid). Dotted lines indicate the hard limit (10% B_0) and soft limit (20% B_0), and dashed lines indicate the management target range (30–50% B_0) (ibid). There was a declining trend from when the fishery started in 1980 through 2004 when the biomass was About as Likely as Not (40–60%) to be below the soft limit (ibid). Biomass has increased steadily since 2005 (ibid).

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 Figure 7 for the estimated SSB trajectory) (Cordue 2019; MPI 2024c). 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%) that biomass is below the soft limit (overfished or depleted, 20% B_0) or the hard limit (collapsed, 10% B_0). Because a quantitative stock assessment reflects that biomass is above a target reference point, but with some uncertainty regarding the biomass estimate (see Justification), abundance is considered a “low concern.”

Supplementary Information

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 the 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).

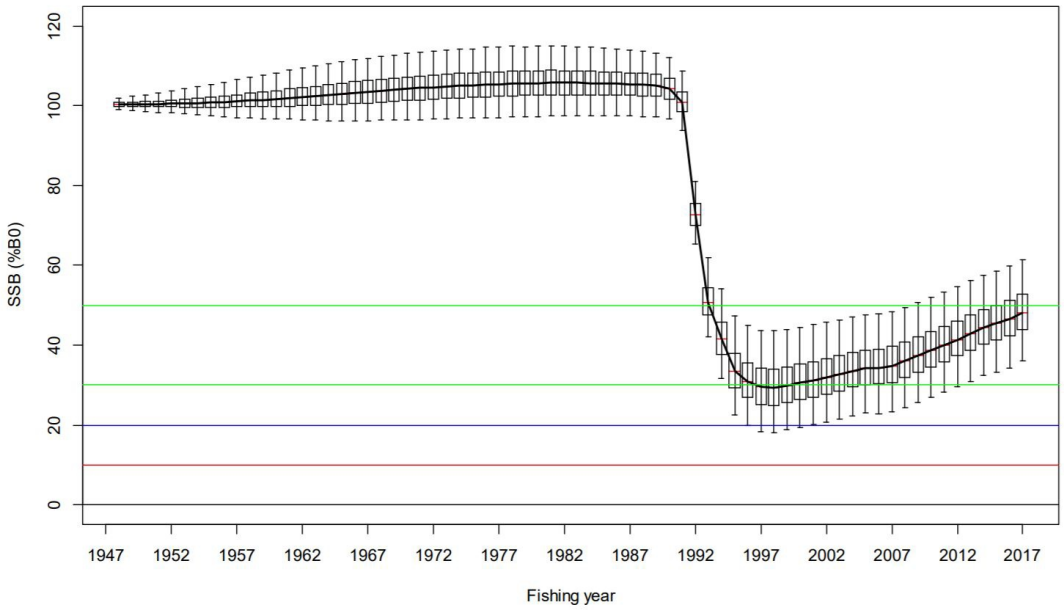

Figure 7: Estimated (MCMC) spawning-stock biomass trajectory for ORH3B Puysegur (MPI 2024c). The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution (ibid). The hard limit (red), soft limit (blue), and biomass target range (green) are marked by horizontal lines (ibid). From the beginning of the fishery in 1990, SSB declined until the fishery was closed in 1998 (ibid). SSB has increased steadily since the closure and has been within target for the past decade (ibid).

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH7A Challenger Plateau

Low Concern

Based on biomass estimates from the 2019 stock assessment, it is As Likely As Not (40–60%) that the orange roughy stock in the ORH7A Challenger Plateau management area is at or above the lower range of target levels (30–050% B_0) and Very Unlikely (< 10%) that the stock is at or above the upper end of the target range (see Figure 8 for the estimated SSB trajectory) (Cordue 2019a; MPI 2024c). It is Unlikely (probability < 40%) that biomass is below the soft limit (overfished or depleted, 20% B_0) and Very Unlikely (< 10%) that biomass is below the hard limit (collapsed, 10% B_0). Because a quantitative stock assessment reflects that biomass is above a target reference point, but with some uncertainty regarding the biomass estimate (see Justification), abundance is considered a "low concern."

Supplementary Information

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 (MPI 2024c).

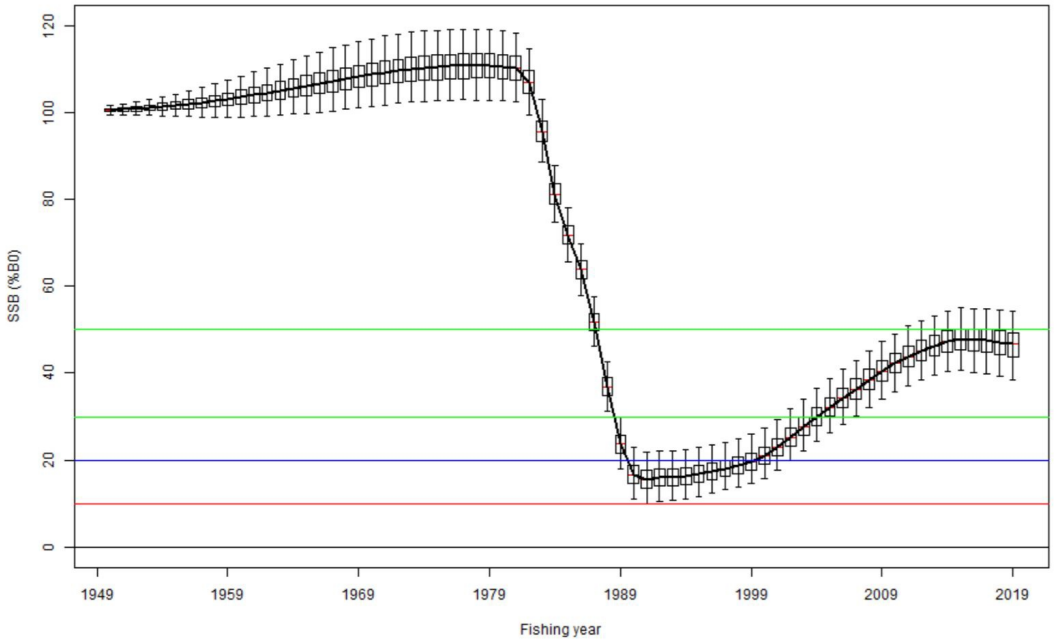

Figure 8: MCMC estimated spawning-stock status (SSB_{2024}/B_0) trajectory. The solid line shows the median, the darker shaded areas covers 50% of the distribution, and the lighter shaded areas 95% of the distribution. The hard limit 10% B_0 (dashed red), soft limit 20% B_0 (dotted orange), and biomass target range 30–50% B_0 (green) are marked by horizontal lines. The stock was fished down to 15% of B_0 after the fishery opened and remained there until the late 1990s (ibid). Biomass gradually increased from the late 1990s until peaking in 2015 and then leveling out in recent years (due to an increase in TACC) (ibid).

1.2 Fishing Mortality

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH1 Northern North Island

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Other

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: 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 a lack of reliable abundance indices. Efforts are ongoing to find an 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 30 MT in 2001 (MPI 2024c). The TACC for ORH1 Northern North Island has been set to 1,400 MT since 2000 and catch has not exceeded this limit. Because 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 (MPI 2024c). The Deepwater Working Group reviewed data on the 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 reference points is unknown, so it is considered a “moderate concern.”

