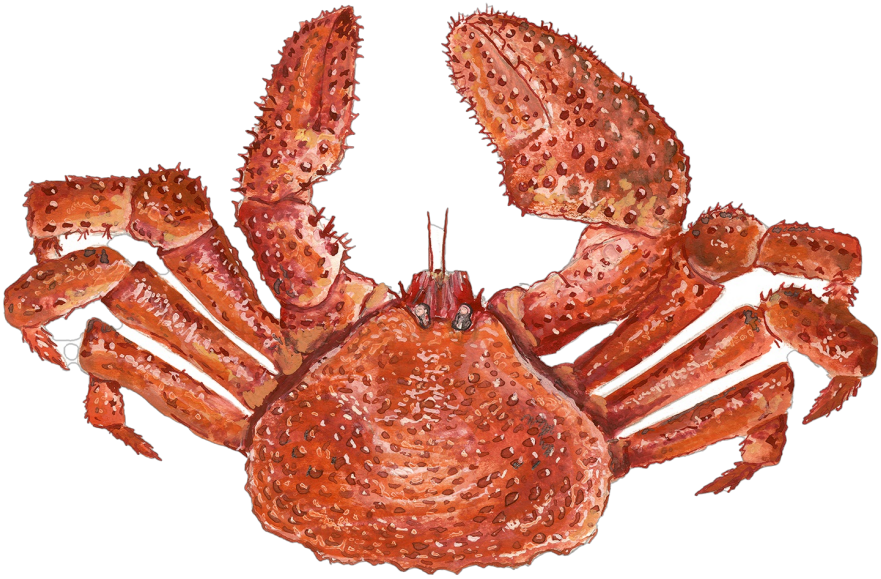
Monterey Bay Aquarium
# Seafood Watch

Environmental sustainability assessment of wild-caught deepsea crab from Chile caught using traps



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| | |
|---|---|
| **Species:** | Deepsea crab (*Paralomis granulosa*) |
| **Location:** | Chile, Patagonia: Southeast Pacific |
| **Gear:** | Traps |
| **Type:** | Wild Caught |
| **Author:** | Seafood Watch |
| **Published:** | March 4, 2024 |
| **Report ID:** | 28276 |

Assessed using Seafood Watch Fisheries Standard v4

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## About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the environmental 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. 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.

Seafood Watch's science-based ratings are available at www.SeafoodWatch.org. Each rating is supported by a Seafood Watch assessment, in which the fishery or aquaculture operation is evaluated using the Seafood Watch standard.

Seafood Watch standards are built on our guiding principles, which outline the necessary environmental sustainability elements for fisheries and aquaculture operations. The guiding principles differ across standards, reflecting the different impacts of fisheries and aquaculture.

- Seafood rated Best Choice comes from sources that operate in a manner that's consistent with our guiding principles. The seafood is caught or farmed in ways that cause little or no harm to other wildlife or the environment.
- Seafood rated Good Alternative comes from sources that align with most of our guiding principles. However, one issue needs substantial improvement, or there's significant uncertainty about the impacts on wildlife or the environment.
- Seafood rated Avoid comes from sources that don't align with our guiding principles. The seafood is caught or farmed in ways that have a high risk of causing harm to wildlife or the environment. There's a critical conservation concern or many issues need substantial improvement.

Each assessment follows an eight-step process, which prioritizes rigor, impartiality, transparency and accessibility. They are conducted by Seafood Watch scientists, in collaboration with scientific, government, industry and conservation experts and are open for public comment prior to publication. Conditions in wild capture fisheries and aquaculture operations can change over time; as such assessments and ratings are updated regularly to reflect current practice.

More information on Seafood Watch guiding principles, standards, assessments and ratings are available at www.SeafoodWatch.org.

## Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] 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, Seafood Watch develops an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guides and online guide:

**Best Choice/Green:** Buy first; they're well managed and caught or farmed responsibly.

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

**Avoid/Red:** Take a pass on these for now; they're caught or farmed 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

Deepsea crab (*Paralomis granulosa*) is a deepwater crab occurring from the Southeast Pacific Ocean (in Chile) to the Southwest Atlantic Ocean (from Argentina to north of Santa Catarina, Brazil, as well as the Falkland Islands/Malvines). In Chile, the targeted fishery started in the late 1970s and has gained relevance in recent years, being restricted to the Magallanes Region.

Recent estimates for values of the deepsea crab spawning potential ratio in the Magallanes Strait subzones are just below the target reference point. Fishing mortality is currently lower than the maximum sustainable yield (MSY) value, deeming a low concern score for this Criterion 1.

Bycatch in this fishery is frequently recorded on a presence/absence approach only. The species mentioned as the most frequent during the fishing season were assessed within a "benthic invertebrate" group: *Pseudocorystes sicarius* (jaiba botón), *Eurypodius latreillii* (camouflaged spider crab) and *Cosmasterias lurida* (common fjord starfish). In addition, southern king crab has a specific fishery that overlaps with the deepsea crab fishing season, so that species was assessed. Benthic invertebrates limit the score for Criterion 2 because of the limited available information on the population.

The Magallanes Region management committee for king crab and deepsea crab is the multistakeholder management committee responsible for establishing guidelines for this fishery. While a management plan is still under development, an "SSS" regulation (sex, season, size), which includes prohibited landings of female crabs, a minimum catch size of 80 mm (cephalothorax length), and an annual fishing season from February 1 until November 30, are measures currently in place. Recent important gear adaptations, to be implemented starting July 1, 2023, were set to avoid entanglements with marine mammals (namely, these adaptations were the use of nonbuoyant ropes connecting traps, or the use of lead throughout the ropes connecting traps to sink ropes). Observer coverage must be increased to assess if current management strategies are sufficient and/or are being fully implemented. There are concerns about whether the historical illegal fishing that has affected the southern king crab fishery may also affect the emerging deepsea crab fishery.

