Monterey Bay Aquarium Seafood Watch

Environmental sustainability assessment of wild-caught Arched swimming crab, Blue crab, and Cortez swimming crab from Mexico caught using crab rings, scoop nets, and traps

Species:	Cortez swimming crab (*Callinectes bellicosus*) Arched swimming crab (*Callinectes arcuatus*) Blue crab (*Callinectes sapidus*)
Location:	Mexico: Pacific and Gulf of Mexico
Gear:	Traps, Crab rings, Scoop nets
Type:	Wild Caught
Author:	Seafood Watch
	Assessed using Seafood Watch Fisheries Standard v3

Table of Contents

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

This report evaluates the swimming crab fisheries in three Mexican states: Sonora and Sinaloa on the Gulf of California (Pacific Ocean) and Campeche on the Gulf of Mexico (GOM) (Atlantic Ocean). The report examines arched swimming crab (*Callinectes arcuatus*) and Cortez swimming crab (*C. bellicosus*) in the Gulf of California, which are caught using traps and rings, and blue crab (*C. sapidus*) in the Gulf of Mexico, which is caught using scoop nets and rings.

A recent stock assessment for swimming crab species in the Gulf of California found that both species are not overfished and no overfishing was occurring. But, the authors reported a significant increase in fishing mortality and recommended that managers monitor these increments in fishing effort closely.

Trap, ring, and scoop net fisheries in all the regions mostly catch swimming crabs. In the case of rings and scoop nets, bycatch is practically nonexistent. But traps, especially in Sonora, have been reported to catch a significant volume of invertebrate species, particularly pink-mouthed murex/pink snail (*Phyllonotus erythrostomus*), which made up more than 5% of the total catch. Nonetheless, it is not listed as a species of concern. In Campeche, the black or sharptooth swimming crab (*C. rathbunae*) has been reported as part of the catch and was included in the analysis as bycatch.

The crab fisheries in Sonora and Sinaloa are generally well managed; however, some activities in research and monitoring could be improved. For example, landing records are not separated by species, so it is difficult to determine the actual catch volume by species. In the Campeche fishery, additional measures are needed to improve the current management system and knowledge of the species. Crab traps have a relatively low impact on the physical and biological structures of the seafloor. Managers are planning to develop an environmental impact study to measure the impacts of fishing activities on the entire ecosystem in all regions.

Considering the results of the most recent assessments, the fisheries for arched swimming crab and Cortez swimming crab in Sonora and Sinaloa were scored a Good Alternative. The blue crab fishery in Campeche is also scored a Good Alternative; this score is driven mostly by concerns about management, which currently is minimal, and there is a need for better monitoring of fishing effort.

Final Seafood Recommendations

SPECIES | FISHERY	C 1 TARGET SPECIES	C 2 OTHER SPECIES	C 3 MANAGEMENT	C 4 HABITAT	OVERALL	VOLUME (MT) YEAR
Arched swimming crab | Eastern Central Pacific | Crab rings | Mexico | Sinaloa	3.318	3.318	3.000	3.000	**Good Alternative (3.155)**	19,964
Arched swimming crab | Eastern Central Pacific | Traps | Mexico | Sinaloa	3.318	3.318	3.000	3.000	**Good Alternative (3.155)**	19,964
Blue crab | Gulf of Mexico | Crab rings | Campeche	3.318	2.644	3.000	3.000	**Good Alternative (2.981)**	8,900
Blue crab | Gulf of Mexico | Scoopnets | Campeche	3.318	2.644	3.000	3.000	**Good Alternative (2.981)**	8,900
Cortez swimming crab | Eastern Central Pacific | Crab rings | Mexico | Sinaloa	3.318	3.318	3.000	3.000	**Good Alternative (3.155)**	19,964
Cortez swimming crab | Eastern Central Pacific | Traps | Mexico | Sonora	3.318	3.413	3.000	3.000	**Good Alternative (3.177)**	11,838
Cortez swimming crab | Eastern Central Pacific | Traps | Mexico | Sinaloa	3.318	3.318	3.000	3.000	**Good Alternative (3.155)**	19,964

Official landings data do not differentiate between species or gear types (SAGARPA-CONAPESCA 2020). Total reported landings in 2020 were 19,964mt, 11,838mt, and 8,900mt in Sinaloa, Sonora, and Gulf of Mexico, respectively.

Summary

Arched swimming crab and Cortez swimming crab from fisheries in Sonora and Sinaloa on the Eastern Central Pacific Ocean are rated as Good Alternative. Blue crab from the fishery in Campeche on the Gulf of Mexico is rated a Good Alternative.

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 addresses three swimming crab species caught with traps and rings in Sonora and Sinaloa (the biggest state producers in Mexico; on the Gulf of California) and with scoop nets and rings by fishers in the state of Campeche (Gulf of Mexico). The Sonora and Sinaloa fisheries are involved in a fishery improvement project (FIP). The species covered by the recommendations and their percentage of the catch, by state, are:

Sonora: *Callinectes bellicosus* (95%) and *C. arcuatus* (5%) {Cisneros-Mata, M. et al. 2014}
Sinaloa: *C. bellicosus* (66%) and *C. arcuatus* (31%) {Cisneros-Mata, M. et al. 2014}
Campeche: *C. sapidus* (89.2%) (DOF 2022)

Species Overview

The three species of crab rated in this assessment are *Callinectes arcuatus*, *C. bellicosus*, and *C. sapidus*. Their common names vary; the U.S. FDA common names—arched swimming crab, Cortez swimming crab, and blue crab, respectively—will be used throughout this assessment (Table 1).

Table 1. Scientific, common, and market names and volumes for three crab species in this report.

Region	Scientific Name (FDA/FAO)	FDA Common Name	FDA Acceptable Market Name	FAO Name	Mexican Name	Volume (mt)
Pacific Ocean (Gulf of California)	*Callinectes arcuatus*	Arched swimming crab	Swimming crab	Cuata swimcrab	Jaiba cuata	≈31,800 mt (SAGARPA-CONAPESCA 2020). Official landing data do not differentiate the species.
	Callinectes bellicosus	Cortez swimming crab	Swimming crab	Warrior swimcrab	Jaiba verde/ guerrera	
Gulf of Mexico	*Callinectes sapidus*	Blue crab	Blue crab	Blue crab	Jaiba azul	≈8,900 mt (SAGARPA-CONAPESCA 2020)

In the Mexican Pacific Ocean (Gulf of California), Cortez swimming crab (*Callinectes bellicosus*) and arched swimming crab (*C. arcuatus*) are the most important in terms of abundance {Cisneros-Mata et al. 2014}. Both species are captured using traps in Sonora and by traps and rings in Sinaloa (Figure 1). These species have wide distributions that extend from California in the United States to Peru in South America (Figure 2). In Mexico, the catch proportion varies by state because of each species' prevalence and distribution. In Sonora, 95% of the landings are represented by Cortez swimming crab, whereas in Sinaloa, the proportion is 57% Cortez swimming crab and 41% arched swimming crab (DOF 2014). Also in Sinaloa, giant swimming crab/black crab (*C. toxotes*) occurs; however, it makes up a minor proportion of the landings and is not assessed in this report.

Figure 1: Crab traps (left) and rings (right) used in Sonora and Sinaloa. (Photo credit COBI AC.)

Figure 2: Distribution of crab species in the Pacific Ocean, including Mexico. (Image from Cisneros-Mata et al., 2014.)

These crab species have an "r-type" reproductive strategy, which means that they have high fecundity and relatively little investment in any individual progeny. They are typically susceptible to predation and environmental changes (Giesel 1976). Like other organisms with "r" strategies, Cortez and arched swimming crabs have short life spans of 4 years {Wilcox, 2007}{Rosas-Correa & Navarrete 2009} {Rodriguez-Felix et al. 2015} and are quick to mature. Several researchers report that these crab species can reach maturity within the first year {Estrada-Valencia 1999}{Ramos-Cruz 2008}{Nevarez-Martinez et al. 2003}{Castro-Longoria et. al. 2002}{Ramirez-Felix et al. 2003}.

In the Gulf of Mexico (GOM), blue crab (*C. sapidus*) is the most abundant species and the main target species for the fishery in this region (DOF 2012). The region's fishers mostly use scoop nets to catch this species (Figure 3). Its distribution has been reported from Nova Scotia in Canada to northern Argentina in South America, including Bermuda and the Caribbean Sea (Figure 4) (FAO Species Fact Sheets, accessed September 2016).

Figure 3: Scoop nets used in Campeche for the crab fishery. (Photo credit: Nakamura, 2014.)

Figure 4: Distribution of blue crab (*Callinectes sapidus*). (Image from FAO, 2016.)

Blue crab's biological characteristics are similar to those of arched swimming crab in the Pacific Ocean. It has a relatively short life span of 4.5 years and reaches maturity between 12 and 18 months of age {Rosas-Correa and Jesus-Navarrete 2008}.

Callinectes species inhabit estuarine and coastal waters. According to Williams (1974) in {Ortiz-Leon et al. 2006}, adults are bottom dwellers found from nearshore marshes to depths of 40 m (130 ft). During juvenile stages, the species prefer shallow, soft mud sediments where they can burrow into the substrate for protection from predators {Amador del Angel et al. 2003}.

In Mexico, the crab fisheries along both coastlines (Pacific Ocean and the Gulf of Mexico) are managed by the federal government of Mexico through the National Aquaculture and Fishing Commission (CONAPESCA) and its technical branch, the National Fisheries Institute (INAPESCA). These bodies are responsible for creating, implementing, and enforcing management strategies for fishing resources in the country. In Mexico, three official documents regulate crab fishing activities: the Official Mexican Norm 039-PESC (NOM-039) regulates crab fisheries in federal waters (Official Federal Paper) {DOF 1993}; the National Fisheries Charter (CNP; Carta Nacional Pesquera) contains information on the status of resources, regulations, and management strategies; and the Sinaloa–Sonora Management Plan (SSMP) (DOF 2014)

contains specific regulations for crab fisheries in these two states (which have the highest levels of production in Mexico).

