Monterey Bay Aquarium Seafood Watch®

Cortez swimming crab (*Callinectes bellicosus*)
Arched swimming crab (*Callinectes arcuatus*)
Blue crab (*Callinectes sapidus*)

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Mexico/Pacific, Mexico/Gulf of Mexico

Traps, Crab rings, Scoopnets

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Seafood Watch Consulting Researcher

Seafood Watch Standard used in this assessment: Standard for Fisheries vF3

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

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

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

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

Summary

This report evaluates the swimming crab fisheries in three Mexican states: two in the Gulf of California (Sonora and Sinaloa) and one in the Gulf of Mexico (GOM) (Campeche). The focus of the report examines the arched swimming crab *(Callinectes arcuatus)* and Cortez swimming crab of the Pacific *(C. bellicosus)* caught using traps and rings, and the blue crab in Campeche *(C. sapidus)* caught using scoopnets and rings.

A recent stock assessment for the arched swimming crab in the Pacific states found that the species is neither overfished nor showing signs of overfishing. However, abundance levels of Cortez crab are uncertain because of the lack of assessments of this population. Similarly, for the blue crab, abundance and fishing levels are uncertain because of the lack of assessments of this species.

Trap, ring, and scoopnet fisheries in all the regions mostly catch swimming crab. In the case of rings and scoops, the bycatch is practically nonexistent; although traps, especially in Sonora, have been reported to catch significant volume of invertebrate species, particularly pink snail *(Hexaplex erythrostomus)* that comprised more than 5% of the total catch, but it is not listed as a species of concern. In Campeche, *Callinectes rathbunae* has been reported as part of the catch and was included in the analysis as bycatch.

The crab fisheries are generally well-managed in Sonora and Sinaloa; 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 case of the Campeche fishery, further measures are needed to improve the current management system and knowledge of the species. The crab traps produce relatively low impact to 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 ecosystem as a whole in all the regions.

Overall, all crab fisheries are rated as "good alternative" for the Sinaloa and Sonora fisheries due to concerns about the status of arched swimming crab and bycatch strategy in Sonora; and for the Campeche fisheries due to concerns about the management in place and monitoring efforts.

Final Seafood Recommendations

SPECIES/FISHERY	CRITERION 1: IMPACTS ON THE SPECIES	CRITERION 2: IMPACTS ON OTHER SPECIES	CRITERION 3: MANAGEMENT EFFECTIVENESS	CRITERION 4: HABITAT AND ECOSYSTEM	OVERALL RECOMMENDATION
Cortez swimming crab Mexico Pacific, Traps (unspecified), Mexico, Sonora	Green (3.32)	Green (3.41)	Yellow (3.00)	Yellow (3.00)	**Good Alternative (3.18)**
Arched swimming crab Mexico Pacific, Traps (unspecified), Mexico, Sinaloa	Yellow (2.64)	Green (3.32)	Yellow (3.00)	Yellow (3.00)	**Good Alternative (2.98)**
Arched swimming crab Mexico Pacific, Crab rings, Mexico, Sinaloa	Yellow (2.64)	Green (3.32)	Yellow (3.00)	Yellow (3.00)	**Good Alternative (2.98)**
Cortez swimming crab Mexico Pacific, Traps (unspecified), Mexico, Sinaloa	Green (3.32)	Yellow (2.64)	Yellow (3.00)	Yellow (3.00)	**Good Alternative (2.98)**
Cortez swimming crab Mexico Pacific, Crab rings, Mexico, Sinaloa	Green (3.32)	Yellow (2.64)	Yellow (3.00)	Yellow (3.00)	**Good Alternative (2.98)**
Blue crab Mexico Gulf of Mexico, Scoopnets, Mexico, Campeche	Yellow (2.64)	Yellow (2.64)	Yellow (3.00)	Yellow (3.00)	**Good Alternative (2.82)**
Blue crab Mexico Gulf of Mexico, Crab rings, Mexico, Campeche	Yellow (2.64)	Yellow (2.64)	Yellow (3.00)	Yellow (3.00)	**Good Alternative (2.82)**

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 Mexican swimming crab caught with traps and rings in Sonora and Sinaloa (the biggest state producers in Mexico) and with scoopnets and rings by fishers in the Yucatan Peninsula. Both fisheries (Sonora-Sinaloa and Yucatan) are currently involved in fisheries improvement projects (FIP). The species covered by the recommendation and their percentage of representation in the catches by region are:

Sonora: *Callinectes bellicosus* (95%) and *C. arcuatus* (5%)
Sinaloa: *Callinectes bellicosus* (57%) and *C. arcuatus* (41%)
Campeche in the Yucatan Peninsula: *C. sapidus* (89.2%) (CNP 2006)

Species Overview

In the Mexican Pacific, *Callinectes bellicosus* (Cortez swimming crab, from now on Cortez crab); and *C. arcuatus* (arched swimming crab, from now on arched crab) are the most important in terms of abundance (Cisneros-Mata et al. 2014). Both are captured using traps in Sonora and traps and rings in Sinaloa (Figure 1). These species have a wide distribution that extends from California in the U.S. to Peru (Figure 2). The catch proportion varies by state due to their prevalence and distribution. In Sonora, 95% of the landings are represented by Cortez crab, while in Sinaloa, the proportion is 57% Cortez crab and 41% arched crab (DOF 2014); although black crab *(C. toxotes)* occurs in Sinaloa, it makes up a minor proportion of the landings and is not assessed in this report.

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

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

These crab species have an "r-type" reproductive strategy. This means they have high fecundity and relatively little investment in any individual progeny and they are typically susceptible to predation and changes in their environment (Giesel 1976). Like other organisms with "r" strategies, Cortez and arched crabs have short lifespans 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 of their life (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), *Callinectes sapidus* (from now on blue crab) is the most abundant species, and the main target species for the fishery in this region (DOF 2012). Fishers in the region mostly use scoops to catch this species (Figure 3). Its distribution has been reported to be from Nova Scotia to Northern Argentina including Bermuda and the Caribbean Sea (FAO Species Fact Sheets, accessed September 2016) (Figure 4).


