Monterey Bay Aquarium

Seafood Watch®

Snapper (Mexico)

Red snapper, Yellowtail snapper

Gulf of Mexico

Hand-operated pole and lines

September 4, 2018

Seafood Watch Consulting Researcher

Seafood Watch Standard used in this assessment: Standard for Fisherie 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 analyzes the Mexican industrial fleet that targets red snapper (*Lutjanus campechanus*) and the small-scale fleet that targets yellowtail snapper (*Ocyurus chrysurus*) off of the Campeche Bank (offshore of the Yucatan Peninsula) in the Gulf of Mexico (GOM). According to managers and local experts, **the products of these fleets are exported** to the US market.

Historically, red snapper has been the main snapper species targeted in the region, and its stock has been showing signs of decline for years, although it is still a major component of the catch (approx. 46% of the total catch by all fleets in the GOM). In comparison, landings of yellowtail snapper have been increasing significantly in recent years. Red and yellowtail snapper life-history characteristics (slow growth and the formation of spawning aggregations) make them vulnerable to fishing pressure.

The red snapper stock was most recently assessed in 2013 by the National Fisheries Institute (INAPESCA) and the National Fisheries Commission (CONAPESCA). Managers concluded that the fishery showed signs of being overfished and has been experiencing overfishing for several years. Landings off Yucatan, Campeche, and Veracruz have been declining, and managers recognize the fishery as deteriorated (not at its optimum in terms of abundance and fishing effort) and recommend reducing fishing mortality. No stock assessment has been developed for yellowtail; therefore, a productivity-susceptibility analysis (PSA) was used to estimate abundance.

While red snapper was once the main species (in terms of volume and value) of this multi-species fishery, several other species are also targeted by the fleet using similar gear in the same fishing areas. These species are not considered to be bycatch, but instead secondary target species or "associated species" by Mexican legislation. Most of these associated species belong to two families (Serranidae and Lutjanidae). For Criterion 2, the most recent catch composition reports were used in order to select species that comprised at least 5% of the total catch or are recognized as ETP species. These were: red grouper (*Epinephelus morio*), black grouper (*Mycteroperca bonaci*), yellowmouth grouper (*Mycteroperca interstitialis*), banded rudderfish (*Seriola zonata*) and lane snapper (*Lutjanus synagris*). Red grouper is the lowest scoring Criterion 2 species because it is overfished with likely high levels of mortality in this fishery. Sea turtles were not included as a Criterion 2 species because there are no reports of sea turtle interactions, and because susceptibility to similar gears in the Gulf of Mexico is documented as low. In the case of the small-scale fleet that targets yellowtail snapper, fishers mostly use hook and line or handlines which have a low impact on bycatch species. However, red and black grouper as well as lane snapper (*L. synagris*) were reported as part of the catches and for that reason included as Criterion 2 species.

Snappers are considered associated species in the red grouper management plan; however, no specific regulations are in place for these species other than a limit on the number of permits and the use of specific hook sizes for the fishing gears.

The overall SFW recommendation for red and yellowtail snappers caught by the industrial and artisanal fleets off of the Campeche Bank is "Avoid" due to high concern of both the target and associated species stock status and the lack of strong and effective management schemes.

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
Yellowtail snapper Gulf of Mexico, Handlines and hand-operated pole-and-lines, Mexico, Artisanal fleet	Yellow (2.64)	Red (1.00)	Red (1.00)	Yellow (2.83)	**Avoid (1.65)**
Red snapper Gulf of Mexico, Vertical lines, Mexico	Red (1.00)	Red (1.00)	Red (1.00)	Yellow (2.83)	**Avoid (1.30)**

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.

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

Introduction

Scope of the analysis and ensuing recommendation

This report focuses on two species of snapper: red snapper (*Lutjanus campechanus*) caught by the Yucatan industrial fleet using a manually operated hook and line system called "bicicleta" (bicycle), which consists of a line with 4 to 5 hooks attached and is operated through a manually operated system that resembles a bicycle, and; yellowtail snapper (*Ocyurus chrysurus*), targeted mostly by the artisanal fleet using handlines (Salas et al. 2006). These two species are also targeted by fleets in others Mexican states in the GOM, but there are no reports that their production reaches the US market, and for this reason other states are not included in this report. However, fishing mortality from these fleets is considered as part of the fishing mortality sub-factors, since these fleets are targeting the same populations.

Species Overview

The snapper fishery in the GOM occurs year-round, with the Campeche Bank as the most important zone for this fishery (Monroy et al. 2002) The main fishing grounds are in the west and northwest regions of the bank (Monroy, M. 2010). Red snapper is the most abundant snapper species in the Campeche Bank, with a distribution along the coast of the Atlantic Ocean, from New England in the US, to the Yucatan Peninsula in Mexico, in depths of 8 to 200 m (Allen, G. 1985). This species is thought to mature between 2 and 5 years of age and can live up to 50 years (Patterson et al. 2001). The International Union for the Conservation of Nature (IUCN) considers red snapper as "Vulnerable" (Anderson et al. 2016). In Mexico, managers recognize that the fishery is deteriorated (DOF 2012).

According to official reports, red snapper (*Lutjanus campechanus*) is still the most important targeted species by the industrial Yucatan fleet, after red grouper, which is the main target species of the fleet (DOF 2012). In 2014, around 46% of the total snapper catch in the GOM was labelled as red snapper, although, according to managers' reports, the percentage of red snapper in landings has declined (from ~90% of the catch in the past (DOF 2012). Other snappers such as yellowtail snapper, (*Ocyurus chrysurus*), have been increasing their percentage in landings reports (~30% in 2014) particularly from the artisanal fleet (CONAPESCA 2016) (landings data analysis, 2016). In the GOM and Atlantic, the red snapper population is considered to consist of three separate stocks: the US Atlantic, the US Gulf of Mexico, and the Mexican Gulf of Mexico (Anderson, et al. 2016). This is corroborated by results of a biophysical model of the GOM, which showed that red snapper larvae released in the Campeche Bank are primarily retained in the bank (Patterson, W.F., III 2007), and an otolith chemical study that suggested little mixing between the populations in US and Mexican waters (ibid.).

Yellowtail snapper ranges from the coast of Massachusetts to Brazil, including Bermuda, the Gulf of Mexico, and the Caribbean (Hill, K. 2005). Juveniles are commonly found in inshore areas, while adults are found in nearshore and offshore waters (Hill, K. 2005). Yellowtail snapper is typically found between 20 and 70 m depth (FMNH 2005), but it has been reported at depths of 0 to 165 m (Lindeman et al. 2016). Yellowtail snapper can reach up to 34 inches total length (TL) (IGFA 2001) and live for up to 14 years (Allen, G. 1985). In the case of yellowtail snapper, it is unclear—based on the species distribution—if the US and Mexican fleets target the same populations, although a genetic study suggested a single population of yellowtail snapper in southern Florida that is self-recruiting (Cummings 2004).

In Mexico, the Secretariat of Agriculture, Livestock, Rural Development, Fisheries, and Food (SAGARPA) is the Mexican Government body that promotes the execution of policy to improve production practices for agricultural, livestock, and fisheries sectors. The National Aquaculture and Fishing Commission (CONAPESCA 2016) is the branch of SAGARPA that is in charge of developing and executing management regulations. CONAPESCA is

supported by its technical branch, the National Fisheries Institute (INAPESCA), which provides technical support and management recommendations based on scientific evidence (INAPESCA 2016). These bodies are charged to create, implement, and enforce management strategies for fishing resources in the country.

Production Statistics

Snapper fisheries in Mexico are one of the most important fisheries in terms of value and volume in the country (Monroy, et al. 2014). The Mexican Pacific snapper landings, (including the Gulf of California) ranged between 4,317 t and 11,617 t/y (Monroy, et al. 2014). In the Gulf of Mexico (GOM), landings averaged 4,125 t from 2008 to 2012 (DOF 2012). Despite the higher amount of production in the Pacific compared to the GOM, the GOM production is the one that reaches the US market (DOF 2012), while Pacific production remains for domestic consumption, due to the high demand on these species in the national market (Monroy, et al. 2014).

In the GOM, the states of Tabasco, Campeche, and Yucatan are the most important states with an average of 26%, 22%, and 21% respectively of the total landings in the GOM from 2006 to 2014 (CONAPESCA 2016). However, while in Tabasco and Campeche (as well as the rest of the country) snappers are targeted by artisanal fleets, in Yucatan, an industrial fleet also actively targets red snapper (SAGARPA-INAPESCA 2000), which is the main source of snapper exported to the US (DOF 2012).