Production Statistics

Mexican crab is accepted internationally for its taste and quality {Cisneros-Mata et al. 2014}. In the GOM, the crab fishery has been a traditional fishery for over six decades {Chavez & Socorro-Hernadez 1980}. In the Pacific Ocean, official reports suggested that the fishery started in the early 1980s {Cisneros-Mata et al. 2014}. Crab landings in Mexico have been relatively stable. In recent years, production has increased from an average of 21,000 metric tons between 2011 and 2013 to more than 40,000 metric tons between 2015 and 2020 (Figure 5).

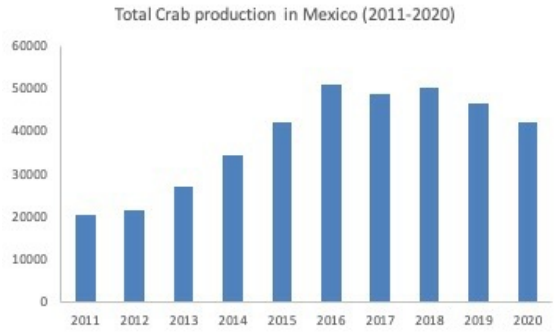

Figure 5: Crab landings in Mexico from 2011 to 2020. (Source: Year book CONAPESCA.)

Most of the crab production is from the Pacific Ocean. In 2020, 78% of the total production using all gears was landed in the Pacific Ocean (CONAPESCA 2020), and more than 94% of that production was landed in Sonora and Sinaloa (Figure 6) (CONAPESCA 2020).

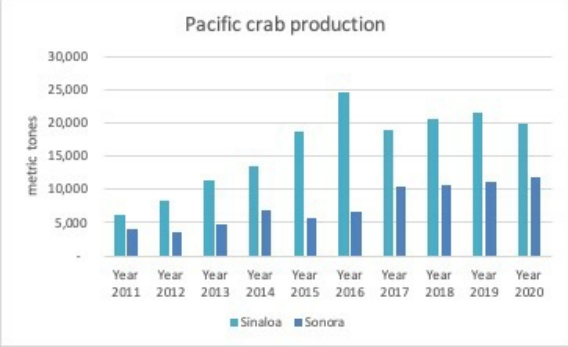

Figure 6: Pacific Ocean crab production per state from 2011 to 2020. (Source: CONAPESCA 2020.)

In the GOM, the most important states for volume are Veracruz, Campeche, and Tamaulipas, followed by Tabasco and Yucatan (Figure 7) (CONAPESCA 2020). Most of this region's production stays in the domestic

market; however, the fishery in Campeche, included in this report, exports 100% of its production (pers. comm., Rudy Abad, PESMAR 2016).

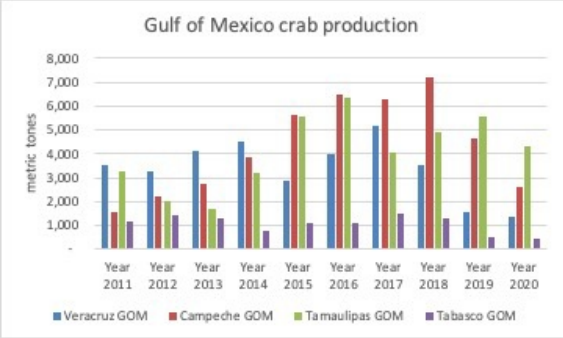

Figure 7: Gulf of Mexico crab production per state from 2011 to 2020. (CONAPESCA 2020)

Importance to the US/North American market.

Imports of crab meat to the United States from Mexico fluctuated between 500 t in 2016 and 875 t in 2021; the highest level was 1,391 t in 2012 (NOAA 2022) In the GOM are some species associated with the blue crab market, they are the small blue crab (*Callinectes similis*) and stone crab (*Menippe mercenaria*) (DOF, 2017). In the region of GOM there is a lack of information about crab market importance, including volume of exportation and prices. According to the National Institute of Fisheries in Mexico (INAPESCA), there are three types of crab registered for the southern zone of Campeche and Tabasco: small blue crab (*Callinectes similis*), black/sharptooth swimming crab (*Callinectes rathbunae*), and blue crab (*Callinectes sapidus*). The latter species is of greater abundance and greater economic importance within the southern zone of Campeche.

Table 2. Crab meat imports to the United States from Mexico by weight and value for select years.

Year	Presentation	Weight (t)	Value (USD)
2014	Crabmeat Swimming (*Callinectes*)	1,225	28,060,050
2016	Crabmeat Swimming (*Callinectes*)	505	5,306,366
2018	Crabmeat Swimming (*Callinectes*)	1,007	22,516,669
2021	Crabmeat Swimming (*Callinectes*)	875	22,859,450

Common and market names.

In the Gulf of California, Cortez swimming crab (*C. bellicosus*) is also known as green crab or brown crab, and the larger size (>250 g) is known as "jaibon." Arched swimming crab (*C. arcuatus*) is also known as blue crab. In the Gulf of Mexico, *C. sapidus* is known as blue crab.

Primary product forms

The primary product forms are pasteurized lump meat, special meat, and claw meat, which can be canned or frozen. In the GOM, the Campeche Bay crab meat is processed exclusively from the true blue crab (*C. sapidus*). A state-of-the-art processing facility, established in 2010, lies adjacent to the Bay of Campeche in the southern Gulf of Mexico. Custom pack arrangements are available for fresh crab meat and are pasteurized in 401-diameter (4-1/16 in.) metal cans and 401- and 307-diameter (3-7/16 in.) plastic cups. (https://pesmar.com.mx/blue-crab-meat/)

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

ARCHED SWIMMING CRAB			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern Central Pacific | Crab rings | Mexico | Sinaloa	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Eastern Central Pacific | Traps | Mexico | Sinaloa	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

BLUE CRAB			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Gulf of Mexico | Crab rings | Campeche	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Gulf of Mexico | Scoopnets | Campeche	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

CORTEZ SWIMMING CRAB			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern Central Pacific | Crab rings | Mexico | Sinaloa	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Eastern Central Pacific | Traps | Mexico | Sonora	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Eastern Central Pacific | Traps | Mexico | Sinaloa	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

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.*

Arched swimming crab

Factor 1.1 - Abundance

Eastern Central Pacific | Crab rings | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sinaloa

Low Concern

Balmori et al. (2021) developed a stock assessment for arched swimming crab in the Mexican Pacific Ocean. The authors fed official landings data from 1980 to 2018 into a catch-maximum sustainable yield (C-MSY) method, to estimate the maximum sustainable yield (MSY), the biomass associated with MSY (B_{MSY}), and the fishing mortality associated with maximum sustainable yield (F_{MSY}) for *C. arcuatus* in the Gulf of California (Table 3) {Balmori et al. 2021}.

The authors declared B_{MSY} as the target reference point for the species, based on its ecology. As a result of the analysis, the authors calculated the MSY for the arched swimming crab as 5,483 t and B_{MSY} as 9,205 t. The results showed that arched swimming crab biomass has been above B_{MSY} (Figure 8).

Table 3. Stock assessment estimates for arched swimming crab.

Species	Reference points			Candidate Reference Points for Management		
	Median (CI = 95%)			Target	Limit	
	MSY (t)	B_{MSY} (t)	F_{MSY}	B_{MSY}	0.5 B_{MSY}	F_{MSY}
Arched swimming crab	5,483	9,205	0.596	9,205	4,603	0.596

A recent stock assessment (i.e., using data <5 years old) that found current biomass to be above B_{MSY} would allow for a score of 5 (very low concern). But, there is great uncertainty in the estimate of B_{MSY}, and the assessment has not yet completed peer review (though it has been accepted). This moderates the score to 3.67, which gives a rating for abundance of low concern.

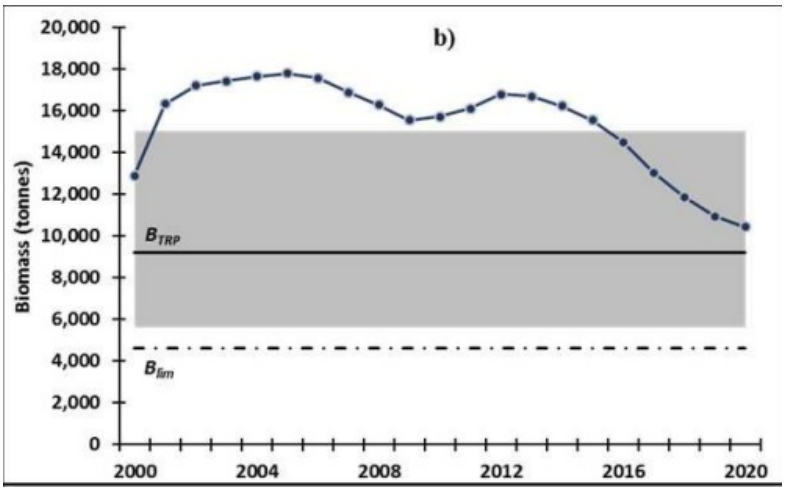

Figure 8: Arched swimming crab biomass in the Gulf of California from 2000 to 2020. B_{TRP} is the candidate reference point and is set at B_{MSY}. The gray shading illustrates the 95% confidence interval around B_{MSY}. Source: {Balmori et al. 2021}.

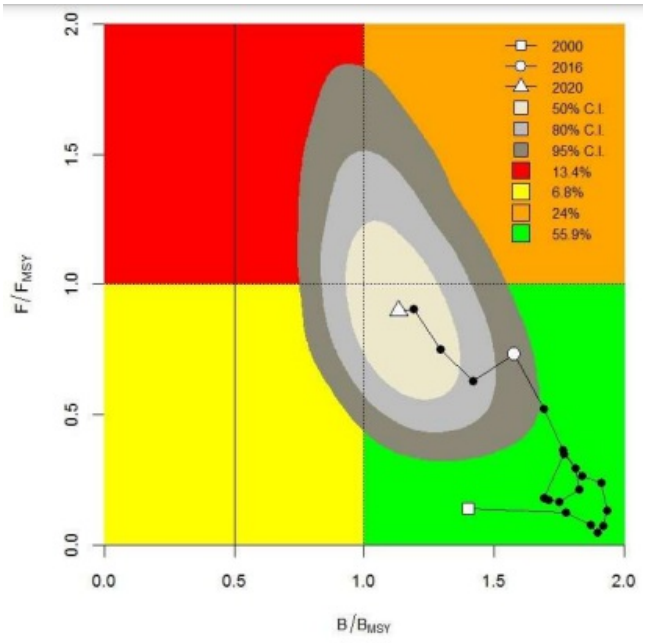

Figure 9: Kobe plot for arched swimming crab in the Gulf of California. Source: {Balmori et al. 2021}.

