



Monterey Bay Aquarium Seafood Watch

Environmental sustainability assessment of wild-caught Patagonian toothfish (*Dissostichus eleginoides*) from Chile and Prince Edward Island caught using deep-set longlines



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Species: Patagonian toothfish (*Dissostichus eleginoides*)
Location: Chile: Southeast Pacific, Prince Edward Island: Southern Ocean
Gear: Longline (deep-set)
Type: Wild Caught
Author: Seafood Watch
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Assessed using [Seafood Watch Fisheries Standard v3](#)

Table of Contents

About Seafood Watch	3
Guiding Principles	4
Summary	5
Final Seafood Recommendations	6
Introduction	7
Assessment	12
<i>Criterion 1: Impacts on the Species Under Assessment</i>	12
<i>Criterion 2: Impacts on Other Species</i>	17
<i>Criterion 3: Management Effectiveness</i>	30
<i>Criterion 4: Impacts on the Habitat and Ecosystem</i>	37
Acknowledgements	42
References	43
Appendix A: Extra By Catch Species	47

About Seafood Watch

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

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

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

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished¹ or farmed that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

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

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

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

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

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

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

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

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

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

Summary

This report assesses the sustainability of Patagonian toothfish (*Dissostichus eleginoides*) fisheries in Chile and Prince Edward Island (South Africa). In both fisheries, Patagonian toothfish accounts for over 80 to 90% of the catch. Patagonian toothfish is distributed in the southernmost part of the Atlantic, Indian and Pacific Ocean, as well as in the Southern Ocean, being a commercially important species in all these regions.

Patagonian toothfish is a long-lived and slow-growing animal. Abundance of this fish severely declined in the 1990's due to IUU fishing in many regions; however, close management and monitoring overseen by an multinational approach have enabled exploitation to continue while keeping stocks recovering to sustainable levels. In some areas, a depleted stock or a stock below a sustainable reference points are still a reality. The level of available information regarding population assessments and fishing mortality varies depending on the region.

Both in Chile and Prince Edward Islands, Patagonian toothfish is caught using longline (deep-set), with a few modifications (cachaloteras and trotline) to decrease bycatch and seabird mortality, and to protect catch from whale depredation. Stocks in both regions are currently below sustainable levels, raising concern. A few vulnerable species are still captured in this fishery, particularly skates and rays, but at low levels. There is also a high concern regarding the impact of this fishery on more sensitive bottom biogenic habitats, especially because very little information is available. Total allowed catch quotas, spatial management and closed seasons, are among the management strategies in place for both Chile and Prince Edward Islands. Bycatch species are also managed by TACs and/or discard/release control. Because rebuilding plans are not in place yet in Chile and recovery strategies have not been in place long enough to safeguard stock recovery in Prince Edward Islands, management strategies have not been fully satisfactory in both cases.

Final Seafood Recommendations

SPECIES/FISHERY	CRITERION 1: IMPACTS ON THE SPECIES	CRITERION 2: IMPACTS ON OTHER SPECIES	CRITERION 3: MANAGEMENT EFFECTIVENESS	CRITERION 4: HABITAT AND ECOSYSTEM	OVERALL RECOMMENDATION
Patagonian toothfish Chile Southeast Pacific, Longline (deep-set)	Red (1.000)	Red (1.732)	Red (1.000)	Yellow (2.739)	Avoid (1.475)
Patagonian toothfish Prince Edward Islands Southern Ocean, Longline (deep-set)	Yellow (2.644)	Red (1.732)	Yellow (3.000)	Green (3.464)	Good Alternative (2.626)

Summary

Due to concerns about a depleted stock, Patagonian toothfish from Chile is rated "red" or "avoid." In Prince Edward Island, Patagonian toothfish is rated as "yellow" or "good alternative" because the stock is stable and management practices have improved over the years.

Scoring Guide

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

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

- **Best Choice/Green** = Final Score >3.2, and no Red Criteria, and no Critical scores
- **Good Alternative/Yellow** = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern², and no more than one Red Criterion, and no Critical scores
- **Avoid/Red** = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

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

Introduction

Scope of the analysis and ensuing recommendation

The present report evaluates the sustainability of the Patagonian toothfish (*Dissostichus eleginoides*) fishery in Chile and Prince Edward Island (South Africa), using longline (deep-set).

Species Overview

Patagonian toothfish is a deep sea (usually 70 to 1500 m), long-lived (50+ years), and slow growing species (maturity at 10 years of age) (FAO 2018) (Collins et al. 2010). Patagonian toothfish is distributed in the southernmost part of the Atlantic, Indian, and Pacific Oceans as well as in the Southern Ocean; it is a commercially important species in all these regions (FAO 2018).



Figure 1 Geographical distribution of Patagonian toothfish. Source: FAO 2018.

As an active predator with a low consumption rate in deep-water ecosystems, this top predator has a heterogeneous diet, which may include grenadiers and hakes (Sallaberry-Pincheira et al. 2018.). Patagonian toothfish spawns in deep waters, where they also spend their adult life, whereas juveniles inhabits shallow shelf areas (Collins et al. 2010). It is believed the populations are isolated between the Indian Ocean, South Georgia, and the Patagonian Shelf (Collins et al. 2010).

Both in Chile and Prince Edward Islands, Patagonian toothfish is caught using longline (deep-set), with a few modifications (cachaloteras and trotline) to decrease bycatch and seabird mortality, and to protect catch from preying whales (Brown et al. 2012) (COLTO. 2018a). In Chile, annual quotas are determined for both the artisanal and industrial fleet, which fish in seasons, whereas in the Prince Edward Islands, quotas are set only for the industrial fleet (Maturana 2017) (COLTO 2018b) (CCAMLR 2017) (Grossi 2017).

The fishery in Chile is managed by the Subsecretaria de Pesca y Acuicultura, a branch of the government responsible to set specific regulations/annual quotas, statistics, monitoring (including bycatch) and presenting

reports (Grossi 2017) (Maturana 2017) (Subsecretaria de Pesca y Acuicultura 2018d), whereas in Prince Edward Island, the Department of Agriculture, Forestry and Fisheries of South Africa is responsible for the management (South Africa 1998). The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) establishes specific regulations for the toothfish fishery in the Southern Ocean (CCAMLR 2017), which are followed in Prince Edward Island, but catch limit values and stock assessments are the responsibility of the South African government.

Production Statistics

Patagonian toothfish is targeted within Chile and Argentina's Exclusive Economic Zones (EEZ), around sub-Antarctic islands belonging to Australia, France, South Africa and the United Kingdom, and the high-seas regions in both South Atlantic and Indian Oceans. This encompasses areas 41 and 87 (the Atlantic and Pacific sides of South America), also areas 48 and 58 (the Antarctic areas of the Atlantic and Indian Ocean, respectively) (FAO 2018). Globally, the production of Patagonian toothfish, which started in the 80s and peaked in 1995 at almost 45,000 tonnes (MT). Since the early 2000s production has reduced to a range between 20,000 to 25,000 MT yearly (FAO 2018).

Global Capture Production for species (tonnes)

Source: FAO FishStat

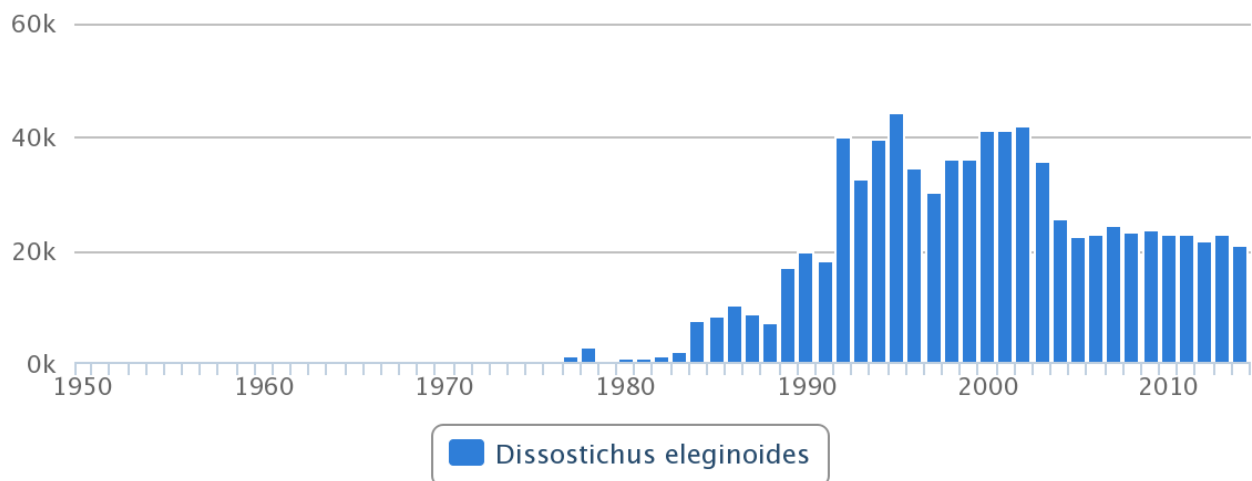


Figure 2 Global capture production for Patagonian toothfish. Source: FAO

In Chile, the records of Patagonian toothfish landings started in 1985. Production peaked in 1992 at over 30,000 MT, with continuous volume decline after that. Since 2005, the production has been oscillating around 5,000 MT per year (Servicio Nacional de Pesca y Acuicultura 2018).

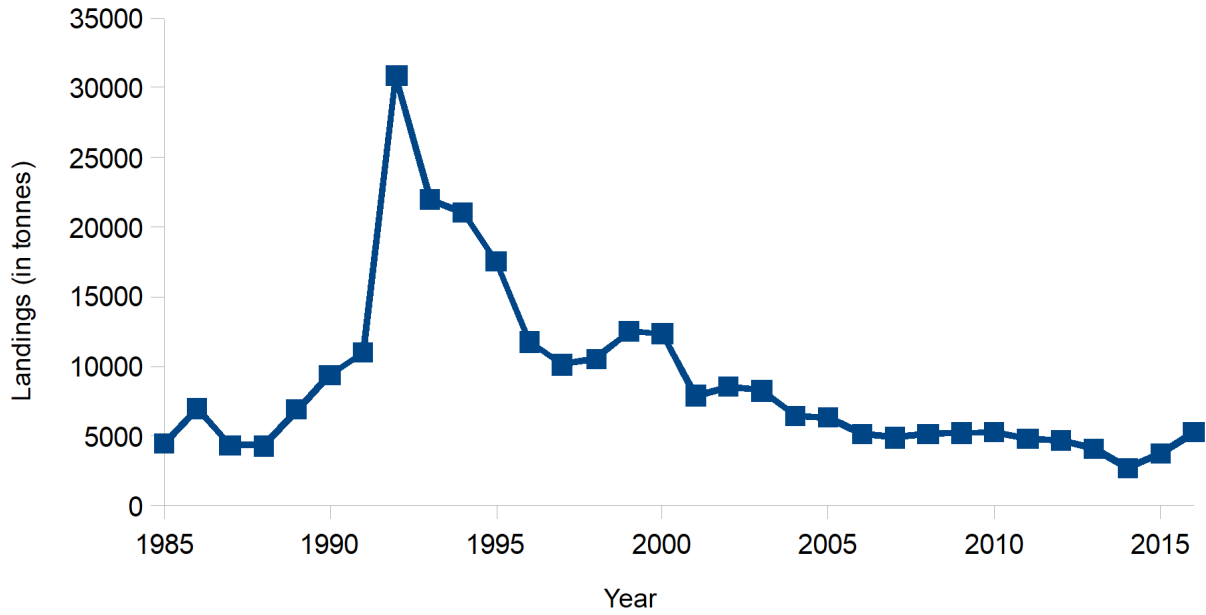


Figure 3 Landings data for Patagonian toothfish in Chile, from 1985-2016. Source: Servicio Nacional de Pesca y Acuicultura 2018.

In Prince Edwards, catch of Patagonian toothfish have become more substantial during the late 1990s, peaking in 1997 at about 1,200 MT. Since 2000, catch values have oscillated at much more modest numbers, around a few hundred MT (CCAMLR 2018).