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH2A north - East Cape

Moderate Concern

Because the ORH2A North—East Cape stock assessment is > 10 years old, there is no overfishing threshold established for the area. Therefore, fishing mortality relative to reference points is unknown and this factor is considered a “moderate concern.”

Supplementary Information

Because of the implementation of reduced catch limits in 2000, fishing mortality remains at ≈200 MT (Fisheries New Zealand 2019a).

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast

Low Concern

It is considered Very Unlikely (< 10% probability) that overfishing is occurring in management areas ORH2A South, ORH2B, and ORH3A (see Figure 9 for the estimated fishing-intensity trajectory) (MPI 2024). The overfishing threshold is considered to be a fishing intensity range from $U_{30\%}B_0$ to $U_{50\%}B_0$, and fishing intensity for 2022 was estimated to be 0.8% (37% of $U_{30\%}B_0$). Because overfishing is not occurring, fishing mortality is considered a “low concern.”

Supplementary Information

Historical Stock Status Trajectory and Current Status

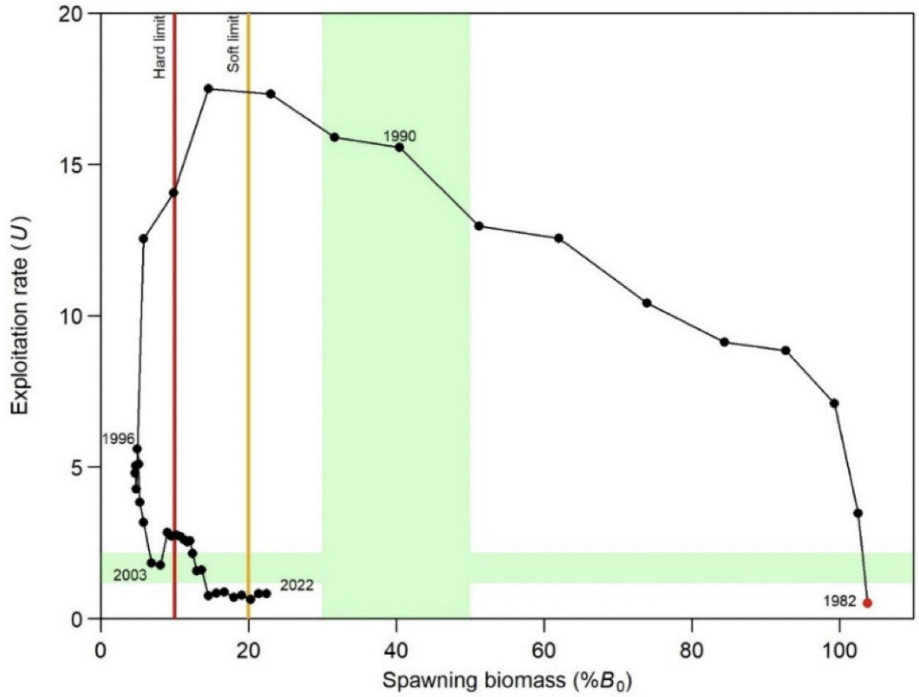

Figure 9: Historical trajectory over time of exploitation rate (U) and spawning biomass (% B_0) for the Mid-East Coast orange roughy base model, from the start of the fishery (represented by a red point) to 2022 (MPI 2024). The red vertical line at 10% B_0 represents the hard limit, the orange line at 20% B_0 is the soft limit, and green shaded areas are the % B_0 target (30–50% B_0) and the corresponding exploitation rate (U_{30} to U_{50}) (ibid). Biomass and exploitation rate estimates are medians from MCMC results (ibid).

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B East and South Chatham Rise

Moderate Concern

Because the 2023 stock assessment for ORH3B East and South Chatham Rise was rejected, the current stock status is unable to be determined and fishing mortality is considered unknown. Therefore, fishing mortality is considered a “moderate concern.”

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: 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 10 for the estimated

fishing-intensity trajectory) (MPI 2024c). The overfishing threshold is considered to be a fishing intensity range from $U_{30\%}B_0$ to $U_{50\%}B_0$, and exploitation rates have remained below the threshold since 2007. Because it is probable that fishing mortality from all sources is at or below a sustainable level, fishing mortality is considered a "low concern."

Supplementary Information

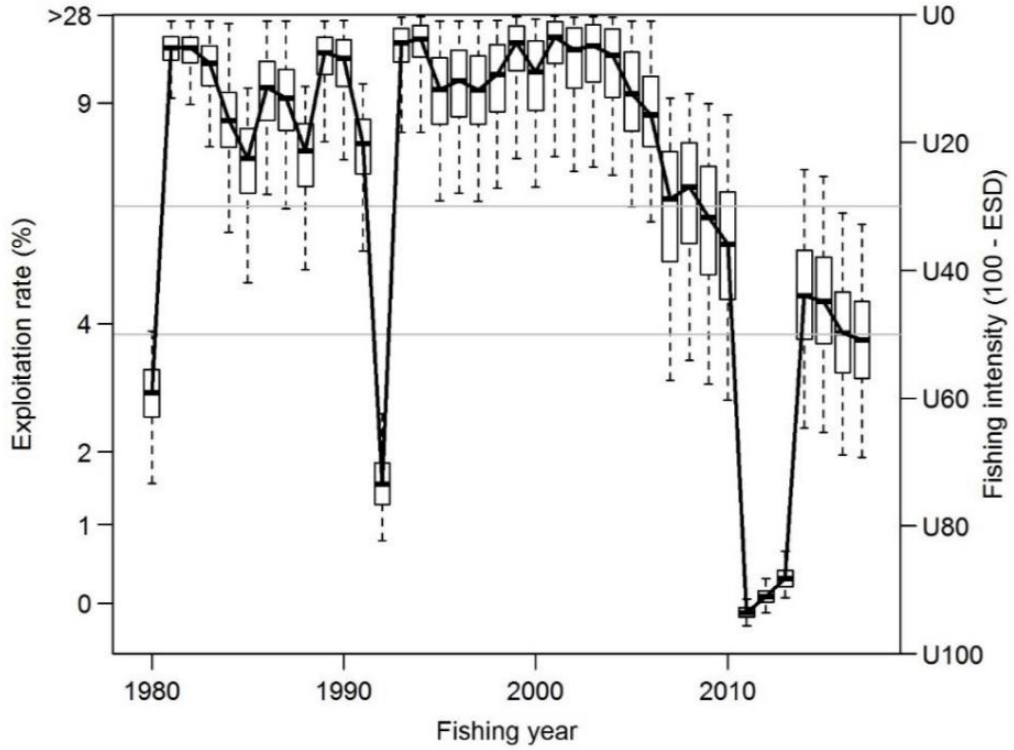

Figure 10: Estimated (MCMC) fishing-intensity trajectory for ORH3B Northwest Chatham Rise (MPI 2024c). The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution (ibid). The fishing-intensity range associated with the biomass target of 30–50% B_0 is marked by horizontal lines (ibid). Estimated fishing intensity was above $U_{20\%}B_0$ for most of the history of the fishery, in the target range from 2009 to 2010, and dropped substantially in 2011 (due to industry fishing curtailment) (ibid). Fishing intensity has been in or just below the target range since 2014 (ibid).

