Southern king crab

Lithodes santolla

Argentina - Southwest Atlantic

Pots

Seafood Watch Consulting Researcher

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Disclaimer

Seafood Watch Standard used in this assessment: Fisheries Standard v3

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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 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, 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: 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 overfished, lack strong management or are 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

The southern king crab *(Lithodes santolla)* is a benthic crustacean inhabiting the Southwest Atlantic from Chile through Argentina to Uruguay and discontinuously around the Falkland Islands. This report addresses the Argentinian commercial trap fishery for this species in the San Jorge Gulf, which is within the Central Patagonia Sector. This fishery accounts for roughly 50% of the catch of southern king crab in Argentina.

The southern king crab has a medium inherent vulnerability based on its reproductive mode, age at sexual maturity, and average maximum age. There is a recent stock assessment for this fishery that suggests southern king crab populations in the Central Patagonia Sector have recovered to sustainable levels. Catch limits and other management measures were installed in 2016 and there is some evidence that these actions have reduced unsustainable harvesting.

There is limited information available on bycatch in this fishery. The most significant bycatch is likely undersized and female southern king crab, which is released overboard due to fishery regulations. But trap modifications (escape rings and biodegradable net) are being implemented so undersized crab may escape before being brought up to the vessel and ghost fishing will be reduced. Also, the survival rate of released crabs is generally high. Marine mammals are known to interact with trap fisheries, particularly the buoy lines, in other fisheries around the globe. Entanglement of marine mammals in trap lines is assumed be low in this fishery, and so is the rate of mortality from entanglements. The marine mammal species that overlap the fishery are generally not stocks of concern; therefore, marine mammals are not assessed as bycatch in this report. Criterion 2 is scored in this report using the unknown bycatch matrix.

The southern king crab fishery has management strategies in place but their effectiveness is uncertain. More data are required to properly assess the target stock status and ensure that current regulations are appropriate. There is some information on bycatch in this fishery. Moreover, the fishery is developed in three jurisdictions (Chubut Province, Santa Cruz Province, and National) and further subdivided into smaller management units with area-specific catch limits.

Trap gear contacts the seafloor and occasionally can disturb the benthic habitat by dragging along the bottom. Companies fishing for southern king crab in Argentina will be required to use biodegradable net and escape rings to reduce ghost fishing and bycatch; however, these gear changes are only in the process of being implemented, so there is no significant mitigation in place for this fishery. Currently, escape rings are widely employed, but biodegradable nets (to avoid ghost fishing) are poorly used {Varisco 2017}.

There are no current efforts to incorporate ecosystem effects into management approaches, but southern king crab is not considered a species of exceptional importance to the ecosystem.

Final Seafood Recommendations

SPECIES | FISHERY	CRITERION 1 TARGET SPECIES	CRITERION 2 OTHER SPECIES	CRITERION 3 MANAGEMENT	CRITERION 4 HABITAT	OVERALL RECOMMENDATION
Southern king crab | Southwest Atlantic | Pots | Argentina | Central Patagonia Sector	4.284	2.236	3.000	3.000	**Good Alternative (3.047)**

Summary

Southern king crab caught in the Central Patagonia Sector receive a Good Alternative recommendation based on stabilized abundance and sustainable fishing levels relative to previous years. There are several new management measures that require continued evaluation to determine overall efficacy.

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

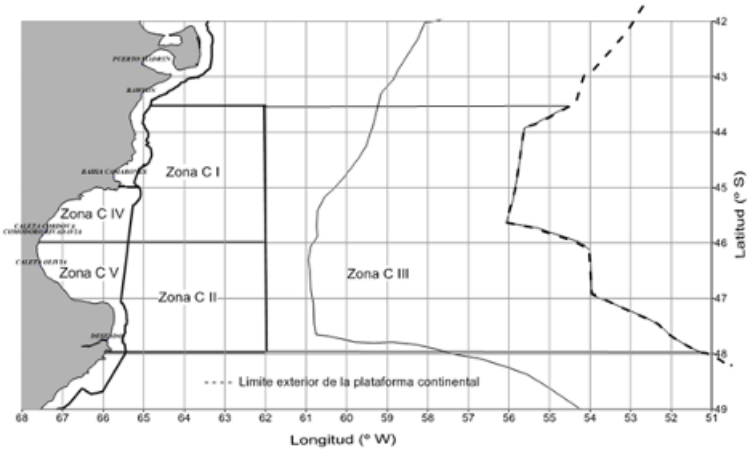
This report covers southern king crab caught in the commercial trap fishery off Argentia *(Lithodes santolla),* which primarily occurs in the San Jorge Gulf. The San Jorge Gulf lies within the Central Patonia Sector (SPS) management area.