Catch history

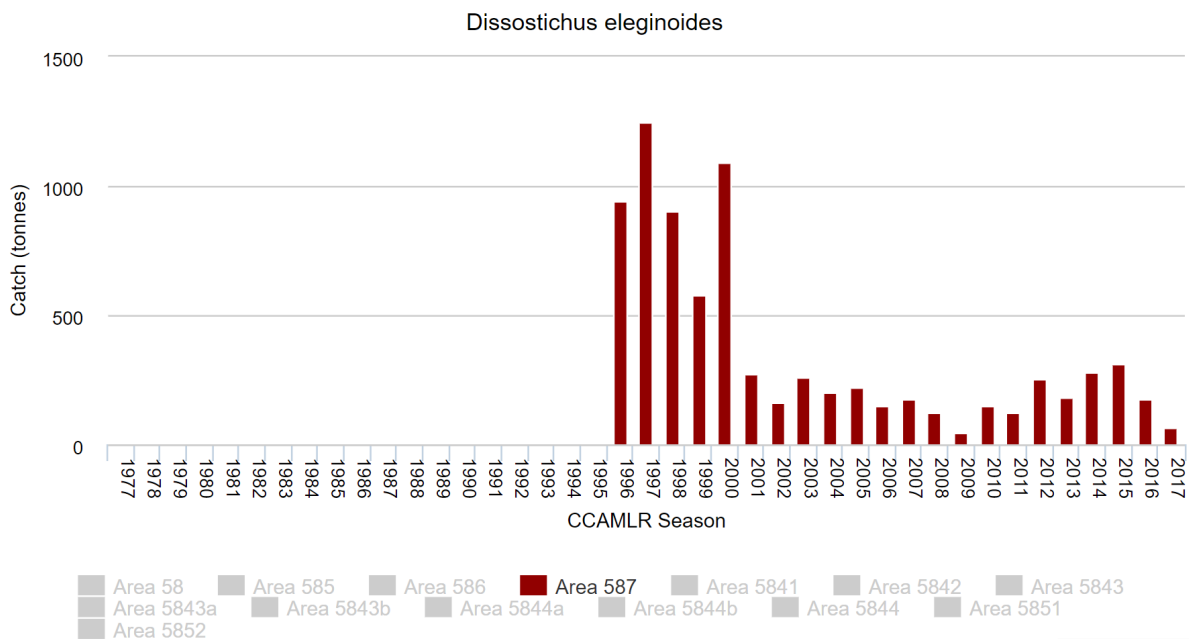


Figure 4 Catch history of Patagonian toothfish in the Prince Edward Island, region 58.7. Source: CCAMLR 2018.

Importance to the US/North American market.

Chile and South Africa began importing Patagonian toothfish in the late 1990s. On average, South Africa exported 260,494.2 kilos (kg) from 1998 to 2017, whereas Chile exported 2,955,974.75 kg during the same period (NMFS 2018a) (NMSF 2018b). A range of values can be observed in the graphs below and represent domestic catches. However, numbers are estimates for Patagonian toothfish, because since the late 2000s the information available began to be labeled as "Toothfish NSPF" (not specifically provided for). Because of that, values may also include data for Antarctic toothfish in both countries.

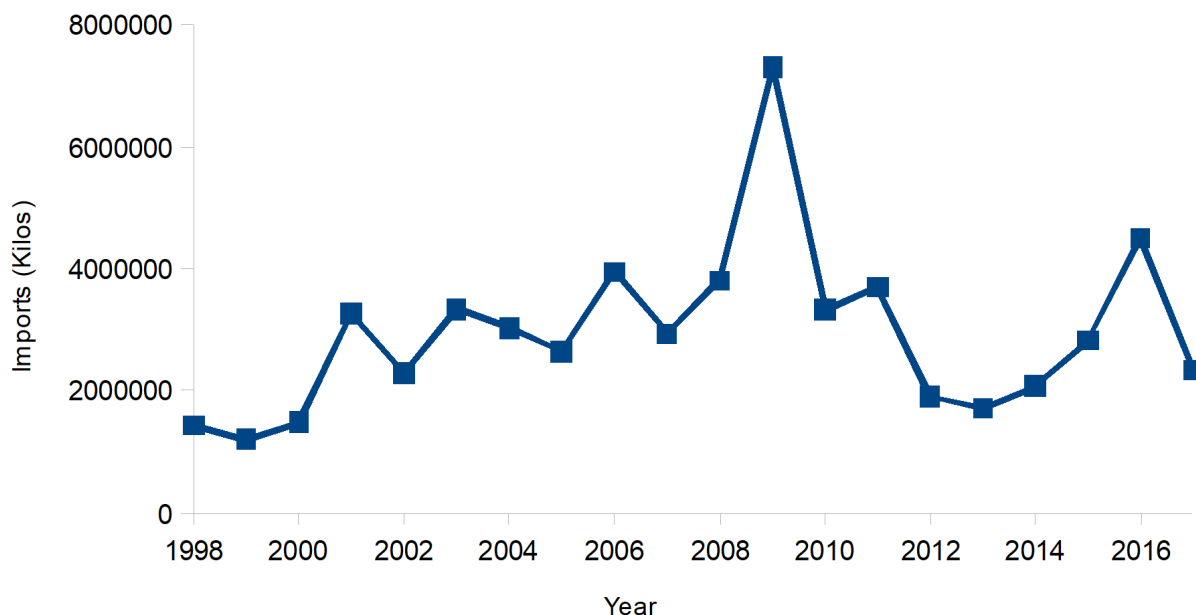


Figure 5 Imports (in kilos) of Patagonian toothfish from Chile, from 1998-2017. Numbers from 2007 onwards may also include Antarctic toothfish, since data reported included NSPF input. Source: NMFS 2018a.

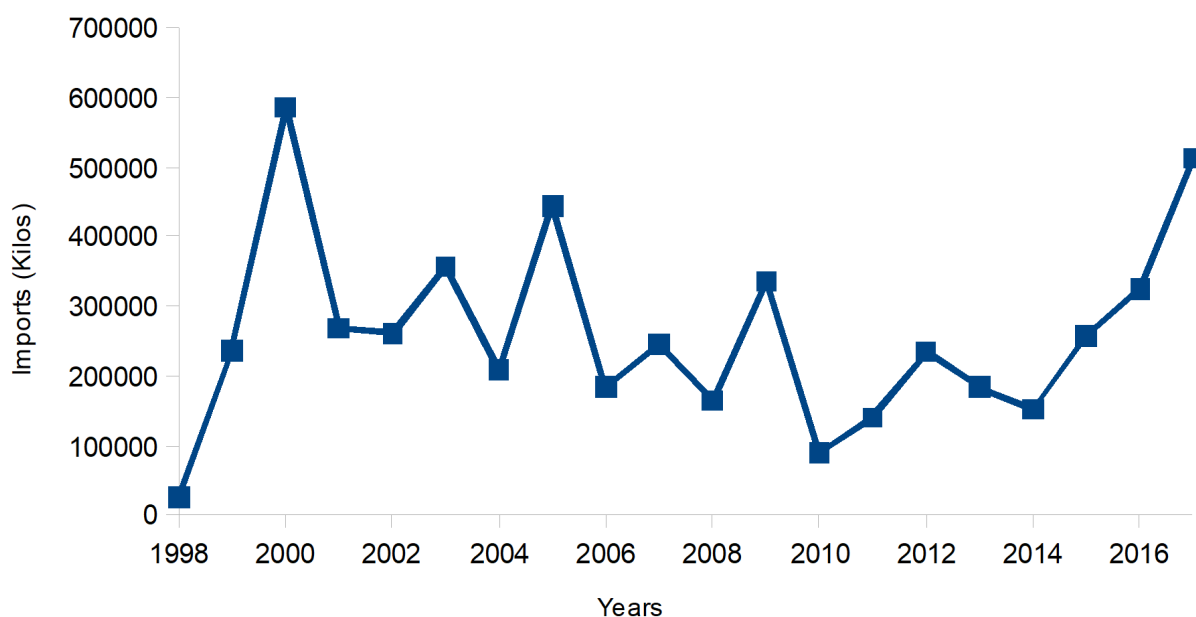


Figure 6 Imports (in kilos) of Patagonian toothfish from South Africa (also encompassing Prince Edwards Islands), from 1998-2017. Numbers from 2009 onwards may also include Antarctic toothfish, since data reported mentions NSPF input. Source: NMFS 2018b. 9

Common and market names.

Patagonian toothfish, Chilean seabass, Bacalao de profundidad, Mero.

Primary product forms

Patagonian toothfish is marketed to the US in frozen, frozen filet, and fresh forms (NMFS 2018a) (NMSF 2018b).

Assessment

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

PATAGONIAN TOOTHFISH			
Region Method	Abundance	Fishing Mortality	Score
Chile/Southeast Pacific Longline (deep-set)	1.00: High Concern	1.00: High Concern	Red (1.000)
Prince Edward Islands/Southern Ocean Longline (deep-set)	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.644)

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.

PATAGONIAN TOOTHFISH

Factor 1.1 - Abundance

CHILE/SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

High Concern

The most recent stock assessment in Chile concludes that the stock is reduced below the level of the spawning biomass limit (established at 50% B_{MSY}) in both evaluation scenarios (see figure), with a level of reduction that qualifies as depleted and in strong overfishing (Servicio Nacional de Pesca y Acuicultura 2018) (Subsecretaria de Pesca y Acuicultura 2017). Studies suggest the existence of a South American stock (Ashford et al. 2012), meaning that the stock explored in Chile is also explored by fleets in Peru and Argentina, including the Falkland Islands, so fishing impacts on the stock from these regions must also be taken into account. In Chile, it is stated as overexploited since 2013, and as depleted since 2017 (Subsecretaria de Pesca y Acuicultura 2018c). Current biomass is estimated to be at 19% of B_0 (Subsecretaria de Pesca y Acuicultura 2018d). Because the stock is below the 20% threshold and is stated as depleted, abundance for Patagonian toothfish is deemed to be a "high" conservation concern.

Justification:

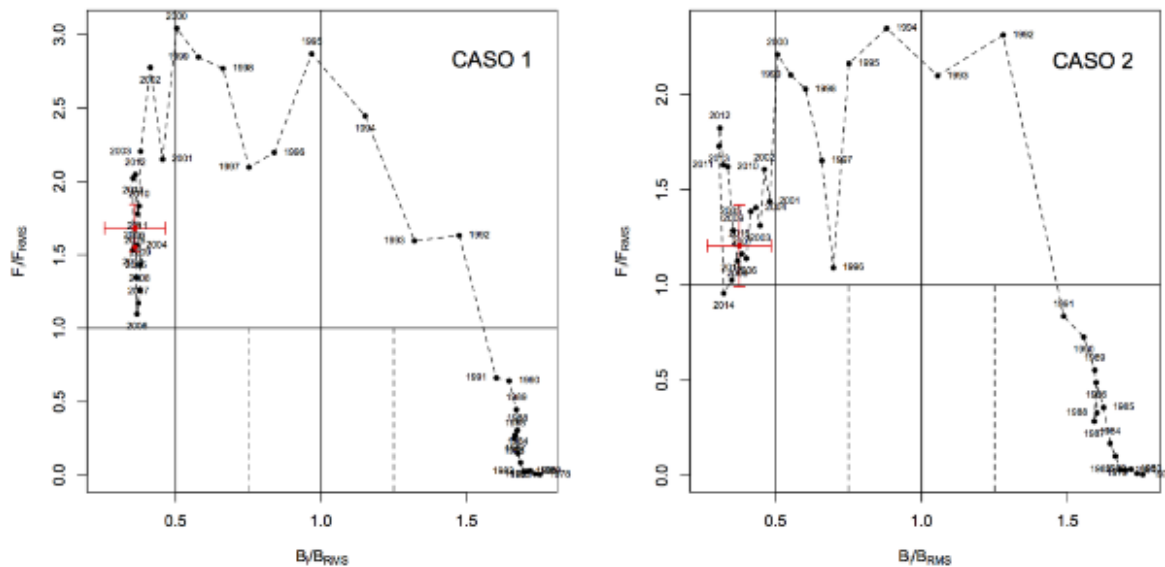


Figura 1: Estatus del bacalao de profundidad para los dos casos de estudio (Caso 1: Stock Patagónico; Caso 2: Stock nacional). Tomado de IFOP (Tascheri, 2017).