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Puysegur

Low Concern

Overfishing is considered to be Exceptionally Unlikely (< 1%) to be occurring in the ORH3B Puysegur management area (see Figure 11 for the estimated fishing intensity trajectory) (MPI 2024c). The overfishing threshold is considered to be a fishing intensity of $U_{30\%}B_0$. A commercial catch limit was set to 347 MT when the fishery was considered rebuilt and reopened (after a 19-year closure) in October 2017. Because it is probable that

fishing mortality from all sources is at or below a sustainable level, fishing mortality is considered a “low concern.”

Supplementary Information

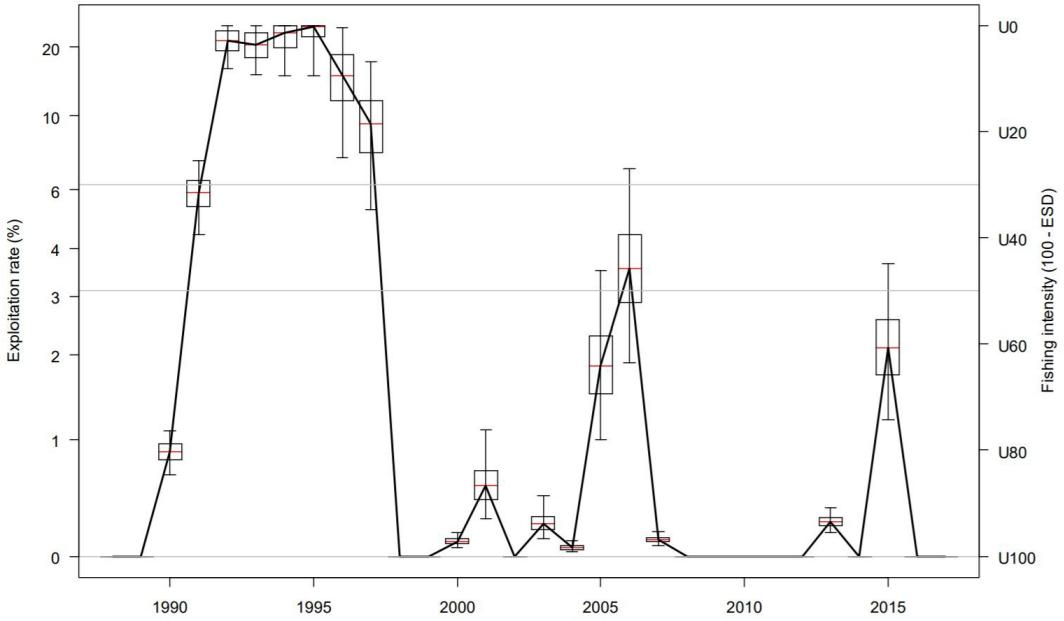

Figure 11: ORH3B Puysegur estimated (MCMC) fishing-intensity trajectory (MPI 2024c). The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution (ibid). The fishing-intensity range associated with the biomass target of 30–50% B_0 is marked by horizontal lines (ibid). The fishery was closed in 1998 and was briefly in the target range ($U_{30\%}B_0$ to $U_{50\%}B_0$) in 2006 when there was a combined acoustic and trawl survey, and the fishery reopened at the end of 2017 (ibid).

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH7A Challenger Plateau

Moderate Concern

Overfishing is considered to be Very Unlikely (< 10%) to be occurring in the ORH7A Challenger Plateau management area (see Figure 12 for the estimated fishing-intensity trajectory) (MPI 2024c). The overfishing threshold is considered to be a fishing intensity range from $U_{30\%}B_0$ to $U_{50\%}B_0$, and exploitation rates have remained near the bottom of the target range since 2014–15; however, the most recent estimate of fishing mortality is from the 2024 stock assessment, whereas the base model used only includes data up to 2013. Because the data used in this estimate are > 10 years old, Seafood Watch deems fishing mortality relative to a sustainable level to be unknown, so a “moderate concern” score is given.

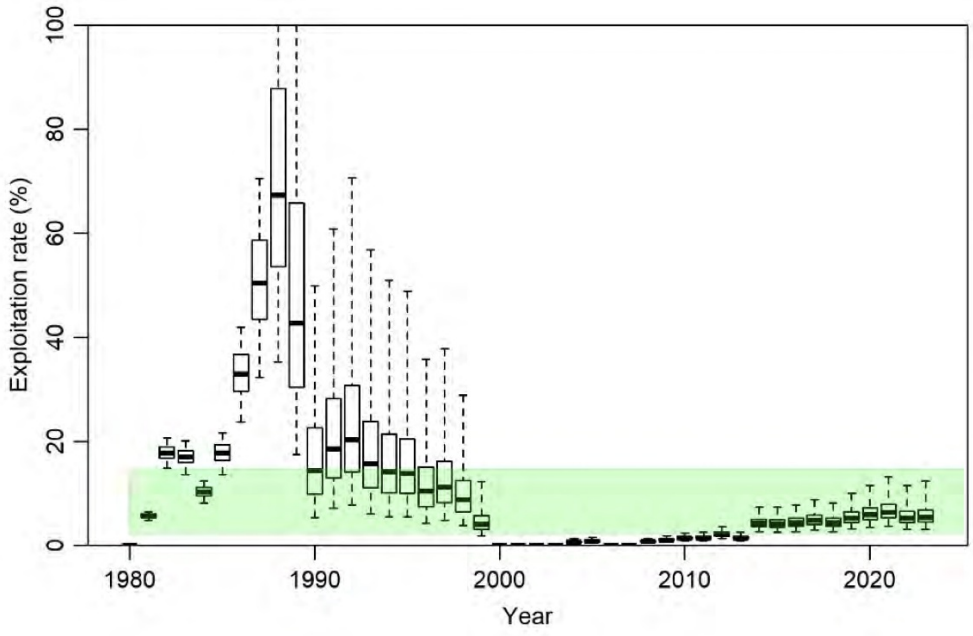

Figure 12: Base (All2) run, MCMC estimated exploitation rate trajectory. The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. The fishing-intensity range associated with the biomass target of 30–50% B_0 is marked by the green shaded area (MPI 2024c).

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 ≤3.2 = **Yellow** or Moderate Concern
- Score ≤2.2 = **Red** or High Concern

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

Guiding principles

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

Criterion 2 Summary

Criterion 2 score(s) overview

This table(s) provides an overview of the Criterion 2 subscore, discards+bait modifier, and final Criterion 2 score for each fishery. A separate table is provided for each species/stock that we want an overall rating for.

Orange roughy			
Region / Method	**Sub Score**	**Discard Rate/Landings**	**Score**
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH1 Northern North Island	1.000	1.000: < 100%	Red (1.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH2A north - East Cape	1.000	1.000: < 100%	Red (1.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast	1.000	1.000: < 100%	Red (1.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B East and South Chatham Rise	1.000	1.000: < 100%	Red (1.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Northwest Chatham Rise	1.000	1.000: < 100%	Red (1.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Other	1.000	1.000: < 100%	Red (1.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Puysegur	1.000	1.000: < 100%	Red (1.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH7A Challenger Plateau	1.000	1.000: < 100%	Red (1.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH1 Mercury-Colville	1.000	1.000: < 100%	Red (1.000)

Criterion 2 main assessed species/stocks table(s)

This table(s) provides a list of all species/stocks included in this assessment for each 'fishery' (as defined by a region/method combination). The text following this table(s) provides an explanation of the reasons the listed species were selected for inclusion in the assessment.