Species Overview

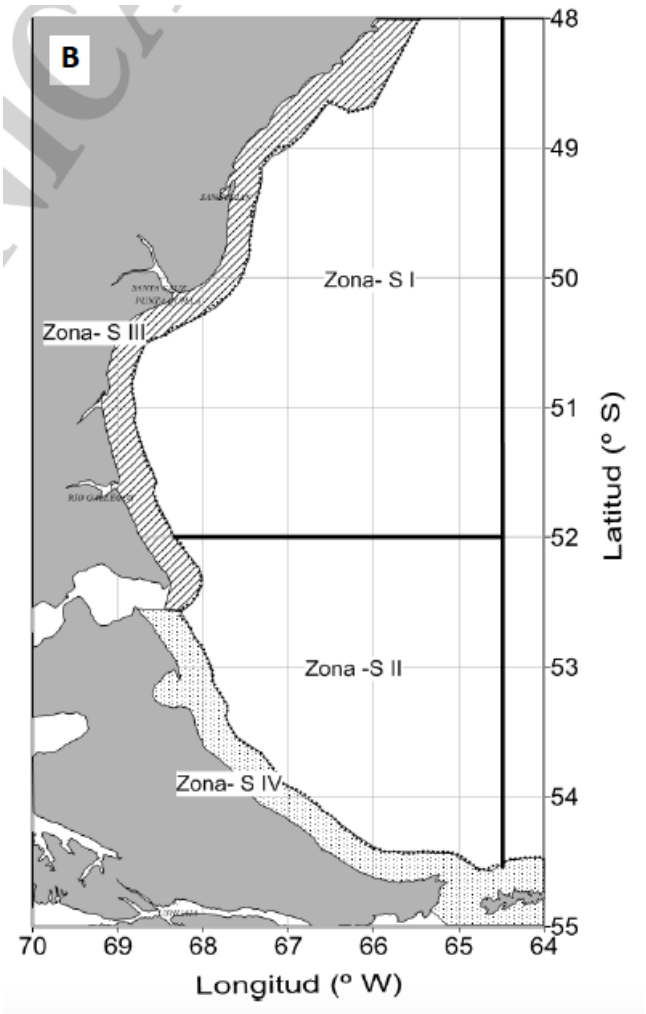
Southern king crab *(Lithodes santolla)* is a benthic crustacean inhabiting the Southwest Atlantic from Tierra del Fuego, Argentina to Uruguay and discontinuously around the Falkland Islands (Wyngaard and Iorio 2000). Argentina supports at least three stocks: one is in the Beagle Channel in southern Argentina, another is centered in the San Jorge Gulf within the Central Patagonia Sector, and a third in the Southern Patagonia Sector (SPS) (Lovrich and Tapella 2014) (Varisco et al. 2017). Only the CPS stock is rated in this report; the fishery for southern king crab in the Beagle Channel has not recovered from historic overfishing and the SPS fishery is still in exploratory stages. Southern king crab attains 198 mm carapace length (CL) and occurs to depths of 700 m {Boschi et al. 1992}. This species reproduces annually, with mating in November and December and females carrying eggs for 9 to 10 months before the eggs hatch into lecithotrophic larvae (Lovrich and Vinuesa 1999) (Calcagno et al. 2004). The larval stage lasts for 19 to 129 days, depending on temperature, before they settle to the benthos (Lovrich and Vinuesa 1999) (Calcagno et al. 2005). Female fecundity increases with size and ranges from 900 to 32,000 eggs per batch (Vinuesa and Balzi 2002) (Calcagno et al. 2005).

Fishing for the southern king crab began in the Beagle Channel, Argentina in the 1930s using gillnets, but these were banned and replaced with trap fishing after 1975 {Goodall et al. 1994} (Lovrich 1997). The management of this fishery in Argentina's federal waters is conducted by the Federal Fisheries Council (Consejo Federal Pesquero [CFP]) and provincial governments (CeDePesca 2010). A decline in the yield and mean size of captured individuals from 1988 to 1994 (Bertuche et al. 1990) caused a closure of the fishery in the Beagle Channel at the end of 1994 (Lovrich 1997). In 2004, Argentina allowed an experimental fishery to begin for the southern king crab; in 2008, this fishery officially opened as a commercial fishery in national waters from 44° to 48° S—essentially, the San Jorge Gulf (CeDePesca 2010).