The trap fishery targeting deepsea crab does not have records of catching sessile, benthic organisms; therefore, impacts on the biogenic substrate and detrimental foodweb impacts are unlikely. Also, marine protected areas in the Magallanes Region include important marine habitats and may benefit important life stages of the species assessed. Although a management plan is not in place, a fishery ecosystem approach is expected as part of recent government policies in this regard. Overall, deepsea crab caught in Chile with trap receives a Yellow rating.

## Final Seafood Recommendations

| SPECIES \| FISHERY | C 1 TARGET SPECIES | C 2 OTHER SPECIES | C 3 MANAGEMENT | C 4 HABITAT | OVERALL | VOLUME (MT) YEAR |
|---|---|---|---|---|---|---|
| Deepsea crab \| Southeast Pacific \| Chile \| Traps | 4.284 | 3.318 | 2.000 | 3.240 | **Good Alternative (3.098)** | 1,925 |


**Summary**

Deepsea crab caught in Chile with trap is rated Yellow as a result of the low habitat impact from the gear and the relatively good condition of the stock. Information on catches of nontarget species should be more detailed to assess the real impact of the fishery on these species. Mitigating measures to avoid entanglement of marine mammals are too recent to be assessed, and the historical problem with illegal catch of southern king crab, a fishery that overlaps in some months with the deepsea crab fishery, poses a concern due to the lack of information on the impacts on deepsea crab.

**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**

This report focuses on trap fisheries for deepsea crab (*Paralomis granulosa*) in Chile.

**Species Overview**

Deepsea crab is a benthic crustacean that commonly inhabits deep waters (SUBPESCA 2023). Its distribution ranges from the Southeast Pacific Ocean (in Chile) to the Southwest Atlantic Ocean (from Argentina to north of Santa Catarina, Brazil, as well as the Falkland Islands/Malvines) (Palomares and Pauly 2023). In Chile, the species is present from the Los Lagos Region to the Magallanes Region. It is bathymetrically distributed between 10 and 150 m deep (Ramírez et al. 2023). Males reach sexual maturity at 50.5 mm carapace length (CL) (and morphometric maturity at 57 mm), while females reach sexual maturity at 60.6 mm CL; this translates into an approximate sexual maturity at 10 years of age (Ramírez et al. 2023). Deepsea crab is considered an alternative resource for the periods when the king crab/centolla (*Lithodes santolla*) fishery is closed. Catch of deepsea crab is allowed between February 1 and November 30 each year, and the remaining months are closed for reproduction (Ramírez et al. 2023).

The deepsea crab fishery started in 1977 in the central area of the Magallanes Strait (Almonacid et al. 2018). The Magallanes Region management committee for king crab and deepsea crab is the multistakeholder management committee responsible for establishing guidelines for this fishery (SUBPESCA 2023). A management plan is being developed, and relevant research was recently concluded, with proposed reference points for the species (Ramírez et al. 2023).

**Production Statistics**

The production of deepsea crab in Chile has reached two peaks in the past 20 years: the first in 2005 at 5,731 metric tons (mt), and more recently in 2017 and 2018 at 6,132 mt and 6,216 mt, respectively (SERNAPESCA 2022)(SERNAPESCA 2012). In 2022, deepsea crab landings in Chile totaled 1,925 mt (SERNAPESCA 2022).

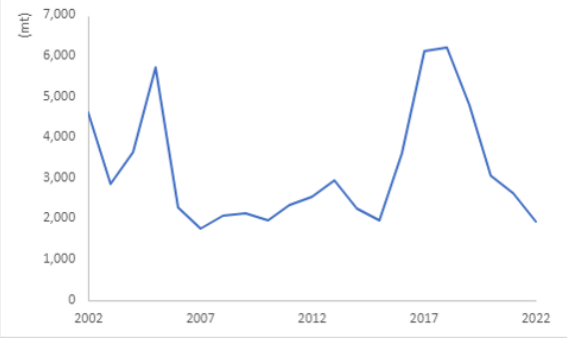


Figure 1: Deepsea crab landings in Chile (in mt), 2002–22 (SERNAPESCA 2012)(SERNAPESCA 2022).

Two other minor producers of the same deepsea crab species are Argentina and the Falkland Islands (Malvines). Since the species' global production has started being recorded (in 1978), both Argentina and Malvines production combined has not reached 500 mt in any given year (FAO 2023). More recently, Chile has been responsible for 100% of the global production from 2018 to 2021 (FAO 2023).

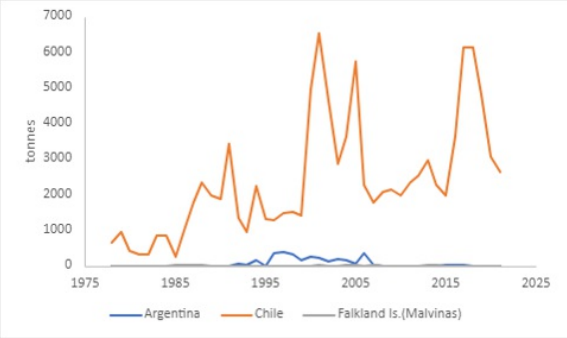


Figure 2: Deepsea crab global production (in mt, live weight), from 1978 to 2021 (FAO 2023).