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Mercury-Colville			
Sub Score: 1.000	**Discard Rate: 1.000**		**Score: 1.000**
Species	**Abundance**	**Fishing Mortality**	**Score**
Corals and other biogenic habitats	1.000: High Concern	1.000: High Concern	Red (1.000)
Orange roughy	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Northern North Island			
Sub Score: 1.000	**Discard Rate: 1.000**		**Score: 1.000**
Species	**Abundance**	**Fishing Mortality**	**Score**
Corals and other biogenic habitats	1.000: High Concern	1.000: High Concern	Red (1.000)
Orange roughy	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A north - East Cape			
Sub Score: 1.000	**Discard Rate: 1.000**		**Score: 1.000**
Species	**Abundance**	**Fishing Mortality**	**Score**
Corals and other biogenic habitats	1.000: High Concern	1.000: High Concern	Red (1.000)
Orange roughy	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast			
Sub Score: 1.000	**Discard Rate: 1.000**		**Score: 1.000**
Species	**Abundance**	**Fishing Mortality**	**Score**
Corals and other biogenic habitats	1.000: High Concern	1.000: High Concern	Red (1.000)
Orange roughy	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B East and South Chatham Rise			
Sub Score: 1.000	**Discard Rate: 1.000**		**Score: 1.000**
Species	**Abundance**	**Fishing Mortality**	**Score**
Corals and other biogenic habitats	1.000: High Concern	1.000: High Concern	Red (1.000)
Orange roughy	1.000: High Concern	3.000: Moderate Concern	Red (1.732)

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Northwest Chatham Rise			
Sub Score: 1.000	**Discard Rate: 1.000**		**Score: 1.000**
Species	**Abundance**	**Fishing Mortality**	**Score**
Corals and other biogenic habitats	1.000: High Concern	1.000: High Concern	Red (1.000)
Orange roughy	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Other			
Sub Score: 1.000	**Discard Rate: 1.000**		**Score: 1.000**
Species	**Abundance**	**Fishing Mortality**	**Score**
Corals and other biogenic habitats	1.000: High Concern	1.000: High Concern	Red (1.000)
Orange roughy	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Puysegur			
Sub Score: 1.000	**Discard Rate: 1.000**		**Score: 1.000**
Species	**Abundance**	**Fishing Mortality**	**Score**
Corals and other biogenic habitats	1.000: High Concern	1.000: High Concern	Red (1.000)
Orange roughy	3.670: Low Concern	5.000: Low Concern	Green (4.284)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH7A Challenger Plateau			
Sub Score: 1.000	**Discard Rate: 1.000**		**Score: 1.000**
Species	**Abundance**	**Fishing Mortality**	**Score**
Corals and other biogenic habitats	1.000: High Concern	1.000: High Concern	Red (1.000)
Orange roughy	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

Bycatch composition for Criterion 2 was informed by an average of 38% observer coverage over a 5-year time series (2015–16 to 2019–20) (Anderson and Finucci 2022). During this period, orange roughy accounted for approximately 80% of the total observed catch and the remainder mainly comprised smooth oreo (4.8%), rattails (1.7%), shovelnose dogfish (1.3%), and ribaldo (1.0%). More than 700 species or species groups were recorded by observers, including various deepwater dogfishes (2%), morid cods (1%), rattails (< 1%), and slickheads (0.5%). The total estimated annual discards of nontarget QMS species were quite low, ranging from only 1 ton (t) in 2007–08 to 46 t in 2015–16, while discards of non-QMS species ranged from 108 t in 2013–14 to 1,504 t in 2017–18 (ibid).

Corals and biogenic habitat were included as a main species under Criterion 2 because 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; Anderson and Finucci 2022; Meyer 2023). Because of their high vulnerability, corals are the species of highest concern interacting with the orange roughy trawl fisheries.

Orange roughy trawls occasionally catch seabirds. Based on observed seabird capture rates, the risk to seabirds in orange roughy fisheries is quite low relative to other fisheries. In the ten years between the 2010–11 and the 2019–20 fishing years, a total of 16 birds were captured from 6,276 observed tows, which equals a capture rate of 0.285 birds per 100 tows. Over this period, the average annual observer coverage was 25% {Richards et al. 2020}. The fishery is thought to pose the most risk to Salvin's albatross, Chatham Island albatross, white-chinned petrel, and northern giant petrel (Fisheries New Zealand 2019a; Robertson et al. 2017; Richards et al. 2020; Anderson and Finucci 2022). But the species-level risk of these seabirds from this fishery/gear was not substantial. This was identified according to the following rationale: the 2023 update to the risk assessment for New Zealand seabirds provided an overall risk rank for seabirds, from which species with observed captures in the most relevant gears in the ORH fishery (deepwater) were preselected {Edwards et al. 2023a}. These are the species listed in Table 8. From this list, we also considered the risk ratios presented in the Aquatic Environment and Biodiversity Annual Review 2021 (see page 28, Table 3.2 (FNZ 2022)), from which only species highlighted as having an increasing proportion of species-level risk by specific gear/fishery (e.g., deepwater) were kept. This was Chatham Island albatross (CIA), which is colored a light yellow in the annual review. But, since CIA did not have a value above 0.1 PST (Population Sustainability Threshold), which represents substantial species-level risk from a fishery group (FNZ 2022), it is not included.

Table 8

Species	Median risk 2023	Mean risk 20/21	IUCN	DOC	PBR
XSA—Salvin's albatross	**0.69**	**0.02**	VU	Threatened: Nationally critical	3,598
XCI—Chatham Island albatross	**0.27**	**0.06**	VU	At-risk: Naturally uncommon	425
XWC—White-chinned petrel	**0.09**	**0**	VU	Not threatened	25,626
XNP—Northern giant petrel	**0.08**	**0.01**	LC	At-risk: Recovering	336

Sharks were not included as main species assessed, because the level of interaction per shark species is low (< 1%) and there is lack of evidence that this interaction level affects 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)

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

Corals and other biogenic habitats *(Unknown coral spp.)*

2.1 Abundance

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Northern North Island

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A north - East Cape

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B East and South Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Northwest Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Other

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Puysegur

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH7A Challenger Plateau

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Mercury-Colville

High Concern

The orange roughy trawl fishery affects biogenic habitat considered to have low resilience, including corals and sponges (Clark et al. 2016). Because of 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). Because abundance is scored solely on the health of the assessed species, and corals are considered highly vulnerable with no evidence that the stocks are above or below reference points, abundance is considered a “high concern.”

2.2 Fishing Mortality

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Northern North Island

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A north - East Cape

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B East and South Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Northwest Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Other

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Puysegur

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH7A Challenger Plateau

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: 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 that is corals is low, with 0.11% (76 tons, 37.49% discarded) of the orange roughy catch from 2001 to 2015 consisting of protected corals (ibid). The orange roughy fishery, along with other deepwater trawl fisheries such as the oreo, black cardinalfish, and alfonsino fisheries, are considered the fisheries that pose the most risk to protected corals (Baird et al. 2013). A study by Meyer (2023) used presence/absence data of observed coral captures from New Zealand's commercial fisheries to analyze the spatiotemporal distribution of observed coral captures between 2007–08 and 2019–20 to characterize coral bycatch, and analyzed fisher reports of coral bycatch for the same period (Meyer 2023). The study found that, overall, fisheries targeting orange roughy have the highest interaction with corals and that the majority of bycatch was branching stony coral from the Northeast Chatham Rise region (ibid). The study also noted that while the analysis of presence-

absence data can help identify risk areas of coral catch in commercial fisheries, it does not provide a comprehensive measure of the actual impact on coral communities (ibid).