Factor 1.2 - Fishing Mortality

Eastern Central Pacific | Crab rings | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sinaloa

Moderate Concern

Balmori et al. (2021) estimated the fishing mortality values for the arched swimming crab in the Gulf of California. According to the landings data, there was a growing increment from 2012 until 2020 near the estimated fishing mortality reference limit (F_{LIM}), which is set in the assessment at F_{MSY} (Figure 10). The authors reported values of fishing mortality throughout most of the time series that were far below the F_{MSY} value. Still, since 2012, fishing mortality increased markedly, reaching a maximum value in 2019 (F_{2020}) of 0.540, which equals approximately 90% of F_{MSY} ($F_{CURRENT}/F_{MSY}$ = 0.54/0.596 = 0.91) {Balmori et al. 2021}.

The Kobe plot placed the arched swimming crab stocks close (within a 50% confidence interval) to the overfishing zone for the most recent year assessed (2020) (see Figure 9). The authors reported a 59.9% probability that arched swimming crab was in the green quadrant {Balmori et al. 2021}. The authors also reported that the number of boats in the Gulf of California participating in the swimming crab fishery increased by 42% from 2011 to 2017, with exploitation rates in recent years close to F_{MSY}.

Based on the most recent information available, values of F have been below F_{MSY}, which would allow a score of 5 (low concern). But, fishing mortality has been increasing toward F_{MSY} in recent years, and is now above the lower 95% CI bound for the estimate of F_{MSY}. In addition, arched swimming crab is reported to be caught as bycatch for shrimp industrial and artisanal fisheries {Lopez-Martinez, J. et al. 2014}, and these sources of mortality are not included in the stock assessment. For these reasons, the score is modified to 3 and a rating of moderate concern.

Justification:

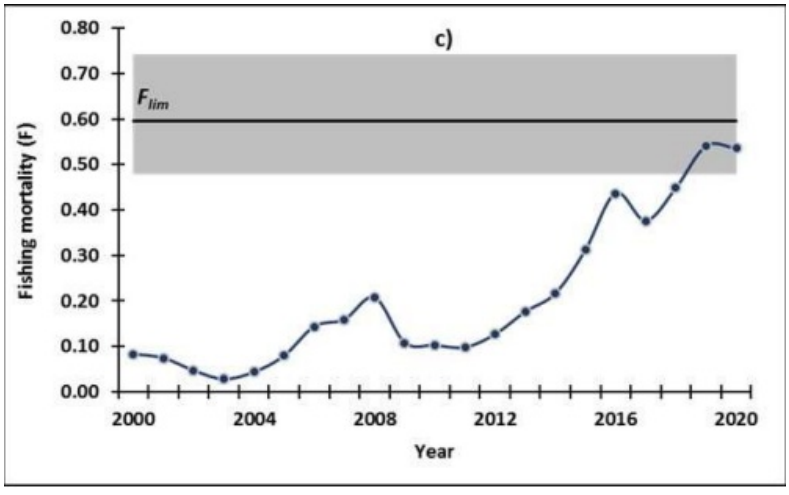

Figure 10: Arched crab fishing mortality from 2000 to 2020; F_{LIM} = F_{MSY}. Source: {Balmori et al. 2021}.

Blue crab

Factor 1.1 - Abundance

Gulf of Mexico | Crab rings | Campeche
Gulf of Mexico | Scoopnets | Campeche

Low Concern

Morales-Azpeitia et al. (2021) released a study that evaluated the biomass of blue crab (*C. sapidus*) in the Gulf of Mexico and estimated the reference points of the species. The authors used a catch-maximum sustainable yield (C-MSY) method to estimate reference points, catch at maximum sustainable yield (MSY), biomass associated with MSY (B_{MSY}), and mortality associated with MSY (F_{MSY}), using production data. Based on the results, the authors reported that the relative biomass has remained above B_{MSY}, although a tendency to decrease can be seen (Figure 11). A recent stock assessment (i.e., using data <5 years old) that found current biomass to be above B_{MSY} would allow for a score of 5 (very low concern). But, there is great uncertainty in the estimate of B_{MSY}, and the assessment has not yet completed peer review (though it has been accepted). This moderates the score to 3.67 and a rating of low concern.

Justification:

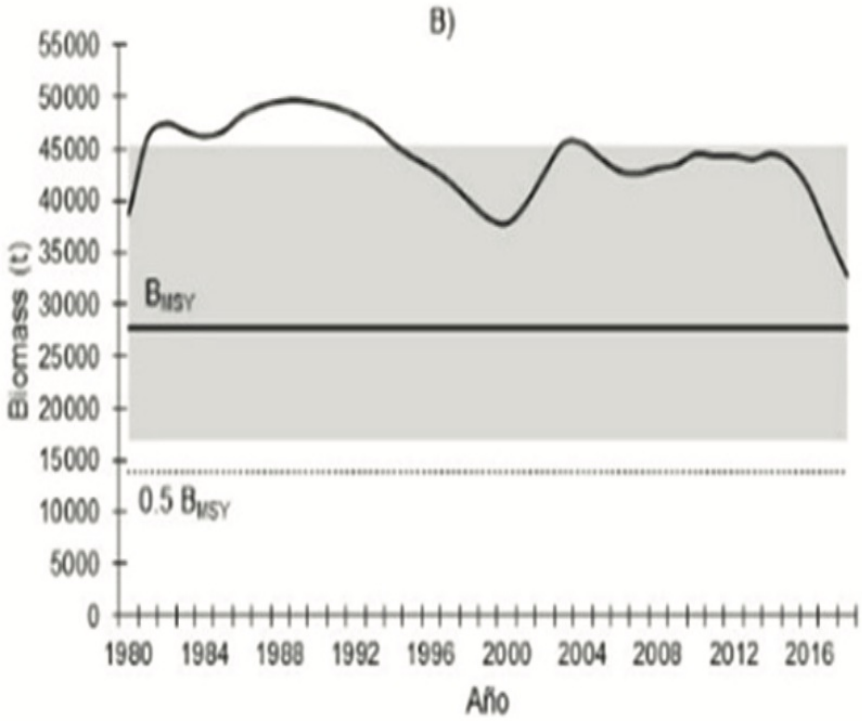

Figure 11: Estimated blue crab biomass in the Gulf of Mexico from 1980 to 2018. Source: {Moralez-Azpeitia et al. 2021}.

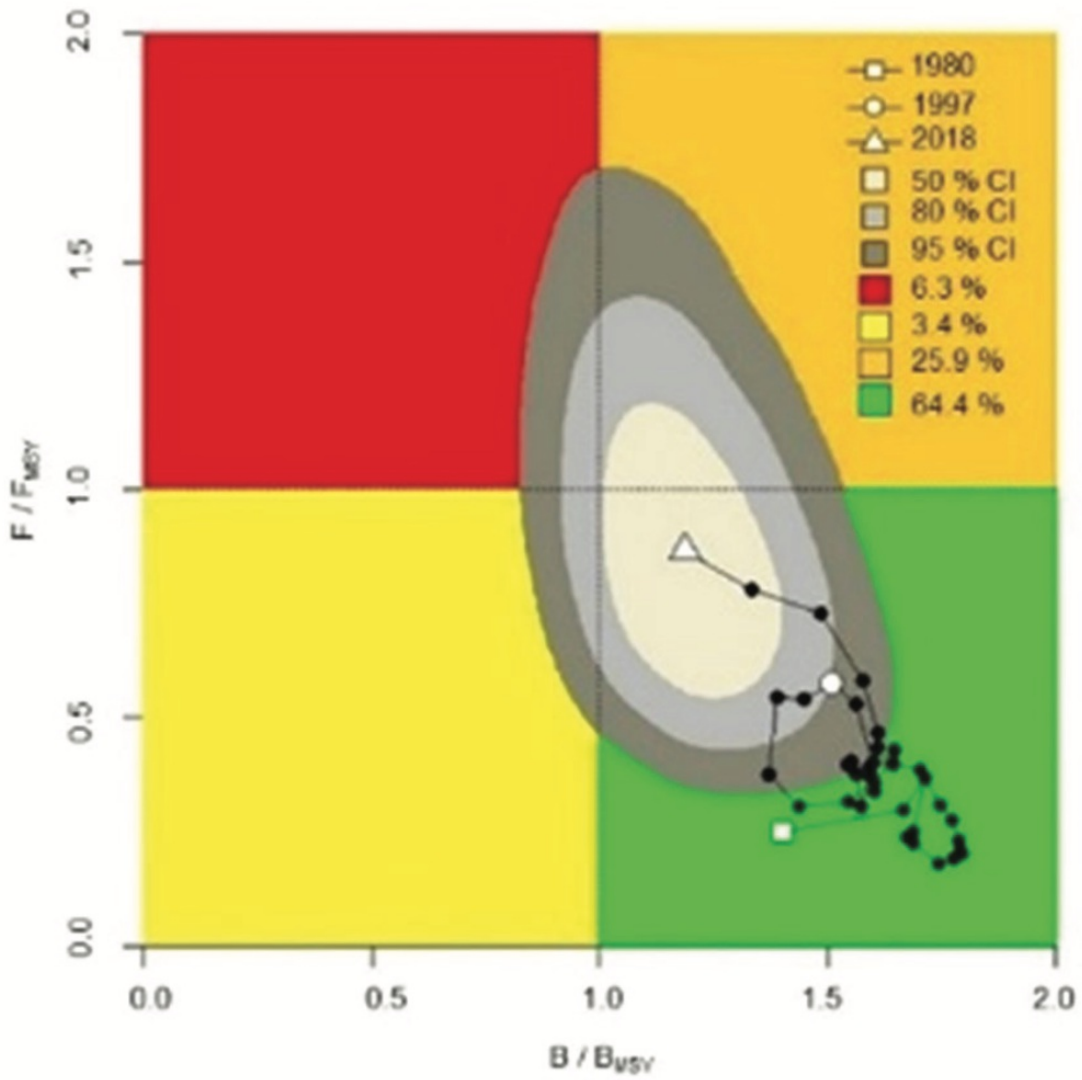

Figure 12: Kobe plot of blue crab in the Gulf of Mexico. Source: {Moralez-Azpeitia et al. 2021}.