Figure 7 Patagonian toothfish stock status for the Patagonian stock (Caso 1) and the Chilean-national stock (Caso 2). Source: Subsecretaria de Pesca y Acuicultura 2017.

PRINCE EDWARD ISLANDS/SOUTHERN OCEAN, LONGLINE (DEEP-SET)

Moderate Concern

Current standing stock of Patagonian toothfish is estimated between 25,000 to 28,000 t, and this value is still seen as low considering that IUU fishing alone would likely catch around 30,000 t in the early 1990s (R. Ball, personal communication 2018). Estimates on the stock are made yearly based on catch per unit effort (CPUE) and tagged specimens returns (CCAMLR 2017) (CCAMLR 2018) (R. Ball, personal communication 2018). Because of recent gear changes, a base case that includes long-term data is not possible because there isn't a CPUE series for one type of gear for the whole period of the fishery; however, the assessment data does use all information available (Brandão and Butterworth 2017). The most recent estimates indicate a stock fluctuating between 41% and 49% of B_0 (Brandão and Butterworth 2017). Because there is still caution from the working group that yearly assesses this stock, due to different components of the data having different impacts on the estimation of the status of the resource (Brandão and Butterworth 2017), a more precautionary score is given. Also, uncertainties regarding such estimates include the high level of depredation known to this fishery, IUU catch (de Moor et al. 2015), and if the assessment model encompasses the entire species' range (M. Belchier, personal communication 2019). A Productivity-Susceptibility Analysis (PSA) was performed to corroborate the score of "moderate concern" (PSA result = 2.986, medium vulnerability, see values below).

Productivity attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
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Average age at maturity	6 to 10 years (males), 10 to 13 years (females) (Collins et al. 2010)	2
Average maximum age	50 years (Collins et al. 2010)	3
Fecundity	177,000 to 424,800 eggs (Arana 2009)	1
Average maximum size (fish only)	230 cm (Collins et al. 2010)	2
Average size at maturity (fish only)	57.7 to 105 cm (male) and 80 to 128.7 (female) (Collins et al. 2010)	2
Reproductive strategy	Broadcast spawner (Collins et al. 2010)	1
Trophic level	4 (Froese and Pauly 2018)	3
Habitat quality	Robust (bathydemersal, usually at 400 to 800 m deep; (Collins et al. 2010)	1
Productivity score	-	1.875

Susceptibility attribute	Relevant information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (considers all fisheries)	Species occurs in South America (southern shelves and slopes) and in the Southern Ocean (sub-Antarctic islands) (Collins et al. 2010). Species is highly targeted throughout its distribution.	3
Vertical overlap (considers all fisheries)	Species is targeted; default value is used.	3
Selectivity of fishery (specific to fishery under assessment)	Species is targeted and "high risk" conditions do not apply.	2
Post-capture mortality (specific to fishery under assessment)	Species is retained.	3
Susceptibility score	—	2.33

Factor 1.2 - Fishing Mortality

CHILE/SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

High Concern

Historical landings data indicate a decline in catches since the early 90s (Servicio Nacional de Pesca y Acuicultura 2018), where fishing mortality rates started oscillating above the sustainable threshold ($F/F_{MSY} = 1$), with F being as high as 3 times F_{MSY} in 2000 ((Subsecretaria de Pesca y Acuicultura 2017); see figure in the Abundance score section). Currently, the F/F_{MSY} rate is estimated to be around 1.7; however, actual values are not available (Subsecretaria de Pesca y Acuicultura 2017). Because fishing mortality has been above the sustainable level for a few decades, this factor receives a score of "high" concern.

PRINCE EDWARD ISLANDS/SOUTHERN OCEAN, LONGLINE (DEEP-SET)

Moderate Concern

Although fishing mortality is unknown, TACs are determined on a year basis, and this year it was set at 575 t (CCAMLR 2017) (FAO 2018) (Brandão and Butterworth 2017). There are concerns regarding IUU and whale depredation in the area of species range, which may impact the reported numbers (Towers et al. 2018) (Arangio 2012), even though IUU has not been recorded in the South African EEZ since 2005 (de Moor et al. 2015). Because fishing mortality is unknown, this factor receives a score of "moderate" concern.

Criterion 2: Impacts on Other Species

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

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

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

Guiding Principles

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

Criterion 2 Summary

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

PATAGONIAN TOOTHFISH - CHILE/SOUTHEAST PACIFIC - LONGLINE (DEEP-SET)					
Subscore:	1.732	Discard Rate:	1.00	C2 Rate:	1.732
Species	Abundance	Fishing Mortality	Subscore		
Yellownose skate	1.00:High Concern	3.00:Moderate Concern	Red (1.732)		
Ridge scaled rattail	1.00:High Concern	3.00:Moderate Concern	Red (1.732)		
Corals and other biogenic habitats	1.00:High Concern	3.00:Moderate Concern	Red (1.732)		
Roughskin ray	1.00:High Concern	3.00:Moderate Concern	Red (1.732)		
Benthic inverts	1.00:High Concern	5.00:Low Concern	Yellow (2.236)		
Bigeye grenadier	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)		
Chilean grenadier	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)		
Banded whiptail	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)		
Blue Antimora	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)		

PATAGONIAN TOOTHFISH - PRINCE EDWARD ISLANDS/SOUTHERN OCEAN - LONGLINE (DEEP-SET)					
Subscore:	1.732	Discard Rate:	1.00	C2 Rate:	1.732
Species	Abundance	Fishing Mortality	Subscore		
Corals and other biogenic habitats	1.00:High Concern	3.00:Moderate Concern	Red (1.732)		
Skates (unspecified)	1.00:High Concern	3.00:Moderate Concern	Red (1.732)		
Benthic inverts	1.00:High Concern	5.00:Low Concern	Yellow (2.236)		
Seabirds	1.00:High Concern	5.00:Low Concern	Yellow (2.236)		
Grenadiers (unspecified)	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)		

The stocks assessed under Criterion 2 were selected based on the main reported species from the most recent available bycatch statements (CCAMLR 2017) (Subsecretaria de Pesca y Acuicultura 2018b). Observer data covers about 50% of the Chilean fleet (Subsecretaria de Pesca y Acuicultura 2018b): therefore, a disclaimer is made that other species could be included/removed if the observer coverage was higher. Other groups included were based on the gear assessed in this report (longline, deep-set) and region according to the Unknown Bycatch Matrix. Seabirds and Marine Mammals were not included in the assessment for Chile, because the bycatch reduction plan shows little to zero impact on these species groups (e.g., for seabirds, bycatch from the latest years were zero in most years, with three dead seabirds in a single year) (Subsecretaria de Pesca y Acuicultura 2018b). Seabirds were included in the assessment for Prince Edward Island because the region is a high risk area for bird incidents (CCAMLR 2017). Benthic invertebrates, corals, and other biogenic habitats were included in the assessment for both Chile and Prince Edward Island because information regarding the presence and impacts of this fishery on such habitats are not consistent.

For the longline fishery in Chile, corals/biogenic habitat, ridge scaled rattail, roughskin ray, and yellownose skate limit the score for Criterion 2 because of potential harm the gear may cause to corals, because yellownose skate is an IUCN species that is "Vulnerable" to severe decline from overfishing, and because ridge scaled rattail and roughskin ray have high vulnerability.

For the longline fishery of Prince Edward Island, corals/biogenic habitats limited the score for Criterion 2 due to potential harm the gear may cause to this group. Skates (unspecified) also limited the score for Criterion 2 due to their high vulnerability status.

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance

(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality

(same as Factor 1.2 above)

CORALS AND OTHER BIOGENIC HABITATS

Factor 2.1 - Abundance

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

High Concern

Corals and other biogenic habitats were included in the assessment because of potential harm the gear may cause to this group. There is no information regarding specific impacts from this fishery in Prince Edward Island over biogenic habitats; therefore, the standard score of "high" concern was attributed to this group, according to the Unknown Bycatch Matrix.

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

High Concern

Corals/other biogenic habitats were included in the assessment because of potential harm the gear may cause to this group. There is no information regarding specific impacts from this fishery in Chile over such habitats; therefore, the standard score of "high" concern was attributed to this group, according to the Unknown Bycatch Matrix.

Factor 2.2 - Fishing Mortality

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

Moderate Concern

The bycatch score from Unknown Bycatch Matrix for biogenic habitats is set for "moderate" concern (UBM score = 3) for this type of gear; however, recent gear modification seems to cause less impact on the substrate (Brown et al. 2012). Because no other information was available, the score of "moderate" concern was maintained.

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

Moderate Concern

The bycatch score from the Unknown Bycatch Matrix for biogenic habitats is set for "moderate" concern (UBM score = 3) for this type of gear; however, recent gear modification seems to cause less impact on the substrate (Brown et al. 2012). Because no other information was available, the score of "moderate" concern was maintained.

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

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

< 100%

Usually, bycatch in this fishery does not surpass 10% of total catch (CCAMLR 2017).

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

< 100%

The discard rate in this fishery corresponds to less than 15% in the last reported statistics (Subsecretaria de Pesca y Acuicultura 2018b).

Justification:

Año	Especie	Capt. Retenida (t)	Capt. Descartada (t)	Capt. Total (t)	%Descarte/Capt. Descartada	%Descarte/Capt. Total
2015	Bacalao de profundidad	597	51	647	57,1%	7,30%
	Raya volantín	0	15	15	17,1%	2,20%
	Peje rata grande	6	7	12	7,6%	1,00%
	Granadero patagónico	3	5	8	5,4%	0,70%
	Raya espinosa	0	4	4	4,5%	0,60%
	raya de magallanes	0	2	2	2,5%	0,30%
	Otras especies	0,1	5	5	5,6%	0,70%
	Total	605	88	694	100,0%	12,7%
2016	Bacalao de profundidad	1719	31	1750	41,1%	1,70%
	Granadero chileno	13	16	29	21,4%	0,90%
	Antimora	0,05	11	11	14,2%	0,60%
	Rata café	2	7	9	8,8%	0,40%
	Raya espinosa	0	5	5	7,0%	0,30%
	Peje rata grande	26	5	31	6,5%	0,30%
	Raya volantín	0	1	1	1,1%	0,05%
	Total	1760	75	1835	100,0%	4,1%

Figure 8 Estimates of retained and discarded catch of main species captured in the Chilean seabass deepset longline fishery, 2015 and 2016. Source: Subsecretaria de Pesca y Acuicultura 2018b.

SKATES (UNSPECIFIED)

Factor 2.1 - Abundance

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

High Concern

Skates are highly vulnerable to fisheries due to their life history (long-lived, late maturity, etc.) and receive a UBM "high vulnerability" score. Data available for this group in Prince Edward Island does not include species composition. This factor is scored as "high" concern because of the "high vulnerability" status set in the UBM.

Factor 2.2 - Fishing Mortality

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

Moderate Concern

There are bycatch limits established for skates in the Patagonian toothfish fishery at Prince Edward Island; for the past 10 years the highest catch recorded was 3 tons (in 2011) (CCAMLR 2017). There are also records of rajids released alive since 2009 (CCAMLR 2017), and studies show that survivorship is very likely, particularly in shallower waters (i.e., 1200 to 1300 m deep) (Endicott and Agnew 2004). Because the individual fishery's contribution to fishing mortality is unknown, a score of "moderate" concern is given for this factor.

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

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

< 100%

Usually, bycatch in this fishery does not surpass 10% of total catch (CCAMLR 2017).

YELLOWNOSE SKATE

Factor 2.1 - Abundance

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

High Concern

Yellownose skate is among the common bycatch species in the Chilean seabass fishery (Subsecretaria de Pesca y Acuicultura 2018b). The most recent available stock and abundance assessment is from IUCN, where the species holds a "Vulnerable" status (Kyne et al. 2007), mainly due to decline in biomass from overexploitation. Because the IUCN assessment classifies the species as "Vulnerable," this criterion is scored as "high" concern.