In 2014, in response to the CFP demand, it opened an experimental fishery for the southern king crab from 50° to 52° S. The results showed good king crab catches; the average CPUE from the prospecting area and the fishing grounds was 2.6 and 1.1, respectively, with maximum CPUE of 11.9 and 10.2 crab/trap, respectively (Wyngaard et al. 2015).



Southern king crab management zones in the Central Patagonia Sector; North (Zona C I), South (Zona C II), Chubut (Zona C IV), and Santa Cruz (Zona C V). Figure from INIDEP (2020).



Southern king crab management zones in the Southern Patagonia Sector; North (Zona S I), South (Zona S II), Santa Cruz (Zona S III), and Land of Fire (Zona S IV). Figure from INIDEP (2020).

Production Statistics

The southern king crab total landings in Argentina for the period between 2004 and 2016, considering only the pot fleet, averaged 2,212.8 tonnes with a maximum in 2012 of 4,522.2 tonnes and a minimum in 2009 of 324.8 tonnes (Navarro et al. 2014) {MinAgri 2016}. Landings have decreased in recent years after total allowable catches were put in place. Annual landings in the CPS from 2016 to 2019 averaged 1,303 mt (Canales et al. 2020), while landings in the SPS averaged 985 mt over the same period (INIDEP 2019).

Importance to the US/North American market.

2019 exports of southern king crab from Argentina were 1,006 tonnes to the United States, 345 tonnes to China and 231 tonnes to Japan, with smaller quantities exported to Belgium, Indonesia and Germany (MiniAgri 2020).

Common and market names.

Southern king crab, king crab, southern red king crab; *centolla* in Spanish. The direct translation of *centolla* into English is any marine crab.

Primary product forms

Frozen crab meat is available as whole legs and claws, split legs and claws, window cut legs and claws, and extracted crab meat {novafish.com}.

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

SOUTHERN KING CRAB			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Southwest Atlantic | Pots | Argentina | Central Patagonia Sector	3.670: Low Concern	5.000: Low Concern	Green (4.284)

There are three primary fishing areas for southern king crab in Argentina: Beagle Channel, Central Patagonian Sector (CPS), and Southern Patagonia Sector (SPS) (Militelli et al. 2019). Only the CPS fishery is rated in this report.

Prior to 2020, the only stock assessment for southern king crab was conducted in 1981–1982 for the Beagle Channel fishery (Boschi et al. 1984). This fishery was closed in 1994 (Vinuesa et al. 1996). Surveys of the Beagle Channel fishery, which started in the 1930s (Lovrich 1997), displayed a decrease in southern king crab yield and decrease in mean size of both sexes from 1988 to 1994, indicating overexploitation of the stock (Bertuche et al. 1990). This species had exhibited a recovering trend (Lovrich and Tapella 2006) since 2003, evidenced by an increase in the proportion of ovigerous females value of approximately 85%, but in 2008, that proportion again dropped to an alarming value of about 45% (Lovrich and Tapella 2014). The population of the southern king crab in the Beagle Channel can only sustain modest landings for the local market (Lovrich and Tapella 2006).

There is a recent (2020) scientific assessment for the CPS that suggests abundance of commercial males to be near target levels, but there were indications that, after 15 years of commercial fishing, the stock is showing signs of overfishing (decreases in landings, catch per unit effort, and fecundity) (Militelli et al. 2019)(Varisco et al. 2018). However, recent data do suggest that recent management changes (i.e. mating season closure and mandatory use of escape rings) has positively affected southern king crab fecundity (Varisco et al. 2019).

An exploratory fishery began in the SPS in 2016, following requests by the Federal Fisheries Council of Argentina and industry representatives; these requests were motivated by the deterioration of the CPS stock (Militelli et al. 2020). This stock was considered to be in virgin condition in 2016, but the fishery is not included in this report.

