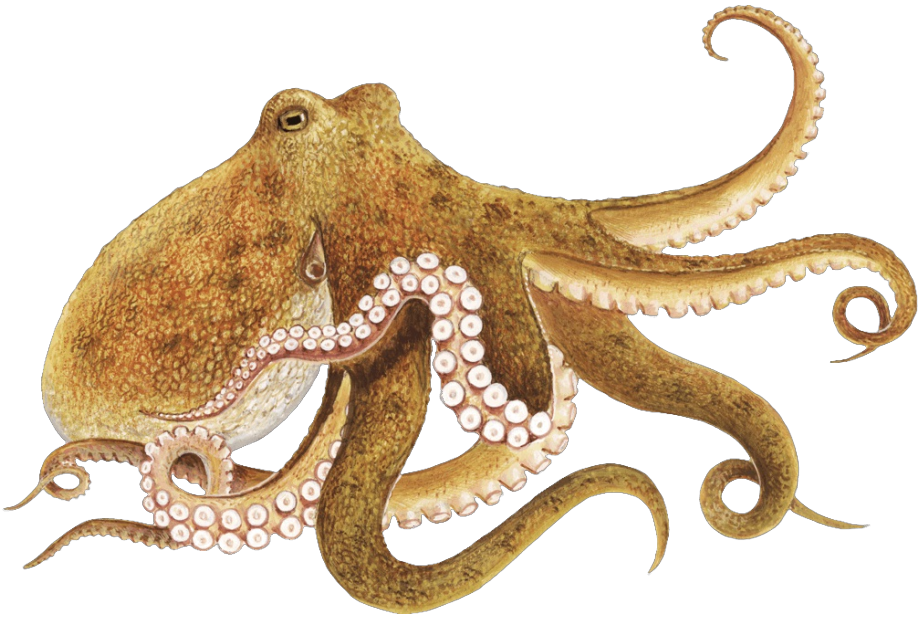
Monterey Bay Aquarium
Seafood Watch

Environmental sustainability assessment of wild-caught common octopus (*Octopus americanus* (*O. vulgaris*)) and Mexican four-eyed octopus (*Octopus maya*) from Mexico using trolling lines



Species:	Common octopus (*Octopus americanus* (*O. vulgaris*)) Mexican four-eyed octopus (*Octopus maya*)
Location:	Mexico
Gear:	Trolling lines
Type:	Wild Caught
Author:	Seafood Watch
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Assessed using Seafood Watch Fisheries Standard v4

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About the Monterey Bay Aquarium Seafood Watch Program

The mission of the Monterey Bay Aquarium is to inspire conservation of the ocean and enable a future where the ocean flourishes and people thrive in a just and equitable world. To do this, the Aquarium is focused on creating extraordinary experiences that inspire awe and wonder, championing science-based solutions, and connecting people across the planet to protect and restore the ocean. We know that healthy ocean ecosystems are critical to enabling life on Earth to exist, and that our very survival depends on them. As such, our conservation objectives are to mobilize climate action, improve the sustainability of global fisheries and aquaculture, reduce sources of plastic pollution, and restore and protect ocean wildlife and ecosystems.

The aquarium is focused on improving the sustainability of fisheries and aquaculture given the role seafood plays in providing essential nutrition for 3 billion people globally, and in supporting hundreds of millions of livelihoods. Approximately 180 million metric tons of wild and farmed seafood is harvested each year (excluding seaweeds). Unfortunately, not all current harvest practices are sustainable and poorly managed fisheries and aquaculture pose the greatest immediate threat to the health of the ocean and the economic survival and food security of billions of people.

The Seafood Watch program was started 25 years ago as a small exhibit in the Monterey Bay Aquarium highlighting better fishing practices and grew into one of the leading sources of information on seafood sustainability, harnessing the power of consumer choice to mobilize change. The program's comprehensive open-source information and public outreach raises awareness about global sustainability issues, identifies areas for improvement, recognizes and rewards best practices and empowers individuals and businesses to make informed decisions when purchasing seafood.

We define sustainable seafood as seafood from sources, whether fished or farmed, that can maintain or increase production without jeopardizing the structure and function of affected ecosystems, minimize harmful environmental impacts, assure good and fair working conditions, and support livelihoods and economic benefits throughout the entire supply chain. As one aspect of this vision, Seafood Watch has developed trusted, rigorous standards for assessing the environmental impacts of fishing and aquaculture practices worldwide. Built on a solid foundation of science and collaboration, our standards reflect our guiding principles for defining environmental sustainability in seafood.