Landings of snappers in the GOM are generated directly from logbooks and self-reports delivered to local INAPESCA offices (DOF 2012). Fishers used common names to report their landings and the use of common names varies even between communities (Ramirez-Rodriguez 2013). During our analysis, several common names of species were found to be inaccurate. For example, names of species exclusively distributed in the Pacific Ocean were assigned to landings from the GOM and vice versa (as observed when analyzing the databases). In addition, databases did not specify catch by the fleet or gear type, making it difficult to distinguish production by fleet (particularly in Yucatan). Therefore, it was not possible to accurately specify the landing volumes for each species with a particular fishing gear. Nonetheless, based on expert opinions, we used managers' data and grouped landings in three main categories: huachinango (mostly red snapper); pargo (or snapper) composed mainly of "other snapper species; and rubia and villajaiba (mostly lane and yellowtail snapper). By doing this, it was possible to estimate landings of these species.

Of the fourteen GOM *Lutjanus* species (Brule et al. 2008), red snapper (*Lutjanus campechanus*) is the most important for commercial fisheries and is exported to the US (DOF 2012) according to the National Fisheries Chart (CNP for its name in Spanish), the official instrument used by managers in Mexico. Snapper production in the GOM averaged above 4,125 tons (t) from 2004 to 2008 (DOF 2012). In 2014, CONAPESCA reported over 7,000 t of snapper production in the GOM (CONAPESCA 2016); Figure 1).

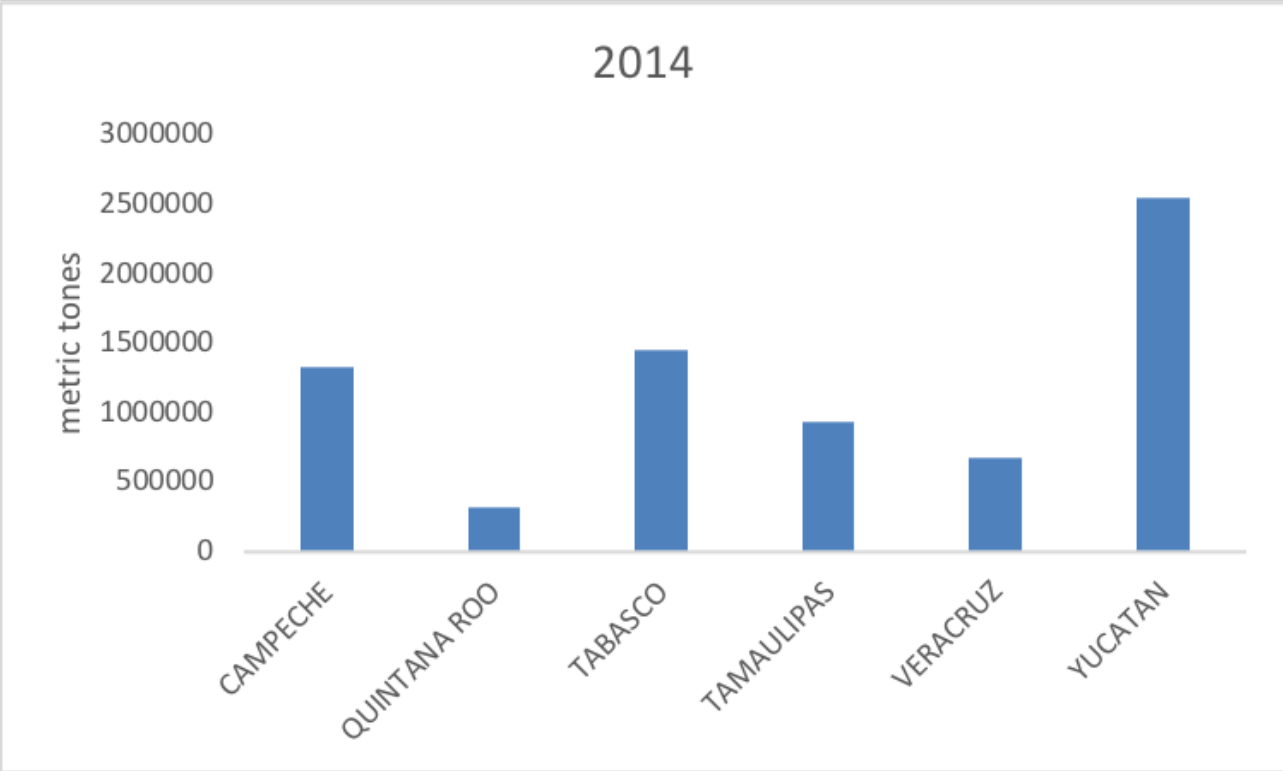

Figure 1 Snapper landings in the GOM by State in 2014 (CONAPESCA, 2017)

Based on landings information, in 2014, red snapper accounted for ~64% (3,315 t) of the total snapper landings in the GOM (7,232 t of all species). Of the 3,390 t of red snapper, 551 t, were landed in Yucatan. Meanwhile, yellowtail (villajaiba) and lane snapper accounted for ~24% of total snapper production in the GOM (~1,696 t), with almost the entire production (1,390 t) landed in Yucatan (CONAPESCA 2016); Figure 2.

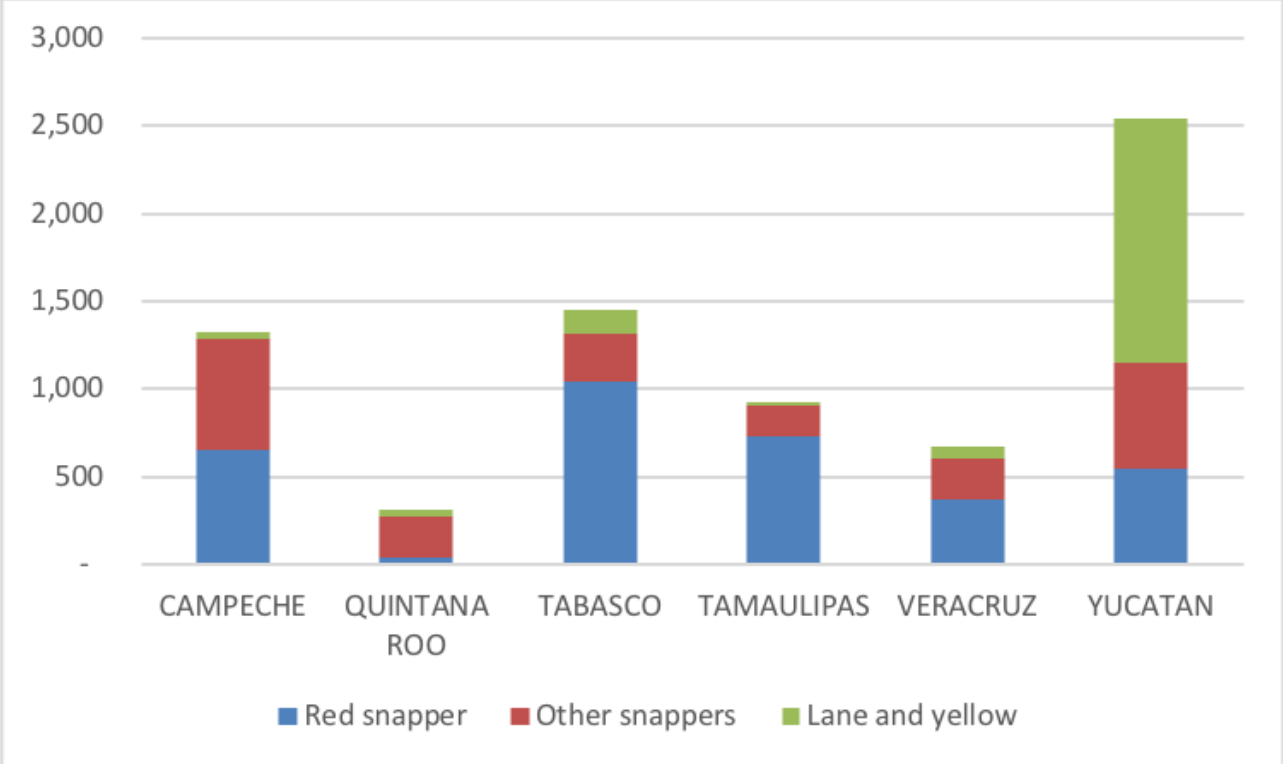

Figure 2 Most important snappers landed in the GOM by state

Importance to the US/North American market.