Figure 3 Scoops used in Campeche for the Crab fishery (Photo credit: Nakamura, 2014)

Figure 4 Distribution of Callinectes sapidus (Image from FAO, 2016)

The Campeche blue crab has similar biological characteristics to the arched crab in the Pacific. 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 down to depths up to 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 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) that regulates crab fisheries in federal waters (Official Federal Paper (DOF 1993); the National Federal Chart (CNP) that contains information on the status of resources, regulations and management strategies, and the Sinaloa-Sonora Management Plan (SSMP) (DOF 2014) which contains specific regulations for crab fisheries in these two states (the ones with the highest levels of production in the country).

Production Statistics

Mexican crab is well accepted in the international market due to its taste and quality (Cisneros-Mata et al. 2014). In the GOM, the crab fishery has been a traditional fishery for more than six decades (Chavez & Socorro-Hernadez 1980), although in the Pacific, official reports suggested that the fishery started in the early 1980's (Cisneros-Mata et al. 2014). Crab landings in Mexico have been relatively stable, averaging 24,000 t/year from 2004 to 2014 (Figure 5).

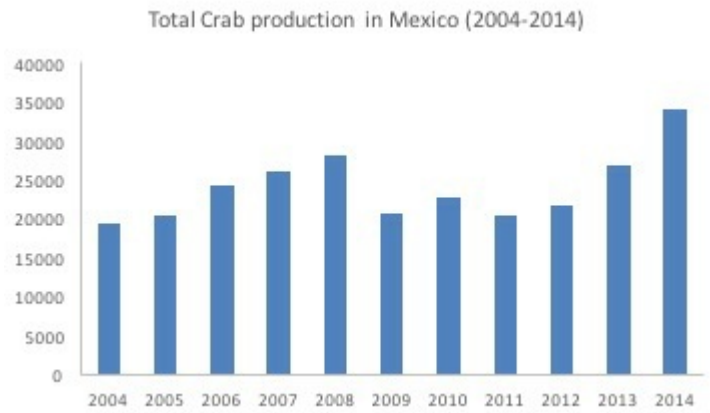

Figure 5 Mexican crab landings from 2004 to 2014 (Data from CONAPESCA)

Most of the crab production is from the Pacific. In 2014, 64% of the total production captured using all gears was landed in the Pacific (Figure 6) (CONAPESCA 2015), and more than 94% (20,500 t) of that production was landed in Sonora and Sinaloa (Figure 7) (CONAPESCA 2015).

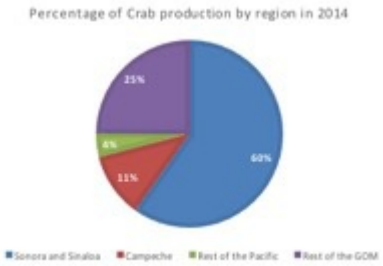

Figure 6 Percentage of crab production by region in 2014

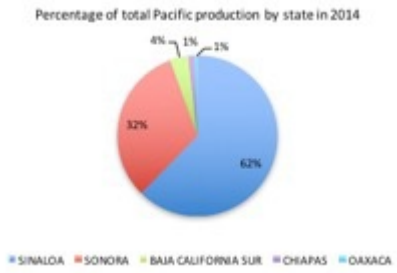

Figure 7 Percentage of crab landed by state in the Mexican Pacific in 2014

In the GOM, the fishery has been developed for more than five decades (DOF, 2014). Veracruz, Campeche, and Tamaulipas are the most important states in terms of production, followed by Tabasco, and Yucatan (Figure 8). Although most of the production of these region stays in the domestic market, the fishery in Campeche included in this report exports 100% of its production (pers. comm., Rudy Abad, PESMAR 2016).

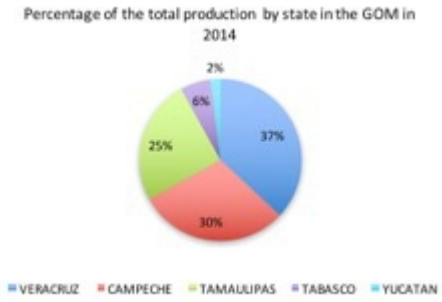

Figure 8 Percentage of Crab landed by State in the GOM in 2014 (CONAPESCA, 2015).

Importance to the US/North American market.

Import levels of all species of crabs (Dungeness, king, snow, swimming, other) reached more than 107 thousand metric tons (MT) in 2016 (NMFS 2017). Canada (40%), Russia (16.3%) and Indonesia (12.9%) were the biggest exporters (NMFS, 2017). When only Swimming crab was considered, ~25,000 MT were imported into the U.S. in 2016. Indonesia was the biggest importer (with 49% in 2016), followed by China (15.7%), Vietnam (10.8%) and the Philippines (10.4%). Mexico with 2% (~500 t in 2016) has been among the biggest

exporters after the Asian nations (NFMS 2017) (Table 1)

Year	Presentation	t	$ USD
2014	CRABMEAT SWIMMING *(CALLINECTES)* FROZEN	106	$1,478,254
2014	CRABMEAT SWIMMING *(CALLINECTES)* IN ATC	156	$2,937,796

Common and market names.

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

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 | Country | Custom Group	**Abundance**	**Fishing Mortality**	**Score**
Mexico/Pacific | Traps (unspecified) | Mexico | Sinaloa	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.64)
Mexico/Pacific | Crab rings | Mexico | Sinaloa	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.64)

BLUE CRAB			
Region | Method | Country | Custom Group	**Abundance**	**Fishing Mortality**	**Score**
Mexico/Gulf of Mexico | Scoopnets | Mexico | Campeche	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.64)
Mexico/Gulf of Mexico | Crab rings | Mexico | Campeche	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.64)

CORTEZ SWIMMING CRAB			
Region | Method | Country | Custom Group	**Abundance**	**Fishing Mortality**	**Score**
Mexico/Pacific | Traps (unspecified) | Mexico | Sonora	3.67: Low Concern	3.00: Moderate Concern	Green (3.32)
Mexico/Pacific | Traps (unspecified) | Mexico | Sinaloa	3.67: Low Concern	3.00: Moderate Concern	Green (3.32)
Mexico/Pacific | Crab rings | Mexico | Sinaloa	3.67: Low Concern	3.00: Moderate Concern	Green (3.32)

Criterion 1 Assessment

SCORING GUIDELINES

Factor 1.1 - Abundance

Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*
- *3.67 (Low Concern) — Population may be below target abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.*
- *2.33 (Moderate Concern) — Population is not overfished but may be below 75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.*
- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality

Goal: Fishing mortality is appropriate for current state of the stock.