Factor 2.2 - Fishing Mortality

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

Moderate Concern

Yellownose skate is bycatch in some fisheries in Chile, including longline and bottom trawl targeting yellow squat lobster, nylon shrimp, and red squat lobster, and in purse seine fisheries (D'Amico 2007) (Kyne et al. 2007) (Queirolo et al. 2011). Currently, this species is discarded in the Patagonian toothfish fishery because of regulations (annual catch quota and discard guidelines) and is now listed as a species associated with Patagonian toothfish (Subsecretaria de Pesca y Acuicultura 2018b). In 2015, fifteen MT of this species was reportedly discarded in this fishery, whereas in 2016, only one ton was caught (Subsecretaria de Pesca y Acuicultura 2018b). Although the catch is low when compared to previous records (Kyne et al. 2007), this factor is deemed as a "moderate" concern because there is not enough evidence that species population is being captured at sustainable levels, especially when considering the IUCN "Vulnerable" status.

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

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

< 100%

The discard rate in this fishery corresponds to less than 15% in the last reported statistics (Subsecretaria de Pesca y Acuicultura 2018b).

Justification:

Año	Especie	Capt. Retenida (t)	Capt. Descartada (t)	Capt. Total (t)	%Descarte/Capt. Descartada	%Descarte/Capt. Total
2015	Bacalao de profundidad	597	51	647	57,1%	7,30%
	Raya volantín	0	15	15	17,1%	2,20%
	Peje rata grande	6	7	12	7,6%	1,00%
	Granadero patagónico	3	5	8	5,4%	0,70%
	Raya espinosa	0	4	4	4,5%	0,60%
	raya de magallanes	0	2	2	2,5%	0,30%
	Otras especies	0,1	5	5	5,6%	0,70%
	Total	605	88	694	100,0%	12,7%
2016	Bacalao de profundidad	1719	31	1750	41,1%	1,70%
	Granadero chileno	13	16	29	21,4%	0,90%
	Antimora	0,05	11	11	14,2%	0,60%
	Rata café	2	7	9	8,8%	0,40%
	Raya espinosa	0	5	5	7,0%	0,30%
	Peje rta grande	26	5	31	6,5%	0,30%
	Raya volantín	0	1	1	1,1%	0,05%
	Total	1760	75	1835	100,0%	4,1%

Figure 9 Estimates of retained and discarded catch of main species captured in the Chilean seabass deepset longline fishery, 2015 and 2016. Source: Subsecretaria de Pesca y Acuicultura 2018b.

RIDGE SCALED RATTAIL

Factor 2.1 - Abundance

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

High Concern

A formal stock assessment and abundance data are not available for ridge scaled rattail, which is among the common bycatch species in the Chilean seabass fishery (Subsecretaria de Pesca y Acuicultura 2018b). The species is known for being abundant, and there is an estimate for ridged scaled rattail biomass in international waters in the Southern Ocean, ranging from 116,000 to 212,000 t (Devine et al. 2012) (Laptikhovski 2011) (Laptikhovsky et al. 2008); however, biomass values for Chile were not available. For this reason, a productivity-susceptibility analysis (PSA) was used for the species. Some of the species information required for the PSA was unavailable. The PSA score equals 3.6867, so the species is deemed to have high vulnerability. Detailed scoring of each attribute is shown below. Ridge scaled rattail is "highly vulnerable" (according to the PSA analysis) and there is no formal stock assessment; therefore, abundance is deemed as "high" concern.

Productivity attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	17 years (van Wijk et al. 2003)	3
Average maximum age	37 years (Laptikhovski et al. 2008)	3
Fecundity	n/a	-
Average maximum size (fish only)	100 cm (Cohen et al. 1990)	2
Average size at maturity (fish only)	41.8 cm (van Wijk et al. 2003)	2
Reproductive strategy	Broadcast spawner (Laptikhovski 2011)	1
Trophic level	3.6 (Giussi et al. 2010)	3
Habitat quality	Robust (bathodemersal, usually at 500 to 800 m deep (Cohen et al. 1990)	1
Productivity score	-	2.14

Susceptibility attribute	Relevant information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (considers all fisheries)	Ridge scaled rattail occurs in many parts of the Southern Ocean and subantarctic to temperate waters in the Southern Atlantic, Indian, and Pacific Oceans (Froese and Pauly 2018); it is susceptible to various fishing activities, particularly bottom-trawling and deep-set longlines (Subsecretaria de Pesca y Acuicultura 2018b) (CCAMLR 2016). Because no more specific information was available, default value was used.	3
Vertical overlap (considers all fisheries)	The species is known as bycatch in trawl, deepset longlines, and other commercial and artisanal fisheries (Subsecretaria de Pesca y Acuicultura 2018b) (Queirolo et al. 2011). A study in the Falkland Islands demonstrates great overlap between the depth range at which the species is most abundant and longline fishery (Laptikhovsky et al. 2008).	3
Selectivity of fishery (specific to fishery under assessment)	A study carried out in the Falkland Islands show greater female bycatch selectivity, due to size of hooks; male individuals are usually smaller and are less likely to be captured (Laptikhovsky et al. 2008).	3
Post-capture mortality (specific to fishery under assessment)	Bycatch is both retained as well as discarded (Subsecretaria de Pesca y Acuicultura 2018b). Earlier in 2018, the Chilean government published a bycatch reduction plan specific to the Patagonian toothfish fishery, with direct guidelines for bycatch release/discard that would ideally guarantee post release survival (Subsecretaria de Pesca y Acuicultura 2018b). However, information regarding effectiveness will only become available in the upcoming years of implementing this reduction plan. To err on the side of caution, this item was scored as "high risk."	3
Susceptibility score		3

Factor 2.2 - Fishing Mortality

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

Moderate Concern

Ridged scaled rattail is a bycatch in both longline and bottom trawl fisheries in Chile (D'Amico 2007) (Subsecretaria de Pesca y Acuicultura 2018b). Currently, this species is both discarded and retained in the Patagonian toothfish fishery and the most recent data reports a catch of 9 MT of this species in this fishery (Subsecretaria de Pesca y Acuicultura 2018b). However, because the individual fishery's contribution to fishing mortality is unknown, a score of "moderate" concern is used for this factor.

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

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

< 100%

The discard rate in this fishery corresponds to less than 15% in the last reported statistics (Subsecretaria de Pesca y Acuicultura 2018b).

Justification:

Año	Especie	Capt. Retenida (t)	Capt. Descartada (t)	Capt. Total (t)	%Descarte/Capt. Descartada	%Descarte/Capt. Total
2015	Bacalao de profundidad	597	51	647	57,1%	7,30%
	Raya volantín	0	15	15	17,1%	2,20%
	Peje rata grande	6	7	12	7,6%	1,00%
	Granadero patagónico	3	5	8	5,4%	0,70%
	Raya espinosa	0	4	4	4,5%	0,60%
	raya de magallanes	0	2	2	2,5%	0,30%
	Otras especies	0,1	5	5	5,6%	0,70%
	Total	605	88	694	100,0%	12,7%
2016	Bacalao de profundidad	1719	31	1750	41,1%	1,70%
	Granadero chileno	13	16	29	21,4%	0,90%
	Antimora	0,05	11	11	14,2%	0,60%
	Rata café	2	7	9	8,8%	0,40%
	Raya espinosa	0	5	5	7,0%	0,30%
	Peje rta grande	26	5	31	6,5%	0,30%
	Raya volantín	0	1	1	1,1%	0,05%
	Total	1760	75	1835	100,0%	4,1%

Figure 10 Estimates of retained and discarded catch of main species captured in the Chilean seabass deepset longline fishery, 2015 and 2016. Source: Subsecretaria de Pesca y Acuicultura 2018b.

ROUGHSKIN RAY

Factor 2.1 - Abundance

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

High Concern

Roughskin ray is among the common bycatch species in the Chilean seabass fishery (Subsecretaria de Pesca y Acuicultura 2018b). A recent stock assessment and abundance data were not available for roughskin ray, but the species holds a "Vulnerable" status from an outdated IUCN assessment (Lamilla and Massa 2007). For this reason, a Productivity-Susceptibility Analysis (PSA) was used for the species. The PSA score equals 3.75, so the species is deemed to have high vulnerability. Detailed scoring of each attribute is shown below. Roughskin ray is highly vulnerable (according to the PSA analysis) and there is no recent stock assessment; therefore, abundance is scored as "high" concern.

Productivity attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	12.6 years (Lamilla and Massa 2007)	2
Average maximum age	21 years (Lamilla and Massa 2007)	2
Fecundity	28-68 follicles (Licandeo et al. 2006a)	3
Average maximum size (fish only)	250 cm (Lamilla and Massa 2007)	2
Average size at maturity (fish only)	215 cm female; 195 male (Licandeo et al. 2006a)	3
Reproductive strategy	Demersal egg layer (Dulvy and Reynolds 1997)	2
Trophic level	3.9 (based on closest relatives (Froese and Pauly 2018)	3
Habitat quality	Robust (bathodemersal, depth range between 93 to 450 m over sandy and muddy bottom sediments (Lamilla and Massa 2007)	1
Productivity score		2.25

Susceptibility attribute	Relevant information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (considers all fisheries)	The species is known for having a relatively limited distribution, making it susceptible to various fisheries (Lamilla and Massa 2007).	3
Vertical overlap (considers all fisheries)	The species is known as bycatch in trawl, deepset longlines, and other commercial and artisanal fisheries (Subsecretaria de Pesca y Acuicultura 2018b) (Queirolo et al. 2011).	3
Selectivity of fishery (specific to fishery under assessment)	There are reports of bycatch of immature individuals (Lamilla and Massa 2007).	3
Post-capture mortality (specific to fishery under assessment)	All bycatch for this species is reported to be discarded (Subsecretaria de Pesca y Acuicultura 2018b). Earlier in 2018, the Chilean government published a bycatch reduction plan specific to the Patagonian toothfish fishery, with direct guidelines for bycatch release/discard that would ideally guarantee post release survival (Subsecretaria de Pesca y Acuicultura 2018b). However, information regarding effectiveness will only become available in the upcoming years of implementing this reduction plan. To err on the side of caution, this item was scored as "high risk."	3
Susceptibility score		3

Factor 2.2 - Fishing Mortality

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

Moderate Concern

Roughskin ray is a bycatch in both longline and bottom trawl fisheries in Chile (D'Amico 2007) (Subsecretaria de Pesca y Acuicultura 2018b). Currently, this species is discarded in the Patagonian toothfish fishery because of regulations (annual catch quota and discard guidelines) (Subsecretaria de Pesca y Acuicultura 2018b). The most recent bycatch report estimates catches at 4 and 5 MT for roughskin ray (all discarded) (Subsecretaria

de Pesca y Acuicultura 2018b). However, because individual fishery's contribution to fishing mortality is unknown, a score of "moderate" concern is used for this factor.

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

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

< 100%

The discard rate in this fishery corresponds to less than 15% in the last reported statistics (Subsecretaria de Pesca y Acuicultura 2018b).

Justification:

Año	Especie	Capt. Retenida (t)	Capt. Descartada (t)	Capt. Total (t)	%Descarte/Capt. Descartada	%Descarte/Capt. Total
2015	Bacalao de profundidad	597	51	647	57,1%	7,30%
	Raya volantín	0	15	15	17,1%	2,20%
	Peje rata grande	6	7	12	7,6%	1,00%
	Granadero patagónico	3	5	8	5,4%	0,70%
	Raya espinosa	0	4	4	4,5%	0,60%
	raya de magallanes	0	2	2	2,5%	0,30%
	Otras especies	0,1	5	5	5,6%	0,70%
	Total	605	88	694	100,0%	12,7%
2016	Bacalao de profundidad	1719	31	1750	41,1%	1,70%
	Granadero chileno	13	16	29	21,4%	0,90%
	Antimora	0,05	11	11	14,2%	0,60%
	Rata café	2	7	9	8,8%	0,40%
	Raya espinosa	0	5	5	7,0%	0,30%
	Peje rata grande	26	5	31	6,5%	0,30%
	Raya volantín	0	1	1	1,1%	0,05%
	Total	1760	75	1835	100,0%	4,1%

Figure 11 Estimates of retained and discarded catch of main species captured in the Chilean seabass deepset longline fishery, 2015 and 2016. Source: Subsecretaria de Pesca y Acuicultura 2018b.