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

Snow crab is a common name that usually represents species from the genus *Chionoecetes* (*Chionoecetes opilio*, *C. bairdii*, *C. japonicus*, *C. tanneri*, and *C. angulatus*) (Palomares and Pauly 2023). Deepsea crab (which is also known as Chilean snow crab) is from a different genus, *Paralomis*, which includes several deepwater/coldwater and Antarctic species (Palomares and Pauly 2023). The U.S. Foreign Trade considers several species within the "snow crab" category, including deepsea crab. Canada is the major snow crab exporter to the United States market (at an average of 75% of total snow crab imports from 2012 to 2022) (NOAA 2023). Deepsea crab from Chile accounted for about 0.06% on average of all snow crab imports into the United States from 2012 to 2022 (NOAA 2023). In 2022, Chile's contribution of deepsea crab to the United States increased almost eight times compared to 2021 (NOAA 2023). So far in 2023, the contribution of deepsea crab reached 0.19% of total snow crab imports, totaling 25.181 mt (NOAA 2023). Deepsea crab from Chile is also exported to the Netherlands, Belgium, Germany, France, Spain, and Italy (SUBPESCA 2023). In 2022, a total of 44,860.8 tonnes of snow crab were imported by the U.S. market, with a value over USD 1.04 billion (NOAA 2023).

Table 1: Volume (in mt) of snow crab imported into the U.S. market from 2012 to 2022. The category "snow crab" may include multiple species. Only Chile and Argentina (highlighted in gray) catch *Paralomis granulosa*, the species assessed in this report. (* = percentage from average values in 2012–22.) Adapted from (NOAA 2023).

| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | %* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Canada** | 36,985.27 | 44,381.325 | 39,829.046 | 40,670.067 | 38,724.322 | 37,729.038 | 29,114.596 | 33,188.406 | 36,063.597 | 4,0137.196 | 39,090.3 | 74.30 |
| **Russia** | 4,113.365 | 7,060.794 | 4,810.761 | 5,590.182 | 8,146.133 | 8,250.676 | 1,1639.781 | 11,744.898 | 1,9368.157 | 18,822.789 | 2,497.817 | 18.22 |
| **Norway** | 0 | 0 | 329.853 | 1,114.182 | 2,009.324 | 740.424 | 617.709 | 1,263.812 | 1,363.526 | 3,282.214 | 1,474.157 | 2.176 |
| **Greenland** | 593.991 | 679.129 | 370.831 | 207.196 | 356.929 | 450.27 | 743.201 | 1,246.929 | 1,250.178 | 1,267.228 | 960.968 | 1.45 |
| **China** | 1,410.649 | 1,380.004 | 685.994 | 814.02 | 838.444 | 1,164.085 | 781.574 | 253.193 | 27.569 | 104.519 | 27.599 | 1.33 |
| **South Korea** | 621.927 | 718.079 | 676.807 | 674.253 | 510.024 | 490.745 | 236.021 | 191.741 | 132.278 | 225.801 | 350.204 | 0.86 |
| **Indonesia** | 724.968 | 395.033 | 23.22 | 139.812 | 77.987 | 51.434 | 124.431 | 206.292 | 247.243 | 184.592 | 312.914 | 0.44 |
| **Lithuania** | 0 | 0 | 542.764 | 1036.214 | 423.865 | 0 | 0 | 0 | 0 | 0 | 0 | 0.35 |
| **Japan** | 70.392 | 94.723 | 33.961 | 37.02 | 40.551 | 51.438 | 87.086 | 66.914 | 142.834 | 108.572 | 114.286 | 0.15 |
| **Vietnam** | 8.749 | 15.094 | 32.53 | 36.55 | 40.838 | 58.808 | 99.531 | 232.14 | 155.822 | 79.635 | 50.73 | 0.14 |
| **Philippines** | 405.814 | 193.346 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.10 |
| **Latvia** | 0 | 0 | 0 | 128.767 | 452.17 | 0 | 0 | 0 | 0 | 0 | 0 | 0.10 |
| **Denmark** | 41.385 | 11.775 | 0 | 0 | 71.862 | 214.476 | 154.043 | 25.448 | 0 | 0 | 13.226 | 0.09 |
| **Thailand** | 311.388 | 74.252 | 0 | 8.567 | 21.76 | 34.232 | 6.206 | 9.269 | 5.278 | 7.635 | 0 | 0.08 |
| **Chile** | 16.711 | 0 | 9.899 | 4.968 | 29.398 | 24.879 | 74.778 | 29.077 | 32.16 | 12.972 | 103.229 | 0.06 |
| **Spain** | 0 | 155.415 | 57.594 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.03 |
| **Ireland** | 0 | 64.62 | 21.54 | 0 | 0 | 0 | 0 | 1.033 | 0 | 0 | 0 | 0.01 |
| **Venezuela** | 0 | 0 | 0 | 0 | 61.603 | 21.163 | 0 | 1.404 | 0 | 0 | 0 | 0.01 |
| **Argentina** | 0 | 0 | 7.838 | 0 | 7.53 | 24.382 | 0 | 0 | 8.267 | 0 | 0 | 0.00 |
| **Greece** | 0 | 0 | 0 | 0 | 25.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| **Netherlands** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17.907 | 0 | 0 | 0 | 0.00 |
| **United Kingdom** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 3.6 | 0 | 0.00 |
| **India** | 0 | 0 | 0 | 3.266 | 0 | 0 | 0 | 0 | 0 | 0 | 0.762 | 0.00 |
| **Mexico** | 0 | 3.219 | 0 | 0 | 0 | 0 | 0.682 | 0 | 0 | 0 | 0 | 0.00 |
| **Bahamas** | 0 | 0 | 0 | 0 | 0 | 0.6 | 0 | 0 | 0.774 | 0 | 0 | 0.00 |
| **Australia** | 0 | 0 | 0.042 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |

**Common and market names.**

Deepsea crab, softshell red crab, Chilean snow crab, false southern king crab, Centollón (Palomares and Pauly 2023).