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.*

Southern king crab

Factor 1.1 - Abundance

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

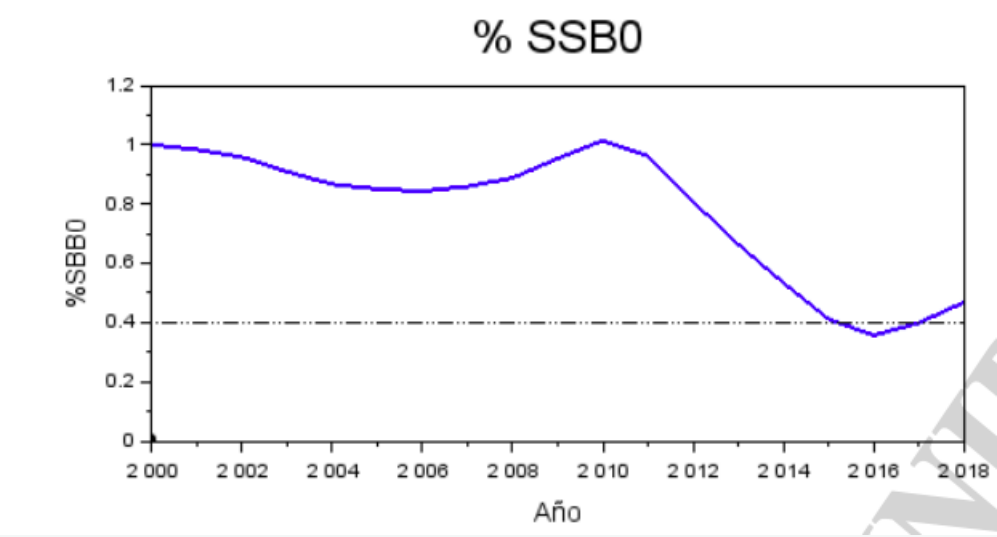
Low Concern

The primary fishing area for southern king crab is in the San Jorge Gulf. This population was assessed for the first time in 2020. Prior to this stock assessment, there were indications that, after 15 years of commercial fishing, the stock showed signs of overfishing (decreases in landings, catch per unit effort, and fecundity) (Militelli et al. 2019) (Varisco et al. 2018){Allega eta al. 2020}. The results of the 2020 stock assessment suggest that recent management measures have stabilized the population of commercial males to levels just above the target reference point, 40%B_0 (Canales et al. 2020). Exploitable biomass has averaged 8,546 mt over the last three years (2016-2019), or 40.7% of estimated virgin exploitable biomass (B_0 = 20,900 mt). However, the results of the stock assessment contain a high level of uncertainty (see explanation below), and, compared to pre-fishery levels, this population experienced a drop in fecundity by 25% during 2014-2016 and 11% during 2017-2018 (Varisco et al. 2019). Southern king crabs are long-lived species with slow growth and fertility rates; therefore, the apparent recovery requires continuous monitoring (INIDEP 2020).

Because the quantitative stock assessment shows the population at or near sustainable levels, but there is considerable uncertainty, a "low" concern, rather than a "very low" concern score is given.

Justification:

The stock assessment model is highly sensitive to parameter assumptions, which generates significant uncertainty in absolute estimates of the population; specifically, it's been suggested that the growth parameters and longevity be re-evaluated with updated information (Canales et al. 2020}.



Southern king crab (Lithodes santolla) reproductive biomass relative to virgin condition (SSB/SSB0); the dotted line represents the target biomass, 40% of virgin biomass. Figure from Canales et al. 2020.

Factor 1.2 - Fishing Mortality

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

Low Concern

There are indications of overfishing (declines in landings, CPUE and fecundity) after years of intense industrial fishing pressure on the CPS stock (Militelli et al. 2019)(Varisco et al. 2019), but a 2020 stock assessment suggests that fishing levels have stabilized to sustainable levels; target fishing mortality is F40% (F = 0.31) and $F_{2016\text{-}2019}$ = 0.204 (Canales et al. 2020). This stock is not undergoing overfishing.

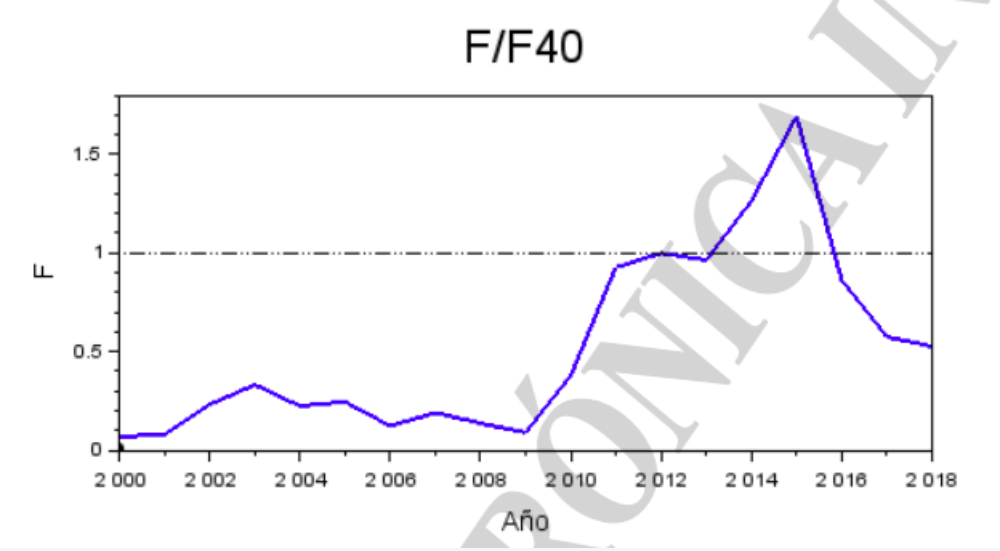
Reported landings for the period between 2004 and 2016, considering only the pot fleet, averaged 2212.8 mt with maximum of 4522.2 mt (2012) and minimum of 324.8 mt (2009) {Navarro et al. 2014; MinAgri 2016}. However, managers implemented a total allowable catch (TAC) for the southern king crab commercial fishery in 2016, which is allocated into four different fishing zones. TACs are set at 10% of the estimated biomass of commercial males (>110 mm carapace length) (Varisco et al. 2018)(INIDEP 2020); the commercial fishery catch has not exceeded the TAC in any year and overfishing has not occured since the 2015-2016 season (Canales et al. 2020). On average, over the last three seasons, the commercial fishery in the CPS reached 62% of the TAC (INIDEP 2020). The 2020-2021 TAC for the entire CPS is 1,815 mt, allocated by zone as follows: Central I (560 t), Central II (280 mt), Central IV (325 mt), and Central V (650 mt) (INIDEP 2020). Reduced catches and failure to reach TACs are believed to be attributed to a reduced fishing season and low density of commercial crabs in national waters (INIDEP 2020).