- *5 (Low Concern) — Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is low enough to not adversely affect its population.*
- *3 (Moderate Concern) — Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.*
- *1 (High Concern) — Probable that fishing mortality from all source is above a sustainable level.*

ARCHED SWIMMING CRAB

Factor 1.1 - Abundance

MEXICO/PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SINALOA
MEXICO/PACIFIC, CRAB RINGS, MEXICO, SINALOA

Moderate Concern

A stock assessment relative to reference points is not available for this species. For this reason, this factor is rated using the Productivity-Susceptibility Analysis (PSA) in the next section. As abundance is unknown and the species has a medium vulnerability to fishing pressure it is considered a "moderate" conservation concern.

Justification:

Productivity Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	12 months (Estrada-Valencia 1999) (Fischer and Wolff 2006)	1
Average maximum age	4 years (Rosas-Correa, and Jesus-Navarrete 2008)	1
Fecundity	872,000 eggs/y (Estrada-Valencia 1999)	1
Reproductive strategy	Brooder	2
Trophic level	3.3 (Morales-Zarate, et al. 2004)	3
Density dependence (invertebrates only)	No depensatory or compensatory dynamics demonstrated or likely	2

Susceptibility Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (Considers all fisheries)	Default value used	3
Vertical overlap (Considers all fisheries)	Default value used	3
Selectivity of fishery (Specific to fishery under assessment)	Traps and rings are highly selective for crab species (Balmori et al. 2012)	2
Post-capture mortality (Specific to fishery under assessment)	With the exception of the sizes that are retained, small size organisms are released alive and in good condition (Balmori et al. 2012) (Loaiza-Villanueva 2016)	3

Factor 1.2 - Fishing Mortality

MEXICO/PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SINALOA
MEXICO/PACIFIC, CRAB RINGS, MEXICO, SINALOA

Moderate Concern

The arched crab is captured mostly in Sinaloa, where it represents approximately 41% of the total catches (DOF 2014). In 2011, there were 162 permits covering around 850 vessels (the biggest number in the country, followed by Sonora) (Cisneros-Mata, et al. 2014). Landings in Sinaloa have been relatively stable from 2005 to 2012 (DOF 2014); however, landing reports are not specific by species, so it is not possible to know the differentiate between efforts directed to the arched crab versus the Cortez crab. For these reasons, arched crab fishing mortality is deemed a "moderate" concern.

BLUE CRAB

Factor 1.1 - Abundance

MEXICO/GULF OF MEXICO, SCOOPNETS, MEXICO, CAMPECHE
MEXICO/GULF OF MEXICO, CRAB RINGS, MEXICO, CAMPECHE

Moderate Concern

A stock assessment relative to reference points is not available for this species. For this reason, this factor is rated using the Productivity-Susceptibility Analysis (PSA) in the next section. Since no data-limited stock indicators are available, and as result of the PSA analysis, this factor is rated as a "moderate" concern.

Justification:

PSA score = 2.71. For this reason, the species is deemed "medium" vulnerability (based on PSA scoring tool). Detailed scoring of each attribute is shown below.

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	12 to 18 months (ADW 2016)	1
Average maximum age	4.5 years (Rosas-Correa, and Jesus-Navarrete 2008)	1
Fecundity	2 to 8 million eggs/y (ADW 2016)	1
Reproductive strategy	Brooder	2
Trophic level	3.73 (Mancinelli et al. 2016)	3
Density dependence (invertebrates only)	None	2

Susceptibility Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (Considers all fisheries)	Blue crab is fished along the whole area of distribution in Campeche (Sanchez and Guzman 1997)	3
Vertical overlap (Considers all fisheries)	Default value used	3
Selectivity of fishery (Specific to fishery under assessment)	(Bravo-Calderon et al. 2016). Scoops are effective to capture crab	2
Post-capture mortality (Specific to fishery under assessment)	Organisms that are not retained (due to size) are released alive and in good condition (Nakamura et al. 2013)	3

Factor 1.2 - Fishing Mortality

MEXICO/GULF OF MEXICO, SCOOPNETS, MEXICO, CAMPECHE
MEXICO/GULF OF MEXICO, CRAB RINGS, MEXICO, CAMPECHE

Moderate Concern

Currently, the fishing effort and levels of fishing mortality are unknown. For these reason, the factor is rated as "moderate" concern.

CORTEZ SWIMMING CRAB

Factor 1.1 - Abundance

MEXICO/PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SONORA

Low Concern

Although biological information for this species has been generated in recent years, no abundance targets or conservation goals have been established by managers. (Cisneros-Mata et al. 2014) evaluated biomass changes for the Cortez crab in the Mexican Pacific using the Martell and Froese methodology (2012). This method is based on Schaefer's biomass dynamic model (1954) that uses catch data and "stock resilience" estimates (r) to calculate the maximum sustainable yield (MSY) based on the carrying capacity of the systems (k). Authors found that Cortez crab biomass in Sinaloa and Sonora was three times bigger than the rest of the states in the Mexican Pacific. However, the Cortez crab in the two states is close to its sustainable limits (figure 9) (Cisneros-Mata et al. 2014). The study results can be seen in Table 2.

According to the CNP, managers rated the status of the Cortez crab fishery at its maximum sustainable level (DOF 2012). Based on (Cisneros-Mata et al. 2014) results, biomass for Cortez crab in Sonora and Sinaloa are on levels of the carrying capacity of the systems (Figure 9), and it is not showing signs of being overfished. Most recently (Rodriguez-Felix D. 2017) ran the biomass dynamic models by Schaefer (1954) in different stocks along the Sonora coastline. As a result, the author found that none of these populations have reached or surpassed the reference point of k/2, which means that the species is not being overfished (Rodriguez-Felix D. 2017). Based on the information available, biomass has been above 50% of time series maximum. Since managers classify the stock as not being overfished and is estimated that biomass is above reference points (k/2), this factor is considered a low conservation concern.