The US is one of the largest importers of snapper in the world. In 2016, the US imported more than 18,000 t of snapper (NOAA 2017). Mexico and Brazil were the main contributors with almost 42% of total snapper imported into the US in 2016 (NOAA 2017); Figure 3. It is not clear what volume of each species is imported into the US. According to an exporter in Yucatan, red and yellowtail snappers are the most exported species (pers. comm., Rudy Abad, Pescados y Mariscos del Caribe, 2018)

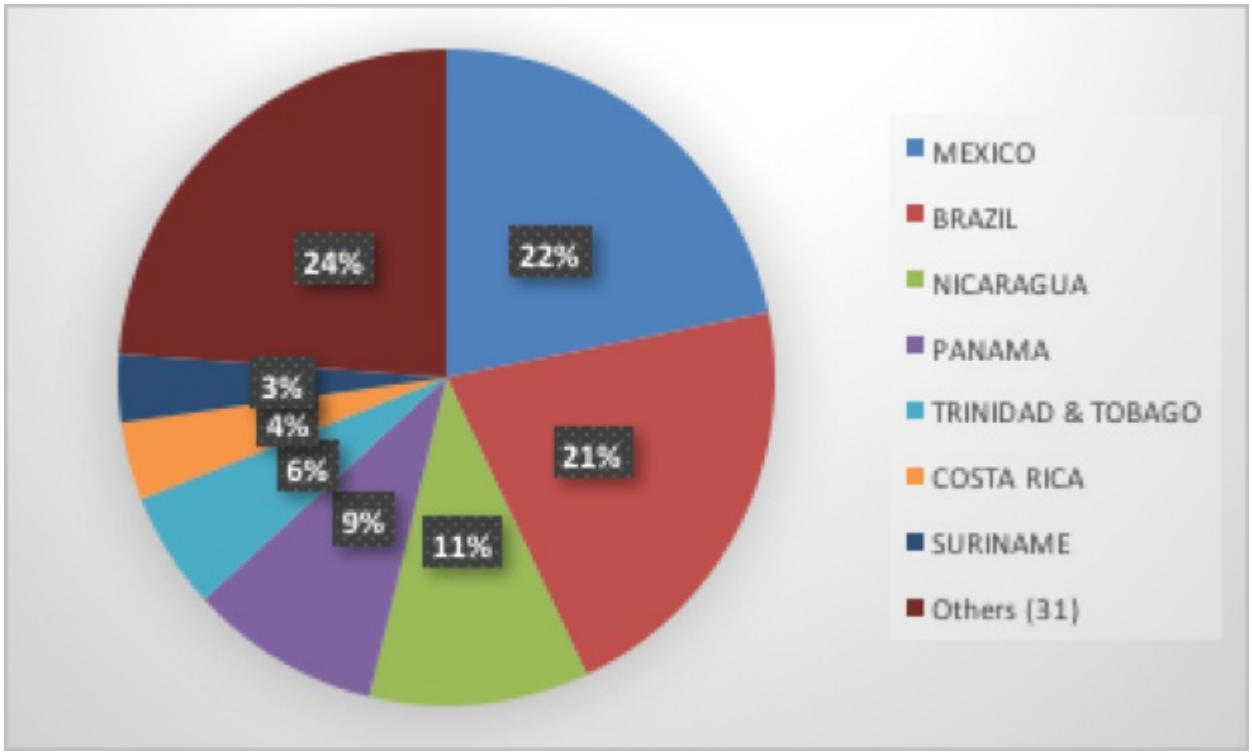

Figure 3 Landings composition in the GOM in 2014 (CONAPESCA, 2016).

Common and market names.

In the US, *Lutjanus campechanus* is known as snapper or red snapper (FDA 2017) and *Ocyurus chrysurus* is known regularly as snapper (ibid).

Primary product forms

In 2016, snapper from Mexico was shipped to the US either as fresh whole fish (67%) or as frozen fillets (32%) (NOAA 2017).

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

RED SNAPPER			
Region | Method	**Abundance**	**Fishing Mortality**	**Score**
Gulf of Mexico | Vertical lines | Mexico	1.00: High Concern	1.00: High Concern	Red (1.00)

YELLOWTAIL SNAPPER			
Region | Method	**Abundance**	**Fishing Mortality**	**Score**
Gulf of Mexico | Handlines and hand-operated pole-and-lines | Mexico | Artisanal fleet	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.64)

The snapper fishery off of the Campeche Bank is a multi-species fishery that targets at least 11 species of snappers {DOF 2012}. Other species associated within the snapper fishery according to the National Fisheries Chart are: yellowtail snapper (*Ocyurus chrysurus*), mutton snapper (*Lutjanus analis*), grey snapper (*Lutjanus griseus*), lane snapper (*Lutjanus synagris*), blackfin snapper (*Lutjanus buccanella*), silk snapper (*Lutjanus vivanus*) and dog snapper (*Lutjanus jocu*) {DOF 2012}.

Red snapper (*Lutjanus campechanus*) is the most important species in terms of volume and value {SAGARPA-CONAPESCA 2014} and is mostly targeted and captured by the industrial fleet using the bicycle gear, or vertical lines for the purpose of this report. Yellow snapper is mostly targeted and harvested by the artisanal fleet using hand-operated lines.

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.*

RED SNAPPER

Factor 1.1 - Abundance

GULF OF MEXICO, VERTICAL LINES, MEXICO

High Concern

Red snapper stock status in the Campeche Bank was most recently assessed in 2000, see Table 1(SAGARPA-INAPESCA 2000).

Table 1 Red snapper population estimates and 95% confidence intervals (SAGARPA INAPESCA 2000)

Factor	Estimate value	Inferior limit	Superior limit
Initial biomass	33,740 t	30,000	35,500
Carrying capacity (k)	32,258 t	28,500	46,000

Growth rate (r)	0.158	0.078	0.175
Catchability rate	3.65 E 05		
MSY	1,271 t/yr	850 t/yr	1,425 t/yr
F_{MSY}	2,191 trips/year		

To estimate the biomass, managers used a Dynamic Biomass model developed by (Hillborn and Punt 1996) (SAGARPA-INAPESCA 2000). The model assumed that changes in stock size are due to the interaction of several factors: growth, recruitment, and natural and fishing mortality (Hillborn and Punt 1996). Using CPUE data, managers found that red snapper biomass declined considerably on Campeche Bank from an estimated initial biomass of 33,740 t in 1984 to ~17,000 t in 1999, a decline of 49.2% (SAGARPA-INAPESCA 2000). The MSY for Red snapper was estimated to be 1,271 t/year (ibid.). There have been no recent efforts to assess the status of the species in the region, and there is no evidence that the stock status has improved from the outdated 1999 stock assessment. In addition, managers recognize the fishery as "deteriorated" (with red snapper as the main contributor) (DOF 2012). Although the meaning of "deteriorated" is unclear, it is clear that the abundance has been declining. In addition, the species is listed as "Vulnerable" by the IUCN (Anderson, et al. 2016). For these reasons, red snapper abundance is deemed a "high" concern.

Factor 1.2 - Fishing Mortality

GULF OF MEXICO, VERTICAL LINES, MEXICO

High Concern

Current fishing mortality for red snapper in the Campeche Bank (from this fleet and cumulatively) is unknown (DOF 2018). However, evidence suggests that overfishing has been occurring; managers recommended that fishing effort in Yucatan should be reduced, and identified the fishery as deteriorated (DOF 2012). In addition to this fleet, the species is also targeted by other gears/fleets (i.e., artisanal fleet). Given the evidence that overfishing is occurring and the need to curtail effort is recognized, this factor scores as "high" concern for the industrial fleet.

YELLOWTAIL SNAPPER

Factor 1.1 - Abundance

GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET

Moderate Concern

The IUCN lists yellowtail snapper as data deficient. The assessment is based on the limited information of landings data in major regions where the species has its distribution, including the Gulf of Mexico. In the US, yellowtail is listed as not overfished, but in Cuba and Brazil it is listed as overfished (Lindeman et al. 2016). In Mexico, no formal stock assessment is available for yellowtail snapper. For this reason, a productivity-susceptibility analysis (PSA) was used.

The PSA score = 2.72; hence, this species is deemed highly vulnerable. Detailed scoring of each attribute is shown below.

Although yellowtail snapper presents a medium vulnerability (according to the PSA analysis) and FishBase scores it as 65 of 100 (Froese and Pauly 2016), there is no quantitative stock assessment for this stock and it

is believed that this population is generally decreasing (Lindeman et al. 2016). For these reasons abundance is deemed as "moderate" concern.