**Primary product forms**

- Whole raw, refrigerated
- Cooked clusters, frozen
- Whole cooked, frozen
- Raw clusters, refrigerated
- Cooked meat (leg and body combo, or leg only), frozen
- Canned

## 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

| DEEPSEA CRAB | | | |
|---|---|---|---|
| **REGION / METHOD** | **ABUNDANCE** | **FISHING MORTALITY** | **SCORE** |
| Southeast Pacific \| Chile \| Traps | 3.670: Low Concern | 5.000: Low Concern | Green (4.284) |

## Criterion 1 Assessments

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.*

## Deepsea crab

**Factor 1.1 - Abundance**

**Southeast Pacific | Chile | Traps**

**Low Concern**

Deepsea crab is a Lithotidae crab species that inhabits the southernmost part of South America, ranging from Valdivia to Cape Horn in Chile, to north of Santa Catarina, Brazil, as well as the Falkland Islands/Malvines (Palomares and Pauly 2023). A full stock assessment is not available for the species; however, biological reference points were recently estimated using a Length-Based Pseudo-Cohort Analysis for the central and southern zones of the Magallanes Region, combined with a set of biological parameters compiled from what is reported in the literature (Ramírez et al. 2023). According to such available data, the spawning potential ratio (SPR) was estimated for the central and south zones at 0.37 and 0.38, respectively, and the biological reference point (BRP) target at 0.40 (40% of $B_0$) (Ramírez et al. 2023). In Chile, though the species is distributed in four regions of the country, the "exploited population" currently covers only two (Magallanes Region: northern zone, central zone and southern zone; and the Aysén Region). The production in the assessed regions (see Factor 1.2) is also greater than in the unassessed regions, because most of the area not covered by the stock assessment is not being fished (SUBPESCA 2019). Therefore, the impact of the fishery on this portion of the stock assessment is likely minimal. Because recent estimated values for SPR are just below the target reference point, this factor is scored a low concern.

**Factor 1.2 - Fishing Mortality**

**Southeast Pacific | Chile | Traps**

**Low Concern**

Fishing mortality has been estimated for deepsea crab in the central and south zones of the Magallanes Region at 0.74 and 0.88, respectively (Ramírez et al. 2023). These values are much lower than the estimated F at maximum sustainable yield (MSY) for each zone: 1.24 (0.54–1.24) and 1.24 (0.75–1.24), respectively (Ramírez et al. 2023). In addition, the maximum sustainable yield for the species was estimated for the south zone at 27.61 kg/trap, which is higher than the current yield (24.4 kg/trap) for the resource ($SPR/SPR_{40\%}$ = 0.95) (Ramírez et al. 2023). The central zone of the Magallanes Strait was responsible for more than 50% of landings in 2021 (Valdebenito et al. 2022). Despite the current exploitation rate being below values of concern, it might have benefited from the suspension of new registrations of deepsea crab fishers in the regions of Los Ríos, Los Lagos, Aysén del General Carlos Ibáñes de Campo y Magallanes and Chilean Antarctica from January 1, 2020 through December 31, 2024, because the species had reached the state of full exploitation in these fishing areas (SUBPESCA 2019). Because the current fishing mortality is below values at MSY, this factor is scored a low 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 Crtitical*

**Guiding principles**

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

## Criterion 2 Summary

**Criterion 2 score(s) overview**

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

| DEEPSEA CRAB | | | |
|---|---|---|---|
| **REGION / METHOD** | **SUB SCORE** | **DISCARD RATE/LANDINGS** | **SCORE** |
| Southeast Pacific \| Chile \| Traps | 3.318 | 1.000: < 100% | Green (3.318) |

**Criterion 2 main assessed species/stocks table(s)**

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

| SOUTHEAST PACIFIC \| CHILE \| TRAPS | | | |
|---|---|---|---|
| SUB SCORE: 3.318 | DISCARD RATE: 1.000 | **SCORE: 3.318** | |
| **SPECIES** | **ABUNDANCE** | **FISHING MORTALITY** | **SCORE** |
| Southern king crab | 3.670: Low Concern | 3.000: Moderate Concern | Green (3.318) |
| Benthic invertebrates | 2.330: Moderate Concern | 5.000: Low Concern | Green (3.413) |
| Deepsea crab | 3.670: Low Concern | 5.000: Low Concern | Green (4.284) |

The deepsea crab fishery has a monitoring program that records incidental catches; however, information on the percentage of such catches compared to the total catch are unavailable because such records are only recorded as presence/absence (Valdebenito et al. 2022). Using a precautionary approach, we included in the assessment a group "benthic invertebrates" with the species mentioned as the most frequent during the fishing season: *Pseudocorystes sicarius* (jaiba botón), *Eurypodius latreillii* (camouflaged spider crab), and *Cosmasterias lurida* (common fjord starfish). The Patagonian octopus (*Enteroctopus megalocyathus*) was among the most frequent bycatch in the past, but because there are no records of this species in the past couple of years, we did not include it in this assessment (Valdebenito et al. 2022). Southern king crab is also mentioned as incidental catch in this fishery, but we assessed the species separately because it has a specific fishery that overlaps with the deepsea crab fishing season (and a significant percentage of vessels end up targeting both species, which varies over the years) (Almonacid et al. 2018){Valdebenito et al. 2020}(Valdebenito et al. 2022).

Regarding species of concern, in 2021 there were no records of incidental catch of marine mammals or seabirds (Valdebenito et al. 2022), but observer coverage is low. The last known whale entanglement in ropes from a trap targeting southern king crab is from 2016 (Valdebenito et al. 2022). Because mitigating measures have been implemented since then (Valdebenito et al. 2022), with no recent entanglement records, we did not include this group in the assessment. Benthic invertebrates limit the score for Criterion 2 due to the limited available information on the population.

## Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance
*(same as Factor 1.1 above)*

Factor 2.2 - Fishing Mortality
*(same as Factor 1.2 above)*

Factor 2.3 - Modifying Factor: Discards and Bait Use
Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

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

| Ratio of bait + discards/landings | Factor 2.3 score |
|---|---|
| <100% | 1 |
| >=100 | 0.75 |

# Benthic invertebrates

**Factor 2.1 - Abundance**

**Southeast Pacific | Chile | Traps**

**Moderate Concern**

Invertebrates most commonly caught as bycatch in the deepsea crab fishery are *Pseudocorystes sicarius* (jaiba botón), *Eurypodius latreillii* (camouflaged spider crab), and *Cosmasterias lurida* (common fjord starfish). These three species make up a significant contribution to the total bycatch recorded in this fishery {Valdebenito et al. 2019 (Valdebenito et al. 2022). Two of these species are of medium inherent vulnerability; see the productivity-susceptibility analysis (PSA) in the Justification section. Therefore, this factor is scored a moderate concern.

**Justification:**

Common fjord starfish

Although there is no information on the population status, common fjord starfish is widely distributed along the temperate shores from Chile to Argentina and the Falkland (Malvines), being one of the most abundant species on both soft sediments and rocky bottoms (Garrido et al. 2021).

| **Productivity Attributes** | **Value** | **Score (1 = low risk; 2 = medium risk; 5 = high risk)** | **Reference** |
|---|---|---|---|
| Avg Age at maturity; Tm (years) | 0 | | |
| von Bertalanffy (K) Fish only | NA | | |
| Avg Max Age; Tmax (years) Inverts only when you know Lmax for Finfish (Col. J) | NA | | |
| Fecundity (Eggs/year) | 0 | | |
| Avg Max Size; Lmax (cm) (fish only) | NA | | |
| Avg Size at maturity; Lm (cm) (fish only) | NA | | |
| Reproductive Strategy | Broadcast spawner | 1 | (Palomares and Pauly 2023) |
| Density Dependence (inverts only) | NA | | |
| **Productivity Subscore** | | **1** | |
| | | | |
| **Susceptibility Attribute** | **Information** | **Score (1 = low risk; 2 = medium risk; 5 = high risk)** | **Reference** |
| Areal overlap | Default value used | 3 | |
| Vertical overlap | Default value used | 3 | |
| Seasonality | Species is recorded as bycatch 5 months/year | 2 | (Valdebenito et al. 2019) |
| Selectivity | Default value used | 2 | |
| Post-capture Mortality | Species is returned and very likely to survive post-release | 1 | (Campos, G. pers. comment, 2023) |
| **Susceptibility Subscore** | | **2.2** | |
| | | | |
| **Productivity-Susceptibility Score** | **2.42** | | |
| **Vulnerability Rating (high, medium or low)** | **Low** | | |

Jaiba botón

| **Productivity Attributes** | **Value** | **Score (1 = low risk; 2 = medium risk; 5 = high risk)** | **Reference** |
|---|---|---|---|
| Avg Age at maturity; Tm (years) | 0 | | |
| von Bertalanffy (K) Fish only | NA | | |

| | | | |
|---|---|---|---|
| Avg Max Age; Tmax (years) Inverts only when you know Lmax for Finfish (Col. J) | NA | | |
| Fecundity (Eggs/year) | 0 | | |
| Avg Max Size; Lmax (cm) (fish only) | NA | | |
| Avg Size at maturity; Lm (cm) (fish only) | NA | | |
| Reproductive Strategy | Brooder (ovigerous female) | 2 | based on studies of the same Family Atelecyclidae (e.g., {(Sasaki and Mihara 1993)) |
| Density Dependence (inverts only) | NA | | |
| **Productivity Subscore** | | **2** | |
| | | | |
| **Susceptibility Attribute** | **Information** | **Score (1 = low risk; 2 = medium risk; 5 = high risk)** | **Reference** |
| Areal overlap | Default value used | 3 | |
| Vertical overlap | Default value used | 3 | |
| Seasonality | Species is recorded as bycatch only 2 months/year | 1 | (Valdebenito et al. 2019) |
| Selectivity | Species maximum size is 6 cm CL (common at 2.5 cm), whereas mesh size varies from 2.5 cm (most traps directed at deepsea crab) to 7.62 cm (some traps directed at southern king crab that may also target deepsea crab) | 1 | (Valdebenito et al. 2022) |
| Post-capture Mortality | Species is returned and very likely to survive post-release | 1 | (Campos, G. pers. comment., 2023) |
| **Susceptibility Subscore** | | **1.8** | |
| | | | |
| **Productivity-Susceptibility Score** | **2.69** | | |
| **Vulnerability Rating (high, medium or low)** | **Medium** | | |

Camouflaged spider crab

| **Productivity Attributes** | **Value** | **Score (1 = low risk; 2 = medium risk; 5 = high risk)** | **Reference** |
|---|---|---|---|
| Avg Age at maturity; Tm (years) | 0 | | |
| von Bertalanffy (K) Fish only | NA | | |
| Avg Max Age; Tmax (years) Inverts only when you know Lmax for Finfish (Col. J) | NA | | |
| Fecundity (Eggs/year) | 1,627–9,384 | 1 | (Palomares and Pauly 2023) |
| Avg Max Size; Lmax (cm) (fish only) | NA | | |
| Avg Size at maturity; Lm (cm) (fish only) | NA | | |
| Reproductive Strategy | Brooder (ovigerous females) | 2 | (Palomares and Pauly 2023) |

| | | | |
|---|---|---|---|
| Density Dependence (inverts only) | NA | | |
| **Productivity Subscore** | | **1.5** | |
| | | | |
| **Susceptibility Attribute** | **Information** | **Score (1 = low risk; 2 = medium risk; 5 = high risk)** | **Reference** |
| Areal overlap | Default value used | 3 | |
| Vertical overlap | Default value used | 3 | |
| Seasonality | Species is recorded as bycatch 5 months/year | 2 | (Valdebenito et al. 2019) |
| Selectivity | Species maximum size is 9 cm CL, whereas mesh size varies from 2.5 cm (most traps directed at deepsea crab) to 7.62 cm (some traps directed at southern king crab that may also target deepsea crab) | 2 | (Valdebenito et al. 2022) |
| Post-capture Mortality | Species is returned and very likely to survive post-release | 1 | (Campos, G. pers. comment., 2023) |
| **Susceptibility Subscore** | | **2.2** | |
| | | | |
| **Productivity-Susceptibility Score** | **2.66** | | |
| **Vulnerability Rating (high, medium or low)** | **Medium** | | |

**Factor 2.2 - Fishing Mortality**

**Southeast Pacific | Chile | Traps**

**Low Concern**

Although fishing mortality remains undetermined for these species, it is essential to note that none of them are kept, and the probability of post-release survival is high (pers. comm., G. Campos, 2023). Therefore, this factor is scored a low concern.