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.

Criterion 3 Summary

Fishery	Management Strategy	Bycatch Strategy	Research and Monitoring	Enforcement	Stakeholder Inclusion	Score
Fishery 1: Chile / Southeast Pacific Longline (deep-set)	Ineffective	Moderately Effective				Red (1.000)
Fishery 2: Prince Edward Islands / Southern Ocean Longline (deep-set)	Moderately Effective	Highly Effective	Highly Effective	Moderately Effective	Highly Effective	Yellow (3.000)

Criterion 3 Assessment

Factor 3.1 - Management Strategy and Implementation

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

Ineffective

Both artisanal and industrial fleets undergo annual catch allowances, divided by both region and season (two per year) (Maturana 2017) (Grossi 2017), where registered vessels are expected to inform all catch and corresponding region. Industrial quota includes an amount of catch for research purposes. Because the most recent species assessments indicate that Patagonian toothfish is depleted and the stock is currently at 19% of B_0 (Subsecretaria de Pesca y Acuicultura 2017) (Subsecretaria de Pesca y Acuicultura 2018) (Subsecretaria de Pesca y Acuicultura 2018d), caution should be used for this criteria. It is likely that current management measures have not been enough to secure stock recovery over the years. Currently, there is a Patagonian toothfish management committee that meets regularly and is developing a management plan to recover the stock (Subsecretaria de Pesca y Acuicultura 2018d). However, because a management plan is not in place yet to be evaluated, this factor is deemed "ineffective," but may be re-assessed once a recovery plan is implemented.

Justification:

Región	1 de marzo - 31 de mayo	2 de octubre - 31 de diciembre	Cuota Global Anual de captura, fracción artesanal (N 47° L.S.)
Macrozona Norte	72,401	72,400	144,801
V	115,565	115,565	231,130
VI	0,024	0,024	0,048
VII	97,485	97,486	194,971
XVI-VIII	362,074	362,074	724,148
IX	4,856	4,856	9,712
XIV	156,009	156,009	312,018
X	43,332	43,332	86,664
XI (N 47°LS)	0,254	0,254	0,508
TOTAL	852,000	852,000	1704,000

Figure 17 2018 annual quota for Patagonian toothfish for the artisanal fleet in Chile. Source: Maturana 2017.

CUOTA DE CAPTURA DE BACALAO DE PROFUNDIDAD, 2018 - U. DE PESQUERIA (al Sur del 47°LS)		
ITEM	Monto	Unidades
CUOTA GLOBAL DE CAPTURA	1.902	toneladas
Deducciones a la Cuota Global de Captura		
Cuota para Investigación (Prog. Marc.y Recapt.)	22	toneladas
Fauna Acompañante	0	toneladas
Cuota Objetivo	1.880	toneladas
Fracción de la Cuota a Licitar (10% de la Cuota Objetivo)	188,00	toneladas
5% Fracción a Licitar entre Armadores Artesanales	94,00	toneladas
5% Fracción a Licitar entre Armadores Industriales	94,00	toneladas

Figure 18 2018 annual quota for Patagonian toothfish for the industrial fleet in Chile. Source: Grossi 2017.

Moderately Effective

"Fisheries operations and management are governed by the South African Marine Living Resources Act" (R. Ball, personal communication 2018), and the region complies with all general regulations established by CCAMLR for this fishery (CCAMLR 2017). Each vessel must have two official observers aboard, must comply with the fishing season (which lasts about 11 months) and all catches are monitored by the South African Marine Resources Authorities, which follows CCAMLR's Toothfish Catch Documentation Scheme (COLTO 2018b). There is an annual total allowable catch (TAC), currently at 575 t for 2017/2018; 11.4% of it is unallocated (R. Ball, personal communication 2018), which is decided by an international panel of experts (COLTO 2018b): TAC follows assessments which are fitted to commercial CPUE and proportion-at-length data (with uncertainties as a result of conflicting CPUE and catch-at-length trends) (de Moor et al. 2015). In the past, the region had severe presence of IUU fishing, which caused decline in the population. During past years, there hasn't been indication of IUU fishing occurring in the area (CCAMLR 2017). Estimates on fishing mortality and stock population are still currently viewed with caution, since different components of the data have different impacts on the estimation of the resource status (de Moor et al. 2015) (Brandão and Butterworth 2017). The stock is closely managed, including clear targets set by scientific advice and there is evidence of its implementation; however, because data on biomass and fishing mortality are not robust, this factor is deemed "moderately effective."

Justification:

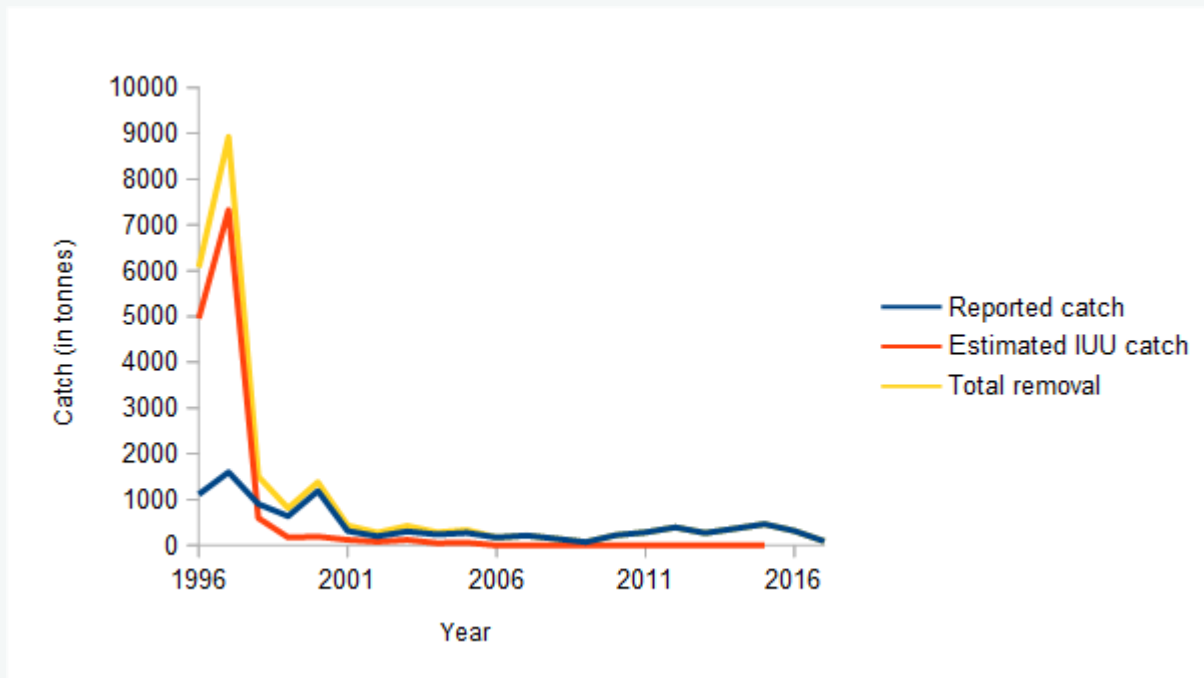


Figure 19 Catch history for Patagonian toothfish in the South African EEZ and estimated IUU catches in tonnes. Reported catch data up to September, 2017 (Source: CCAMLR 2017).

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.

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

Moderately Effective

In 2012, the Government in Chile released the "Discards Law" 20.625 to better address monitoring and inspection of discards in fishing activities, particularly against the incidental mortality of non-commercial species in the catches. In February 2018, a Discards Reducing Plan was published specifically for the Patagonian toothfish fishery, with distinguishing guidelines to reduce bycatch (Subsecretaria de Pesca y Acuicultura 2018b). Such guidelines include capacity building, a good practice code to decrease bycatch, regulations, and quotas for some of the most vulnerable bycatch (such as skates and rays) (Subsecretaria de Pesca y Acuicultura 2018b). The Chilean longline gear system includes "cachaloterías," which are netting sleeves that cover fishing hooks. This device also has weights attached to sink it quickly, preventing marine mammals as well as seabirds, from accessing baited hooks during hauling. This strategy has proved to be highly effective in preventing marine mammals and seabird bycatch (COLTO 2018a); it also seems to cause less impact on the substrate (Brown et al. 2012). However, there are concerns that the use of cachaloterías could lead to higher discard mortality for elasmobranchs, and this might be confirmed with a higher level of observer coverage (M. Belchier, personal communication 2019). TACs, fishing season, and designated fishing grounds are yearly established for licensed vessels (Grossi 2017)(Subsecretaria de Pesca y Acuicultura 2017). Current bycatch still contain vulnerable species such as elasmobranchs, including species with IUCN status (e.g., yellownose skate) and management has not been in place long enough to prove its effectiveness; therefore, this factor is deemed "moderately effective."

Justification:

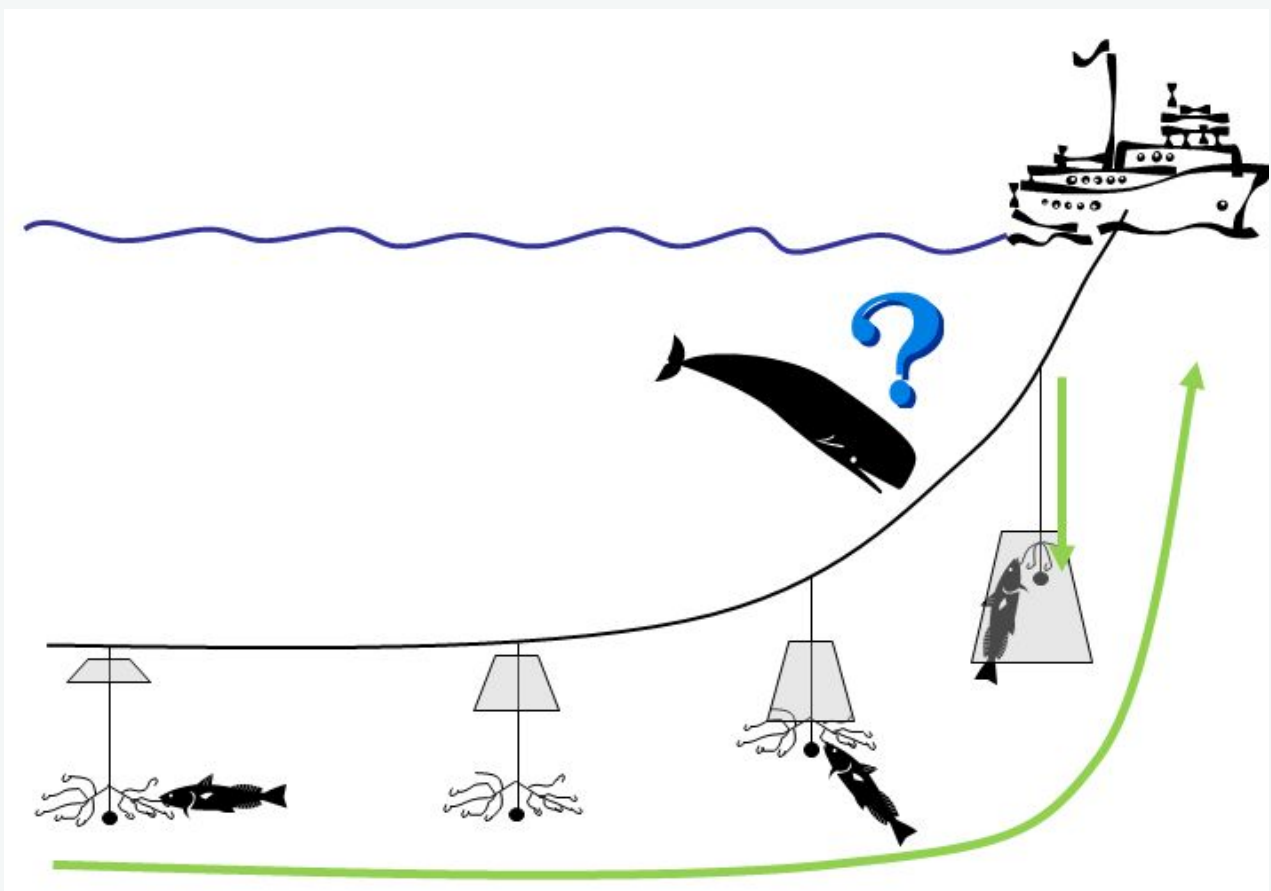


Figure 20 Diagram showing the cachalotería setup for the Chilean Longline system. Source: COLTO 2018