Justification:

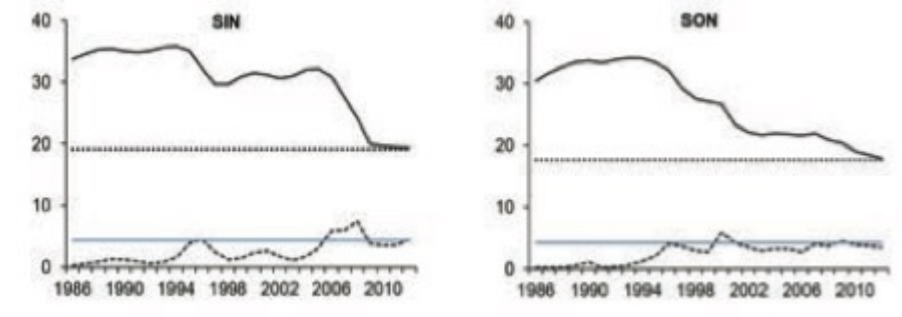

Figure 9 Stock evaluation of Cortez crab (Callinectes bellicosus) in Sinaloa and Sonora. Y axis shows metric tons (thousands) while X axis shows time (years). Dark and continuous line= biomass. Dotted line= K (carrying capacity). Blue line= MSY and dashed line= reported catches using all gears. (Source: Cisneros-Mata et al., 2014).

Table 2. Carrying capacity "K" (t) and MSY (t/year) by state for 2013 for Green crab (Cisneros-Mata et al. 2014)

State	K	MSY
Sonora	37,129	4,246
Sinaloa	38,030	4,410

Factor 1.2 - Fishing Mortality

MEXICO/PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SONORA

Moderate Concern

Current values of F_{MSY} for the Cortez crab fishery in the Gulf of California are unknown. The landings for the fishery have shifted from low catches (in the early 1980s) to maximum levels (in the 1990s) to relatively stable landings in recent years (2006 to 2012). (Figure 8)

Justification:

In 2014, Rodriguez-Dominguez et al. estimated the MSY for the Cortez crab in Sonora, using catch data and a combination of values for rate population increase (r) and carrying capacity (K). As a subproduct, authors calculated that fishing mortality to reach MSY (F_{MSY}) should be around 0.56 (Rodriguez-Dominguez et al. 2014).

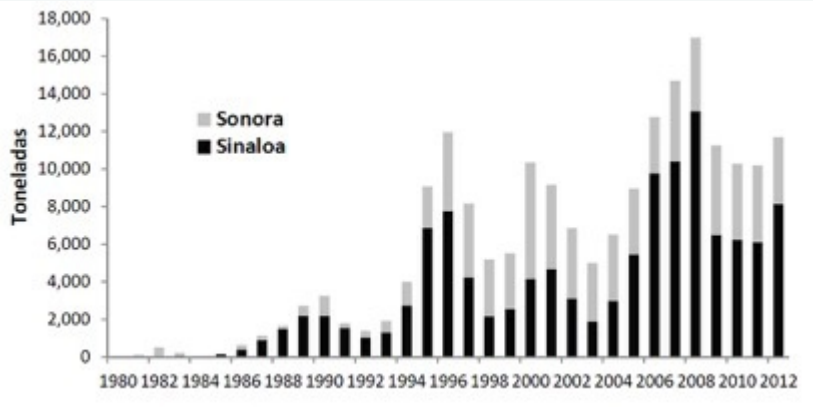

Figure 10 Crab landings in Sonora and Sinaloa (Cortez and arched crabs) from 1980 to 2012 (Source: Cisneros-Mata et al., 2015)

It is not clear how many authorized vessels are allowed in the Mexican Pacific. Cisneros-Mata et al. (2014) estimated that around 874 small vessels were operating in Sinaloa, and 461 in Sonora in 2011, based on the number of permits granted by CONAPESCA (Cisneros-Mata et al. 2014). Catch data does not specify level of production by species so it is unclear if current fishing effort is having a direct effect on a specific species, like Cortez crab. In addition, (Lopez-Martinez et al. 2014) reported that crab species are also captured by industrial shrimp trawlers that operate in the region. They recommended that stock analysis consider the combined effect of both traps and trawlers on the stocks (Lopez-Martinez et al. 2014).

Since it is apparent that Crab landings have been relatively stable in the last years (Cisneros-Mata et al. 2014), but no more specific data is available in relation to fishing mortality, this factor is deemed a "moderate" concern.

CORTEZ SWIMMING CRAB

Factor 1.1 - Abundance

MEXICO/PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SINALOA
MEXICO/PACIFIC, CRAB RINGS, MEXICO, SINALOA

Low Concern

Although biological information for this species has been generated in recent years, no abundance targets or conservation goals have been established by managers. (Cisneros-Mata et al. 2014) evaluated biomass changes for the Cortez crab in the Mexican Pacific using the Martell and Froese methodology (2012). This method is based on Schaefer's biomass dynamic model (1954) that uses catch data and "stock resilience"

estimates (r) to calculate the maximum sustainable yield (MSY) based on the carrying capacity of the systems (k). Authors found that Cortez crab biomass in Sinaloa and Sonora was three times bigger than the rest of the states in the Mexican Pacific. However, the Cortez crab in the two states is close to its sustainable limits (figure 9) (Cisneros-Mata et al. 2014). The study results can be seen in Table 2.

According to the CNP, managers rated the status of the Cortez crab fishery at its maximum sustainable level (DOF 2012). Based on (Cisneros-Mata et al. 2014) results, biomass for Cortez crab in Sonora and Sinaloa are on levels of the carrying capacity of the systems (Figure 9), and it is not showing signs of being overfished. Most recently (Rodriguez-Felix D. 2017) ran the biomass dynamic models by Schaefer (1954) in different stocks along the Sonora coastline. As a result, the author found that none of these populations have reached or surpassed the reference point of k/2, which means that the species is not being overfished (Rodriguez-Felix D. 2017). Based on the information available, biomass has been above 50% of time series maximum. Since managers classify the stock as not being overfished and is estimated that biomass is above reference points (k/2), this factor is considered a low conservation concern.