## Deepsea crab

**Factor 2.3 - Discard Rate/Landings**

**Southeast Pacific | Chile | Traps**

**< 100%**

The traps are usually baited with skeletal remains and heads left over from the processing of fishing resources such as Patagonian toothfish, southern hake, golden conger eel, and salmon. But some boats have some fishing gear (line and/or nets) that allows them to have daily fresh bait for their traps (litter, skate, bass, and hoki, among others) (Valdebenito et al. 2019). Incidental catches of nontarget species and undersized individuals are also discarded after being recorded (Valdebenito et al. 2019)(Valdebenito et al. 2022). Because the discard rate/landing is below 100%, this factor is scored accordingly.

## Southern king crab

**Factor 2.1 - Abundance**

**Southeast Pacific | Chile | Traps**

**Low Concern**

Southern king crab is also a Lithotidae crab species that inhabits the southernmost part of South America, ranging from Talcahuano to Cape Horn in Chile, the Falkland Islands/Malvines, Argentina, and Uruguay (Palomares and Pauly 2023). A stock assessment for centolla was released in 2023 (Monsalva et al. 2023), and the poor data model estimates a better condition of the resource in the northern zone of the Magallanes Region, associated with landings—mainly from Puerto Natales. In this area, the spawning potential ratio (SPR) is reduced to around 44% compared to the virgin condition; that is, above the reference value for the spawning biomass (SB) (40% $SB_0$; SPR target 0.4) (Monsalva et al. 2023). The central zone presents the SPR estimate at 38% of $SB_0$, whereas the south zone estimate is at 37% of $SB_0$. The estimates of biomass for the most recent year in the model ($B_{current} = B_{2021}$) are 4,576 t for the north zone, 19,923

t for the central zone, and 5,334 t for the south zone. Because the recent estimated values of SPR are only slightly below the target reference point, this factor is scored a low concern.

**Factor 2.2 - Fishing Mortality**

**Southeast Pacific | Chile | Traps**

**Moderate Concern**

Fishing mortality for southern king crab was estimated for three zones of the Magallanes Region: the north (0.25; $F_{MSY}$ = 0.33; overfishing index = 0.77), central (0.39; $F_{MSY}$ = 0.38; overfishing index ≈1), and south (0.47; $F_{MSY}$ = 0.40; overfishing index = 1.08) (Monsalva et al. 2023). Because fishing mortality estimates are oscillating around the reference points among the three zones in the Magallanes Region, this factor is scored a moderate concern.

**Factor 2.3 - Discard Rate/Landings**

**Southeast Pacific | Chile | Traps**

**< 100%**

The traps are usually baited with skeletal remains and heads left over from the processing of fishing resources such as Patagonian toothfish, southern hake, golden conger eel, and salmon. But some boats have some fishing gear (line and/or nets) that allows them to have daily fresh bait for their traps (litter, skate, bass, and hoki, among others) (Valdebenito et al. 2019). Incidental catches of nontarget species and undersized individuals are also discarded after being recorded (Valdebenito et al. 2019)(Valdebenito et al. 2022). Because the discard rate/landing is below 100%, this factor is scored accordingly.

## Criterion 3: Management Effectiveness

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

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

The Criterion 3 rating is determined as follows:

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

*Rating is Critical if Management Strategy and Implementation is Critical.*

**Guiding principle**

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

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

## Criterion 3 Summary

| FISHERY | MANAGEMENT STRATEGY | BYCATCH STRATEGY | DATA COLLECTION AND ANALYSIS | ENFORCEMENT | INCLUSION | SCORE |
|---|---|---|---|---|---|---|
| Southeast Pacific \| Chile \| Traps | Moderately Effective | Moderately Effective | Moderately Effective | Ineffective | Highly effective | **Red (2.000)** |

## Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - Management Strategy and Implementation

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

Factor 3.2 - Bycatch Strategy

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

Factor 3.3 - Scientific Research and Monitoring

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

Factor 3.4 - Enforcement of Management Regulations

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

Factor 3.5 - Stakeholder Inclusion

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

**Factor 3.1 - Management Strategy And Implementation**

**Southeast Pacific | Chile | Traps**

**Moderately Effective**

Deepsea crab is managed through the Magallanes Region management committee for king crab and deepsea crab, a multistakeholder committee that comprises fishers, processors, researchers, NGOs, and government representatives (Nahuelhual et al. 2019). The committee may establish recommendations to the fishery guidelines, following the General Law of Fisheries and Aquaculture of Chile. Although a management plan is still under development, deepsea crab follows the "SSS" regulation (sex, season, size), which includes prohibited landings of female crabs, a minimum catch size of 80 mm (cephalothorax length), and a fishing season from February 1 until November 30 each year (Almonacid et al. 2018). In addition, information on the number of individuals under legal size, carapace consistency, and the presence of females is consistently recorded (Valdebenito et al. 2019).

From January 1, 2020 through December 31, 2024, any subscription of new registration in the Artisanal Fishing Registers of the regions of Los Ríos, Los Lagos, Aysén del General Carlos Ibáñes de Campo y Magallanes and La Antarctica Chilena targeting deepsea crab and southern king crab is suspended, because the fleet has reached full exploitation in these fishing areas (Ramírez et al. 2023)(Valdebenito et al. 2022).