Factor 1.2 - Fishing Mortality

Gulf of Mexico | Crab rings | Campeche

Moderate Concern

Moralez-Azpeitia et al. (2021) used the landings data to estimate the levels of fishing mortality for the blue crab fishery in the Gulf of Mexico. The authors used the officially authorized fishing effort (≈2,100 small-scale vessels) {www.pescandodatos.org} and the annual landings, which averaged 4,000 t for the past 10 years {Pescandodatos, 2021}, to run a C-MSY model. From this, the authors estimated the annual fishing mortality values between 1980 and 2018. According to the results, F remained well below the limit reference point F_{MSY} value. After 2014, F continued to increase, reaching a maximum value in 2018, when the exploitation rate was 0.74 (Figure 13) {Morales-Azpeitia et al. 2021}.

Based on the results reported by the authors, the exploitation rate of the stock in the most recent years has been increasing but has remained under F_{MSY} {Morales-Azpeitia et al. 2021}. Considering the clear increasing trend of F in recent years, and that the species is reported to be caught in other fisheries in the region (e.g., shrimp fishery), fishing mortality is deemed a moderate concern.

Justification:

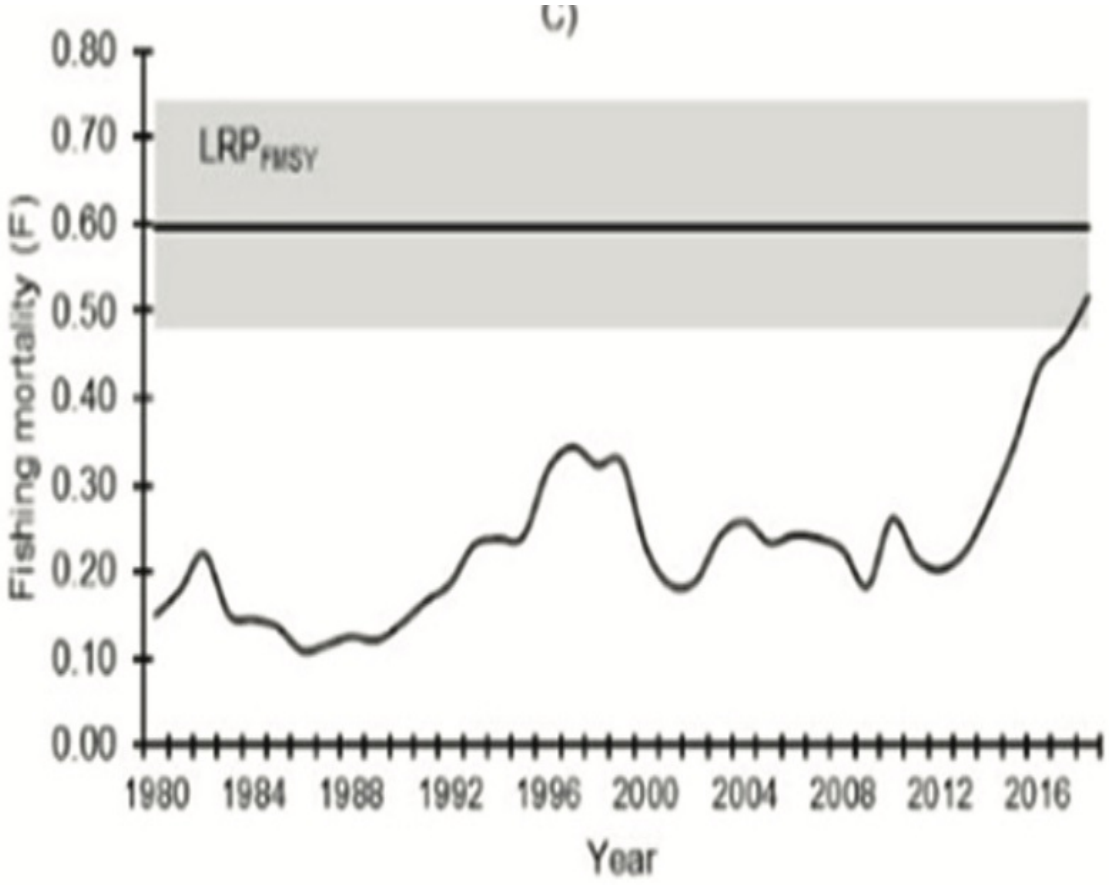

Figure 13: Estimated blue crab fishing mortality in the Gulf of Mexico from 1980 to 2018. Source: {Moralez-Azpeitia et al. 2021}.

Gulf of Mexico | Scoopnets | Campeche

Moderate Concern

Currently, the fishing effort and levels of fishing mortality are unknown for scoop nets. For these reasons, fishing mortality is rated a moderate concern.

Cortez swimming crab

Factor 1.1 - Abundance

Eastern Central Pacific | Crab rings | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sonora
Eastern Central Pacific | Traps | Mexico | Sinaloa

Low Concern

Balmori et al. (2021) developed a stock assessment for Cortez swimming crab in the Mexican Pacific Ocean. The authors fed official landings data from 1980 to 2018 into a catch-maximum sustainable yield (C-MSY) method, to estimate the maximum sustainable yield (MSY), the biomass associated with MSY (B_{MSY}), and the fishing mortality associated with maximum sustainable yield (F_{MSY}) for *C. bellicosus* in the Gulf of California (Table 4).

The authors declared B_{MSY} as the target reference point for the species, based on its ecology. As a result of the analysis, the authors calculated MSY for the arched swimming crab as 24,687 t and B_{MSY} as 41,448 t. The results showed that Cortez swimming crab biomass has been above B_{MSY} (Figure 14). In addition, managers estimated B_{LIM} at 50% of the B_{MSY} as a reference point for future management decisions.

Table 4. Stock assessment estimates for Cortez swimming crab.

Species	Reference points			Candidate Reference Points for Management		
	Median (CI = 95%)			Target	Limit	
	MSY (t)	B_{MSY} (t)	F_{MSY}	B_{MSY}	0.5 B_{MSY}	F_{MSY}
Cortez swimming crab	24,687 (14,031–43,437)	41,448 (24,969–68,800)	0.596	41,448	20,724	0.596

A recent stock assessment (i.e., using data <5 years old) that found current biomass to be above B_{MSY} would allow for a score of 5 (very low concern). But, there is great uncertainty in the estimate of B_{MSY}, and the assessment has not yet completed peer review (though it has been accepted). This modifies the score to 3.67 and a rating of low concern.

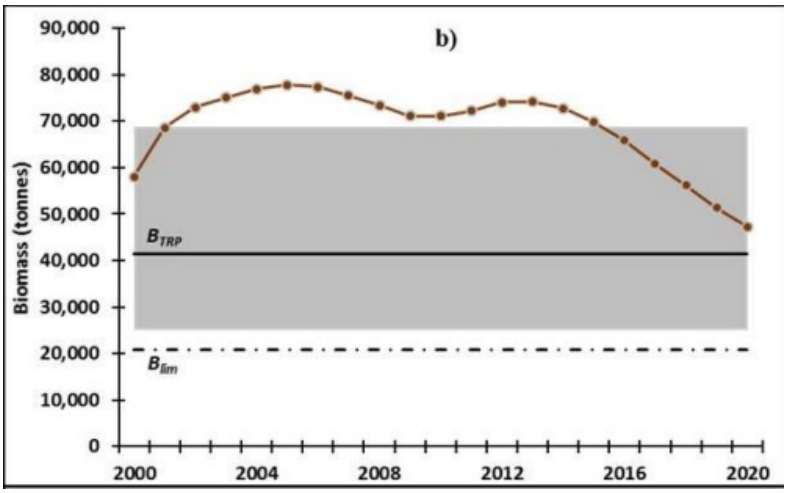

Figure 14: Cortez swimming crab biomass estimates for 2000 to 2020 in the Gulf of California. B_{TRP} is the candidate reference point and is set at B_{MSY}. The grey area represents the 95% confidence intervals around B_{MSY}. Source: {Balmori et al. 2021}.

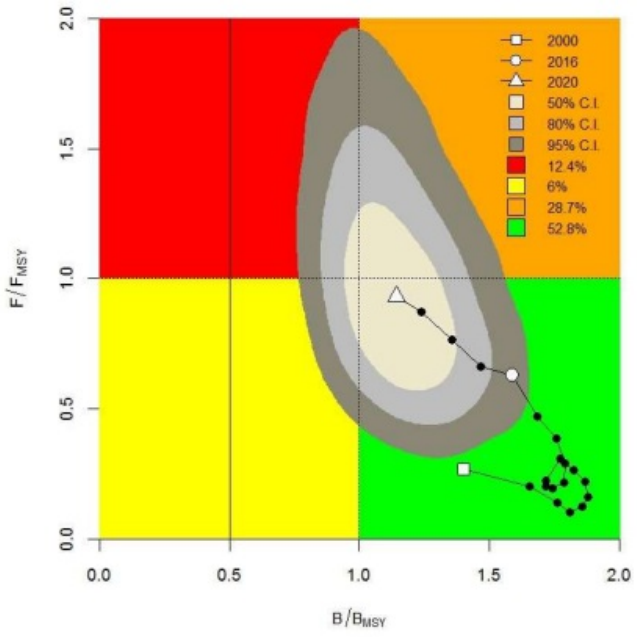

Figure 15: Kobe plot of Cortez swimming crab in the Gulf of California. Source: {Balmori et al. 2021}.