Justification:

Table 2. Productivity-Susceptibility Analysis for Yellowtail Snapper:

Productivity attribute	Relevant information	Score (1= low risk, 2= medium risk, 3= high risk
Average age at maturity	Females can reach 50% maturity at an average age of 1.7 years old (Muller et al. 2003)	1
Fecundity	Batch fecundity estimates ranged from 14,102 to 164,756 oocytes (mean +- s.d.- 43,852 = - 32,684 oocytes (Trejo-Martinez et al. 2010)	1
Average maximum size at maturity (fish only)	Maximum length is 81 cm (Anderson, W.D. 2002)	1
Average maximum age	14 years (Manooch 1984)	2
Average size at maturity	Estimated maturity at 26.1 cm TL for this species in the Campeche Bank (Trejo-Martinez et al. 2010) (Trejo-Martinez et al. 2011)	1
Reprodcutive strategy	Broadcast spawner (Allen 1985)	1
Trophic level	4 (Froese and Pauly 2016)	3
Density dependence (invertebrates only)		
Total productivity (average)		1.43

Susceptibility attribute	**Relevant information**	**Score (1= low risk, 2= medium rish, 3= high risk)**

Areal overlap (Considers all fisheries)	Yellowtail snapper is fished throughout its range: from Brazil, Cuba, the GOM and the US Atlantic (Lindeman et al. 2016).	3
Vertical overlap (Considers all fisheries)	Yellowtail depth range is from 1 to 65 m, and commonly less than 70 m (Lindeman et al. 2016), which allows high overlap with the gear (DOF 2014).	3
Selectivity of the fishery (Specific to the fishery under assessment)	The fleet captures mostly adult snappers (Brule et al. 2008). It has been reported that yellowtail snapper aggregates to spawn (Heyman and Kjerfve 2008), although these aggregations are reported to happen in open waters (Claro and Lindeman 2002). Currently, there are no effective management measures in place to mitigate interactions with spawning aggregations.	2
Post-capture mortality (Specific to the fishery under assessment)	Most of the catch is retained (Brule et al. 2008)	**3**
Total susceptibility (multiplicative)		3

PSA score for yellowtail snapper in the GOM handline fishery is calculated as follows:

Vulnerability (V) = $\sqrt{(P^2 + S^2)}$

$V = \sqrt{(1.43^2 + 3.0^2)}$

V = 2.72

Factor 1.2 - Fishing Mortality

GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET

Moderate Concern

Fishing mortality data is not available for yellowtail snapper (DOF 2012). It is unclear how much effort is in place for yellowtail snapper, since there is no data on how many vessels are actively targeting the species.

In addition, yellowtail snapper has been reported to be caught by other gears like bottom longlines, when targeting grouper (Monroy, Salas, and Bello-Pineda 2010), but no quantitative data are available. Therefore, yellowtail snapper fishing mortality is considered unknown, and considering the current status of the abundance, this factor is rated as 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.

RED SNAPPER - GULF OF MEXICO - VERTICAL LINES - MEXICO					
Subscore:	**1.00**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.00**
Species	**Abundance**		**Fishing Mortality**		**Subscore**
Red grouper	1.00:High Concern		1.00:High Concern		Red (1.00)
Yellowmouth grouper	1.00:High Concern		3.00:Moderate Concern		Red (1.73)
Black grouper	1.00:High Concern		3.00:Moderate Concern		Red (1.73)
Banded rudderfish	2.33:Moderate Concern		3.00:Moderate Concern		Yellow (2.64)

YELLOWTAIL SNAPPER - GULF OF MEXICO - HANDLINES AND HAND-OPERATED POLE-AND-LINES - MEXICO - ARTISANAL FLEET					
Subscore:	**1.00**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.00**
Species	**Abundance**		**Fishing Mortality**		**Subscore**
Red grouper	1.00:High Concern		1.00:High Concern		Red (1.00)
Lane snapper	1.00:High Concern		3.00:Moderate Concern		Red (1.73)
Black grouper	1.00:High Concern		3.00:Moderate Concern		Red (1.73)

The snapper fishery off of the Campeche Bank is a multi-species fishery that targets at least nine species of snappers (DOF 2012). The associated species according to managers are: mutton snapper (*Lutjanus analis*), grey snapper (*Lutjanus griseus*), lane snapper (*Lutjanus synagris*), blackfin snapper (*Lutjanus buccanella*), silk snapper (*Lutjanus vivanus*) and dog snapper (*Lutjanus jocu*), as well as jolthead (*Calamus bajonado*), knobbed porgy (*C. nodosus*), crevalle jack (*Caranx hippos*), red grouper (*Epinephelus morio)*, yellowfin grouper (*Mycteroperca venenosa*), gag grouper (*M. microlepis*), yellowmouth grouper (*M. interstitialis*), black grouper (*M. bonaci*), snowy grouper (*Hyporthodus niveatus*), coney (*Cephalopholis fulva*), Spanish grunt (*Haemulon macrostonum*), black grunt (*H. bonariense*), and the Atlantic sharpnose shark (*Rhizoprionodon terraenovae* (DOF 2012).

Studies on catch composition for the industrial fleet that target snapper are not abundant. We used the most recent reports available on selected species in this section, based on (Monroy, Salas, and Bello-Pineda 2010) who analyzed the catch composition of the industrial snapper fleet in Yucatan, using monthly samplings and fish logs from vessels. The authors determined that the catch was mainly composed of red snapper (~ 48% of the catch), red grouper (~ 17%), black grouper (~ 7%), yellowmouth grouper (~ 6%), banded rudderfish (~ 5%), silk snapper (~ 3%), blackfin, mutton and lane snapper (~ 2% for each species), Atlantic sharp nose shark (~ 1.3%), and at least another 8 species that together represent less than 7% of the catch (Monroy 2010).

Due to their percentage of the catch, red grouper, black grouper, yellowmouth grouper, and banded rudderfish were included in Criterion 2 for the industrial fleet.

In the case of the artisanal fleet, (Brule et al. 2009) studied the composition of the small-scale fleet and identified red grouper (36%), lane snapper (17%) and black grouper (7%) as the main components of the catch in addition to the yellowtail snapper (Brule et al. 2008). For these reasons lane snapper, and red and black grouper were included as Criteria 2 species for the artisanal fleet (DOF 2012).

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)

RED GROUPER

Factor 2.1 - Abundance

GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET
GULF OF MEXICO, VERTICAL LINES, MEXICO

High Concern

The most recent effort to measure red grouper stock status in the region was developed by INAPESCA researchers in 2013 (Monroy, et al. 2014). Researchers used the data recorded in the fishing logbooks from 1984 to 2009 by the industrial fleet (i.e., no fishery-independent data were used). Catch per unit effort (CPUE)

as kg of grouper per fishing trip was used in the Schaefer excess production model (1954) to produce biomass estimates and to calculate biomass at maximum sustainable yield (B_{MSY}) (Monroy, et al. 2014). This is a simple model without age structure and with uniform population growth and mortality rates.

The data requirements are not as demanding; for example, there is no need to determine cohorts (Sparre and Venema 1998). Managers concluded that the data fit well with the Schaefer model, and accepted the results for management (DOF 2014). These results showed a decreasing trend in Mexican red grouper biomass from the 200,000 t estimated in the 1970s to ~50,000 t in recent years, which is equivalent to 25% of the 1970 estimation. In comparison, US red grouper stocks were reported as healthy in the most recent red grouper stock assessment report (SEDAR 2015). Based on biophysical transport models used by the SouthEast Data, Assessment, and Review group (SEDAR), "little connectivity exists for red grouper mixing of Mexico and US stocks" (unpublished data, M. Karnauskas, SEFSC/NMFS Miami, FL).

The biomass estimated by the model (B_{2009}) was 48,524 t and B_{MSY} was 97,433 t, confirming that the stock was overfished (SAGARPA-CONAPESCA 2012). Signs of the Yucatan stock being overfished had been observed for years; for example, in the reduction of landings and the decrease of the CPUE since the 1970s (Diario Oficial de la Federacion [DOF] 2014). Abundance is deemed a "high" concern because available evidence suggests that the stock remains overfished.

Factor 2.2 - Fishing Mortality

GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET
GULF OF MEXICO, VERTICAL LINES, MEXICO

High Concern

In 2013, managers estimated the levels of fishing mortality (F) for the red grouper fishery in the GOM (SAGARPA-INAPESCA 2014). Some of the vessels using bottom longlines that take part in the red grouper fishery also take part in the snapper fishery (Monroy 2010). Managers used a virtual population analysis and found that F increased substantially with time, in particular between 1990 and 1995, the period of time when the size of the artisanal fleet increased (Figure 5) (SAGARPA-INAPESCA 2014).