Justification:

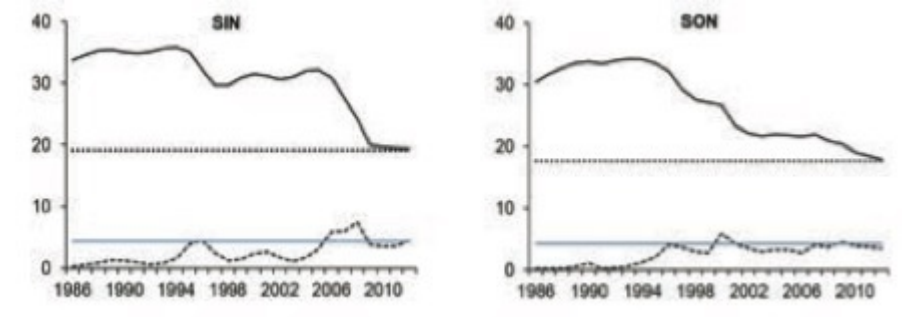

Figure 11 Stock evaluation of Cortez crab (Callinectes bellicosus) in Sinaloa and Sonora. Y axis shows metric tons (thousands) while X axis shows time (years). Dark and continuous line= biomass. Dotted line= K (carrying capacity). Blue line= MSY and dashed line= reported catches using all gears. (Source: Cisneros-Mata et al., 2014).

Table 2. Carrying capacity "K" (t) and MSY (t/year) by state for 2013 for Green crab (Cisneros-Mata et al. 2014)

State	K	MSY
Sonora	37,129	4,246
Sinaloa	38,030	4,410

Factor 1.2 - Fishing Mortality

MEXICO/PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SINALOA
MEXICO/PACIFIC, CRAB RINGS, MEXICO, SINALOA

Moderate Concern

Current values of F_{MSY} for the Cortez crab fishery in the Gulf of California are unknown. The landings for the fishery have shifted from low catches (in the early 1980s) to maximum levels (in the 1990s) to relatively stable landings in recent years (2006 to 2012). (Figure 8)

Justification:

In 2014, Rodriguez-Dominguez et al. estimated the MSY for the Cortez crab in Sonora, using catch data and a combination of values for rate population increase (r) and carrying capacity (K). As a subproduct, authors calculated that fishing mortality to reach MSY (F_{MSY}) should be around 0.56 (Rodriguez-Dominguez et al. 2014).

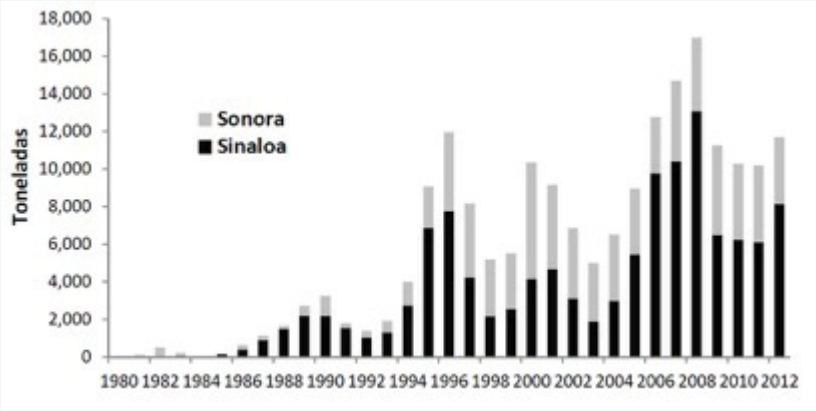

Figure 12 Crab landings in Sonora and Sinaloa (Cortez and arched crabs) from 1980 to 2012 (Source: Cisneros-Mata et al., 2015)

It is not clear how many authorized vessels are allowed in the Mexican Pacific. Cisneros-Mata et al. (2014) estimated that around 874 small vessels were operating in Sinaloa, and 461 in Sonora in 2011, based on the number of permits granted by CONAPESCA (Cisneros-Mata et al. 2014). Catch data does not specify level of production by species so it is unclear if current fishing effort is having a direct effect on a specific species, like Cortez crab. In addition, (Lopez-Martinez et al. 2014) reported that crab species are also captured by industrial shrimp trawlers that operate in the region. They recommended that stock analysis consider the combined effect of both traps and trawlers on the stocks (Lopez-Martinez et al. 2014).

Since it is apparent that Crab landings have been relatively stable in the last years (Cisneros-Mata et al. 2014), but no more specific data is available in relation to fishing mortality, this factor is deemed a "moderate" concern.

Criterion 2: Impacts on Other Species

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

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

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

Guiding Principles

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

Criterion 2 Summary

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

ARCHED SWIMMING CRAB - MEXICO/PACIFIC - CRAB RINGS - MEXICO - SINALOA					
Subscore:	**3.32**	**Discard Rate:**	**1.00**	**C2 Rate:**	**3.32**
Species	**Abundance**	**Fishing Mortality**	**Subscore**		
Cortez swimming crab	3.67:Low Concern	3.00:Moderate Concern	Green (3.32)		

ARCHED SWIMMING CRAB - MEXICO/PACIFIC - TRAPS (UNSPECIFIED) - MEXICO - SINALOA					
Subscore:	**3.32**	**Discard Rate:**	**1.00**	**C2 Rate:**	**3.32**
Species	**Abundance**	**Fishing Mortality**	**Subscore**		
Cortez swimming crab	3.67:Low Concern	3.00:Moderate Concern	Green (3.32)		

BLUE CRAB - MEXICO/GULF OF MEXICO - CRAB RINGS - MEXICO - CAMPECHE					
Subscore:	**2.64**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.64**
Species	**Abundance**	**Fishing Mortality**	**Subscore**		
Sharptooth swimming crab	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.64)		

BLUE CRAB - MEXICO/GULF OF MEXICO - SCOOPNETS - MEXICO - CAMPECHE					
Subscore:	**2.64**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.64**
Species	**Abundance**	**Fishing Mortality**	**Subscore**		
Sharptooth swimming crab	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.64)		

CORTEZ SWIMMING CRAB - MEXICO/PACIFIC - CRAB RINGS - MEXICO - SINALOA					
Subscore:	**2.64**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.64**
Species	**Abundance**	**Fishing Mortality**	**Subscore**		
Arched swimming crab	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.64)		