The southern king crab is significant bycatch in the Patagonian red shrimp (*Pleoticus mulleri*) and Argentine hake (*Merluccius hubbsi*) trawl fisheries in the San Jorge Gulf (Pettovello 1999). During fishing in 1996 and 1997, 0.31% of the biomass from 34 observed Patagonian red shrimp tows was southern king crab (Pettovello 1999). Mortality estimated at the beginning of handling was 19%, but this value may be greater due to the long time of onboard handling (Varisco et al. 2017). Crab caught as bycatch in the shrimp fisheries cannot be landed for sale and therefore is not covered in this report, however the bycatch of southern king crab in these trawl fisheries is significant (Lovrich and Tapella 2014). Between 2006 and 2011, the estimated bycatch was 2432 mt/year (Varisco et al. 2017). However, annual bycatch in the shrimp fishery has decreased to an average of 627 mt (2012-2016); likely as a result of a lower fishing effort in areas with high crab yields (Mauna et al. 2019).

Although historical catches of southern king crab in the CPS were likely unsustainable, fishing levels have been reduced since TACs were implemented in 2016 and mandatory escape rings in traps has decreased the catch of non-commercial individuals (Varisco et al. 2019). Additionally, managers moved the start of the fishing season from November to January to protect crabs during the mating; this change could explain an increase in fecundity observed in 2018 and 2019 (Varisco et al. 2019).

Because mortality from directed fishing and incidental catch in trawl fisheries has been substantially reduced from previous years, TACs are not exceeded, and current fishing levels appear sustainable, a "low" concern score is given.

Justification:



Fishing mortality (F) of southern king crab (Lithodes santolla) relative to target levels (F40%). Figure from Canales et al. 2020

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.

SOUTHERN KING CRAB			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Southwest Atlantic | Pots | Argentina | Central Patagonia Sector	2.236	1.000: < 100%	Yellow (2.236)

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.

SOUTHWEST ATLANTIC | POTS | ARGENTINA | CENTRAL PATAGONIA SECTOR			
SUB SCORE: 2.236	DISCARD RATE: 1.000	**SCORE: 2.236**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Corals and other biogenic habitats	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Benthic inverts	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Finfish	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Southern king crab	3.670: Low Concern	5.000: Low Concern	Green (4.284)

No significant bycatch exists and no other main species are landed for this fishery. Because there is no monitoring of bycatch in this fishery (see Factor 3.3), the Unknown Bycatch Matrices have been used and have identified benthic invertebrates, finfish, corals, and other biogenic habitats as potentially caught in trap fisheries. Southern king crab research surveys in the 2018-19 season incidentally caught sea urchins, starfish, snails, and other invertebrates, but these organisms are not identified to the species level; however, none of the encountered species accounted for more than 3% of the catch in these surveys (INIDEP 2019).