From the point of view of sustainability, it is considered imperative to monitor biological and fishing indicators in the months when there is a biological ban (December and January), because in February it is common to find male and female specimens with soft shells, which would indicate that during this month there should still be reproductive activity (Valdebenito et al. 2022). Another important aspect that has been observed in fishing operations and that probably should progressively influence fishing yields from one season to the next relates to the way in which undersized males and especially females are discarded (Valdebenito et al. 2022). It is common to observe large detachment of eggs, fragmentation of pleopods, and rupture of shells in fishing operations as a result of blows against the deck or scuppers of the boats in the effort to return them to the sea (Valdebenito et al. 2022).

The experience acquired during the years of monitoring led to suggestions for implementing new forms of management for this resource, where it is essential to advance in direct evaluations for the estimation of biomass through depletion models (or others) in historical fishing grounds as the fishing season progresses, regulate the fishing effort (traps), and introduce cultural changes translated into responsible fishing codes (Valdebenito et al. 2022). Because there is some management in place, but with many improvements needed, this factor is scored moderately effective.

**Factor 3.2 - Bycatch Strategy**

**Southeast Pacific | Chile | Traps**

**Moderately Effective**

Bycatch concerns in crab trap fisheries in the region include catches of undersized individuals and nontarget species, and entanglements of larger marine fauna (e.g., marine mammals) on the ropes that connect the traps and are used for deployment of the gear. Incidental catches are reported on a presence/absence basis (Valdebenito et al. 2022), so their contribution to the total catch cannot be assessed. Observer coverage is also low (Valdebenito et al. 2022), so the absence of recent interactions with species of concern (e.g., marine mammals, seabirds) should be regarded with caution.

In the deepsea crab and southern king crab fishery, the incidental catch has rarely been described, nor have their relationships regarding the target species, in addition to the type of interactions associated with the fishing gear and its status according to the Undersecretariat of Fisheries and Aquaculture. In most cases, there is no information that allows the identification of basic ecological indicators for a more complete diagnosis of the impact of the fishery on local populations (Valdebenito et al. 2022).

With some studies being developed in recent years in this regard, it was possible to establish that the use of escape rings in crab traps reduces the capture of noncommercial specimens, which led to a recommendation for their use in the short term, ultimately leading to a reduction in the overall incidental catch (Valdebenito et al. 2022). The use of escape rings also favors the handling of the traps, and there is less impact on noncommercial specimens when returning them to the marine environment (discard) (Valdebenito et al. 2022). On the other hand, the study mentions that it is important to advance in the standardization of the type of trap used in the region, which should include among its regulatory aspects:

- Geographical differences (e.g., weight, size, type of materials)

- Incorporation of escape rings (e.g., diameter, quantity, position)

• Biodegradable materials to reduce ghost fishing

• Traceability system that incorporates year of construction, owner, geographical location where it will be used and stacked (Valdebenito et al. 2022).

A recent study tested floating devices on southern king crab fishing ropes, and the use of two mitigation measures proposed by fishers in this fishery has led to a new regulation to be implemented on July 1, 2023 for both the southern king crab and deepsea crab fisheries: the use of nonbuoyant ropes connecting traps, or the use of lead throughout the ropes connecting traps to sink the ropes and avoid entanglements with marine mammals. It is also forbidden to deploy traps in the presence of whales (any sight of whales must also be immediately reported to other fleets). The regulation also prohibits the dumping of all plastic materials, ropes, gear, or fishing gear made of synthetic fibers into the sea (SUBPESCA 2021)(SUBPESCA 2022). Because important mitigating measures are quite recent and their efficiency cannot be evaluated at this time, this factor receives a score of moderately effective.

**Factor 3.3 - Scientific Data Collection and Analysis**

**Southeast Pacific | Chile | Traps**

**Moderately Effective**

The Monitoring of Benthic Crustaceans in the Magallanes Region obtains biological, fishing, and ecological information on crab and king crab species, through monitoring carried out by IFOP Scientific Observers at the main landing points (Puerto Natales, Punta Arenas, Porvenir, and Puerto Williams) and fishing areas (aboard extractive and transport vessels) (Valdebenito et al. 2022).

The characteristics of the extractive activity for southern king crab and deepsea crab resources in the Magallanes Region present difficulties that do not exist in most of the country's artisanal fisheries. Among these may be mentioned:

a) Complexity and geographic extension, typical of the system of Patagonian and Fuegian fjords and channels, whose amplitude determines distances of no less than 15 hours of navigation from the landing ports to the extraction areas.

b) Permanent displacement of the fleet throughout the extractive season between fishing areas in search of fishing grounds with better yields.

c) Adverse climatic factors, with a predominance of winds that can reach speeds greater than 120 km/h and that determine that navigation or fishing activities on many occasions cannot be carried out (Valdebenito et al. 2022).

Recent research to develop mitigating measures to decrease the incidental catch and entanglements of species of concern has led to important science-based fishing rules (Valdebenito et al. 2022)(SUBPESCA 2021)(SUBPESCA 2022). Observer coverage is low in this fishery (usually only one vessel was monitored each month in 2021) (Valdebenito et al. 2022). Incidental catch should also be monitored related to the total catch, to assess the actual contribution of each nontarget species in the fishery. Currently, this information is only available as their presence/absence (Valdebenito et al. 2022). Because only some data are collected and used to support management, but an increase in observer coverage is needed and a more detailed research framework for incidental catch should be developed, this factor is scored moderately effective.