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

Highly Effective

Bycatch strategies directed to avoid unwanted capture of seabirds and marine mammals have been in place: there has been no record of seabird death since 2012, and no mortality of marine mammals for over 10 years (CCAMLR 2017) (COLTO 2018a) and also seems to cause less impact on the substrate (Brown et al. 2012). Cachaloteras are used in both vessels to reduce whale depredation (R. Ball, personal communication 2018); however, the use of such gear could lead to higher discard mortality for elasmobranch (M. Belchier, personal communication 2019). The three no-take zones within the MPA created in 2013 aim to improve recovery of bycatch that was once severely impacted by this fishery (CCAMLR 2017) (MCI 2018). Other still common bycatch, such as rajids and macrourids, are under catch limits (5 and 16% of total catch, respectively) (CCAMLR 2017). Since 2002, CCAMLR has recommended that live skates and rays should be cut from the line and released while still in the water (Endicott and Agnew 2004). Tagged skates and rays should not be re-released and, unless otherwise specified by scientific observers, all other skates and rays caught alive and with a high probability of survival should be released alive by vessels, by cutting snoods, and when practical, removing the hooks; the number should be recorded and reported to the Secretariat (CCAMLR 2018b). Overall, this fishery has very low bycatch (usually less than 5%) and has a precautionary strategy to minimize impacts on such species (CCAMLR 2017). This factor is deemed "highly effective" because measures are in place and updated periodically.

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.

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

Highly Effective

South Africa's Marine Living Resource Act requires the Department of Agriculture, Forestry and Fishing to use the best available scientific input every year to set TAC (South Africa 1998). For the Patagonian toothfish fishery, TAC is calculated by including CPUE values, catch-at-length data, and tagged returns, and is established towards a 2025 target to have 40% of pristine biomass by then (R. Ball, personal communication 2018). Because South Africa's fleet is very small, it is closely monitored (including bycatch and interactions with marine mammals, particularly orcas) by the government and is endorsed by independent researchers, a scientific working group and the right holders (R. Ball, personal communication 2018). This factor is deemed as "highly effective" because scientific research and monitoring criteria are fully met, since this is a small fleet to enforce.

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.

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

Moderately Effective

Two observers are present on all licensed vessels in the Prince Edward Islands fleet (COLTO 2018b). Both target and bycatch is recorded and published, following catch limits that are established based on scientific advice (CCAMLR 2017). "The South African Patagonian Toothfish fishery presently consists of 6 Rights Holders and an unallocated 11.4% of the Total Allowable Catch (TAC)" (R. Ball, personal communication). VMS is also used on all vessels. However, IUU fishing may still be occurring in subarea 58.4.4 (CCAMLR 2017), which may impact fisheries in the Prince Edward Islands due to its proximity. Enforcement follows a series of compliance measurements (e.g., (CCAMLR 2018a)); therefore, this factor is deemed "moderately effective."

Factor 3.5 - Stakeholder Inclusion

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

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

Highly Effective

Crew from fishing vessels are involved in the protection of target species and the environment, and are also involved in combating IUU fishing (COLTO 2018b). "Labour and Safety matters are also extensively legislated and our crew [has medical coverage] and are members of a Provident Fund, to which the operators pay" (R. Ball, personal communication). Because all major user groups are involved in the management, including holders' rights (COLTO 2018b), a scientific advisory board, and government agencies (R. Ball, personal communication), management is participatory and conflicts are addressed; therefore, this factor is deemed "highly effective."

Criterion 4: Impacts on the Habitat and Ecosystem

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

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

GUIDING PRINCIPLES

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

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

Region / Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Score
Chile / Southeast Pacific / Longline (deep-set)	2	+0.5	Moderate Concern	Yellow (2.739)
Prince Edward Islands / Southern Ocean / Longline (deep-set)	2	+1	Low Concern	Green (3.464)

Criterion 4 Assessment

SCORING GUIDELINES

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

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

- *5 - Fishing gear does not contact the bottom*
- *4 - Vertical line gear*
- *3 - Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.*

- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*
Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

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

- *+1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.*
- *+0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.*
- *0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

Factor 4.3 - Ecosystem-Based Fisheries Management

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

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

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

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

2

Toothfish fisheries in Chile use longline (deep-set, cachalotera or palangre Chileno type), initially adopted as an attempt to reduce catch depredation by killer whales and seabirds from being catch (COLTO 2018a). Mention has been inconclusive about the existence of the vulnerable marine ecosystem where this fishery occurs, and with the current level of uncertainty surrounding gear interaction with vulnerable marine ecosystem species, a more precautionary score was chosen.

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

2

Trotlines are the main type of longline gear used in the Patagonian toothfish fishery in Prince Edward Island (CCAMLR 2017). Information regarding vulnerable marine ecosystems (VME) are not clear for this region; however, the impacts of drop weights on the seafloor may damage VME in situ. Because of uncertainty regarding trotlines interaction with species from VME, this factor is scored with a precautionary approach.

Justification:

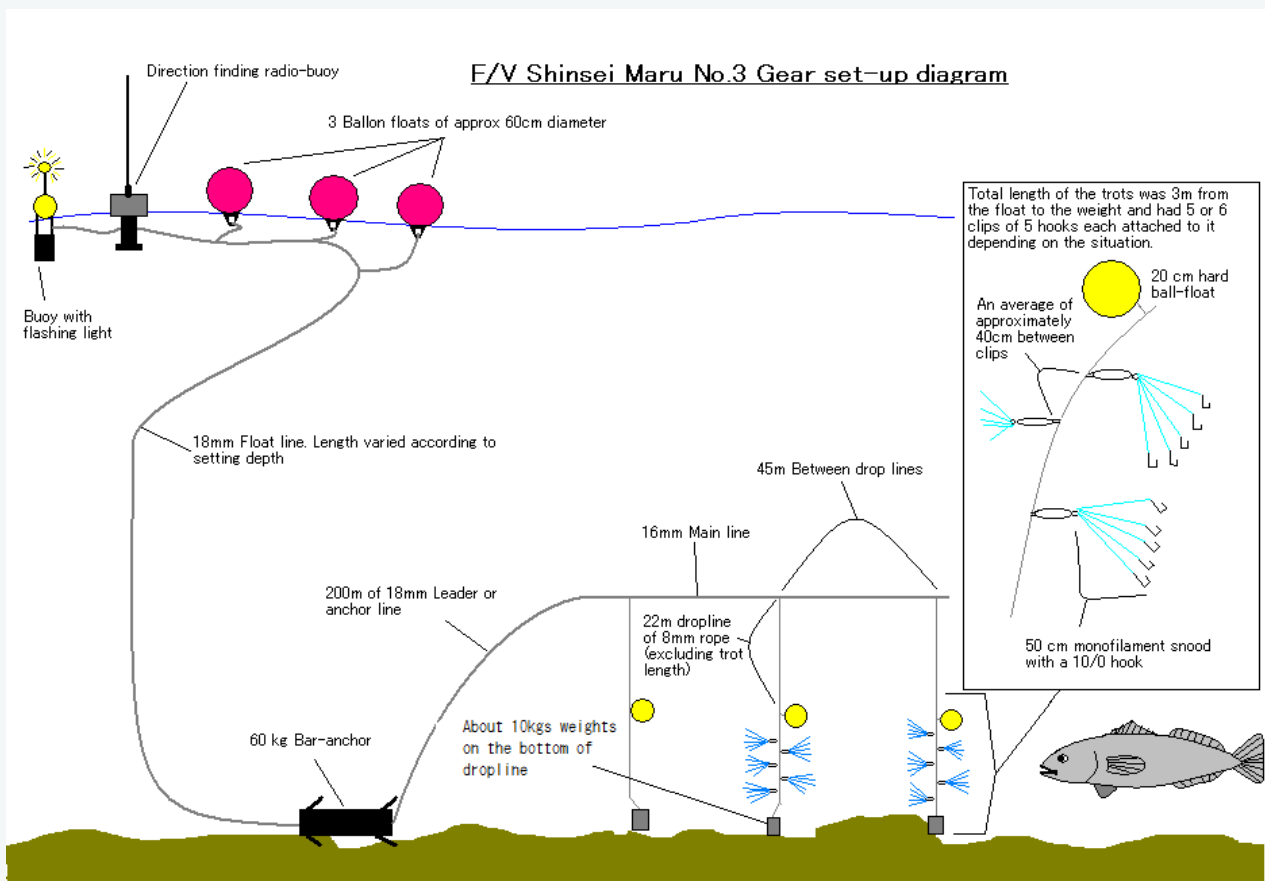


Figure 21 Trotline fishing gear. Source: Commission for the Conservation of Antarctic Marine Living Resources

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

+0.5

Although regulations to mitigate potential impacts on the seabed are not available, some of the fishing regulations may help decrease potential impacts to more vulnerable substrate. Such regulations include limited fishing area and fishing season (Subsecretaria de Pesca y Acuicultura 2018c) (Servicio Nacional de Pesca y Acuicultura 2017b) (Subsecretaria de Pesca y Acuicultura 2017). Gear modification (cachalotera) seems to have less impact on the substrate, as studies on similar gear modification indicate less loss of hooks due to snagging on benthos or substrate (Brown et al. 2012). Because such measures are reasonably expected to be effective in protecting substrate, gear impacts from the Patagonian toothfish fishery in Chile are considered to have "moderate mitigation."

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

+1

Prince Edward Island was designated a Marine Protected Area (MPA) in 2013, encompassing an area of approximately 181,230 km² of land and body of water (Protected Planet 2018), which includes four no-take IUCN 1a areas, and maintains the fishing closure within 12 nm of shore. This decision is an attempt to mitigate impacts from overfishing by IUU vessels and bycatch from Patagonian toothfish fishing (MCI 2018). The gear modifications in trotlines are also likely to cause less impacts on the sea bed than the regular demersal longlines (Brown et al. 2012). Because spatial protection is present (including restricted no-take zones) and gear modification is also adopted in this region, gear impacts from the Patagonian toothfish fishery are assumed to have a strong mitigation in the region.

Factor 4.3 - Ecosystem-Based Fisheries Management

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

Moderate Concern

Patagonian toothfish is a piscivorous species inhabiting waters 700 to 1500 m deep in the Southern Hemisphere (Sallaberry-Pincheira et al. 2018). While juvenile, they feed on abundant fish in their area (this will vary as they increase in size, which also results in changes in depth of occurrence and composition of available species at each depth) and are classified as opportunistic carnivores as adults feeding mostly on rattails (Collins et al. 2010) (Sallaberry-Pincheira et al. 2018). Predators of Patagonian toothfish while juveniles include penguins, fur seals, and elephant seals, but potential predators tend to decline as they reach maturity (mainly due to adult habitat depth) (Collins et al. 2010). Disturbances from the Patagonian toothfish fishery on the ecosystem and food web are not well studied; however, interactions with sperm and killer whales are known. These whales are opportunistic near longline fisheries and will deplete when gear is being retreated (Towers et al. 2018). The depleting behavior is also known of marine birds (Collins et al. 2010). This behavior is known to be different (both energetically and physiologically) when compared to natural foraging (Collins et al. 2010) (Towers et al. 2018).