Marine mammals are not caught in traps, but have the potential to be entangled in buoy lines of crab traps, especially derelict ones {Donaldson et al. 2010}. Entanglement in lines from pots is not necessarily lethal; in fact, (Johnson et al. 2005) found that only 18% of 17 entanglements of humpback whale *(Megaptera novaeangliae)* and North Atlantic right whale *(Eubalaena glacialis)* in the western North Atlantic resulted in death. It is possible that individuals that survive an entanglement will prematurely die based on their sustained injuries. Still, (Johnson et al. 2005) claims that 71% of whales observed entangled by pot gear in the western North Atlantic had positive outcomes. The Alaska crab pot fishery operating in the Bering Sea, Aleutian Islands, and the Gulf of Alaska has reported no marine mammal interactions with almost 600 vessels operating in the fishery, and the Office of Protected Resources has listed this fishery as a category III — remote likelihood or no known interactions (NMFS 2012). The Southeast Alaska crab trap fishery has reported interactions with humpback whale, but this fishery is still a category III fishery (NMFS 2012). The Alaska crab trap fishery is larger and more extensive than the Argentine fishery, so the southern king crab fishery likely has fewer interactions with marine mammals than the Alaskan fishery. The northeast Atlantic lobster trap fishery is a category I fishery (frequent interactions with marine mammals), but this ranking results from the local marine mammal populations affected: North Atlantic right whale, humpback whale, and minke whale *(Balaenoptera acutorostrata)* (NMFS 2012). These affected populations do not occur off Argentina, but this highlights that marine mammal interactions in the southern king crab fishery must be recorded. Rankings by experts of trap gear's influence on marine mammals are low to medium in U.S. and Canadian fisheries (Chuenpagdee et al. 2003) (Fuller et al. 2008). Additionally, according to the IUCN Red List of threatened species {iucnredlist.org}, only 4 of at least 30 marine mammals that occur in Argentine waters are vulnerable or endangered: sperm whale *(Physeter macrocephalus)*, blue whale *(B. musculus)*, sei whale *(B. borealis)*, and fin whale *(B. physalus)*. The global range of these species combined with the infrequency of trap line entanglements and the rarity of mortality from entanglements renders the assessment of marine mammals as bycatch unnecessary for the fishery covered in this report.

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 inverts

Factor 2.1 - Abundance

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

Moderate Concern
Abundance of benthic invertebrates is considered to be a moderate conservation concern.

Factor 2.2 - Fishing Mortality

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

Low Concern
The impact of traps on benthic invertebrates is considered to be a low conservation concern.

Corals and other biogenic habitats

Factor 2.1 - Abundance

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

High Concern
Corals and biogenic habitat are highly vulnerable to fishing impacts therefore abundance is considered a high conservation concern.

Factor 2.2 - Fishing Mortality

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

Low Concern
As traps are not mobile, the impact on corals and biogenic habitat is considered a low conservation concern.

Finfish

Factor 2.1 - Abundance

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

Moderate Concern
Abundance of finfish is considered to be a moderate conservation concern.

Factor 2.2 - Fishing Mortality

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

Low Concern
The impact of traps on finfish is considered to be a low conservation concern.

Factor 2.3 - Discard Rate/Landings

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

< 100%
Releases of the target species, southern king crab, do occur because regulations prohibit the landing of female crabs or any crab under 110 mm carapace length (CL) (CeDePesca 2010). The survival of crabs brought to the surface and subsequently discarded is high in other crab trap fisheries (93.8% survival in (Tallack 2007); 88.8% survival with exposure of –4° x hours or less in (Stoner 2009)); although not well studied, survival is likely high in this fishery as well.

The amount of bait used in this fishery is unknown; however, fisheries for king crab in Alaska have a bait use that ranges between 11% and 60% relative to landings {NPMFC 2015}. The bait type used in this fishery is hake viscera and sometimes whole hake, anchovies, and squid {Góngora 2017} (Varisco et al. 2016). There is a bait use estimate of about 1 kg per trap, or almost 1,000 kg per line. For the two vessels that operate in the San Jorge Gulf, the estimate of bait use is about 6,000 kg per day (approximately 1,000 t during the season). The experimental fleet comprised four or five vessels, so the bait used would be nearly 40%–50% of landings {Góngora 2017}.

It is expected that bait use in this fishery would fall within this range, so bait use and discard mortality is likely <100% of landings.

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	RESEARCH AND MONITORING	ENFORCEMENT	INCLUSION	SCORE
Southwest Atlantic | Pots | Argentina | Central Patagonia Sector	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**

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

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

Moderately Effective

The fishery is conducted mainly with traps, and all female and undersized crab and fish bycatch must be released (CeDePesca 2010). The CPS fishery is closed from June 1 to December 31; the closure is for stock protection (molt of the males) and reproductive protection (Pretterebner et al. 2019)(INIDEP 2020). TACs were put in place in 2016 and are set according to an exploitation rate of 10% of biomass of commercial males (INIDEP 2020). Like other crab fisheries, management is based on the "3S" rule: size, sex and season. Specifically, only males with carapace length greater than 110 mm can be landed; the fishery does not operate in molting and reproductive seasons (Varisco et al. 2019).