**Factor 3.4 - Enforcement of and Compliance with Management Regulations**

**Southeast Pacific | Chile | Traps**

**Ineffective**

The deepsea crab fishery is usually considered a secondary fishery compared to the southern king crab fishery, and has sometimes been considered a mixed fishery or an alternative resource when the southern king crab fishery is in its closed season (Almonacid et al. 2018). The close link to the southern king crab fishery is relevant because most of the historical records and research effort were directed at southern king crab, because of its greater economic importance in the past (Almonacid et al. 2018). The volume of catches of both species has varied over the years, with a significant decrease of southern king crab and an increase of deepsea crab in the most recent years (Valdebenito et al. 2022).

The overlap between the two fisheries may vary throughout the years: up to 2017, a total of 162 vessels were registered as working actively, of which 25% were working on both resources (deepsea crab and southern king crab), 54% targeted king crab, and 21% targeted deepsea crab (Almonacid et al. 2018). In 2019, 65% of the registered fleet (n = 122) focused on southern king crab, whereas the remaining 35% targeted deepsea crab {Valdebenito et al. 2020}. In 2021, 95 vessels were actively working on these two resources, with 55% targeting exclusively southern king crab, 28% on deepsea crab, and 17% on both species (Valdebenito et al. 2022). The

number of nonauthorized ships might reach half the registered number, according to estimations of the Magallanes Region management committee for king crab and deepsea crab (Nahuelhual et al. 2019), although illegal fishing (types, magnitude, causes, solutions) has the most significant presence in the king crab fishery (Nahuelhual et al. 2023). The impacts of illegal fishing on the southern king crab fishery involves not only the catch of undersized males, retention of females, and catches outside the legal fishing season (all of this being unregistered catches), but also the illegal chain may include both legal and illegal stakeholders (Nahuelhual et al. 2023)(Zambrano et al. 2023).

The Magallanes Region management committee for king crab and deepsea crab in recent meetings has discussed illegal fishing; however, the discussions only account for the existence of broad goals such as "Ensuring the biological sustainability of the fishery" and "Eradicate the illegal fishing of king crab and deepsea crab, that may tend to zero" (CMM Act No. 7, 2021) {Ramiréz et al. 2023}. In this case, there are not many elements to consider guiding the selection of indicators (Ramírez et al. 2023).

Although the production of deepsea crab has reached greater relevance only in recent years, the historical struggle of illegal fishing in the southern king crab fishery may raise concerns. Because a more detailed configuration of the impact of illegal fishing on deepsea crab cannot be determined at this time, and the existing management measures to mitigate such impacts are not very clear, we take a precautionary approach on this factor with an ineffective score.

**Factor 3.5 - Stakeholder Inclusion**

**Southeast Pacific | Chile | Traps**

**Highly effective**

The Magallanes Region management committee for king crab and deepsea crab is a multistakeholder committee that comprises fishers, processors, researchers, NGOs, and government representatives (Nahuelhual et al. 2019). New members of the management committee were recently appointed in 2022 for a 4-year period (SUBPESCA 2022). The committee meets regularly, and the minutes and deliverables of each meeting are recorded and publicly available at the government's official website. A management plan is currently underway under the coordination of this committee. Because there is evidence that the management process is transparent and includes stakeholder input, this factor is scored 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

| FISHERY | FISHING GEAR ON THE SUBSTRATE | MITIGATION OF GEAR IMPACTS | ECOSYSTEM-BASED FISHERIES MGMT | FORAGE SPECIES? | SCORE |
|---|---|---|---|---|---|
| Southeast Pacific \| Chile \| Traps | Score: 3 | +.5 | Moderate Concern | | **Green (3.240)** |

**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**

**Southeast Pacific | Chile | Traps**

**Score: 3**

Trap gear targeting deepsea crab in Chile contacts the bottom, but there are no records of bycatch of sessile benthic organisms (Valdebenito et al. 2022), which indicates that this fishery most likely does not take place near biogenic deepwater reefs.

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

**Southeast Pacific | Chile | Traps**

**+.5**

Deepsea crab may occur between 15 and 150 m deep, where deep reefs (20–40 m) may be present with a progression to a less complex sandy/silky benthic substrate in deeper waters (Friedlander et al. 2021). In the Chilean Patagonian, 13 marine protected areas exist, with 5 in the Magallanes Region (Guijón et al. 2021) covering a significant portion of important marine habitats in the region throughout the species' distribution.

**Factor 4.3 - Ecosystem-based Fisheries Management**

**Southeast Pacific | Chile | Traps**

**Moderate Concern**

Currently, the need to include in the management of Chilean fisheries the concept of a fisheries ecosystem approach (FEA) that seeks to balance various objectives, taking into account the knowledge and uncertainties about the abiotic, biotic, and human components of the fishery, has gained importance (Valdebenito et al. 2022). Chilean FEA does not contradict or replace conventional fisheries management but seeks to improve its application and strengthen its ecological relevance in order to contribute to sustainable development. Likewise, it aims to prevent incidental capture through the modification of fishing gear and/or the use of spatiotemporal management windows and to discourage fishing practices or gear that modify or damage aquatic habitats (Valdebenito et al. 2022).

Regardless, the General Law on Fisheries and Aquaculture considers the conservation and sustainable use of hydrobiological resources, through the application of the precautionary approach and an ecosystem approach in fishing regulation and the safeguarding of marine ecosystems (Valdebenito et al. 2022). Also, it considers applying the ecosystem approach for the conservation and administration of fishing resources and the protection of their ecosystems, understanding by such an approach that it considers the interrelation of the predominant species in a given area (Valdebenito et al. 2022).

In practice, a management plan for deepsea crab does not exist, and specific rules with an ecosystem approach are not available. Other management measures, such as Marine Protected Areas (MPAs) do exist with multiple levels of use and implementation (Guijón et al. 2021), which may benefit important life stages of the species assessed (Friedlander et al. 2021). Because the fishery is not a substantial contributor to forage species' fishing mortality, and detrimental food web impacts are unlikely, this factor is scored a moderate concern.

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