In Chile, the mandatory use of cachaloteras to avoid depredation by whales is known to be effective in the region (COLTO 2018a). TACs, fishing season, and designated fishing grounds are yearly established for licensed vessels (Grossi 2017) (Subsecretaria de Pesca y Acuicultura 2017). Because detrimental food web impacts are not likely, despite studies targeting this issue are not available (particularly to its natural predators), this factor is deemed "moderate" concern.

Low Concern

Patagonian toothfish is a piscivorous species inhabiting waters 700 to 1500 m deep in the Southern Hemisphere (Sallaberry-Pincheira et al. 2018.). While juvenile, they feed on abundant fish in their area (this will vary as they increase their size, which also results in changes in depth of occurrence and composition of available species at each depth) and are classified as opportunistic carnivores as adults feeding mostly on rattails (Collins et al. 2010) (Sallaberry-Pincheira et al. 2018). Predators of Patagonian toothfish while juveniles include penguins, and fur and elephant seals, but potential predators tend to decline as they reach maturity (mainly due to adult habitat depth) (Collins et al. 2010). Disturbances from the Patagonian toothfish fishery on the ecosystem and food web are not well studied; however, interactions with sperm and killer whales are known. These whales are opportunistic near longline fisheries and will depredate when gear is being retreated (Towers et al. 2018). The depredating behavior is also known of marine birds (Collins et al. 2010). This behavior is known to be different (both energetically and physiologically) when compared to natural foraging (Collins et al. 2010) (Towers et al. 2018).

In Prince Edward Island, a new MPA was designated in 2013, including four no-take zones (IUCN category 1a) as a tool to mitigate ecological impacts from Patagonian toothfish fishing (MCI 2018) (Protected Planet 2018). Catch limits are established for both target and bycatch species (COLTO 2018b) (CCAMLR 2017). Cachalotes/trotlines are used to prevent whales from eating the catch; a "move on and cease fishing" rule is also enforced when sighting whales, so this eating habit is not reinforced (R. Ball, personal communication 2018). Because various rules are established for this region, including spatial management with the purpose of ecosystem recovery from this fishery, and because detrimental food web impacts are unlikely, this factor is deemed as "low" concern.

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

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Appendix A: Extra By Catch Species

BENTHIC INVERTS

Factor 2.1 - Abundance

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

High Concern

Benthic invertebrates are included because of potential harm the gear may cause to this group. There is inconsistent information regarding impacts from this fishery in Prince Edward Island over benthic invertebrates (Brown et al. 2012) (R. Ball, personal communication); therefore, the standard score was attributed to this group, according to the Unknown Bycatch Matrix. The established MPA in the region contains four IUCN 1a no-take zones (MCI 2018), but information benefiting vulnerable marine ecosystems from the no-take areas are not available. This factor is scored as "high" concern because the taxon is comprised of species of "High Vulnerability."

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

High Concern

Benthic invertebrates are included because of potential harm the gear may cause to this group. There is inconsistent information regarding impacts from this fishery over benthic invertebrates (Brown et al. 2012) and the impact from this fishery in Chile is also unclear (Subsecretaria de Pesca y Acuicultura 2018b), therefore, the standard score was attributed to this group, according to the Unknown bycatch matrix. This factor is scored with a 'high concern' because the taxon is comprised of species of high vulnerability.

Factor 2.2 - Fishing Mortality

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

Low Concern

The bycatch score from Unknown Bycatch Matrix for this group and this type of gear is set for "low" concern (UBM score = 4.5). Because no other information was available, this score was maintained.

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

Low Concern

The bycatch score from Unknown Bycatch Matrix for this group and this type of gear is set for low concern (UBM score = 4.5). Because no other information was available, this score was maintained.

Factor 2.3 - Discard Rate

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

< 100%

Usually, bycatch in this fishery does not surpass 10% of total catch (CCAMLR 2017).

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

< 100%

The discard rate in this fishery corresponds to less than 15% in the last reported statistics (Subsecretaria de Pesca y Acuicultura 2018b).

Justification:

Año	Especie	Capt. Retenida (t)	Capt. Descartada (t)	Capt. Total (t)	%Descarte/Capt. Descartada	%Descarte/Capt. Total
2015	Bacalao de profundidad	597	51	647	57,1%	7,30%
	Raya volantín	0	15	15	17,1%	2,20%
	Peje rata grande	6	7	12	7,6%	1,00%
	Granadero patagónico	3	5	8	5,4%	0,70%
	Raya espinosa	0	4	4	4,5%	0,60%
	raya de magallanes	0	2	2	2,5%	0,30%
	Otras especies	0,1	5	5	5,6%	0,70%
	Total	605	88	694	100,0%	12,7%
2016	Bacalao de profundidad	1719	31	1750	41,1%	1,70%
	Granadero chileno	13	16	29	21,4%	0,90%
	Antimora	0,05	11	11	14,2%	0,60%
	Rata café	2	7	9	8,8%	0,40%
	Raya espinosa	0	5	5	7,0%	0,30%
	Peje rta grande	26	5	31	6,5%	0,30%
	Raya volantín	0	1	1	1,1%	0,05%
	Total	1760	75	1835	100,0%	4,1%

Figure 12 Estimates of retained and discarded catch of main species captured in the Chilean seabass deepset longline fishery, 2015 and 2016. Source: Subsecretaria de Pesca y Acuicultura 2018b.

GRENADIERS (UNSPECIFIED)

Factor 2.1 - Abundance

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

Moderate Concern

Macrourids include many broad range species (Giussi et al. 2010) that, although not holding recent stock assessments, are known for having "moderate" concern regarding abundance (see PSA below, total score: 2.91). Because this group is not considered as overfished in the region (Devine et al. 2012) (Giussi et al. 2010), the score of "moderate" concern was maintained.

Productivity attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)

Average age at maturity	23 years (the most conservative value for a species in this group was used (Devine et al. 2004))	3
Average maximum age	70 years (the most conservative value for a species in this group was used (Devine et al. 2004))	3
Fecundity	97000 (the most conservative value for a species in this group was used; (Morley et al. 2004))	1
Average maximum size (fish only)	92 cm (the most conservative value for a species in this group was used (Giussi et al. 2010))	1
Average size at maturity (fish only)	21 cm (the most conservative value for a species in this group was used (Morley et al. 2004))	1
Reproductive strategy	Broadcast spawner	1
Trophic level	4.48 (the most conservative value for a species in this group was used (Devine et al. 2004))	3
Habitat quality	Robust (the most conservative value for a species in this group was used; bathydemersal at 300 to 1400 m deep (Cohen et al. 1990))	1
Productivity score	-	1,75

Susceptibility attribute	Relevant information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (considers all fisheries)	No information available; default value used	3
Vertical overlap (considers all fisheries)	Grenadiers are a common bycatch in deepset longline, trawl, and purse seine fisheries (the most conservative value for a species in this group was used; (D'Amico 2007)).	3
Selectivity of fishery (specific to fishery under assessment)	No information available; default value used	2

Post-capture mortality (specific to fishery under assessment)	Because this is a deep-sea fishing gear, post-capture release survival is unlikely. However, gear changes have decreased bycatch of this group (CCAMLR 2017) (R. Ball, personal communication).	3
Susceptibility score		2,33

Factor 2.2 - Fishing Mortality

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

Moderate Concern

For the past 10 years, catches of Macrourids have ranged from 4 to 30 MT per season (CCAMLR 2017). The catches are considered to be minimal by specialists in the region, as a result of gear changes that reduced bycatch (R. Ball, personal communication). However, because individual fishery's contribution to fishing mortality is unknown, a score of "moderate" concern is used for this factor.

Factor 2.3 - Discard Rate

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

< 100%

Usually, bycatch in this fishery does not surpass 10% of total catch (CCAMLR 2017).

BIGEYE GRENADIER

Factor 2.1 - Abundance

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

Moderate Concern

A productivity-susceptibility analysis (PSA) was used for bigeye grenadier because there are no recent stock assessments available for the species. The PSA score equals 2.8365, so the species is deemed to have "Moderate Vulnerability." Detailed scoring of each attribute is shown below. Bigeye grenadier is moderately vulnerable (according to the PSA analysis) and there is no recent stock assessment, therefore, abundance is scored as "moderate" concern.

Productivity attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	9 years (Morley et al. 2004)	2

Average maximum age	30 years (Morley et al. 2004)	3
Fecundity	97000 (Morley et al. 2004)	1
Average maximum size (fish only)	92 cm (Giusi et al. 2010)	1
Average size at maturity (fish only)	21 cm (Morley et al. 2004)	1
Reproductive strategy	Broadcast spawner	1
Trophic level	3.7 (Froese and Pauly 2018)	3
Habitat quality	Robust (bathydemersal at 300 to 1400 m deep (Cohen et al. 1990)	1
Productivity score	-	1.625

Susceptibility attribute	Relevant information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (considers all fisheries)	No information available; default value used	3
Vertical overlap (considers all fisheries)	Besides being bycatch in deepset longline targeting Chilean seabass, this species is also bycatch in trawl and purse seine fisheries (D'Amico 2007).	3
Selectivity of fishery (specific to fishery under assessment)	No information available; default value used	2

Post-capture mortality (specific to fishery under assessment)	Bycatch is both retained as well as discarded (Subsecretaria de Pesca y Acuicultura 2018b). Earlier in 2018, the Chilean government published a bycatch reduction plan specific to the Patagonian toothfish fishery, with direct guidelines for bycatch release/discard that would ideally guarantee post release survival (Subsecretaria de Pesca y Acuicultura 2018b). However, information regarding effectiveness will only become available in the upcoming years of implementing this reduction plan. To err on the side of caution, this item was scored as "high risk."	3
Susceptibility score		2.325

Factor 2.2 - Fishing Mortality

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

Moderate Concern

Bigeye grenadier is taken as bycatch in both longline and bottom trawl fisheries in Chile (D'Amico 2007) (Subsecretaria de Pesca y Acuicultura 2018b). The last reported catches are for the 2015 season at 12 MT and 31 MT for the 2016 season (Subsecretaria de Pesca y Acuicultura 2018b). The species is both discarded and retained in the Patagonian toothfish fishery (Subsecretaria de Pesca y Acuicultura 2018b). However, because the individual fishery's contribution to fishing mortality is unknown, a score of "moderate" concern is given for this factor.

Factor 2.3 - Discard Rate

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

< 100%

The discard rate in this fishery corresponds to less than 15% in the last reported statistics (Subsecretaria de Pesca y Acuicultura 2018b).

Justification:

Año	Especie	Capt. Retenida (t)	Capt. Descartada (t)	Capt. Total (t)	%Descarte/Capt. Descartada	%Descarte/Capt. Total
2015	Bacalao de profundidad	597	51	647	57,1%	7,30%
	Raya volantín	0	15	15	17,1%	2,20%
	Peje rata grande	6	7	12	7,6%	1,00%
	Granadero patagónico	3	5	8	5,4%	0,70%
	Raya espinosa	0	4	4	4,5%	0,60%
	raya de magallanes	0	2	2	2,5%	0,30%
	Otras especies	0,1	5	5	5,6%	0,70%
	Total	605	88	694	100,0%	12,7%
2016	Bacalao de profundidad	1719	31	1750	41,1%	1,70%
	Granadero chileno	13	16	29	21,4%	0,90%
	Antimora	0,05	11	11	14,2%	0,60%
	Rata café	2	7	9	8,8%	0,40%
	Raya espinosa	0	5	5	7,0%	0,30%
	Peje rata grande	26	5	31	6,5%	0,30%
	Raya volantín	0	1	1	1,1%	0,05%
	Total	1760	75	1835	100,0%	4,1%

Figure 13 Estimates of retained and discarded catch of main species captured in the Chilean seabass deepset longline fishery, 2015 and 2016. Source: Subsecretaria de Pesca y Acuicultura 2018b.

CHILEAN GRENADIER

Factor 2.1 - Abundance

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

Moderate Concern

Chilean grenadier is a deep-water, non-migratory species which ranges from Peru to central Chile (Cohen et al. 1990). Because studies on abundance for this species are not available, a PSA analysis was performed. Some information provided are from close species, detailed in the table below. The PSA score equals 2.8606, so the species is deemed to have medium vulnerability. Chilean grenadier has "moderate vulnerability" (according to the PSA analysis) and there is no formal stock assessment; therefore, abundance is deemed to be a "moderate" concern.