CORTEZ SWIMMING CRAB - MEXICO/PACIFIC - TRAPS (UNSPECIFIED) - MEXICO - SINALOA					
Subscore:	**2.64**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.64**
Species	**Abundance**	**Fishing Mortality**	**Subscore**		
Arched swimming crab	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.64)		

CORTEZ SWIMMING CRAB - MEXICO/PACIFIC - TRAPS (UNSPECIFIED) - MEXICO - SONORA					
Subscore:	**3.41**	**Discard Rate:**	**1.00**	**C2 Rate:**	**3.41**
Species	**Abundance**	**Fishing Mortality**	**Subscore**		
Pink-mouthed murex	2.33:Moderate Concern	5.00:Low Concern	Green (3.41)		

The trap and ring fisheries in Sinaloa, and the scoopnets and ring fisheries in Campeche generally catch low amounts of non-target 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 was assessed in 2012 as part of the Fisheries Improvement Project (FIP) that the fishery is engaged in {SFP 2015}. Assessment results suggested that the crab-bycatch proportion was 1:0.31 on average for Sonora and 1:0.06 for Sinaloa {Balmori et al. 2012}. The study found greater retention of bycatch in traps (230 g in average per 1 kg of crab) as compared to rings (10 g per 1 kg of Crab) {Balmori et al 2012}. In total, 20 bycatch species were identified in the study; 80% were mollusks, 11% fishes, and 9% crustaceans. The primary bycatch species was the pink snail *Hexaplex erythrostomus* (with 75% of the total weight of bycatch); 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 the Spotted Sand bass *(Paralabrax maculatofasciatus)* with 4.1% of the abundance of the total bycatch) {Balmori et al. 2012}. All other species accounted for <5% of the bycatch. Of these species only pink snail and the 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 species reported catch are under a special category of risk and only pink snail in Sonora is considered for further examination.

In Campeche, managers reported *C. rathbunae* were caught in the blue crab fishery up to almost 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 no species listed on the IUCN are caught {Nakamura et al. 2013}. However, no quantitative data on bycatch was presented in the report. Considering the limited information available, sharp-toothed crab was included as 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)

PINK-MOUTHED MUREX

Factor 2.1 - Abundance

MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SONORA

Moderate Concern

Managers recommended limiting the commercial extraction to about 40% of the calculated biomass (DOF 2012). However, there is no evidence that either a stock assessment has been conducted or that catch limits have been established. For this reason, a PSA was used to determined pink snails vulnerability and score abundance.

Hexaplex erythrostomus has a "medium" vulnerability (according to the PSA analysis), and since there is no quantitative stock assessment, abundance is deemed a "moderate" concern.

Justification:

PSA score = 2.82. For this reason, the species is deemed "medium" vulnerability (based on PSA scoring tool). Detailed scoring of each attribute is shown below.

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	Within one year (Baqueiro, Masso and Velez 1983)	1
Average maximum age	Unknown	
Fecundity	Unknown for the species. Average values of marine snails with similar ecology was used. 5,000,000 eggs (FAO 1999)	1
Reproductive strategy	Demersal egg layer	2
Trophic level	Unknown.	
Density dependence (invertebrates only)	Depensatory, this species aggregate to spawn. (Cudney-Bueno and Hinojosa-Huerta 2008)	3

Susceptibility Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (Considers all fisheries)	The area of distribution of the snail is also an area of distribution for the fishery (DOF 2014)	3
Vertical overlap (Considers all fisheries)	Traps are set in the bottom where snails inhabit	3
Selectivity of fishery (Specific to fishery under assessment)	In Sonora, traps were reported to catch up to 5% of the total catch in the traps (Balmori et al. 2012)	2
Post-capture mortality (Specific to fishery under assessment)	According to managers, all of the snail is retained (Cisneros-Mata et al. 2014)	3

Factor 2.2 - Fishing Mortality

MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SONORA

Low Concern

There is a fishery in the region that target this species as well as black snail (*Hexaplex nigritus*). However, levels of fishing mortality are unknown for pink snail (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 snail) as one of the few fisheries in the country with chances of 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 does not report any concern on the status in the Sonoran region. Although fishing mortality on the pink snail is unknown, the unknown bycatch matrix suggests that bycatch of invertebrates in pot and trap gear is a "low" conservation concern.

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

MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SONORA

< 100%

According to fishery experts, since the implementation of the standard measures for the crab traps (DOF 2012), discards of crabs are minimal; most of the organisms in the traps are above the minimum size requirement, and those that are under the minimum size 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). Based on this information, the ratio is estimated to be close to 60% or 70%.

SHARPTOOTH SWIMMING CRAB

Factor 2.1 - Abundance

MEXICO / GULF OF MEXICO, CRAB RINGS, MEXICO, CAMPECHE
MEXICO / GULF OF MEXICO, SCOOPNETS, MEXICO, CAMPECHE

Moderate Concern

A stock assessment relative to reference points is not available for this species. For this reason, this factor is rated using the Productivity-Susceptibility Analysis (PSA) in the next section.

As abundance is unknown and the species has a "medium" vulnerability, according to the PSA analysis (see below) this factor is deemed a "moderate" conservation.

Justification:

PSA score = 2.71. For this reason, the species is deemed “medium” vulnerability (based on PSA scoring tool). Detailed scoring of each attribute is shown below.

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	1.75 years (Chavez and Fernandez 1976)	1
Average maximum age	3.5 years (Chavez and Fernandez 1976)	1
Fecundity	$0.7X10^6$ to $1.5X10^6$ eggs/y (Chavez and Fernandez 1976)	1
Reproductive strategy	Brooder	2
Trophic level	Unknown	
Density dependence (invertebrates only)	No depensatory or compensatory dynamics demonstrated or likely	2

Susceptibility Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (Considers all fisheries)	Default value used	3
Vertical overlap (Considers all fisheries)	Default value used	3
Selectivity of fishery (Specific to fishery under assessment)	According to managers and literature, scoops are highly selective for Crab species in the region (SAGARPA-INAPESCA 2013)	2
Post-capture mortality (Specific to fishery under assessment)	Organisms that are not retained (due to size) are released alive and in good condition (Nakamura et al. 2013)	3

Factor 2.2 - Fishing Mortality

MEXICO / GULF OF MEXICO, CRAB RINGS, MEXICO, CAMPECHE
MEXICO / GULF OF MEXICO, SCOOPNETS, MEXICO, CAMPECHE

Moderate Concern

Currently, the fishing effort and levels of fishing mortality are unknown. For these reason, the factor is rated as a "moderate" concern.