For the Snapper fishery, Monroy estimated that ~60 vessels operate year-round using the bicycle gear and around 17% of the bycatch using this gear is red grouper (Monroy 2010). Based on the 2014 landings reported by the fleet, ~196 t of red grouper was potentially caught using the bicycle gear by the industrial fleet, and handlines by the small-scale fleet, in 2014. It is unclear if these landings and fishing efforts are considered in the recommended red grouper vessel cap (F_{MSY} = 320 industrial vessels (DOF 2012) (SAGARPA-INAPESCA 2014). In addition, Brule 2008 reported that the artisanal fleet has a significant impact on the species (~35%) (Brule et al., 2008), although it is unclear how many vessels are actively participating in the fishery.

Considering that managers had identified the red grouper fishery as experiencing overfishing (overall fishing mortality is too high) (SAGARPA-INAPESCA, 2014), fishing mortality is deemed a "high" concern for both fleets.

Justification:

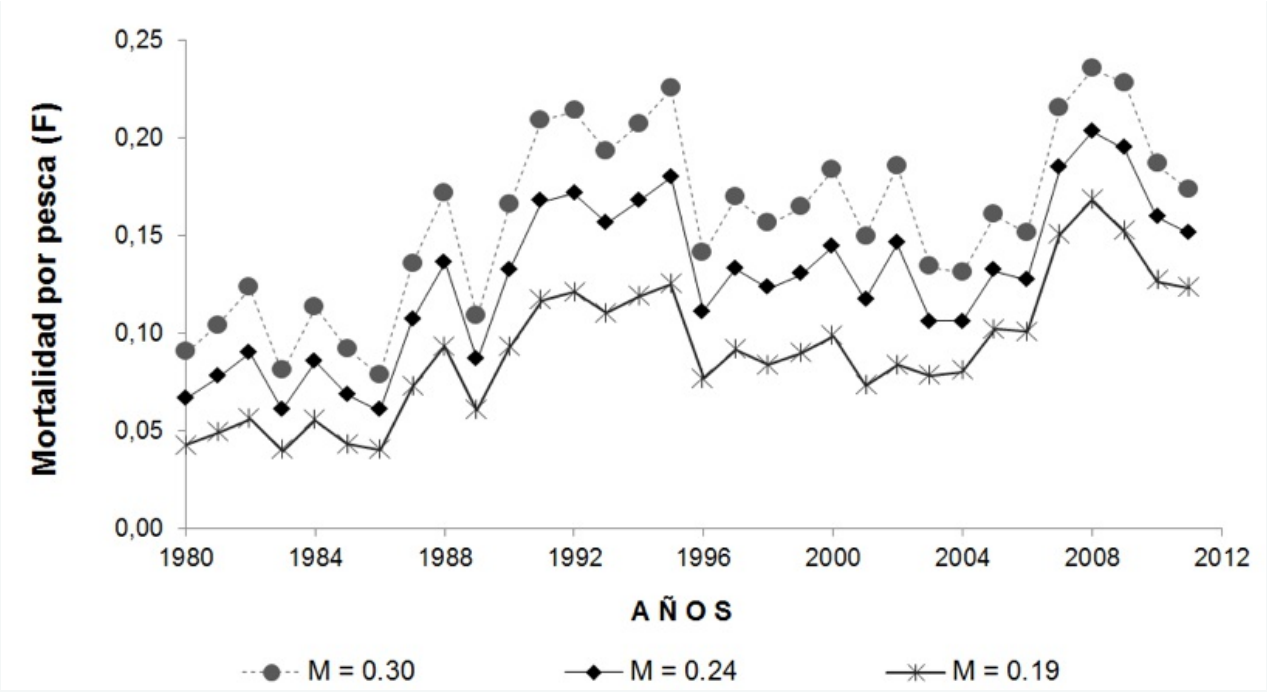

Figure 4 Estimated values of Fishing mortality (F) over time in the Red grouper fishery in the GOM using different natural mortality values (M) (SAGARPA-INAPESCA, 2014).

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

GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET
GULF OF MEXICO, VERTICAL LINES, MEXICO

< 100%

The discards + bait/landings ratio cannot be estimated for the red and yellowtail snapper fishery in Yucatan due to the lack of information. Some researchers suggest low levels of discards are typical in handline fisheries (Kelleher 2005). Also, similar fisheries in the GOM (US handline fishery that targets mutton snapper) used observer data and estimated a discards/landings ratio of 33% to 34% (Scott-Denton and Williams 2013). Given the similarities in gear and targeted species between this fishery and the US GOM handline fishery, this factor is rated at <100%; hence, a score of 1 is given.

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: Gulf of Mexico | Handlines and hand-operated pole-and-lines | Mexico | Artisanal fleet	Ineffective	Highly Effective				Red (1.00)
Fishery 2: Gulf of Mexico | Vertical lines | Mexico	Ineffective	Highly Effective				Red (1.00)

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.

GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET
GULF OF MEXICO, VERTICAL LINES, MEXICO

Ineffective

Mexican authorities manage red snapper as part of the multispecies fishery known as "snapper" or "huachinango" (DOF 2012) in the Gulf of Mexico. There is no management plan in place for the target species in the Gulf of Mexico, and it's unclear if the few regulations (e.g., hook size) are based only on red snapper biology, due to its historical importance in terms of volume.

In 2000, INAPESCA researchers suggested that establishing stricter control on fishing mortality could help recover the snapper's species biomass (SAGARPA-INAPESCA 2000). In their report, researchers proposed to limit fish extraction in the Campeche Bank to an annual quota of 1,117 t (ibid.). Also, in 2012, CONAPESCA suggested that total landings for snapper in the Gulf of Mexico should remain under 4,295 t (82% of the maximum historic catch of 5,252 t (DOF 2012), and recommended that stronger management regulations should be in place in order to reduce fishing mortality by about 30% in Yucatan, Campeche, and Veracruz (DOF 2012).

It is important to mention that almost all the species caught are retained since most of these have commercial value. For this reason, management of these species is also considered for this factor.

Red, black, and yellowmouth grouper are included in another fishery called by managers the "grouper fishery" (that targets at least 19 species between objective and associated species (DOF 2014). This fishery has been regulated by the Official Mexican Norm (NOM-065-PESC-2007) since 2007. This NOM, (a federal document with standards and regulations for diverse activities in Mexico (DOF 2009) was generally applied to all the grouper species in the Gulf of Mexico and the Caribbean (DOF, 2009) for both fleets (industrial and artisanal).

However, the management plan refers mostly to red grouper (*Epinephelus morio)* and was developed in 2014 (DOF 2014). This document states that the objective species for the plan is red grouper, but it includes the other associated species (included in the NOM) captured by both fleets in the Yucatan area (DOF 2014).

The current regulations included a minimum size limit (just for red grouper) of 36.3 cm, which applies to both fleets; specifications of fishing gear (e.g., for the industrial fleet no more than four bottom longlines with 500 eagle claw hooks each or 1 longline with no more than 2,000 #6 eagle claw hooks; for Artisanal, a limit of one bottom longline no longer than 750 m long and a maximum of 250 #7 eagle claw hooks. In addition, it includes an annual off-season for the whole fishery that applies to both fleets) from February 15 to March 15.

These regulations for the grouper fishery have had mixed results; managers recognize that intense fishing pressure on juveniles is still a problem, particularly with the artisanal fleet (SAGARPA-INAPESCA 2014). It is questionable if the management plan will curtail the negative impacts of the artisanal fleet on grouper stocks. Currently, management effectiveness seems to not be enough to improve the status of the fishery, and it is likely that the fishery is having serious negative impacts on retained populations from all the fleets.

Finally, it is not clear if these and snapper recommendations have been executed. No indication of a snapper quota for the Campeche Bank was found and the only limits of fishing mortality are the number of permits authorized and the hook size (#7 or #8) (DOF 2012). No new regulations have been established in order to achieve the goal of reducing fishing effort. The only requirement US buyers place on Mexican exporters is a commercial size minimum (not an official limit) of 370 mm fork length for red snapper (Brule et al. 2008). Considering that: 1) no formal management plan or other regulations (e.g., official minimum size or off-season) is/are in place for the fishery; 2) it is likely that the fishery is having serious negative impacts on both target and retained species (i.e., abundance of targeted species is of high concern) 3) managers have

recognized that this is a deteriorated fishery (DOF 2012), and 4) 2014 landings for Yucatan (5,381 t) surpassed the reference point recommended by managers in the CNP (4,295 t), this factor is rated as ineffective.