Because there is no assessment of the impacts of the orange roughy fisheries on coral or sponge populations with a reference point indicating a sustainable level of mortality, the Unknown Bycatch Matrix (UBM) was used to score fishing mortality. Thus, fishing mortality is scored a “high concern” (UBM score = 1).

Supplementary Information

There have been significant research and data analysis advancements on interactions between protected corals and fisheries, as well as improved modeling of coral occurrence and potential “hot spots.” In addition to these, NIWA (commissioned by the DOC) produced a report, “Deep diving into decades of uncatalogued corals” (Mills et al. 2023), that updated records for known protected coral locations in New Zealand, which were collected from biodiversity surveys, research trawl surveys, and by fisheries observers since the 1950s through 2023. Another study has identified protected coral hotspots using species distribution modeling (Anderson et al. 2023). This paper presents maps of abundance within the New Zealand region for 11 coral taxa, based on species distribution modeling using abundance values measured at 949 sample sites from image data collected by towed camera or remotely operated vehicle (ROV) systems (ibid).

2.3 Discard Rate/Landings

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH1 Northern North Island

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH2A north - East Cape

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B East and South Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Northwest Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Other

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH3B Puysegur

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH7A Challenger Plateau

New Zealand - Southwest Pacific Ocean - Bottom trawls - Management Unit: ORH1 Mercury-Colville

< 100%

The annual discard ratio (kilograms of discards/kilograms of target species catch) in the orange roughy fishery remained at 0.1 or below for much of the period since 2002–03 (Anderson and Finucci 2022). Between 2015–16 and 2017–18, the annual discard ratio rose to near 0.2 (ibid). The average discard ratio from 2002–03 to 2019–20 was 0.075, which is unchanged from the previous assessment (Anderson and Finucci 2022). The majority of orange roughy and QMS species are retained. The main species discarded in recent years are rattails and shovelnose spiny dogfish, at 4.8% and 1.7% of the catch, respectively (ibid).

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 ≤3.2 = **Yellow** or Moderate Concern
- Score ≤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.

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:

Criterion 3 Summary

Fishery	Management Strategy And Implementation	Bycatch Strategy	Scientific Research And Monitoring	Enforcement Of Management Regulations	Stakeholder Inclusion	Score
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Mercury-Colville	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Yellow (3.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Northern North Island	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Yellow (3.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A north - East Cape	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Yellow (3.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Yellow (3.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B East and South Chatham Rise	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Yellow (3.000)

Fishery	Management Strategy And Implementation	Bycatch Strategy	Scientific Research And Monitoring	Enforcement Of Management Regulations	Stakeholder Inclusion	Score
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Northwest Chatham Rise	Highly effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Green (4.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Other	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Yellow (3.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Puysegur	Highly effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Green (4.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH7A Challenger Plateau	Highly effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Green (4.000)

Criterion 3 Assessment

Scoring Guidelines

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.

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.

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.

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.

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.

3.1 Management Strategy And Implementation

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Northern North Island

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A north - East Cape

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B East and South Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Other

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Mercury-Colville

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 were not representative of stock-wide abundance and aging data with low precision) (Tingley & Dunn 2018). Management has responded to stock depletion (below B_{MSY}) by implementing total allowable catch (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 an 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 aging orange roughy have also allowed for incorporation of age composition data into recent stock assessments (after 2011), although some imprecision remains, leading to uncertainty (Horn et al. 2016). 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; MPI 2024c). Recruitment dynamics are poorly understood in relation 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 interannual variability to account for recruitment uncertainty.

The ORH1 Northern North Island, ORH1 Mercury-Colville, and ORH3B Other orange roughy fisheries do not have 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 the fishing mortality relative to limit reference points based on biological data is unknown. The ORH2A South, ORH2B, ORH3A Mid-East Coast stock is below 75% of the target reference point, with overfishing not occurring. At recent catch levels, the stock is expected to continue to slowly rebuild, with spawning stock biomass estimated to be greater than the lower bound of the target zone (30% B_0) with at least 70% probability by 2037 (Dunn et al. 2022). The most recent ORH3B East and South Chatham Rise stock assessment has been rejected due to data inconsistencies; therefore, stock status is currently unknown. Furthermore, more conservative target reference points, such as maintaining biomass at a conservative 60% of B_0, are thought to be more appropriate for species with low productivity and high vulnerability to overfishing compared to traditional biomass reference points (BRPs) of 40–50% of unfished biomass (Cattoni et al. 2024). For example, the Southern Indian Ocean Fisheries Agreement (SIOFA) has adopted interim reference points for orange roughy, setting the target at 40% B_0 and the limit at 20% B_0 (SIOFA n.d.).

The fisheries do not meet all the standards of highly effective management, but management measures are in place to minimize mortality of stocks of concern and for > 70% of the fishery's primary target, and these measures are believed to be effective. In addition, for those fisheries that are overfished, there are rebuilding plans in place for which eventual success is probable. But, there is concern regarding data uncertainty. Thus, management is considered a "moderate concern."

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Northwest Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Puysegur

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: 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 were not representative of stock-wide abundance and aging 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 an 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. 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 aging orange roughy have also allowed for incorporation of age composition data into recent stock assessments (after 2011), although some imprecision remains, leading to uncertainty (Horn et al. 2016). 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) MPI 2024c}. Recruitment dynamics are poorly understood 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 interannual 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 previous absolute spawning stock biomass estimates, which required assumptions that introduce bias (MPI 2024c). Stock assessments reflect that recruitment may have historically fallen below average for several decades. ORH3B Northwest Chatham Rise, ORH3B Puysegur, and ORH7A Challenger Plateau have regularly scheduled stock assessments that are peer reviewed, effective management measures are in place for main and bycatch species, and all stocks are considered to be at or above target levels, with fishing mortality a low concern. Because management measures are in place with appropriate reference points for > 70% of the fishery's primary target, and management implements precautionary measures including scientific advice and incorporating uncertainty, management is considered "highly effective."

Supplementary Information

Research in 2023 raised some concerns about the results of the most recent stock assessment models of the Northwest Chatham Rise (2018) and East and South Chatham Rise (2020), which estimated both stocks to be in the target zone of 30–50% B_0 (MPI 2024c). The concerns stemmed from inconsistencies between the stock biomass and trends estimated by the models, and observational data such as local estimates of CPUE and acoustic time series (ibid). MSC certification for ORH3B was self-suspended by the Deepwater Group because of these inconsistencies.

3.2 Bycatch Strategy

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Northern North Island

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A north - East Cape

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B East and South Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Northwest Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Other

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Puysegur

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH7A Challenger Plateau

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Mercury-Colville

Moderately Effective

Trawl gear is relatively unselective; however, bycatch is rather low, with 4% of the catch being discards (not orange roughy or other QMS species) (MRAG Americas 2016). 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 2020; MPI 2013b). Scare devices are required on vessels > 28 m to keep seabirds from interacting with fisheries gear (MPI 2024c). There are also regulations in place to manage disposal of fish discards such that they minimize attracting foraging seabirds. Deepwater corals in New Zealand are diverse, and because of their fragility, they are a species of concern at risk from bottom trawling. Spatial management measures are in place to protect the habitat from trawling (see Factor 4.2 for details).