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

MEXICO / GULF OF MEXICO, CRAB RINGS, MEXICO, CAMPECHE

< 100%

MEXICO / GULF OF MEXICO, SCOOPNETS, MEXICO, CAMPECHE

< 100%

Criterion 3: Management Effectiveness

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

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

The Criterion 3 rating is determined as follows:

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

Rating is Critical if Management Strategy and Implementation is Critical.

GUIDING PRINCIPLE

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

Criterion 3 Summary

Fishery	Management Strategy	Bycatch Strategy	Research and Monitoring	Enforcement	Stakeholder Inclusion	Score
Fishery 1: Mexico / Gulf of Mexico | Crab rings | Mexico | Campeche	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective	Moderately Effective	Yellow (3.00)
Fishery 2: Mexico / Gulf of Mexico | Scoopnets | Mexico | Campeche	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective	Moderately Effective	Yellow (3.00)
Fishery 3: Mexico / Pacific | Crab rings | Mexico | Sinaloa	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective	Highly Effective	Yellow (3.00)
Fishery 4: Mexico / Pacific | Traps (unspecified) | Mexico | Sinaloa	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective	Highly Effective	Yellow (3.00)
Fishery 5: Mexico / Pacific | Traps (unspecified) | Mexico | Sonora	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Yellow (3.00)

Criterion 3 Assessment

Factor 3.1 - Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? Do 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.

MEXICO / GULF OF MEXICO, CRAB RINGS, MEXICO, CAMPECHE
MEXICO / GULF OF MEXICO, SCOOPNETS, MEXICO, CAMPECHE

Moderately Effective

There are no reference points or appropriate fishing level goals established for Campeche blue crab. The CNP recommends to keep production close to the "average fishing index" estimated from the total landings reported between 2000 and 2007. This index was set at 2,500 t for Campeche in 2012 (DOF 2012).

Unlike in the Pacific fishery, no formal management plan or NOM is in place for this region. The regulations in place to control fishing mortality are: a minimum size limit (110 mm carapace width), access through a permit system and a limit on the number of gear by boat (DOF 2012). However, no other rules that regulate fishing gear characteristics are in place, and no official off-seasons or other regulations are comparable to those that exist in the Pacific Coast fishery. Managers monitor the health of the fishery based on catch data from fishers' reports (DOF 2012). Managers identified the fishery as exploited to the maximum sustainable level and did not recommend increasing fishing effort in 2012 (DOF 2012). It seems that current management has been effective (based on trends in production (CONAPESCA 2015); therefore, this factor is rated as "moderately effective."

MEXICO / PACIFIC, CRAB RINGS, MEXICO, SINALOA
MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SINALOA
MEXICO / PACIFIC, TRAPS (UNSPECIFIED), 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 (including Sonora and Sinaloa) (DOF, 2014) and the Sinaloa and Sonora Management Plan (SSMP).

Both instruments contained clear 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 rings and/or traps; while in Sonora the limit is 43,600 traps/rings (DOF, 2006) (DOF 2012). The NOM also limits the amount of time that the gear can be under the water (24 hours) (DOF, 2006).

To protect the reproductive stages, an off season was established in 2013 (DOF 2013) based on the biological opinion generated by SAGARPA-INAPESCA (2013). This off season prohibits the extraction of both species and both sexes from May 1st to June 30 every year, with an additional restriction on female extraction from July 1st to July 9th, also every year (DOF 2013). Managers concluded that by keeping the off season, the crab biomass will be maintained 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 started working together in order to improve harvest

regulations to protect the stocks (DOF, 2014). As a result, the SSMP includes strategies to help the long-term sustainability use of the species, such as a regulation on minimum retainable size (95 mm carapace width for arched crab and 115 mm for Cortez crab). The current size limits are above the size at which 50% of crabs reach sexual maturity in the region (DOF 2014). The size limit is to ensure that crabs are able to spawn or reproduce before they are caught.

Finally, although the most recent stock assessment identified MSY values for the fishery, these values are not used as reference levels. Instead, a limit reference point of 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 not possible to know if the reference points are appropriate for the current stock status. Sonora and Sinaloa represent ~95% of the production in the Pacific, the management instruments in place clearly define fishing regulations that aim to protect the stocks. In addition, no special concern species are reported to be caught in the fisheries. However, appropriate conservation targets have not been defined (e.g., current reference points have not changed from the National Fisheries Chart of 2010). For these reasons, management strategy is deemed a "moderately effective" score.

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.

MEXICO / GULF OF MEXICO, CRAB RINGS, MEXICO, CAMPECHE
MEXICO / GULF OF MEXICO, SCOOPNETS, MEXICO, CAMPECHE
MEXICO / PACIFIC, CRAB RINGS, MEXICO, SINALOA
MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SINALOA

Highly Effective

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

MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SONORA

Moderately Effective

An analysis of the bycatch was developed in 2012 to measure the impact of the fishery in other species (Balmori et al. 2012). Although no current strategy is in place to minimize the impact on pink snail (the only species considered as bycatch because of volume), this is not a species of concern. Furthermore, since no other species or stocks of concern are caught, and reported interaction and bycatch in traps is minimal, this factor is rated as "moderately effective.

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.

MEXICO / GULF OF MEXICO, CRAB RINGS, MEXICO, CAMPECHE
MEXICO / GULF OF MEXICO, SCOOPNETS, MEXICO, CAMPECHE

Moderately Effective

Data on Catch per unit effort (CPUE) has been monitored through the FIP for the Campeche crab fishery since 2003 (Nakamura et al., MSC Pre-assessment for Campeche Blue Crab 2014). This fishery access is managed through fishing licenses and a minimum size limit (110 mm) and limits on the number of gears allowed (maximum number of traps and pots) (DOF 2012). Although a bycatch monitoring program is not in place, the bycatch caught in the fishery is nonexistent (Nakamura et al. 2013). For these reasons, the factor is rated as "moderately effective" for Campeche.