Factor 1.2 - Fishing Mortality

Eastern Central Pacific | Crab rings | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sonora
Eastern Central Pacific | Traps | Mexico | Sinaloa

Moderate Concern

Balmori et al. (2021) estimated the fishing mortality values for Cortez swimming crab in the Gulf of California. According to the landings data, there was a growing increment from 2011 until 2020, when it was near the estimated limit fishing mortality reference limit (F_{MSY}) (Figure 16). The authors reported that the annual fishing mortality throughout most of the time series was below half the F_{MSY} value. Still, since 2012, fishing mortality increased markedly, reaching a maximum value in the last year (F_{2020}) of 0.556, which equals 93% of the F_{MSY} value (F_{2020}/F_{MSY} = 0.556/0.596 = 0.93) {Balmori et al. 2021}.

The Kobe plot placed the Cortez swimming crab stocks close (within a 50% confidence interval) to the overfishing zone for the most recent year assessed (2020) (see Figure 15). The authors reported a 52.8% probability that the Cortez swimming crab was in the green quadrant {Balmori et al. 2021}. The authors also reported that the number of boats in the Gulf of California participating in the swimming crab fishery increased by 42% from 2011 to 2017, with exploitation rates in recent years above F_{LIM}.

Based on the most recent information available, values of F have been below F_{MSY}, which would allow a score of 5 (low concern). But, fishing mortality has been increasing toward F_{MSY} in recent years, and is now above the lower 95% CI bound for the estimate of F_{MSY}. Still, the value has constantly been increasing toward F_{MSY}, and the authors suggested that managers should be aware of this. In addition, Cortez swimming crab is reported to be caught as bycatch for the shrimp industrial and artisanal fisheries {Lopez-Martinez, J. et al. 2014}, and these sources of mortality are not included in the stock assessment. For these reasons, the score is modified to 3 and a rating of moderate concern.

Justification:

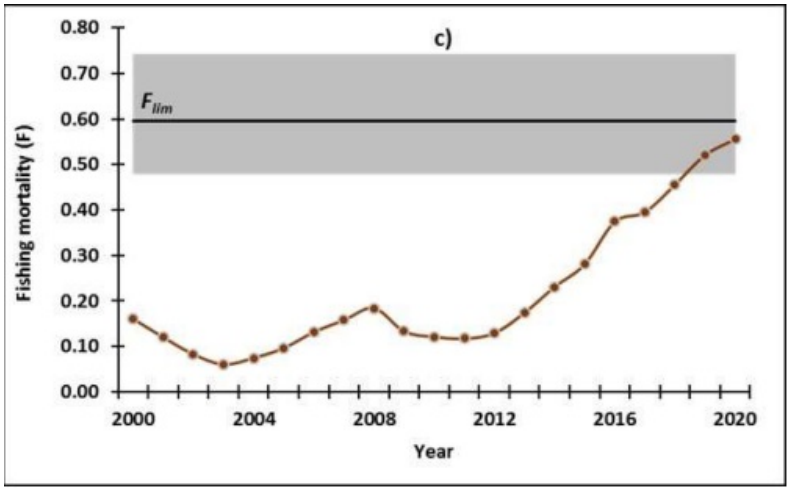

Figure 16: Cortez swimming crab fishing mortality (F) estimates from 2000 to 2020. F_{LIM} = F_{MSY}. Source: {Balmori et al. 2021}.

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.

ARCHED SWIMMING CRAB			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Eastern Central Pacific | Crab rings | Mexico | Sinaloa	3.318	1.000: < 100%	Green (3.318)
Eastern Central Pacific | Traps | Mexico | Sinaloa	3.318	1.000: < 100%	Green (3.318)

BLUE CRAB			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Gulf of Mexico | Crab rings | Campeche	2.644	1.000: < 100%	Yellow (2.644)
Gulf of Mexico | Scoopnets | Campeche	2.644	1.000: < 100%	Yellow (2.644)

CORTEZ SWIMMING CRAB			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Eastern Central Pacific | Crab rings | Mexico | Sinaloa	3.318	1.000: < 100%	Green (3.318)
Eastern Central Pacific | Traps | Mexico | Sonora	3.413	1.000: < 100%	Green (3.413)
Eastern Central Pacific | Traps | Mexico | Sinaloa	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.

EASTERN CENTRAL PACIFIC | CRAB RINGS | MEXICO | SINALOA			
SUB SCORE: 3.318	DISCARD RATE: 1.000	**SCORE: 3.318**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Arched swimming crab	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Cortez swimming crab	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

EASTERN CENTRAL PACIFIC | TRAPS | MEXICO | SINALOA			
SUB SCORE: 3.318	DISCARD RATE: 1.000		**SCORE: 3.318**
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Arched swimming crab	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Cortez swimming crab	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

EASTERN CENTRAL PACIFIC | TRAPS | MEXICO | SONORA			
SUB SCORE: 3.413	DISCARD RATE: 1.000		**SCORE: 3.413**
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Cortez swimming crab	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Pink-mouthed murex	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)

GULF OF MEXICO | CRAB RINGS | CAMPECHE			
SUB SCORE: 2.644	DISCARD RATE: 1.000		**SCORE: 2.644**
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Sharptooth swimming crab	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Blue crab	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

GULF OF MEXICO | SCOOPNETS | CAMPECHE			
SUB SCORE: 2.644	DISCARD RATE: 1.000		**SCORE: 2.644**
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Sharptooth swimming crab	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Blue crab	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

The trap and ring fisheries in Sinaloa and Sonora and the scoop net and ring fisheries in Campeche generally catch low amounts of nontarget species, based on a few studies {Torre-Cosio 2002}{Balmori et al. 2012}{Cisneros-Mata et al. 2014}. In Sinaloa and Sonora, the swimming crab traps' bycatch composition and proportion were assessed in 2012 as part of the fisheries improvement project (FIP) that the fishery was engaged in (SFP 2015). Table 5 shows the seven species or species groups with the highest percentages of bycatch in the Sinaloa and Sonora fisheries {Balmori, A. et al. 2012}. The rest of the species in the list were present at lower than 1%.

Table 5. Species or species groups with the highest bycatch rates in the Sinaloa and Sonora fisheries.

Common name	Scientific name	%	Retained?	Protected?
Pink-mouthed murex	*Phyllonotus erythrostomus*	74.55	Yes (commercialized)	No
Hermit crab	*Pagurus* spp.	7.75	No (released alive)	No
Sea snails	*Turridae* spp.	5.28	No (released alive)	No

Spotted sand bass	*Paralabrax maculatofasciatus*	4.71	Yes (commercialized/consumption)	No
Bullseye pufferfish	*Sphoeroides annulatus*	2.74	Yes (commercialized)	No
Trigger fish	*Balistes polylepis*	2.24	Yes (commercialized)	No
Crab	*Hepatus lineatus*	1.24	No (released alive)	No

Based on their evaluations, the authors reported that the crab bycatch proportion on average was 1:0.31 for Sonora and 1:0.06 for Sinaloa {Balmori et al. 2012}. The study found greater retention of bycatch in traps (an average 230 g per 1 kg of crab) compared to rings (an average 10 g per 1 kg of crab) {Balmori et al. 2012}. In total, 28 bycatch species were identified in the study; 80% were mollusks, 11% were fishes, and 9% were crustaceans. The primary bycatch species was pink-mouthed murex snail (*Phyllonotus erythrostomus*) (≈75% of the total weight of bycatch); other bycatch included some hermit crab species (*Pagurus* spp.) (7% of the total bycatch) and some species of small snails from the Turridae family (5% of the total bycatch). The most commonly caught finfish species was spotted sand bass (*Paralabrax maculatofasciatus*) (4.71% of the total bycatch) {Balmori et al. 2012}. Each of the remaining species was <5% of the bycatch. Of the main bycatch species, only pink-mouthed murex and spotted sand bass were reported to be retained for commercial or personal consumption; the rest are returned alive and in good condition to the water {Balmori et al. 2012} (pers. comm., Loaiza-Villanueva 2016). None of the reported species are under a special risk category, and only pink-mouthed murex in Sonora is considered for further examination.

A more recent study in Sonora found that, for each kilogram of swimming crab, between 0.30 and 0.74 kg of bycatch was cached (Loaiza-Villanueva, R. 2021). Similarly to Balmori, A. et al. (2012), this study's author reported that the most important species in terms of percentage of the catch were pink-mouthed murex, bullseye pufferfish, spotted sand bass, and the crab *Hepatus lineatus*. Based on the report, none of the species reached 5% of the total catch.

In Campeche, managers reported that sharptooth swimming crab (*Callinectes rathbunae*) was caught in the blue crab fishery, at rates up to 8% of total catches in 2006 (DOF 2006). A more recent analysis of the fishery against the Marine Stewardship Council standards reported that bycatch is minimal and that no species listed by the International Union for the Conservation of Nature (IUCN) are caught {Nakamura et al. 2013}. But, no quantitative data on bycatch were presented in the report. Considering the limited information, Seafood Watch included sharptooth swimming crab as a bycatch species in the Campeche fishery.

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

Pink-mouthed murex

Factor 2.1 - Abundance

Eastern Central Pacific | Traps | Mexico | Sonora

Moderate Concern

Managers recommended limiting the commercial extraction of pink-mouthed murex to about 40% of the calculated biomass (DOF 2012). But, there is no evidence that either a stock assessment has been conducted or that catch limits have been established. There is also no IUCN assessment of the species. For these reasons, a productivity-susceptibility analysis (PSA) was used to determined pink snail's vulnerability and score for abundance. According to the PSA, *Phyllonotus erythrostomus* has a medium vulnerability, and because there is no quantitative stock assessment, abundance is deemed a moderate concern.