Tows are located in Benthic-optimized Marine Environment Classification (BOMEC) (Leathwick et al. 2012) classes J; K (mid-slope); M (mid-lower slope); and N and O (lower slope and deeper waters) (Baird and Wood 2012), and 94% were between 700 and 1,200 m depths (Baird et al. 2011). The BOMEC areas with the highest proportion of area covered by the orange roughy footprint were classes J (comprising mainly the Challenger Plateau and northern and southern slopes of the Chatham Rise) and N (deeper areas around the

North Island and Chatham Rise). In 2018–19, the orange roughy footprint represented 0.69% of the 312,645 km^2 in class J and 0.1% of the 495,154 km^2 of class N (Baird and Mules 2021). In addition, bottom trawl fishing takes place in areas identified by the New Zealand Department of Conservation as coral hotspots and is not subject to measures like the "encounter protocol" and "move-on rule" that apply in the South Pacific high seas under the management of the South Pacific Regional Fisheries Management Organisation (SPRFMO) (Anderson et al. 2023) (Karli Thomas 2025, pers comm). Furthermore, much of the orange roughy fishery is based on targeting fish on seamounts and features that are known hotspots of coral biodiversity (Karli Thomas 2025, pers comm). Therefore, it is uncertain if the proportion and distribution of habitat protected is suitable for the sustainability of these vulnerable deepwater coral species, because 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 (ibid). 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).

The fisheries do not meet all the standards of highly effective management because species of concern are caught. There are some bycatch management measures in place, but there is uncertainty whether deepwater corals actually benefit from protected areas because the majority occur in depths where orange roughy are not fished. As a result, bycatch strategy is considered "moderately effective."

3.3 Scientific Research And Monitoring

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Northern North Island

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A north - East Cape

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B East and South Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Northwest Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Other

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Puysegur

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH7A Challenger Plateau

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Mercury-Colville

Moderately Effective

The Deepwater Fisheries Assessment Working Group (DWFAWG), an open scientific forum including MPI scientists, independent scientists, fishery managers, industry, and environmental nongovernmental organizations (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 that are most heavily targeted or require rebuilding (70% of annual catch) are the most regularly monitored and assessed. Uncertainty in recruitment, from high interannual recruitment variability, leads to complications in the use of predictive population models based on observational data (Doonan et al. 2015).

Harvest control rules (HCRs) are used for informing total allowable commercial catches (TACCs) for each quota management area (QMA) or biological stock within the 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 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; McGovern and Hewetson 2025)), 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 (overfishing not occurring), but is projected to increase slowly over the next five years and to be above the soft limit but below the lower bound of the target in 2027 (MPI 2024).

ORH3B Northwest Chatham Rise, ORH3B Puysegur, and ORH7A Challenger Plateau have regularly scheduled stock assessments that are peer reviewed; however, the most recent ORH3B East and South Chatham Rise stock assessment has been rejected due to data inconsistencies; therefore, stock status is currently unknown. ORH3B Northwest

Chatham Rise is thought to have similar data inconsistencies as well (Karli Thomas May 2025, pers. comm). The ORH7A stock assessment has not incorporated the most recent data (acoustic survey) (Barry Weeber May 2025, pers comm). Because 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 and accepted stock assessments, scientific research and monitoring is considered "moderately effective."

3.4 Enforcement Of Management Regulations

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Northern North Island

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A north - East Cape

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B East and South Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Northwest Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Other

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Puysegur

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH7A Challenger Plateau

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Mercury-Colville

Moderately 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 noncompliance are examined before executing enforcement, and the model is designed to facilitate communication between government and industry

(ibid). 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) (ibid).

Enforcement and monitoring measures include vessel monitoring systems (VMS), aerial patrols, and patrol boats, which address lower-end noncompliance through infringement notices or lower-end penalties (directed compliance) (ibid). When fraud and criminal activity are discovered, they are prosecuted in the court system (enforced compliance), and penalties can include vessel forfeiture, imprisonment, and/or large monetary penalties (ibid). All vessels are required to have VMS with an onboard automatic location communicator (ALC) (ibid). There is also an observer program that provides data to verify catch quantity and composition (*ibid*).

But, even though the Ministry for Primary Industries does prosecute illegal trawling, legal loopholes (such as in the Marine Reserves Act) have allowed some companies to overturn convictions on appeal, even when illegal trawling was confirmed, as seen in the Amaltal Mariner case (RNZ 2021; RNZ 2022). Illegal fishing activities include violations such as trawling in protected areas, including marine reserves and Benthic Protection Areas (BPAs), as well as breaches of international regulations (MPI n.d.; Gee 2020; Gee 2020a). Companies often continue operations during legal proceedings, and redemption fees for forfeited vessels are typically a small fraction of the vessels' values {Business Desk 2023}. For instance, Sealord paid NZD66,000 to reclaim a vessel valued at NZD24 million (Mongabay 2022). Companies with repeated convictions include Talley's Group Ltd/Amaltal Fishing Co., Sanford Ltd, and Sealord Group Ltd (New Zealand Herald 2019; Greenpeace Aotearoa 2021; RNZ 2021; Otago Daily Times 2021; Greenpeace Aotearoa 2022; RNZ 2022; Business Desk 2023}. Because enforcement and monitoring are in place to ensure that goals are successfully met, but the effectiveness of enforcement and monitoring is uncertain, enforcement of management regulations is considered "moderately effective."

3.5 Stakeholder Inclusion

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Northern North Island

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A north - East Cape

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B East and South Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Northwest Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Other

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Puysegur

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH7A Challenger Plateau

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Mercury-Colville

Highly effective

The orange roughy fishery in New Zealand is managed by the Fisheries New Zealand (a business group 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 (ibid). Management includes input from Treaty Partners (Maori), stakeholders, and the public (ibid).

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, and other government agencies (ibid). Working groups, stock assessment plenary meetings, and their records are open to the public (ibid). Guidelines for MPI have been established for required consultation with stakeholders before providing advice to the Minister (ibid). Stakeholders include groups 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 (ibid). MPI provides a discussion document for stakeholders, to inform them of potential management changes, and solicits stakeholder input (ibid). Stakeholder comments are summarized and provided to the Minister with MPI's recommendations for decision-making (ibid). Final decisions are posted publicly on the MPI website (ibid). Because 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 fishers, stakeholder inclusion is considered "highly effective."

Supplementary Information

It is important to note that the current level of stakeholder inclusion is at risk under a proposed fisheries reform that would allow catch limits to be set for up to 5 years, reducing opportunities for annual stakeholder input {MPI 2025} {Karli Thomas May 2025, pers comm}. The proposal also includes provisions to exempt footage from onboard electronic monitoring of bycatch from the Official Information Act {Karli Thomas May 2025, pers comm}.