MEXICO / PACIFIC, CRAB RINGS, MEXICO, SINALOA
MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SINALOA
MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SONORA

Moderately Effective

In these two Gulf of California states, commercial catch-per-unit-effort data are collected by local fishing offices, and fishers deliver catch reports by area and species (DOF 2014). These catch data are used as an indicator 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, led by INAPESCA and with the participation of COBI and CEDO (two regional Non-government organizations), which conduct sampling every 2 years to maintain the information updated; a new report is in progress (Garcia-Caudillo 2017). Therefore, this factor is rated as "moderately effective" for all the fisheries in both states.

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.

MEXICO / GULF OF MEXICO, CRAB RINGS, MEXICO, CAMPECHE
MEXICO / GULF OF MEXICO, SCOOPNETS, MEXICO, CAMPECHE
MEXICO / PACIFIC, CRAB RINGS, MEXICO, SINALOA
MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SINALOA
MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SONORA

Moderately Effective

Federal regulations (NOM-039 specifications, management plan, and Fisheries National Chart regulations) are enforced by federal CONAPESCA agents (Inspectores Federales de Pesca), which coordinate with the Mexican Navy (DOF 2014). In 2013, coordination efforts between the CONAPESCA and the Navy were formalized with the creation of the "National Enforcement plan" (CONAPESCA b 2015). This plan is implemented along the Pacific and Gulf of Mexico coasts. The aim of this campaign is 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 to 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 up to 6 million pesos/year (approx. $320,000 USD) as a group, or 2 million ($108,000 USD) as a single person to cover costs of enforcement activities (CONAPESCA b 2015).

Although an enforcement plan and subsidy programs to improve these actions are in place, the effectiveness of these systems is uncertain, since there is no independent scrutiny of these programs. A report on illegal fishing in Mexico (IMCO et al 2013) 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 as "moderately effective."

Factor 3.5 - Stakeholder Inclusion

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

MEXICO / GULF OF MEXICO, CRAB RINGS, MEXICO, CAMPECHE
MEXICO / GULF OF MEXICO, SCOOPNETS, MEXICO, CAMPECHE

Moderately Effective

Although management regulations are public and the participation process is open, there is no record of participation from producers or other stakeholders on regulations. Recent communications to increase involvement in the fishery started in 2013 when a FIP was launched for this fishery; (https://sites.google.com/site/yucatancrabfip/) in order to improve its sustainability. According to the FIP tracker, in 2014 FIP representatives and INAPESCA managers started collaborating to collect more information and generate a management plan for the fishery in the region (DOF 2012). Based on this information, the factor is rated as "moderately effective" for the Campeche crab fishery.

MEXICO / PACIFIC, CRAB RINGS, MEXICO, SINALOA
MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SINALOA
MEXICO / PACIFIC, TRAPS (UNSPECIFIED), 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 commissions "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). Since the management process is transparent and includes stakeholder inclusion, the Sonora and Sinaloa crab fishery is deemed "highly effective" for this factor.

Criterion 4: Impacts on the Habitat and Ecosystem

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

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

GUIDING PRINCIPLES

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

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

Region / Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Score
Mexico / Gulf of Mexico / Scoopnets / Mexico / Campeche	3	0	Moderate Concern	Yellow (3.00)
Mexico / Gulf of Mexico / Crab rings / Mexico / Campeche	3	0	Moderate Concern	Yellow (3.00)
Mexico / Pacific / Traps (unspecified) / Mexico / Sonora	3	0	Moderate Concern	Yellow (3.00)
Mexico / Pacific / Traps (unspecified) / Mexico / Sinaloa	3	0	Moderate Concern	Yellow (3.00)
Mexico / Pacific / Crab rings / Mexico / Sinaloa	3	0	Moderate Concern	Yellow (3.00)

Criterion 4 Assessment

SCORING GUIDELINES

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

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

biological communities.

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

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

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

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

Factor 4.3 - Ecosystem-Based Fisheries Management

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

- *5 — Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.*
- *4 — Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.*
- *3 — Policies are not in place to protect species' ecological roles and ecosystem functioning but detrimental food web impacts are not likely or policies in place may not be sufficient to protect species' ecological roles and ecosystem functioning.*

- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.*
- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

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

MEXICO / GULF OF MEXICO, CRAB RINGS, MEXICO, CAMPECHE
MEXICO / GULF OF MEXICO, SCOOPNETS, MEXICO, CAMPECHE
MEXICO / PACIFIC, CRAB RINGS, MEXICO, SINALOA
MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SINALOA
MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SONORA

3

The crab traps, rings, and scoops use in the crab fisheries in Mexico have a low impact on the physical and biological structures of the seafloor (Balmori et al. 2012) for Sonora and Sinaloa; (Nakamura et al. 2012) for Campeche. 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 is deemed a "low" concern (3).

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

MEXICO / GULF OF MEXICO, CRAB RINGS, MEXICO, CAMPECHE
MEXICO / GULF OF MEXICO, SCOOPNETS, MEXICO, CAMPECHE
MEXICO / PACIFIC, CRAB RINGS, MEXICO, SINALOA
MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SINALOA
MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SONORA

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 (DOF 2014) action 1.3.2, but it has not been implemented. Therefore, no further credit is granted.

Factor 4.3 - Ecosystem-Based Fisheries Management

MEXICO / GULF OF MEXICO, CRAB RINGS, MEXICO, CAMPECHE
MEXICO / GULF OF MEXICO, SCOOPNETS, MEXICO, 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. Although spatial management is lacking, according to researchers, food web impacts due to this fishery are not apparent (Arreguin-Sanchez and Arcos-Huitron 2011). For this reason, the factor is rated as "moderate concern" for the Campeche fishery.

MEXICO / PACIFIC, CRAB RINGS, MEXICO, SINALOA
MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SINALOA
MEXICO / PACIFIC, TRAPS (UNSPECIFIED), MEXICO, SONORA

Moderate Concern

The crab fishery in Sonora and Sinaloa does not have a spatial management in place, other than the total closure of crab fishing activities during the no-fishing season. The fishery does not catch species of exceptional ecological importance for 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) (see Appendix A). For these reasons, and since no food web impacts from the fishery are evident, this factor is deemed a "moderate concern" for Sinaloa and Sonora.

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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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