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.

GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET
GULF OF MEXICO, VERTICAL LINES, MEXICO

Highly Effective

The snapper fishery (both industrial and artisanal) in the GOM considered most of the species caught as associated species (DOF 2002). Producers retained most of the species for commercial purposes, and for this reason, the bycatch level could be considered minimal. In addition, no species of concern have been reported to be caught by any of the fleets.

Since the current management of the C1 and C2 species has been considered in the 3.1 factor, this factor scores as "highly effective" because minimal bycatch management is needed and there are no species of concern caught by this fishery.

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.

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
Gulf of Mexico / Handlines and hand-operated pole-and-lines / Mexico / Artisanal fleet	4	0	High Concern	Yellow (2.83)
Gulf of Mexico / Vertical lines / Mexico	4	0	High Concern	Yellow (2.83)

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

GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET
GULF OF MEXICO, VERTICAL LINES, MEXICO

4

The wide continental shelf of the Campeche Bank includes a variety of habitats, including rocky areas (DOF 2014). The bottom characteristics of the bank allow several fish species, including snappers, to move throughout the area depending on the season (Brule et al. 2008) and its life history stage (Martinez-Trejo et al. 2006).

Although juvenile snappers are normally found in shallow coastal waters on sandy or muddy bottoms (e.g. red snapper), adults are associated with hard bottom substrates in deeper waters (Brule et al. 2003). Monroy found that the industrial fleet that targets snappers (using the bicycle gear) operates mainly near deep-water coral reefs, such as Los Bajos del Norte, Arrecife Alacranes, Cayo Arenas, and Triangles (squares 1, 2, 4 and 8 in Figure 6 a) (Monroy 2010), while the artisanal fleet using hand lines operates south of the areas where the industrial fleet operates (Figure 6 b). In addition, when comparing these fishing areas with the substrate map for the region (Figure7), the industrial fleet operates mostly on a combination of hard and sandy bottom, while artisanal operates on mostly muddy and sandy bottom. Finally, according to catch composition reports, both fleets, despite the fishing area, primarily capture adults (Brule et al. 2008).

For these reasons, and considering that fishing gears could have some contact with the bottom, this factor is scored as 4 for vertical lines and hand operated lines.

Justification:

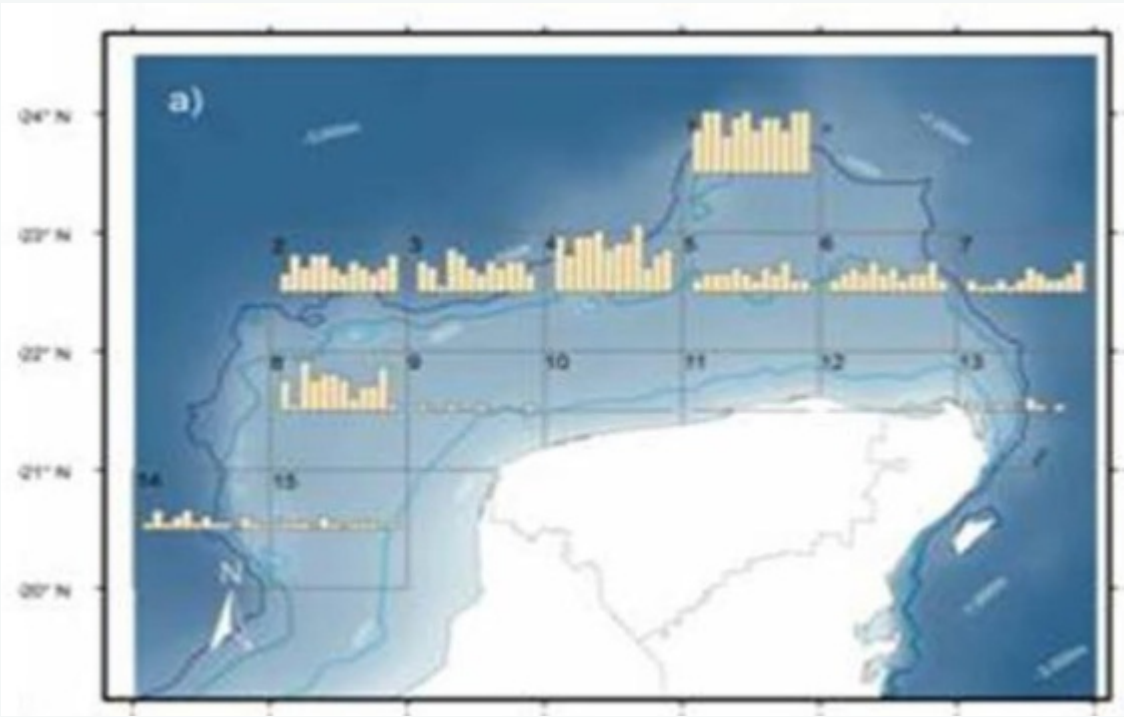

Figure 5 Fishing areas where the industrial fleet targets snapper in the Campeche Bank (taken from Monroy 2010). The bar plots within the boxes show the intensity of fishing (higher bars = greater number of fishing days).

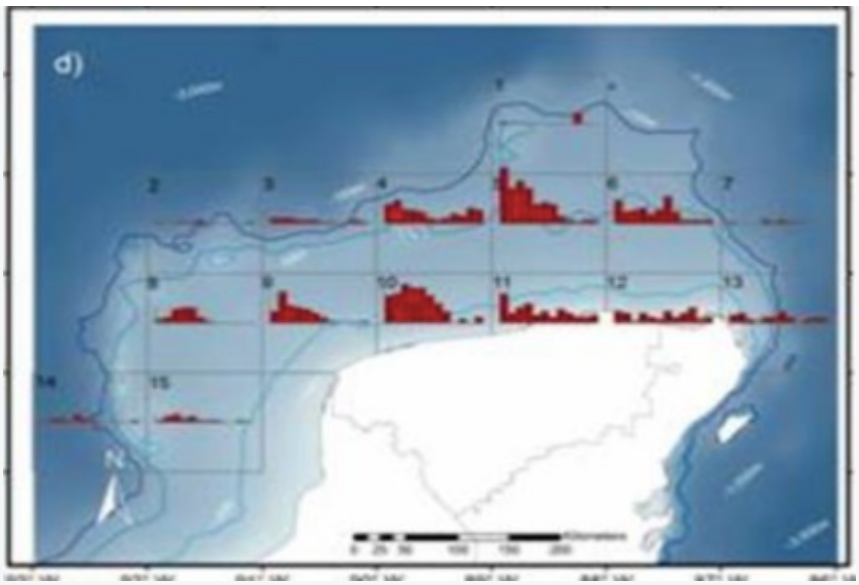

Figure 6 Fishing areas where the artisanal fleet targets snapper in the Campeche Bank using handlines (taken from Monroy 2010). The bar plots within the boxes show the intensity of fishing (higher bars = greater number of fishing days).

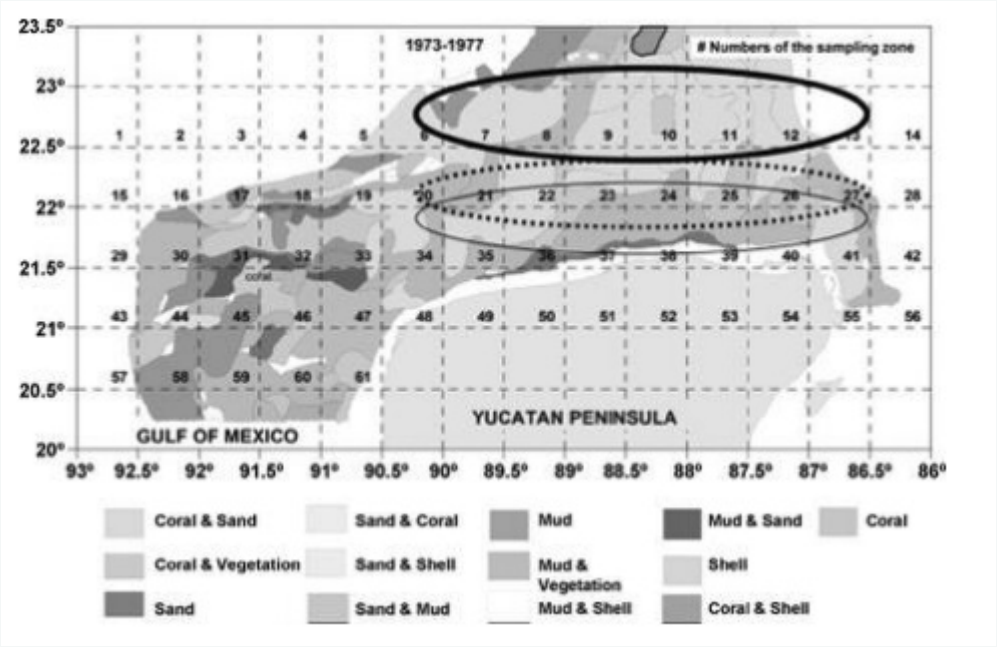

Figure 7 Campeche Bank continental shelf bottom types. Ellipses indicate the gross area of operation for the artisanal fleet (thin line) and the industrial fleet (bold line) (Image from Garcia 1980 in Albarez-Lucero and Arreguin-Sanchez 2009).