Justification:

Productivity-Susceptibility Analysis for pink-mouthed murex (*Phyllonotus erythrostomus*)

Productivity Attribute	High productivity (score = 1)	Medium productivity (score = 2)	Low productivity (Score = 3)	Score	Value and Notes; {Reference}
Average age at maturity (yrs)	**<5**	5–15	>15	1	Within 1 year {Baqueiro, Masso and Velez 1983}
Average maximum age (yrs) (use for inverts)	**<10**	10–25	>25	1	Unknown for this species; 8+ years estimated for black murex in Mexico (Cudney-Bueno and Hinojosa-Huerta 2008) -Bueno and Hinojosa-Huerta 2008}
Fecundity (eggs/yr)	>20,000	100 to 20,000	<100	1	Unknown for the species; average values of marine snails with similar ecology was used (5,000,000 eggs) (FAO 1999)
Average maximum size (cm) (do not use for invertebrates)	<100	100–300	>300	N/A	39 cm {Velasco, E.M. et al. 2011}{Daley, T. 2018}

Average size at maturity (cm) (do not use for invertebrates)	<40	40–200	>200	N/A	21 cm {Vasconcelos, J. et al. 2012}{Reis, R. et al. 2010}
Reproductive strategy	Broadcast spawner	**Demersal egg layer or brooder**	Live bearer	2	Demersal egg layer
Trophic level	<2.75	**2.75–3.25**	>3.25	2	Carnivorous mollusc
Density dependence (invertebrates only)	Compensatory dynamics at low population size demonstrated or likely	No depensatory or compensatory dynamics demonstrated or likely	**Depensatory dynamics at low population sizes (Allee effects) demonstrated or likely**	3	Depensatory: this species aggregates to spawn (Cudney-Bueno and Hinojosa-Huerta 2008)
Quality of Habitat	Habitat is robust, no known degradation from nonfishery impacts	**Habitat has been moderately altered by nonfishery impacts**	Habitat has been substantially compromised from nonfishery impacts	2	Coastal, relatively shallow habitat
Productivity score (mean of attribute scores)				**1.71**	

Susceptibility Attribute (default scores in bold)	**Low S (score = 1)**	**Medium S (score = 2)**	**High S (score = 3)**	**Score**	**Value and Notes; {Reference}**
Areal overlap (all fisheries)	>90% of species concentration is unfished	70%–90% of species concentration is unfished	**>30% of the species concentration is fished**	3	The area of distribution of the snail is also an area of distribution for the fishery (DOF 2014)
Vertical overlap (all fisheries)	>67% of species' depth range is unfished	33%–66% of species' depth range is unfished	**>33% of species' depth range is unfished**	3	Traps are set in the bottom where snails inhabit
Selectivity of fishery (specific to fishery under assessment)	Species is not targeted AND is not likely to be captured by gear	**Species is targeted, or is incidentally encountered AND is not likely to escape the gear**	Species is targeted or is incidentally encountered AND combination of fishery attributes and species' biology increase its susceptibility to the gear	2	Balmori et al. (2012) had reported that the species is frequently caught in crab traps, representing up to 5% of the total catch
Post-capture mortality (specific to fishery under assessment)	>66% individuals survive post-capture	33%–66% individuals survive post-capture	**Retained species, or >66% do not survive post capture**	3	According to managers, all the snail bycatch is retained {Cisneros-Mata et al. 2014}
Susceptibility score [(S1 × S2 × S3 × S4 − 1) ÷ 40 + 1]				**2.33**	

Productivity-Susceptibility Score [$V = \sqrt{(P^2 + S^2)}$]	2.89
Vulnerability Rating: <2.64 = Low vulnerability; ≥2.64 and ≤3.18 = Medium vulnerability; >3.18 = High vulnerability	Medium

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Traps | Mexico | Sonora

Low Concern

There is a fishery in the region that targets this species, as well as black snail (*Muricanthus nigritus*). But, the levels of fishing mortality are unknown for pink-mouthed murex (DOF 2012).

Arreguin-Sanchez and Huitron (2011) analyzed the exploitation status of different species in Mexico, using official catch and effort data. The researchers identified the snail fishery (including pink-mouthed murex) as one of the few fisheries in the country with chances for growth (based on the ecology of the species and the catch information) {Arreguin-Sanchez and Huitron 2011}. These species are targeted by commercial divers, but gillnet fishers and trap fishers are allowed to collect them as bycatch (DOF 2012). Managers found a decrease in catches in the Baja Peninsula coast, but did not report any concern on the status in the Sonoran region. Although fishing mortality on pink-mouthed murex is unknown, the Unknown Bycatch Matrix (UBM) suggests that bycatch of invertebrates in pot and trap gear is a low conservation concern.

Sharptooth swimming crab

Factor 2.1 - Abundance

Gulf of Mexico | Crab rings | Campeche
Gulf of Mexico | Scoopnets | Campeche

Moderate Concern

A stock assessment relative to reference points is not available for this species, and there is no IUCN assessment. For these reasons, this factor is rated using the productivity-susceptibility analysis (PSA) to determine sharptooth swimming crab's vulnerability and score for abundance. Because abundance is unknown and the species has a medium vulnerability (according to the PSA analysis), abundance is deemed a moderate concern.

Justification:

Productivity-Susceptibility Analysis for sharptooth swimming crab (*Callinectes rathbunae*)

Productivity Attribute	High productivity (score = 1)	Medium productivity (score = 2)	Low productivity (Score = 3)	Score	Value and Notes; {Reference}

Average age at maturity (yrs)	**<5**	5–15	>15	1	1.75 years (Chavez and Fernandez 1976)
Average maximum age (yrs) (use for inverts)	**<10**	10–25	>25	1	3.5 years (Chavez and Fernandez 1976)
Fecundity (eggs/yr)	**>20,000**	100 to 20,000	<100	1	0.7×10^6 to 1.5×10^6 eggs/year (Chavez and Fernandez 1976)
Average maximum size (cm) (do not use for invertebrates)	<100	100–300	>300	N/A	
Average size at maturity (cm) (do not use for invertebrates)	<40	40–200	>200	N/A	
Reproductive strategy	Broadcast spawner	**Demersal egg layer or brooder**	Live bearer	2	Brooder
Trophic level	**<2.75**	2.75–3.25	>3.25	1	Feeds on a variety of foods, including mollusks, other bottom invertebrates, some fishes, carrion, and detritus (Tavares 2003)
Density dependence (invertebrates only)	Compensatory dynamics at low population size demonstrated or likely	**No depensatory or compensatory dynamics demonstrated or likely**	Depensatory dynamics at low population sizes (Allee effects) demonstrated or likely	2	No depensatory or compensatory dynamics demonstrated or likely
Quality of Habitat	Habitat is robust, no known degradation from nonfishery impacts	**Habitat has been moderately altered by nonfishery impacts**	Habitat has been substantially compromised from nonfishery impacts	2	Coastal, relatively shallow habitat
Productivity score (mean of attribute scores)				**1.42**	

Susceptibility Attribute (default scores in bold)	Low S (score = 1)	Medium S (score = 2)	High S (score = 3)	Score	Value and Notes {Reference}
Areal overlap (all fisheries)	>90% of species concentration is unfished	70%–90% of species concentration is unfished	**>30% of the species concentration is fished**	3	Default value used
Vertical overlap (all fisheries)	>67% of species' depth range is unfished	33%–66% of species' depth range is unfished	**>33% of species' depth range is unfished**	3	Default value used
Selectivity of fishery (specific to fishery under assessment)	Species is not targeted AND is not likely to be captured by gear	**Species is targeted, or is incidentally encountered AND is not likely to escape the gear**	Species is targeted or is incidentally encountered AND combination of fishery attributes and species' biology increase its susceptibility to the gear	2	According to managers and literature, scoops are highly selective for crab species in the region (SAGARPA-INAPESCA 2013)
Post-capture mortality (specific to fishery under assessment)	>66% individuals survive post-capture	33%–66% individuals survive post-capture	**Retained species, or >66% do not survive post capture**	3	Organisms that are not retained (due to size) are released alive and in good condition {Nakamura et al. 2013}
Susceptibility score [(S1 × S2 × S3 × S4 – 1) ÷ 40 + 1]				**2.33**	

Productivity-Susceptibility Score [$V = \sqrt{(P^2 + S^2)}$]	**2.73**
Vulnerability Rating: <2.64 = Low vulnerability; ≥2.64 and ≤3.18 = Medium vulnerability; >3.18 = High vulnerability	Medium

Factor 2.2 - Fishing Mortality

Gulf of Mexico | Crab rings | Campeche
Gulf of Mexico | Scoopnets | Campeche

Moderate Concern

Currently, the fishing effort and levels of fishing mortality are unknown. For these reasons, fishing mortality is rated a moderate concern.

Factor 2.3 - Discard Rate/Landings

Eastern Central Pacific | Crab rings | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sonora

< 100%

According to fishery experts, since the implementation of the standard measures for crab traps (DOF 2012), discards of crabs are minimal; most organisms in the traps are above the minimum size requirement, and those that are under are returned to the water alive and in good condition (pers. comm., Loaiza-Villanueva 2016). Also, other bycatch species were reported to be in good condition when returned to the water {Balmori et al. 2012}. In the crab fishery, traps are baited with fish—mostly mackerel, small grouper (*Palabrax maculatofasciatus*), or chano (*Micropogonias megalops*) {Turk-Boyer et al. 2014}—and on average, 500 g of bait are used per trap to obtain 1 kg of crab (pers. comm., Loaiza-Villanueva 2016). Based on this information, the discard to landings ratio is estimated to be close to 60% or 70%.

Gulf of Mexico | Crab rings | Campeche
Gulf of Mexico | Scoopnets | Campeche

< 100%

According to available information, discards of crabs are minimal; most organisms in the rings that are under the minimum size are returned to the water alive and in good condition (Cedepesca 2020). In the case of the traps, these are baited with fish (mostly captured in previous sets) (Cedepesca 2020). On average, ≈500 g of bait are used per trap to obtain 1 kg of crab. Based on this information, the discard to landings ratio is estimated to be close to 60% or 70%. The FIP in place has actions that aim to have better quantitative data on this relationship, but no reports were available for this assessment.