Productivity attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	n/a	-
Average maximum age	19 (based on close species <i>C. fasciatus</i> ; see respective PSA table for references)	2
Fecundity	17000 (based on close species <i>C. fasciatus</i> ; see respective PSA table for references)	2

Average maximum size (fish only)	48 cm (Cohen et al. 1990)	1
Average size at maturity (fish only)	n/a	-
Reproductive strategy	Broadcast spawner	1
Trophic level	3.6 based on close relatives (Froese and Pauly 2018)	3
Habitat quality	Robust (bathymersal at 260 to 1480 m deep (Cohen et al. 1990)	1
Productivity score	-	1.666

Susceptibility attribute	Relevant information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (considers all fisheries)	No information available; default value used	3
Vertical overlap (considers all fisheries)	It overlaps with trawl fishery targeting shrimp but as a small component of bycatch (Queirolo et al., 2011). The species is known as a bycatch in trawl, deepset longlines (Subsecretaria de Pesca y Acuicultura 2018b) (Queirolo et al. 2011).	3
Selectivity of fishery (specific to fishery under assessment)	No information available; default value used	2
Post-capture mortality (specific to fishery under assessment)	Bycatch is both retained as well as discarded (Subsecretaria de Pesca y Acuicultura 2018b). Earlier in 2018, the Chilean government published a bycatch reduction plan specific to the Patagonian toothfish fishery, with direct guidelines for bycatch release/discard that would ideally guarantee post release survival (Subsecretaria de Pesca y Acuicultura 2018b). However, information regarding effectiveness will only become available in the upcoming years of implementing this reduction plan. To err on the side of caution, this item was scored as "high risk."	3

Susceptibility score		2.325
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Factor 2.2 - Fishing Mortality

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

Moderate Concern

Chilean grenadier is a bycatch in both longline and bottom trawl fisheries in Chile (D'Amico 2007) (Subsecretaria de Pesca y Acuicultura 2018b). In 2016, a total catch of 29 MT was estimated for this species in the Patagonian toothfish fishery, both discarded (16 t) and retained (13 t) (Subsecretaria de Pesca y Acuicultura 2018b). However, because the individual fishery's contribution to fishing mortality is unknown, a score of "moderate" concern is given for this factor.

Factor 2.3 - Discard Rate

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

< 100%

The discard rate in this fishery corresponds to less than 15% in the last reported statistics (Subsecretaria de Pesca y Acuicultura 2018b).

Justification:

Año	Especie	Capt. Retenida (t)	Capt. Descartada (t)	Capt. Total (t)	%Descarte/Capt. Descartada	%Descarte/Capt. Total
2015	Bacalao de profundidad	597	51	647	57,1%	7,30%
	Raya volantín	0	15	15	17,1%	2,20%
	Peje rata grande	6	7	12	7,6%	1,00%
	Granadero patagónico	3	5	8	5,4%	0,70%
	Raya espinosa	0	4	4	4,5%	0,60%
	raya de magallanes	0	2	2	2,5%	0,30%
	Otras especies	0,1	5	5	5,6%	0,70%
	Total	605	88	694	100,0%	12,7%
2016	Bacalao de profundidad	1719	31	1750	41,1%	1,70%
	Granadero chileno	13	16	29	21,4%	0,90%
	Antimora	0,05	11	11	14,2%	0,60%
	Rata café	2	7	9	8,8%	0,40%
	Raya espinosa	0	5	5	7,0%	0,30%
	Peje rta grande	26	5	31	6,5%	0,30%
	Raya volantín	0	1	1	1,1%	0,05%
	Total	1760	75	1835	100,0%	4,1%

Figure 14 Estimates of retained and discarded catch of main species captured in the Chilean seabass deepset longline fishery, 2015 and 2016. Source: Subsecretaria de Pesca y Acuicultura 2018b.

BANDED WHIPTAIL

Factor 2.1 - Abundance

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

Moderate Concern

A formal stock assessment and abundance data are not available for banded whiptail. There are no data-limited assessment indicators available for this species, which is among the common bycatch species in the Chilean seabass fishery (Subsecretaria de Pesca y Acuicultura 2018b). For this reason, a productivity-susceptibility analysis (PSA) was used for the species. Some of the species information required for the PSA was unavailable. The PSA score equals 2.7668, so the species is deemed to have moderate vulnerability. Detailed scoring of each attribute is shown below. Banded whiptail is moderately vulnerable (according to the PSA analysis) and there is no formal stock assessment, therefore, abundance is scored as "moderate" concern.

Productivity attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	n/a	-
Average maximum age	19 years (Laptikhovsky et al. 2008)	2
Fecundity	17,000 (Alekseev et al. 1992) (Laptikhovsky et al. 2008)	2
Average maximum size (fish only)	50 cm (Bianchi et al. 1999)	1
Average size at maturity (fish only)	n/a	-
Reproductive strategy	Broadcast spawner (Laptikhovsky et al. 2008)	1
Trophic level	3.2 (Giussi et al. 2010)	2
Habitat quality	Robust (bathydemersal, usually at 400 to 800 m deep) (Cohen et al. 1990)	1
Productivity score	-	1.5

Susceptibility attribute	Relevant information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (considers all fisheries)	Species native to Atlantic, Pacific, and Indian Oceans (Froese and Pauly 2018), where it might be susceptible to various deep-sea fishing activities. Because no more specific information was available, the default value was used.	3
Vertical overlap (considers all fisheries)	In Chile, the species is known as bycatch in trawl, deepset longlines, and other commercial fisheries (Subsecretaria de Pesca y Acuicultura 2018b) (Priede 2017)	3
Selectivity of fishery (specific to fishery under assessment)	Because information was unavailable regarding the size of specimens usually captured, default value was used.	2
Post-capture mortality (specific to fishery under assessment)	Bycatch is both retained as well as discarded (Subsecretaria de Pesca y Acuicultura 2018b). Earlier in 2018, the Chilean government published a bycatch reduction plan specific to the Patagonian toothfish fishery, with direct guidelines for bycatch release/discard that would ideally guarantee post release survival (Subsecretaria de Pesca y Acuicultura 2018b). However, information regarding effectiveness will only become available in the upcoming years of implementing this reduction plan. To err on the side of caution, this item was scored as "high risk."	3
Susceptibility score		2.33

Factor 2.2 - Fishing Mortality

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

Moderate Concern

Banded whiptail is taken as bycatch in both longline and bottom trawl fisheries in Chile (D'Amico 2007) (Subsecretaria de Pesca y Acuicultura 2018b). The last reported catch in the Patagonian toothfish fishery was for the 2015 season at 8 MT, being both discarded and retained (Subsecretaria de Pesca y Acuicultura 2018b). However, because the individual fishery's contribution to fishing mortality is unknown, a score of "moderate concern" is given for this factor.

Factor 2.3 - Discard Rate

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

< 100%

The discard rate in this fishery corresponds to less than 15% in the last reported statistics (Subsecretaria de Pesca y Acuicultura 2018b).

Justification:

Año	Especie	Capt. Retenida (t)	Capt. Descartada (t)	Capt. Total (t)	%Descarte/Capt. Descartada	%Descarte/Capt. Total
2015	Bacalao de profundidad	597	51	647	57,1%	7,30%
	Raya volantín	0	15	15	17,1%	2,20%
	Peje rata grande	6	7	12	7,6%	1,00%
	Granadero patagónico	3	5	8	5,4%	0,70%
	Raya espinosa	0	4	4	4,5%	0,60%
	raya de magallanes	0	2	2	2,5%	0,30%
	Otras especies	0,1	5	5	5,6%	0,70%
	Total	605	88	694	100,0%	12,7%
2016	Bacalao de profundidad	1719	31	1750	41,1%	1,70%
	Granadero chileno	13	16	29	21,4%	0,90%
	Antimora	0,05	11	11	14,2%	0,60%
	Rata café	2	7	9	8,8%	0,40%
	Raya espinosa	0	5	5	7,0%	0,30%
	Peje rta grande	26	5	31	6,5%	0,30%
	Raya volantín	0	1	1	1,1%	0,05%
	Total	1760	75	1835	100,0%	4,1%

Figure 15 Estimates of retained and discarded catch of main species captured in the Chilean seabass deepset longline fishery, 2015 and 2016. Source: Subsecretaria de Pesca y Acuicultura 2018b.

SEABIRDS

Factor 2.1 - Abundance

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

High Concern

Seabirds occurring in the Southern Ocean are generally highly vulnerable to fisheries that use baited hooks; such is the case of trotlines (COLTO 2018a). This score is set to the standard UBM "high" concern due to their high vulnerability.

Factor 2.2 - Fishing Mortality

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

Low Concern

Fishing mortality of seabirds in this region has been zero since mitigation measures were adopted about ten years ago (COLTO 2018a). Because fishing mortality in this fishery has not happened for many years, this

factor is scored as "low" concern.

Factor 2.3 - Discard Rate

PRINCE EDWARD ISLANDS / SOUTHERN OCEAN, LONGLINE (DEEP-SET)

< 100%

Usually, bycatch in this fishery does not surpass 10% of total catch (CCAMLR 2017).

BLUE ANTIMORA

Factor 2.1 - Abundance

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

Moderate Concern

Blue antimora is a deep-water species with a broad distribution, an abundant species in abyssal depths (Iwamoto 2015). It has an IUCN status of "Least Concern," particularly for its abundance and wide range distribution (Iwamoto 2015). This factor is deemed as "moderate" concern because of its IUCN "Least Concern" status.

Factor 2.2 - Fishing Mortality

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

Moderate Concern

Blue antimora is a widespread species, taken as bycatch in both longline and bottom trawl fisheries in Chile (Iwamoto 2015) (D'Amico 2007) (Subsecretaria de Pesca y Acuicultura 2018b). The last reported catch was for the 2016 season at 11.05 MT (Subsecretaria de Pesca y Acuicultura 2018b). Currently, this species is both discarded and retained (mostly discarded) in the Patagonian toothfish fishery (Subsecretaria de Pesca y Acuicultura 2018b). Also, the species is not described as commercially important in the IUCN global assessment (Iwamoto 2015). However, because the individual fishery's contribution to fishing mortality is unknown, the score of "moderate" concern is given for this factor.

Factor 2.3 - Discard Rate

CHILE / SOUTHEAST PACIFIC, LONGLINE (DEEP-SET)

< 100%

The discard rate in this fishery corresponds to less than 15% in the last reported statistics (Subsecretaria de Pesca y Acuicultura 2018b).

Justification:

Año	Especie	Capt. Retenida (t)	Capt. Descartada (t)	Capt. Total (t)	%Descarte/Capt. Descartada	%Descarte/Capt. Total
2015	Bacalao de profundidad	597	51	647	57,1%	7,30%
	Raya volantín	0	15	15	17,1%	2,20%
	Peje rata grande	6	7	12	7,6%	1,00%
	Granadero patagónico	3	5	8	5,4%	0,70%
	Raya espinosa	0	4	4	4,5%	0,60%
	raya de magallanes	0	2	2	2,5%	0,30%
	Otras especies	0,1	5	5	5,6%	0,70%
	Total	605	88	694	100,0%	12,7%
2016	Bacalao de profundidad	1719	31	1750	41,1%	1,70%
	Granadero chileno	13	16	29	21,4%	0,90%
	Antimora	0,05	11	11	14,2%	0,60%
	Rata café	2	7	9	8,8%	0,40%
	Raya espinosa	0	5	5	7,0%	0,30%
	Peje rta grande	26	5	31	6,5%	0,30%
	Raya volantín	0	1	1	1,1%	0,05%
	Total	1760	75	1835	100,0%	4,1%

Figure 16 Estimates of retained and discarded catch of main species captured in the Chilean seabass deepset longline fishery, 2015 and 2016. Source: Subsecretaria de Pesca y Acuicultura 2018b.