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET
GULF OF MEXICO, VERTICAL LINES, MEXICO

0

No measures are currently in place to limit gear impacts on the habitat, so no mitigation credit, or a score of 0, is awarded.

Factor 4.3 - Ecosystem-Based Fisheries Management

GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET
GULF OF MEXICO, VERTICAL LINES, MEXICO

High Concern

The Campeche Bank has been studied in detail for several reasons: fishing activities, oil exploration, and the ecology of the region (Tunnell and Chapman 2000) (Zarco-Perelló et al. 2013). The trophic role of snappers was evaluated in two regions of the Gulf of Mexico (Southwest coast and the Campeche Bank) (Arreguin-Sanchez and Manickchand-Heileman 1998). Using the Eco-path and Ecosim models, researchers simulated the trophic changes in the areas and measured the perturbations in the ecosystems due to changes in snapper fishing mortality (ibid.). The authors concluded that snappers act like top predators in the ecosystems, and play an active role in the energy flow dynamics of both study areas. When the system was perturbed (due to changes in biomass) the impact propagated through the food web to different trophic levels (ibid.). The study's authors found that the Yucatan shelf was less resilient to changes to the snapper populations (ibid.).

Despite this, no spatial management is in place for the snapper fishery in the GOM. Plans to increase the level of knowledge of these species have been proposed within the red grouper management plan, which considered red and yellowtail snappers as associated species (DOF 2014). However, no management plan is in place for the snapper fishery. Other than limited access and regulations on the fishing gear, no spatial management regulations are in place (e.g., no protected areas, off season, or protection during spawning aggregation season). Due to the lack of policies to protect the ecosystem, and the potential food web impacts, this factor is rated as "high" concern.

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.

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Appendix A: Extra By Catch Species

LANE SNAPPER

Factor 2.1 - Abundance

GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET

High Concern

Lane snapper is incidentally caught in other fisheries, like the snapper/grouper fishery in the US (SERO-NOAA 2015). However, neither a formal stock assessment nor abundance data is available for lane snapper in the GOM. For this reason, a productivity-susceptibility analysis (PSA) is used for this species. The PSA score = 3.32, hence the species is deemed to have a high vulnerability. Detailed scoring of each attribute is shown below.

Lane snapper is highly vulnerable (according to the PSA analysis), there is no quantitative stock assessment and the IUCN classifies it as "Near Threatened" with a decreasing population trend (Lindeman et al. 2016); therefore, abundance is considered a "high" concern.

Justification:

Table 6. Productivity-Susceptibility Analysis for Lane snapper:

Productivity attribute	Relevant information	Score (1= low risk, 2= medium risk, 3= high risk
Average age at maturity	2 (Manooch 1984)	1
Average maximum age	10 (Manooch 1984)	2
Fecundity	Ranges between 30,870 and ,59,280 (Viana et al. 2015)	1
Average maximum size (fish only)	43 cm (Trejo-Martinez et al. 2011)	1
Average size at maturity (fish only)	18.4 cm (Trejo-Martinez et al. 2011)	1
Reproductive strategy	Broadcast spawner (Donahue et al. 2015)	1
Trophic level	3.8 (Froese and Pauly 2016)	3
Density dependence (invertebrates only)		
Total productivity (average)		**1.43**

Susceptibility attribute	**Relevant information**	**Score (1= low risk, 2= medium risk, 3= high risk)**

Areal overlap (Considers all fisheries)	The species is reported as bycatch in the commercial fisheries that target red snapper (SAGARPA-CONAPESCA 2012)	3
Vertical overlap (Considers all fisheries)	Its maximum depth is reported at 400 m (Anderson 2002), but this species is typically found at shallower depths, where the fleet that targets Red snapper fishes (Brule et al. 2008)	3
Selectivity of the fishery (Specific to the fishery under assessment)	Lane snapper is known to form spawning aggregations (Donahue et al. 2015) and according to IUCN, is highly vulnerable to fishing pressure (Lindeman et al. 2016).	3
Post-capture mortality (Specific to the fishery under assessment)	Unknown (default value used)	3
Total susceptibility (multiplicative)		**3**

PSA score for Lane snapper in the GOM handline fishery is calculated as follows:

Vulnerability (V) = $\sqrt{(P2+ S2)}$

V = $\sqrt{1.43^2 + 32)}$

V = 3.32

Factor 2.2 - Fishing Mortality

GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET

Moderate Concern

Fishing mortality data is not available for lane snapper in the GOM (DOF 2012). Since fishing mortality (across all fisheries on this stock) is unknown, this factor is rated "moderate" concern.

Factor 2.3 - Discard Rate

GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET

< 100%

The discards + bait/landings ratio cannot be estimated for the red and yellowtail snapper fishery in Yucatan due to the lack of information. Some researchers suggest low levels of discards are typical in handline fisheries (Kelleher 2005). Also, similar fisheries in the GOM (US handline fishery that targets mutton snapper) used observer data and estimated a discards/landings ratio of 33% to 34% (Scott-Denton and Williams 2013). Given the similarities in gear and targeted species between this fishery and the US GOM handline fishery, this factor is rated at <100%; hence, a score of 1 is given.

YELLOWMOUTH GROUPER

Factor 2.1 - Abundance

GULF OF MEXICO, VERTICAL LINES, MEXICO

High Concern

Neither a formal stock assessment nor abundance data is available for yellowmouth grouper in the (GOM). For this reason, a productivity-susceptibility analysis (PSA) is used for the species. The PSA score = 3.51; hence, the species is deemed to have a high vulnerability. Detailed scoring of each attribute is shown below.

Yellowmouth grouper is highly vulnerable (according to the PSA analysis); there is no formal stock assessment for the species in Mexico, and it is identified by the IUCN as "Vulnerable" with a decreasing population trend (Ferreira et al. 2008). For these reasons, abundance is deemed a "high" concern for yellowmouth grouper.

Justification:

Table 7. Productivity-Susceptibility Analysis for Yellowmouth grouper:

Productivity attribute	Relevant information	Score (1= low risk, 2= medium risk, 3= high risk
Average age at maturity	Yellowmouth grouper females begin to mature at age 2; all are mature by age 4. Youngest mature male found at 4 (Bullock and Murphy 1994)	1
Average maximum age	41 years (Manickchand-Heileman and Phillip 2000)	3
Fecundity	N/A	-
Average maximum size (fish only)	Maximum reported length 84 cm (Burton et al. 2014)	1
Average size at maturity (fish only)	Sexual maturity for female Yellowmouth grouper is reached at 39 to 43 cm (Bullock and Murphy 1994)	2
Reproductive strategy	Broadcast spawner (Bullock and Murphy 1994)	1
Trophic level	4.5 (Froese and Pauly 2016)	3
Density dependence (invertebrates only)		
Total productivity (average)		**1.83**

Susceptibility attribute	Relevant information	Score (1= low risk, 2= medium risk, 3= high risk)
Areal overlap (Considers all fisheries)	Yellowmouth distribution coincides with the fishing area of the fleet (DOF 2012)	3
Vertical overlap (Considers all fisheries)	Yellowmouth (a reef-associated species) is found from the shore to 55 m depth (Froese and Pauly 2016). The snapper industrial fleet works in the depth range of this species (DOF 2012).	3
Selectivity of the fishery (Specific to the fishery under assessment)	Yellowmouth is not directly targeted in this fishery, but is incidentally encountered and is not likely to escape the gear. In addition, although it reproduces all year long, it is believed that this species forms large reproduction aggregations (Bullock and Murphy 1994)	3
Post-capture mortality (Specific to the fishery under assessment)	The amount of Yellowtail discards is unknown (if any). It is thought that most are kept and sold (pers. comm., Rudy Abad, 2018)	3
Total susceptibility (multiplicative)		**3**

PSA score for Yellowmouth grouper in the GOM handline fishery is calculated as follows:

Vulnerability (V) = $\sqrt{(P2+ S2)}$

$V = \sqrt{1.83^2 + 3^2)}$

Factor 2.2 - Fishing Mortality

GULF OF MEXICO, VERTICAL LINES, MEXICO

Moderate Concern

Fishing mortality data is not available for yellowmouth grouper in the GOM (DOF 2012) (DOF 2014). Since fishing mortality (across all fisheries on this stock) is unknown, this factor is rated "moderate" concern.