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
Eastern Central Pacific | Crab rings | Mexico | Sinaloa	Moderately Effective	Highly effective	Moderately Effective	Moderately Effective	Highly effective	**Yellow (3.000)**
Eastern Central Pacific | Traps | Mexico | Sinaloa	Moderately Effective	Highly effective	Moderately Effective	Moderately Effective	Highly effective	**Yellow (3.000)**
Eastern Central Pacific | Traps | Mexico | Sonora	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	**Yellow (3.000)**

Gulf of Mexico | Crab rings | Campeche	Moderately Effective	Highly effective	Moderately Effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**
Gulf of Mexico | Scoopnets | Campeche	Moderately Effective	Highly 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

Eastern Central Pacific | Crab rings | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sonora

Moderately Effective

Managers rely on two main instruments to regulate the crab fishery: the Mexican Official Norm (NOM) 039-PESC, which is a federal regulation that specifies the terms and conditions for the crab fishery in the Mexican Pacific Ocean (including Sonora and Sinaloa) {DOF, 2014}, and the Sinaloa and Sonora Management Plan (SSMP).

Both instruments contain specifications related to fishing mortality (e.g., dimensions and number of traps and rings per vessel and by state). Currently, the maximum number of traps and rings authorized in Sinaloa is 70,800; in Sonora, the limit is 43,600 traps and rings {DOF, 2006}(DOF 2012). The NOM also limits the time that the gear can be under the water (24 hours) {DOF, 2006}.

An off-season was established in 2013 {DOF 2013}, based on the biological opinion generated by SAGARPA-INAPESCA (2013) to protect the reproductive stages. This off-season prohibits the extraction of both species and sexes from May 1 to June 30 every year, with an additional restriction on female extraction from July 1 to July 9 annually {DOF 2013}. Managers concluded that keeping the off-season would maintain the crab biomass at sustainable levels (SAGARPA-INAPESCA 2013).

In addition, crab producers in Mexico started fisheries improvement projects on both sides of the country. Producers and managers in Sonora and Sinaloa began working to improve harvest regulations to protect the stocks {DOF, 2014}. As a result, the SSMP includes strategies to help the long-term, sustainable use of the species, such as a regulation on the minimum retention size (95 mm carapace width for arched swimming crab and 115 mm for Cortez swimming crab). The current limits are above the size of 50% of crabs reaching sexual maturity in the region (DOF 2014). The size limit ensures that crabs can spawn or reproduce before they are caught.

Although the most recent stock assessment identified maximum sustainable yield (MSY) values for the fishery, these values are not used as reference levels by managers. Instead, a limit reference point of catch per unit effort (CPUE) (350g/gear/day or 84 kg/gear/year) is used as an indicator of the status of the stock. It is unclear how managers monitor this index; it does not explain what mechanisms are in place once this target has been reached, so it is unclear whether the reference points are appropriate for the current stock status. Sonora and Sinaloa represent ≈95% of the production in the Pacific, and the management measures clearly define fishing regulations that aim to protect the stocks. In addition, none of the main retained species are of special concern. But, appropriate conservation targets have not been defined (e.g., current reference points have not changed from the National Fisheries Chart of 2010). It is thus considered that, for most of the fishery's main primary targeted species, the management measures in place still exceed those for a rating of ineffective; and, although these measures are expected to be effective, there is a need for increased precaution, considering the recent trends in biomass and fishing mortality reported during the most recent assessment (Balmori et al 2021). Therefore, management strategy is deemed moderately effective.

Gulf of Mexico | Crab rings | Campeche
Gulf of Mexico | Scoopnets | Campeche

Moderately Effective
In general, other than controlling access (by fishing permits), the fishery does not have management regulations (DOF 2022). No reference points or appropriate fishing-level goals are established for blue crab in Campeche. The National Fisheries Charter (CNP) recommends keeping production close to the "average fishing index," which is estimated from the total landings reported between 2000 and 2007. This index was set at 2,500 t for Campeche in 2012 (DOF 2012), and this value was not even mentioned in the 2022 update of the fishery's profile within the CNP (DOF 2022).

There is one management measure that aims to protect juveniles: the minimum size limit (110 mm carapace width) (DOF 2012). But, no other measures are in place, and no official off-seasons or other regulations exist that are comparable to those in the Pacific Coast fishery. Managers identified the fishery as exploited to the maximum sustainable level and did not recommend increasing fishing effort, increasing the control on fishing gears (number), or creating a management plan for the fishery {DOF 2020}. Considering the current status of the target species (see Criterion 1) and the potential impacts on associated species (see Criterion 2), current measures might be effective. But, given the current increase in F, precaution might be needed. For these reasons, we scored this factor moderately effective.

Factor 3.2 - Bycatch Strategy

Eastern Central Pacific | Crab rings | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sinaloa
Gulf of Mexico | Crab rings | Campeche
Gulf of Mexico | Scoopnets | Campeche

Highly effective
No bycatch species of concern have been identified in these fisheries. Also, no other species are reported to be caught. This factor is rated highly effective for these fisheries.

Eastern Central Pacific | Traps | Mexico | Sonora

Moderately Effective
An analysis of the bycatch was developed in 2012 to measure the impact of the fishery on other species {Balmori et al. 2012}. Although no current strategy is in place to minimize the impact on pink-mouthed murexl (the only species considered as bycatch because of volume), it is not a species of concern. In addition, no other species or stocks of concern are caught, and reported interactions and bycatch in traps are minimal. Therefore, this factor is rated moderately effective.

Factor 3.3 - Scientific Research And Monitoring

Eastern Central Pacific | Crab rings | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sonora

Moderately Effective

In the two Gulf of California states of Sinaloa and Sonora, local fishing offices collect commercial catch-per-unit-effort data, and fishers deliver catch reports by area and species (DOF 2014). These catch data are used as indicators of the current status of the populations. According to the 2012 assessment, bycatch levels were not significant. A bycatch data monitoring program is ongoing under the FIP and is led by INAPESCA, with the participation of COBI and CEDO (two regional nongovernmental organizations), and this program conducts sampling every 2 years to keep the information up to date; a new report is in progress {Garcia-Caudillo 2017} but is not public yet. The improvement project in Sonora, led by CEDO, released a report of their bycatch monitoring program (Loaiza-Villanueva, R. 2021). The report shows the catch composition of the fishery for the 2020 fishing season and confirmed the low ratios of crab catch to bycatch. The author reported that, for each kilogram of crab, between 0.036 and 0.074 kg of bycatch species were caught.

One result of these efforts was an evaluation of the stock status that was developed and published by FIP participants (Balmori et al 2021). Managers, as well as FIP participants, consider that this data can continue to be used to monitor and maintain the stock (including to monitor bycatch), and they continue to develop the data-limited assessment methodology (C-MSY) to inform management strategies. For these reasons, this factor is rated moderately effective for all the fisheries in both states.

Gulf of Mexico | Crab rings | Campeche
Gulf of Mexico | Scoopnets | Campeche

Moderately Effective

Data on catch per unit effort (CPUE) have been monitored through the FIP for the Campeche crab fishery since 2003 (Nakamura et al., MSC pre-assessment for Campeche blue crab 2014). Fishery access is managed through fishing licenses, a minimum size limit (110 mm CW), and limits on the number of gears allowed (maximum number of traps and pots) (DOF 2012). Although a bycatch monitoring program was not in place, bycatch in the fishery is nonexistent {Nakamura et al. 2013}.

The active improvement project led by CeDePesca has a monitoring system in place that aims to collect information related to catch composition and to generate biological information about the fishery, in order to contribute to its knowledge and management. According to a 2020 report, 14 species were identified as species associated with the Campeche crab fishery. Some pieces of information related to the proportion of these species to the total catch were not reported. In addition, fishers return to the water organisms that are alive and "do not represent a commercial value for them" (Cedepesca 2020).

Managers rely mostly on average landings to monitor the status of the fishery (DOF 2022). The landings information was used to evaluate stock assessments {Morales-Azpeitia et al. 2021} (Diaz-

Lugo and Alonso-Aleman 2021). Because bycatch in this fishery (similar to the fisheries in the Pacific) has historically been reported to be low and there are currently efforts to monitor changes in bycatch, we scored this factor moderately effective.

Factor 3.4 - Enforcement Of Management Regulations

Eastern Central Pacific | Crab rings | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sinaloa
Gulf of Mexico | Crab rings | Campeche
Gulf of Mexico | Scoopnets | Campeche
Eastern Central Pacific | Traps | Mexico | Sonora

Moderately Effective

Federal regulations (NOM-039 specifications, management plan, and National Fisheries Charter regulations) are enforced by federal CONAPESCA agents (Inspectores Federales de Pesca), which coordinate with the Mexican Navy (DOF 2014). In 2013, coordination efforts between CONAPESCA and the Navy were formalized by creating the "National Enforcement Plan" (CONAPESCA b 2015). This plan is implemented along the Pacific Ocean and Gulf of Mexico coasts. It aims to prevent acts of illegal fishing (CONAPESCA b 2015). Specific measures include:

- Random inspections of small-scale vessels on the sea all year long but with special emphasis during off-seasons.
- Road checkpoints on land along most of the most important landing sites.
- Inspection of storage and processing plants and other infrastructure, in order to verify inventory.

CONAPESCA has also opened the opportunity for fishing organizations to be part of enforcement efforts by providing federal funds to the fishing industry through the "Enforcement and Monitoring Fishing and Aquaculture Program," which allows fishers to apply for funds of up to 6 million pesos/year (approximately USD320,000) as a group or up to 2 million pesos (approximately USD108,000) as a single person to cover the costs of enforcement activities (CONAPESCA b 2015).

Although an enforcement plan and subsidy programs to improve these actions are in place, their effectiveness is uncertain because there is no independent scrutiny of these programs. A report on illegal fishing in Mexico {IMCO et al. 2013} that was released in 2013 recognized that enforcement actions—particularly in small-scale fisheries in Mexico—have yet to be improved; however, no further information regarding enforcement activities and compliance was found. For these reasons, this factor is rated moderately effective.