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

Fishery	Impact of Fishing Gear on the Habitat/Substrate	Modifying Factor: Mitigation of Gear Impacts	Ecosystem-based Fisheries Management	Score
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Mercury-Colville	Score: 0	Score: 0	Low Concern	**Red (0.000)**
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Northern North Island	Score: 0	Score: 0	Low Concern	**Red (0.000)**
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A north - East Cape	Score: 0	Score: 0	Low Concern	**Red (0.000)**
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast	Score: 0	Score: 0	Low Concern	**Red (0.000)**
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B East and South Chatham Rise	Score: 0	Score: 0	Low Concern	**Red (0.000)**
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Northwest Chatham Rise	Score: 0	Score: 0	Low Concern	**Red (0.000)**

Fishery	Impact of Fishing Gear on the Habitat/Substrate	Modifying Factor: Mitigation of Gear Impacts	Ecosystem-based Fisheries Management	Score
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Other	Score: 0	Score: 0	Low Concern	Red (0.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Puysegur	Score: 0	Score: 0	Low Concern	Red (0.000)
New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH7A Challenger Plateau	Score: 0	Score: 0	Low Concern	Red (0.000)

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.*

4.1 Impact of Fishing Gear on the Habitat/Substrate

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Northern North Island

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A north - East Cape

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B East and South Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Northwest Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Other

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Puysegur

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH7A Challenger Plateau

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Mercury-Colville

Score: 0

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

Supplementary Information

Although 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 and vulnerable seep and vent areas, which contain structure-forming tubeworms, and near underwater topographical features (UTFs) such as canyons, knolls, hills, and seamounts, where fish aggregate and trawls interact with deepsea corals and sponges

(Clark & O'Driscoll 2003; Clark & Rowden 2009; Clark et al. 2016; MRAG 2016; Tingley & Dunn 2018; Anderson et al. 2019). The overall trawl footprint for orange roughy (1989–90 to 2020–21) covered 12% of the seafloor at 800–1,000 m, 9% of the 1,000–1,200 m seafloor, and 3% of the 1,200–1,600 m seafloor {MacGibbon & Mules 2023}. In 2018–19, the orange roughy footprint contacted 2%, 1%, and 0.2% of those depth ranges, respectively (ibid). Tows are located in Benthic-optimized Marine Environment Classification (BOMEC; (Leathwick et al. 2012)) classes J; K (mid-slope); M (mid-lower slope); and N and O (lower slope and deeper waters) {Baird & Wood 2012}, and 94% were between 700 and 1,200 m deep (Baird et al 2011). The BOMEC areas with the highest proportion of area covered by the orange roughy footprint were classes J (comprising mainly the Challenger Plateau and northern and southern slopes of the Chatham Rise) and N (deeper areas around the North Island and Chatham Rise). In 2018–19, the orange roughy footprint represented 0.69% of the 312,645 km^2 in class J and 0.1% of the 495,154 km^2 in class N {Baird & Mules 2021}.

There is evidence that recolonization and regrowth of deepsea corals on previously heavily trawled deepsea features can take place, but that the process of recovery is slow, with the first detectable signs of coral recruitment and regrowth occurring approximately two decades after the cessation of trawling (Clark et al. 2022). Benthic community resilience to bottom trawling on seamounts can be quite low, as 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 (> 2,000 passes) (Clark et al. 2014). Although in some regions the habitat trawled over is less sensitive, it is not possible to determine when nonbiogenic habitat is trawled over exclusively, because of high heterogeneity leading to uncertainty in distribution.

A 2023 report from New Zealand's Department of Conservation shows that bottom trawling, especially for orange roughy, is the main cause of coral bycatch in New Zealand waters (Meyer 2023). From 2007 to 2020, 99% of reported coral bycatch, over 211 MT, came from bottom trawl gear (ibid). Nearly half of these coral bycatch events occurred during orange roughy fishing. Most of the coral was caught in just three FMAs: FMA4, FMA6, and FMA9, accounting for 96% of all coral catch within the EEZ, with FMA 4 being responsible for 45% of the total (ibid).

FNZ considers that fishing effort, and therefore the trawl footprint, is unlikely to increase in the short term (FNZ 2023c). In the longer term, fishers may choose to trawl on new areas as they apply more effort to flat areas with longer trawl tows (ibid). There are ongoing efforts to expand knowledge of the fisheries' impacts through data collection from vessel monitoring and observer programs on trawl footprint and by monitoring impacts on the benthos (comparing 15 environmental classes based on a Benthic-optimized Marine Environmental Classification (BOMEC)) (MPI 2015). 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 the distribution of biogenic habitat is more heterogenous.

4.2 Modifying Factor: Mitigation of Gear Impacts

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Northern North Island

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A north - East Cape

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B East and South Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Northwest Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Other

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Puysegur

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH7A Challenger Plateau

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Mercury-Colville

Score: 0

Over 12% (22,000 km^2) of New Zealand's territorial sea is protected, with the majority in remote areas; however, an analysis of the country's existing MPAs determined that 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 over 1,000 m elevation, and 88% of identified hydrothermal vents) in the New Zealand EEZ from bottom trawling (Figure 13), including high-relief areas around underwater topographic features (UTFs), which are protected from trawling because their extreme slopes prevent gear contact (MPI 2015; MPI 2024c). The overall trawl footprint for orange roughy (1989–90 to 2018–19) covered 11% of the seafloor at 800–

1,000 m deep, 9% of the 1,000–1,200 m seafloor, and 3% of the 1,200–1,600 m seafloor (FNZ 2024). In 2018–19, the orange roughy footprint contacted 1%, 0.6%, and 0.2% of those depth ranges, respectively (Baird and Mules 2021).

Although a small number of seamounts were protected before the establishment of New Zealand's BPAs, the broader BPA network has been widely criticized for lacking ecological representativeness and scientific rigor (DSCC 2021). The 2007 designation of 17 BPAs, covering over 1.2 million km^2, was developed with substantial industry input and predominantly excluded areas targeted by bottom trawling. Official data indicate that only 4 of approximately 40,000–47,000 bottom trawl tows in the year before implementation occurred within the current BPA boundaries, suggesting a minimal disruption to fishing operations and a limited conservation impact (DSCC 2021).

Furthermore, over 80% of the BPA area lies at depths exceeding 1,500 m, which is beyond the primary distribution range of orange roughy, bottom-contact fishing gear, and most vulnerable marine ecosystems (VMEs), including deepsea coral assemblages (Clark et al. 2014; Rieser et al. 2013). Of the 1,907 geomorphic features such as seamounts, knolls, and hills identified within the country's EEZ, 1,118 (approximately 59%) remain open to bottom trawling (DSCC 2021), further indicating that the BPA network fails to provide meaningful spatial protection for representative benthic habitats or known high-biodiversity areas. Because a substantial proportion of habitat (> 20%) is protected from gear contact, but these habitats are not usually where orange roughy is fished, mitigation of gear impacts is rated 0.