The Federal Fisheries Council (Consejo Federal Pesquero [CFP]) has implemented some management strategies outlined above (CeDePesca 2010){INIDEPT 2020}(Varisco et al. 2018). In May of 2013, the CFP enacted a new provincial law (Act 931) that enables fishing for crab in an area that was closed for the last 19 years in the Beagle Channel region. This new law imposes time closures without biological support (Lovrich et al. 2014). An analysis of the most recent fishing seasons in the Patagonia region showed a reduction of 25% in the total landings of crab, which was the largest reduction in the Chubut sector (Firpo et al. 2016). Because southern king crab is targeted in the trap fleet and caught as bycatch in the trawl fishery, there is a need to investigate these effects on the king crab population. The bycatch of southern king crab in trawl fisheries is significant (Lovrich and Tapella 2014), but declining (INIDEP 2020). Trawling has king crab as a regular component of its bycatch, and current regulations state that the crab caught must be returned to the sea immediately. But there is uncertainty regarding the survival levels of this bycatch (Iorio et al. 2013). The main problem with southern king crab bycatch is the detrimental effect on its reproductive potential because of the increase in the proportion of non-ovigerous females and the mortality of ovigerous females, along with extensive handling (which can also result in a significant egg loss) (Varisco et al. 2017). There has been a reduction in crab bycatch in trawl fisheries in recent years, but this is likely due to lower fishing effort in areas rather than new management measures (Mauna et al. 2019).

There have been several new management strategies aimed at improving the status of this resource. Specifically, the Federal Fisheries Council has:

- Shortened the commercial season from 8 months to 4.5 months in the CPS (INIDEP 2020).
- Established new management units: Central Area (between parallels 43 ° 30 'and 48 ° of South latitude) and South Area parallels 48 ° and 54 ° 30' of South latitude. The central area is dividing into five geographic zones, and the second into four; each zone has a specific TAC (INIDEP 2020).
- Required a scientific research campaign to be carried out at least 15 days before the start of the fishing season to estimate biomass and establish the season's TAC (INIDEP 2020).
- Required escape rings to protect females and juveniles (Allega et al. 2020)

There are numerous recent management measures that have not been in place long enough to evaluate their success. Therefore, a "moderately effective" score is given.

Factor 3.2 - Bycatch Strategy

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

Moderately Effective
The fishery has no or very low (<5%) bycatch (including any unintended or unmanaged catch, even if retained), with no bycatch of species of concern. The CFP 19/08 law requires the identification of the trap and the use of deactivation mechanisms, such as biodegradable net, to prevent ghost fishing if the trap is lost. The LEY No. 931 (Argentina 2013) imposes sanctions on anyone who loses traps. But there are situations in which small boats abandoned their traps into the sea for economic reasons {Varisco 2017}. According to (CeDePesca 2010), there was historically noncompliance with these rules; now, all fishery participants are required to tag their traps and fisheries managers inspect traps for escape rings and tags at the beginning of the season (Varisco 2020). These new measures have not been in place long enough to evaluate their effectiveness; the bycatch strategy is deemed "moderately effective."

Factor 3.3 - Scientific Research And Monitoring

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

Moderately Effective
There is knowledge of the reproduction of southern king crab (e.g., (Lovrich and Vinuesa 1999) (Vinuesa and Balzi 2002) (Calcagno et al. 2004) (Calcagno et al. 2005)), and there is a recent fishery stock assessment in the Central Patagonia Sector (Canales et al. 2020). The Federal Fisheries Council (Consejo Federal Pesquero [CFP]) has performed annual research campaigns before each of the last few fishing seasons to estimate crab abundance and determine catch limits (INIDEP 2020). Additionally, these surveys estimate fertility, identify variations in reproductive potential, measure egg quality, determine selectivity of escape rings for spider crabs (*Libidoclaea granaria*), and monitor bycatch (INIDEP 2019). Fishing activities are monitored by on-board observers (Allega et al. 2020) and there are strategies to mitigate and monitor ghost gear impacts (e.g. escape rings and mandatory trap tagging) (Argentina 2013)(Varisco 2020). However, further research on interactions with incidentally encountered species is needed. Therefore, a "moderately effective" score is given.

Factor 3.4 - Enforcement Of Management Regulations

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

Moderately Effective
Each vessel must carry an observer on board (CeDePesca 2010). The effectiveness of enforcement overall is unknown. The enforcement of management regulations is deemed "moderately effective."