Factor 3.5 - Stakeholder Inclusion

Eastern Central Pacific | Crab rings | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sonora

Highly effective

The process to create and evaluate the new management regulations in these two states was developed with the participation of different stakeholders involved in the fishery (SFP 2015)(DOF 2014). Stakeholders are included within official bodies called "Comite Sistema Producto Jaiba" (CSP; National Crab Production System) and its state commission, "Comite Sistema Producto Sonora" (CSPS; Sonoran Crab Production System; www.jaibasonora.org). These bodies incorporate producers, managers, and all other participants in the supply chain in order to improve the fishery as a whole. Analyses of the fishery were developed and action plans were decided upon as a group (SFP 2015). Also, in 2014, managers organized and paid for workshops to build capacity within the fishing communities, where fishers learned about sustainable fishing and national and international regulations (ASEPYA 2014). Because the management process is transparent and includes stakeholder inclusion, the Sonora and Sinaloa crab fishery is deemed highly effective for this factor.

Gulf of Mexico | Crab rings | Campeche
Gulf of Mexico | Scoopnets | Campeche

Moderately Effective

Although management regulations are public and the participation process is open, there is no record of participation in regulations from producers or other stakeholders. Recent communications to increase involvement in the fishery started in 2013 when an FIP was launched for this fishery to improve its sustainability (https://sites.google.com/site/yucatancrabfip/). According to the FIP tracker, in 2014, FIP representatives and INAPESCA managers began collaborating to collect more information and to generate a management plan for the fishery in the region (DOF 2012). The FIP transitioned to new coordinators, and information shared within the project shows that close communication and collaboration with managers (i.e., INAPESCA and CONAPESCA) have been restarted. Overall, it is still unclear if all the factors are in place to achieve a highly effective score. For these reasons, this factor is scored 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
Eastern Central Pacific | Crab rings | Mexico | Sinaloa	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**
Eastern Central Pacific | Traps | Mexico | Sinaloa	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**
Eastern Central Pacific | Traps | Mexico | Sonora	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**
Gulf of Mexico | Crab rings | Campeche	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**
Gulf of Mexico | Scoopnets | Campeche	Score: 3	Score: 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

Eastern Central Pacific | Crab rings | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sinaloa
Gulf of Mexico | Crab rings | Campeche
Gulf of Mexico | Scoopnets | Campeche
Eastern Central Pacific | Traps | Mexico | Sonora

Score: 3

The crab traps, rings, and scoop nets used in the crab fisheries in Mexico have a low impact on the physical and biological structures of the seafloor {Balmori et al. 2012}{Nakamura et al. 2012}. During fishing operations (launch and retrieval of traps), there is minimal dragging on the bottom {Loaiza-Villanueva 2016}. Mexican crab species live in sandy and muddy habitats, which are resilient habitat types {Johnston et al. 2012}. Therefore, this factor scores a 3 and is deemed a low concern.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Eastern Central Pacific | Crab rings | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sinaloa
Gulf of Mexico | Crab rings | Campeche
Gulf of Mexico | Scoopnets | Campeche
Eastern Central Pacific | Traps | Mexico | Sonora

Score: 0

Currently, there are no measures in place to mitigate the impacts of fishing gear in the fishery. One of the activities included in the new management plan for Sonora and Sinaloa includes the evaluation of fishing gear modifications that reduce environmental impact (Action 1.3.2) (DOF 2014), but it has not been implemented. Therefore, no further modification is granted.

Factor 4.3 - Ecosystem-based Fisheries Management

Eastern Central Pacific | Crab rings | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sinaloa
Eastern Central Pacific | Traps | Mexico | Sonora

Moderate Concern

The crab fisheries in Sonora and Sinaloa do not have spatial management in place, other than the total closure of crab fishing activities during the off-season. The fisheries do not catch species of exceptional importance to the local ecosystem {Balmori et al. 2012}(DOF 2014), and scientific assessment and management efforts to account for species' ecological roles are supposed to be completed in the coming years (DOF 2014). For these reasons, and because no food web impacts from the fisheries are evident, this factor is deemed a moderate concern for Sonora and Sinaloa.

Gulf of Mexico | Crab rings | Campeche
Gulf of Mexico | Scoopnets | Campeche

Moderate Concern

Impacts of the Campeche crab fishery on the ecosystem have not been described. Arreguin-Sanchez and Arcos-Huitron (2011) described the Campeche bank ecosystem and its role in fisheries dynamics, but did not specifically mention whether crab fishing activities may drive change in the ecosystem. Spatial management is lacking, but according to researchers, food web impacts from this fishery are not apparent (Arreguin-Sanchez and Arcos-Huitron 2011). For this reason, this factor is rated a moderate concern for the Campeche fishery.

Acknowledgements

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

Seafood Watch would like to thank the consulting researcher and author of this report, Ivan Martinez Tovar , as well as several anonymous reviewers for graciously reviewing this report for scientific accuracy.

References

Arreguin-Sanchez, F. & Arcos-Huitron, E. 2011. La Pesca en Mexico: estado de la explotacion y uso de los ecosistemas. Hidrobiologica 2011, 21 (3): 431-462.

ASEPYA, 2014. Plan de capacitacion sobre topicos del manejo de la pesca responsible y de la normatividad nacional e internacional. Informe Final. Julio 2014.

Balmori, A., Rivera-Parra, G., Moralez-Azpeitia, R., and Seegoo-Ramos, A. 2021 In press. Evaluation and estimation of reference points for the crab stocks (Callinectes spp.) from the Gulf of California and West Coast of Baja California Sur, Mexico. Ciencia Pesquera

Cedepesca 2020. Mexico, Yucatan Blue Crab dipnet / pot trap FIP. Implementing monitoring program

Chavez, E. and Fernandez, S. 1976. Contribucion al conocimiento de la biologia de la jaiba prieta (Callinectes rathbunae: Decapoda) del estado de Veracruz. Escuela de Biologia, Faculta de Ciencias. Universidad Veracruzana.

CONAPESCA 2015 b. Programa de Inspeccion y Vigilancia.

CONAPESCA 2020. Anuario Estadistico de Acuacultura y Pesca 2020 https://nube.conapesca.gob.mx/sites/cona/dgppe/2020/ANUARIO_ESTADISTICO_DE_ACUACULTURA_Y_PESCA_2020.pdf

Cudney-Bueno, R; Prescott, R and Hinojosa-Huerta, G. 2008. The Black Murex snail, Hexaplex nigritus (Mollusca, Muricidae), in the Gulf of California, Mexico: Reproductive ecology and breedings aggregations. Bulletin of Marine Science 83(2): 285-298.

Diaz-Lugo and Alonso-Aleman 2021. Crecimiento, mortalidad y rendimiento relativo por recluta de la jaiba Callinectes sapidus, Rathbun (1896), Laguna de Términos, Campeche México.

DOF 2006. Diario Oficial de la Federacion. Norma Oficial Mexicana NOM-039-PESC-2003. Pesca responsible de Jaiba en aguas de jurisdiccion federal del litoral del Oceano Pacifico. Especificaciones para su aprovechamiento. Diario Oficial de la Federacion. Julio 2006.

DOF 2022. ACUERDO mediante el cual se da a conocer la actualización de la Carta Nacional Pesquera.

DOF, Diario Oficial de la Federacion, 2012. Acuerdo por el que se da a conocer la Actualizacion de la Carta Nacional Pesquera. Secretaria de Agricultura, Ganaderia, Desarrollo Rural, Pesca, y Alimentacion. Diario Oficial de la Federacion. Agosto, 2012.

DOF, Diario Oficial de la Federacion, 2014. Diario Oficial de la Federacion. Acuerdo por el que se da a conocer el Plan de Manejo Pesquero de Jaiba (Callinectes spp) de Sinaloa y Sonora. Secretaria de Agricultura, Ganaderia, Desarrollo Rural, Pesca y Alimentacion. Julio, 2014

FAO 1999. MARINE SNAILS SEED PRODUCTION TOWARDS RESTOCKING ENHANCEMENT BASIC

MANUAL. FAO

Giesel, 1976. Reproductive Strategies as Adaptations to Life in Temporally Heterogeneous EnvironmentsAnnual Review of Ecology and Systematics

Loaiza-Villanueva, R. 2021. Reporte Proyecto de Mejora Pesquera FIP Jaiba Puerto Peñasco. Programa de Monitoreo de la fauna de acompañamiento en la pesquería de jaiba.

NOAA 2022 Foreign Trade Data https://www.fisheries.noaa.gov/foss/f?p=215:2:27297568638736::NO:::

SAGARPA-CONAPESCA 2020. Anuario Estadistico de Pesca

SAGARPA-INAPESCA, 2013. Opinion Tecnica. Efectos a corto, mediano y largo plazo de la veda de jaiba en Sinaloa y Sonora.

SFP, 2015. Sustainable Fisheries Partnership. Gulf of California Swimming Crab Fishery Improvement Project. January 2015.

Tavares, M. 2003 True Crabs. pp. 327-352. In Carpenter, K.E. (ed.) The living marine resources of the Western Central Atlantic. Volume1: introduction, molluscs, crustaceans, hagfishes, sharks, batoid fishes, and chimaeras. FAO Species Identification Guide for Fishery Purposes and American Society of Ichthyologists and Herpetologists Special Publication No. 5. Rome, FAO. pp. 1-600.

Appendix A: Review Schedule

Updates to the Cortez swimming crab, arched swimming crab, and blue crab assessments:

This updated report is scored against the Seafood Watch Standard for Fisheries Version F3.2. The main changes are at the Criterion 1 level for all the species. Individual criterion updates follow.

Arched swimming crab fishery

Factor 1.1. Arched swimming crab abundance was upgraded from moderate concern to low concern, because the most recent stock assessment found that biomass is above B_{MSY}. Previously, there were no stock assessments available, and the factor was scored using the results of the productivity-susceptibility analysis (PSA).

Blue crab fishery

Factor 1.1. Blue crab abundance was upgraded from moderate concern to low concern, because the most recent stock assessment found that biomass is above B_{MSY}; however, the fishery does not meet all the requirements for a rating of very low concern. Previously, no stock assessments were available, and the factor was scored using the PSA results.