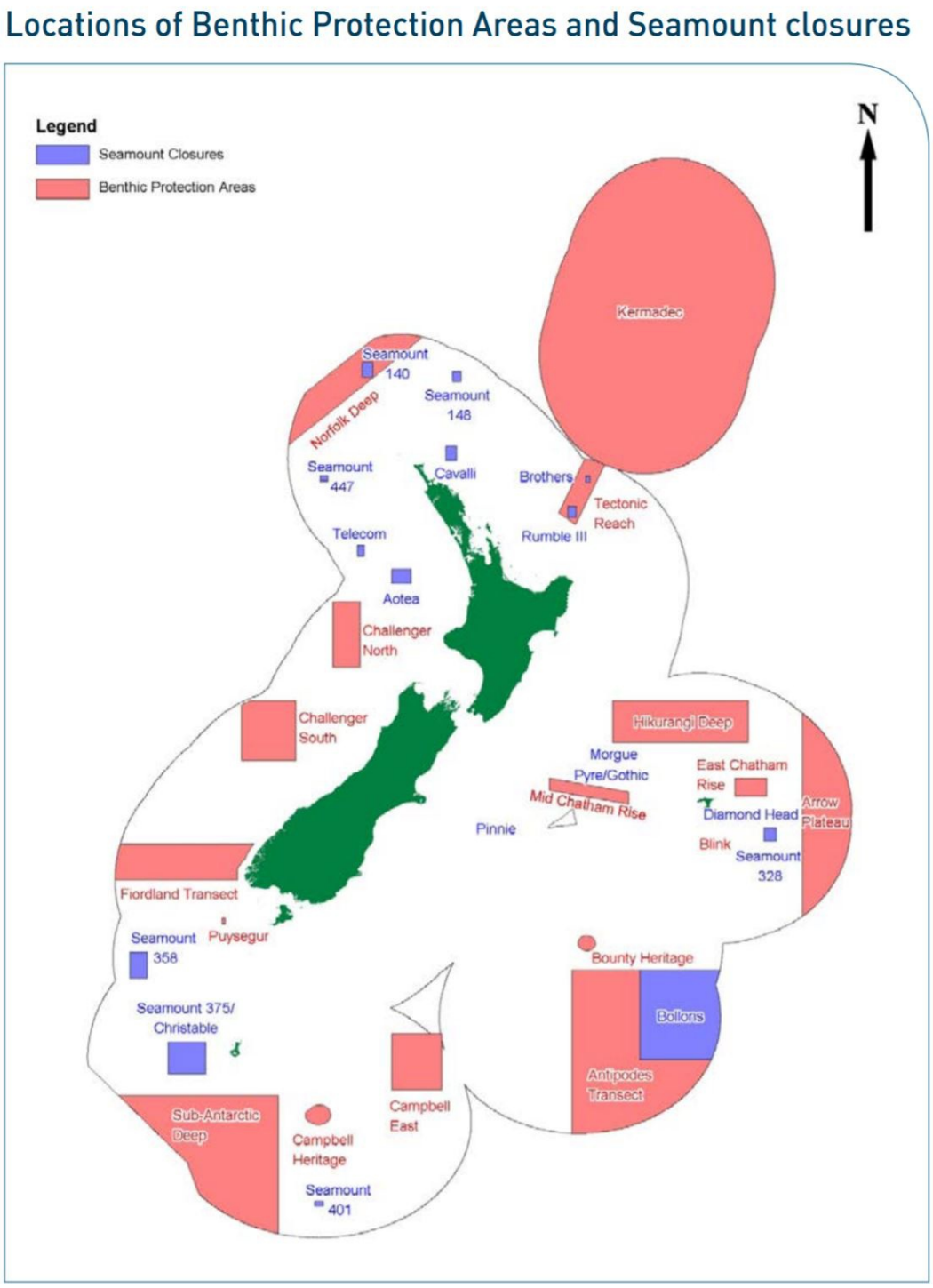

Figure 13: Benthic protection areas (BPAs) of New Zealand (MPI 2015).

4.3 Ecosystem-based Fisheries Management

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Northern North Island

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A north - East Cape

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH2A south | ORH2B | ORH3A - Mid East Coast

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B East and South Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Northwest Chatham Rise

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Other

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH3B Puysegur

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH7A Challenger Plateau

New Zealand - Southwest Pacific Ocean - Bottom trawls - Flag Country: New Zealand - FAO Major Area: Pacific, Southwest - Management Unit: ORH1 Mercury-Colville

Low Concern

Orange roughy is an opportunistic feeder that consumes 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 has a unique role in the ecosystem, and other species in the system consume similar prey types; however, orange roughy is 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 from a lack of some data for each group (Pinkerton 2013). The model indicated that 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, which is 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) of keystone species, 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) in place to protect ecosystem functioning and to account for capture species' ecological roles, and detrimental food web impacts are not likely. Because 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 considered a "low concern."

Acknowledgements

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: Updates to the New Zealand Orange Roughy Report

The July 6, 2020, orange roughy report was reviewed on April 29, 2024, and it was determined that changes to the report were necessary to reflect changes in the fisheries' performance against the Seafood Watch Standard for Fisheries. These changes follow. The updated report was published on September 8, 2025.

Criterion 1: Impacts on the Species Under Assessment

- Factor 1.1 (Abundance) was downgraded from "moderate concern" to "high concern" for ORH2A, because the most recent stock assessment for ORH2A is over 10 years old (from 2003). Orange roughy is considered highly vulnerable (see details of PSA; score of 3.54).
- Factor 1.1 (Abundance) was upgraded from "high concern" to "moderate concern" for ORH2A South, ORH2B, and ORH3A, because the current stock biomass is Very Unlikely (< 10%) to be at or above the lower end of the management target range, and B2022 is About as Likely as Not (40–60%) to be below the Soft Limit and Unlikely (< 40%) to be below the Hard Limit. Hence, the stock is above a limit reference point, but below 75% of the target reference point.
- Factor 1.2 (Fishing mortality) was upgraded from "moderate concern" to "low concern" for ORH2A South, ORH2B, and ORH3A, because it is considered Very Unlikely (< 10% probability) that overfishing is occurring in these three management areas (MPI 2024}. The overfishing threshold is considered to be a fishing intensity range from $U_{30\%}B_0$ to $U_{50\%}B_0$, and fishing intensity for 2022 was estimated to be 0.8% (37% of $U_{30\%}B_0$).
- Factor 1.1 (Abundance) was downgraded from "low concern" to "high concern" for ORH3B East and South Chatham Rise, because the stock assessment was rejected; therefore, the stock status is considered unknown and the PSA (score of 3.54) was used.
- Factor 1.2 (Fishing mortality) was downgraded from "low concern" to "moderate concern" for ORH3B East and South Chatham Rise, because the stock assessment was rejected; therefore, fishing mortality considered unknown.
- Factor 1.1 (Abundance) was downgraded from "low concern" to "moderate concern" for ORH3B Northwest Chatham Rise, because aging data used in the stock assessment are old/uncertain and are the same data used in the invalidated assessment of ORH3B East and South Chatham Rise. Similar results were used in the 2018 stock assessment, suggesting a lower confidence in stock status than would be reflected by a "low concern" score, so stock status is downgraded to a "moderate concern."
- Factor 1.2 (Fishing mortality) was downgraded from "low concern" to "moderate concern" for ORH7A Challenger Plateau, because the 2024 stock assessment only uses data up to 2013 (hence, data are > 10 years old and fishing mortality is considered unknown).

Criterion 2: Impacts on Other Species

- Smooth oreo was removed from the assessment because it composed < 5% of current total landings.
- Seabirds were removed from the assessment using the same methodology/justification as the Tai snapper report (see the Criterion 2 Summary for details).

Criterion 3: Management Effectiveness

- Factor 3.1 (Management Strategy) was downgraded from "highly effective" to "moderately effective" for the ORH3B East and South Chatham Rise fishery because of the invalidated stock assessment.
- Factor 3.3 (Scientific Research and Monitoring) was downgraded from "highly effective" to "moderately effective" for all ORH3B and ORH7A fisheries because of uncertain stock assessments (e.g., the management process does not use an up-to-date scientific analysis).
- Factor 3.4 (Enforcement) was downgraded from "highly effective" to "moderately effective" because the deterrents are insufficient, particularly since the same companies are being found in violation multiple times.

Criterion 4: Impacts on the Habitat and Ecosystem

Factor 4.2 (Mitigation of gear impacts) was downgraded from "+0.5" to "0" because even though a substantial proportion of habitat (> 20%) is protected from gear contact, these habitats are not usually where orange roughy is fished.