Factor 3.5 - Stakeholder Inclusion

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

Moderately Effective
The management of the fishery is under the jurisdiction of the Argentine government (national and provincial), and a commision monitors the fishery with participation from INIDEP technicians, stakeholders, and fishery managers (Varisco 2020). The overall effectiveness of these measures and the level of input of stakeholders at the management level is unknown. Stakeholder inclusion is deemed "moderately 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	SCORE
Southwest Atlantic | Pots | Argentina | Central Patagonia Sector	3	0	Moderate Concern	**Yellow (3.000)**

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate
Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

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

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

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

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

Factor 4.3 - Ecosystem-Based Fisheries Management
Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

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

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

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

3
This fishery is conducted using traps or pots. Traps fishing for crustaceans affect the ecosystem by resting on, and incidentally dragging across, the seafloor, which can destroy habitat and crush benthic organisms (Donaldson et al. 2010). Ecosystem damage by traps was deemed 38/100 from expert ranking for U.S. fisheries (Chuenpagdee et al. 2003) and 44/100 for Canadian fisheries (Fuller et al. 2008). Similar impacts are assumed to occur in this fishery. The score deemed to physical Impact of fishing gear on the habitat/substrate is 3.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

0

Biodegradable net would reduce the impact on the habitat through reduced entangling of benthic organisms, but reducing derelict crab traps entirely is still necessary. Measures to reduce ghost fishing by derelict crab traps have been shown to be effective (VIMS 2009). For the San Jorge Gulf, there are temporal closures (Lovrich and Tapella 2014) and a coastal marine protected area in the northern region (Argentina 2017). For the Beagle Channel region, most fishery closures are temporal, but there are some spatial closures in accordance with Ley No. 931 (Argentina 2013). For the purposes of gear impact mitigation, these closures are insufficient to protect the seabed habitats from damage. For these reasons, the mitigation of gear impacts is scored as 0.

Factor 4.3 - Ecosystem-based Fisheries Management

Southwest Atlantic | Pots | Argentina | Central Patagonia Sector

Moderate Concern

Lithodids have opportunistic generalist feeding habits: they are predators that feed on prey that are more abundant in the environment. Records on predators of adult lithodids are scarce. Their large size, hardness of the exoskeleton, and covering of spines probably confer protection against predators. The reported main cause of mortality among southern king crab likely occurs during the first juvenile stages and is caused by parasites {Vinuesa y Balzi 2008} (Lovrich and Tapella 2014) {Vinuesa et al 2015}. The southern king crab is not an exceptional species according to the Seafood Watch criteria. The greatest impact on the population comes from the fishing activity. The fishery regulations are as follows: (1) In both Argentina and Chile, the trap is the unique fishing gear allowed. (2) Only males above the legal size are permitted to be landed. Legal sizes are 112 mm carapace length (CL) (120 mm CL in Chile) for *L. santolla* and 74 mm CL for *P. granulosa*. Landings of females are expressly banned. (3) In the Argentinean Beagle Channel, the total effort was limited to 1,000 traps per season (Lovrich and Tapella 2014). For the trawl fishery, the current regulation states that any king crab caught must be returned to the sea quickly (Iorio et al. 2013).

There are no efforts to assess the ecological impacts of this fishery at this time (CeDePesca 2010). The fishery lacks spatial management or other policies to protect ecosystem functioning and to account for captured species' ecological roles, but detrimental food web impacts are not likely. For these reasons, management of the ecosystem and food web impacts of the fishery is deemed a "moderate" 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

Appendix A

Updates to Southern King Crab Report :
Updates to the July 10, 2017 Argentina southern king crab report were made on January 21, 2021:

Overall Recommendations for southern king crab caught with pots upgraded from Avoid to Good Alternative. Changes are due to recent reduction in fishing mortality and implementation of management and research procedures in the CPS fishery, the only fishery covered in this report.

C1.1: Upgraded from "Moderate" Concern to "Low" Concern because a recent stock assessment suggests that crab abundance is above management targets.
C1.2: Upgraded from "High" Concern to "Low" Concern because recent catches are below suggest catch limits, mortality from trawl fisheries has declined, and management measures have reduced mortality of non-commercial individuals. Current levels of fishing mortality appear sustainable.
C3.1: Upgrade from "Ineffective" to "Moderately Effective" because there are new management measures that are expected to be effective but the measures have not been in place long enough to evaluate their success.

C3.3: Upgraded from "Ineffective" to "Moderately Effective" because managers are now collecting and analyzing data to monitor the health of the stock, a recent stock assessment has been produced, and policies are in place to monitor lost gear, but data on bycatch is still limited.