Factor 2.3 - Discard Rate

GULF OF MEXICO, VERTICAL LINES, MEXICO

< 100%

The discards + bait/landings ratio cannot be estimated for the red and yellowtail snapper fishery in Yucatan due to the lack of information. Some researchers suggest low levels of discards are typical in handline fisheries (Kelleher 2005). Also, similar fisheries in the GOM (US handline fishery that targets mutton snapper) used observer data and estimated a discards/landings ratio of 33% to 34% (Scott-Denton and Williams 2013). Given the similarities in gear and targeted species between this fishery and the US GOM handline fishery, this

factor is rated at <100%; hence, a score of 1 is given.

BLACK GROUPER

Factor 2.1 - Abundance

GULF OF MEXICO, VERTICAL LINES, MEXICO
GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET

High Concern

A formal stock assessment is not available for black grouper. For this reason, a productivity-susceptibility analysis (PSA) is used. The PSA score = 3.605, so the stock is deemed as highly vulnerable. Detailed scoring of each attribute is shown below.

Black grouper is highly vulnerable (according to the PSA analysis); there is no quantitative stock assessment, and IUCN lists it as "Near Threatened," so abundance is deemed a "high" concern for black grouper.

Justification:

Table 4. Productivity-Susceptibility Analysis for Black grouper:

Productivity attribute	Relevant information	Score (1= low risk, 2= medium risk, 3= high risk
Average age at maturity	5 (Ferreira et al. 2008)	2
Fecundity	500,000 (Brule et al. 2003)	1
Average maximum size at maturity (fish only)	133 cm (Brule et al. 2003)	2
Average maximum age	34 (Brule et al. 2003)	3
Average size at maturity	72.1 cm (Brule et al. 2003)	2
Reproductive strategy	Broadcast spawner (Paz and Sedberry 2007)	1
Trophic level	4.3 (Ferreira et al. 2003)	3
Density dependence (invertebrates only)		
Total productivity (average)		**2**

Susceptibility attribute	**Relevant information**	**Score (1= low risk, 2= medium risk, 3= high risk)**

Areal overlap (Considers all fisheries)	Black grouper is fished throughout its range along the Campeche Bank (Coronado and Salas) (DOF 2014).	3
Vertical overlap (Considers all fisheries)	There is a high overlap of target species and retained species with both gears (DOF 2014).	3
Selectivity of the fishery (Specific to the fishery under assessment)	The industrial fleet captures mostly mature black groupers (Coronado and Salas 2011) This species forms spawning aggregations, but they have not been observed in the Campeche Bank (Brule et al. 2003) The artisanal fleet has been reported to catch smaller sizes of the species (Coronado and Salas. 2011).	3
Post-capture mortality (Specific to the fishery under assessment)	Most of the catch is retained for both fleets (Brule et al. 2003).	3
Total susceptibility (multiplicative)		**3**

PSA score for Black grouper in the GOM handline fishery is calculated as follows:

Vulnerability (V) = $\sqrt{(P2+ S2)}$

$V = \sqrt{(2^2 + 3^2)}$

V = 3.60

Factor 2.2 - Fishing Mortality

GULF OF MEXICO, VERTICAL LINES, MEXICO
GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET

Moderate Concern

Fishing mortality information is not available for black grouper in the Mexican GOM, so it is unknown whether this stock is experiencing overfishing. Based on landings data, the majority of fishing mortality for black grouper occurs with industrial bottom longline gear (DOF 2014). Black grouper makes up an estimated ~7% of catches in the bicycle gear assessed in this report. (DOF 2012) (DOF 2014) (SAGARPA-CONAPESCA 2012). Regarding the impact from the artisanal fleet, (Brule et al. 2008) reported that there is some catch (~5%) by this fleet; however, the levels of fishing effort and fishing mortality are unclear.

Because cumulative fishing mortality is unknown and it is unknown whether these fisheries are a substantial contributor to fishing mortality this factor is rated "moderate" concern for black grouper for both fleets.

Factor 2.3 - Discard Rate

GULF OF MEXICO, VERTICAL LINES, MEXICO
GULF OF MEXICO, HANDLINES AND HAND-OPERATED POLE-AND-LINES, MEXICO, ARTISANAL FLEET

< 100%

The discards + bait/landings ratio cannot be estimated for the red and yellowtail snapper fishery in Yucatan due to the lack of information. Some researchers suggest low levels of discards are typical in handline fisheries (Kelleher 2005). Also, similar fisheries in the GOM (US handline fishery that targets mutton snapper) used observer data and estimated a discards/landings ratio of 33% to 34% (Scott-Denton and Williams 2013). Given the similarities in gear and targeted species between this fishery and the US GOM handline fishery, this factor is rated at <100%; hence, a score of 1 is given.

BANDED RUDDERFISH

Factor 2.1 - Abundance

GULF OF MEXICO, VERTICAL LINES, MEXICO

Moderate Concern

This species is widely distributed in the Caribbean (Smith-Vaniz et al. 2015). IUCN assessed the species as "Least Concern" because there are no indications of regional declines from harvesting (Smith-Vaniz et al. 2015). In Mexico, neither a formal stock assessment nor abundance data are available for Banded rudderfish in the GOM. For this reason, a productivity-susceptibility analysis (PSA) is used for this species. The PSA score = 3.07, hence the species is deemed to have a high vulnerability (based on the PSA scoring tool). Detailed scoring of each attribute is shown below.

The combination of high vulnerability (according to the PSA analysis) and the lack of a formal stock assessment or another index of current abundance, leads to a score of "moderate" concern for banded rudderfish.

Justification:

Table 3. Productivity-Susceptibility Analysis for Banded Rudderfish:

Productivity attribute	Relevant information	Score (1= low risk, 2= medium risk, 3= high risk
Average age at maturity	N/A	-
Fecundity	N/A	-
Average maximum size at maturity (fish only)	75 cm (Cervigon et al., 1992)	1
Average maximum age	N/A	-
Average size at maturity	N/A	-

Reproductive strategy	N/A	-
Trophic level	4.5 (Froese and Pauly 2016)	3
Density dependence (invertebrates only)		
Total productivity (average)		2

Susceptibility attribute	**Relevant information**	**Score (1= low risk, 2= medium risk, 3= high risk)**
Areal overlap (Considers all fisheries)	In the GOM, it is taken as bycatch in longline fisheries (DOF 2014)	3
Vertical overlap (Considers all fisheries)	Its depth range is 3 to 36m (Smith-Vaniz et al. 2015); therefore, a high overlap exists.	3
Selectivity of the fishery (Specific to the fishery under assessment)	This species is not targeted, but its presence in the catch (5.7%) (Monroy 2010) suggests that is is not likely to escape the gear	2
Post-capture mortality (Specific to the fishery under assessment)	Unknown (default value use)	3
Total susceptibility (multiplicative)		2.33

PSA score for banded rudderfish in the GOM handline fishery is calculated as follows:

Vulnerability (V) = $\sqrt{(P^2 + S^2)}$

V = $\sqrt{(2^2 + 2.33^2)}$

V = 3.07

Factor 2.2 - Fishing Mortality

GULF OF MEXICO, VERTICAL LINES, MEXICO

Moderate Concern

Fishing mortality data is not available for banded rudderfish in the GOM (DOF 2012). Since fishing mortality (across all fisheries on this stock) is unknown, this factor is rated "moderate" concern.

Factor 2.3 - Discard Rate

GULF OF MEXICO, VERTICAL LINES, MEXICO

< 100%

The discards + bait/landings ratio cannot be estimated for the red and yellowtail snapper fishery in Yucatan due to the lack of information. Some researchers suggest low levels of discards are typical in handline fisheries (Kelleher 2005). Also, similar fisheries in the GOM (US handline fishery that targets mutton snapper) used observer data and estimated a discards/landings ratio of 33% to 34% (Scott-Denton and Williams 2013). Given the similarities in gear and targeted species between this fishery and the US GOM handline fishery, this factor is rated at <100%; hence, a score of 1 is given.