Seafood Watch Ratings

The Seafood Watch Standard for Fisheries is used to produce assessments for wild-capture fisheries resulting in a Seafood Watch rating of green, yellow, or red. Seafood Watch uses the assessment criteria to determine a final numerical score as well as numerical subscores and colors for each criterion. These scores are translated to a final Seafood Watch color rating according to the methodology described in the table below. The table also describes how Seafood Watch defines each of these categories. The narrative descriptions of each Seafood Watch rating, and the guiding principles listed below, compose the framework on which the criteria are based.

Green	Final Score >3.2, and either criterion 1 or criterion 3 (or both) is green, and no red criteria, and no critical scores	Wild-caught and farm-raised seafood rated green are environmentally sustainable, well managed and caught or farmed in ways that cause little or no harm to habitats or other wildlife. These operations align with all of our guiding principles.
Yellow	Final score >2.2, and no more than one red criterion, and no critical scores, and does not meet the criteria for green (above)	Wild-caught and farm-raised seafood rated yellow cannot be considered fully environmentally sustainable at this time. They align with most of our guiding principles, but there is either one conservation concern needing substantial improvement, or there is significant uncertainty associated with the impacts of the fishery or aquaculture operations.
Red	Final Score ≤2.2, or two or more red criteria, or one or more critical scores.	Wild-caught and farm-raised seafood rated red are caught or farmed in ways that have a high risk of causing significant harm to the environment. They do not align with our guiding principles and are considered environmentally unsustainable due to either a critical conservation concern, or multiple areas where improvement is needed.

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Guiding Principles

Monterey Bay Aquarium defines sustainable seafood as seafood from sources, whether fished or farmed, that can maintain or increase production without jeopardizing the structure and function of affected ecosystems, minimize harmful environmental impacts, assure good and fair working conditions, and support livelihoods and economic benefits throughout the entire supply chain.

As one aspect of this vision, Seafood Watch has developed trusted, rigorous standards for assessing the environmental impacts of fishing and aquaculture practices worldwide. Environmentally sustainable wild capture fisheries:

1. **Follow the principles of ecosystem-based fisheries management**

   The fishery is managed to ensure the integrity of the entire ecosystem, rather than solely focusing on maintenance of single species stock productivity. To the extent allowed by the current state of the science, ecological interactions affected by the fishery are understood and protected, and the structure and function of the ecosystem is maintained.

2. **Ensure all affected stocks[1] are healthy and abundant**

   Abundance, size, sex, age and genetic structure of the main species affected by the fishery (not limited to target species) is maintained at levels that do not impair recruitment or long-term productivity of the stocks or fulfillment of their role in the ecosystem and food web.

   Abundance of the main species affected by the fishery should be at, above, or fluctuating around levels that allow for the long-term production of maximum sustainable yield. Higher abundances are necessary in the case of forage species, in order to allow the species to fulfill its ecological role.

3. **Fish all affected stocks at sustainable levels**

   Fishing mortality for the main species affected by the fishery should be appropriate given current abundance and inherent resilience to fishing while accounting for scientific uncertainty, management uncertainty, and non-fishery impacts such as habitat degradation.

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[1]"Affected" stocks include all stocks affected by the fishery, no matter whether target or bycatch, or whether they are ultimately retained or discarded.

The cumulative fishing mortality experienced by affected species must be at or below the level that produces maximum sustainable yield for single-species fisheries on typical species that are at target levels.

Fishing mortality may need to be lower than the level that produces maximum sustainable yield in certain cases such as forage species, multispecies fisheries, highly vulnerable species, or fisheries with high uncertainty.

For species that are depleted below target levels, fishing mortality must be at or below a level that allows the species to recover to its target abundance.

4. **Minimize bycatch**

   Seafood Watch defines bycatch as all fisheries-related mortality or injury other than the retained catch. Examples include discards, endangered or threatened species catch, pre-catch mortality and ghost fishing. All discards, including those released alive, are considered bycatch unless there is valid scientific evidence of high post-release survival and there is no documented evidence of negative impacts at the population level.

   The fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss and by efficiently using marine and freshwater resources as bait.

5. **Have no more than a negligible impact on any threatened, endangered or protected species**

   The fishery avoids catch of any threatened, endangered or protected (ETP) species. If any ETP species are inadvertently caught, the fishery ensures and can demonstrate that it has no more than a negligible impact on these populations.

6. **Are managed to sustain the long-term productivity of all affected species**

   Management should be appropriate for the inherent resilience of affected marine and freshwater life and should incorporate data sufficient to assess the affected species and manage fishing mortality to ensure little risk of depletion. Measures should be implemented and enforced to ensure that fishery mortality does not threaten the long term productivity or ecological role of any species in the future.

   The management strategy has a high chance of preventing declines in stock productivity by taking into account the level of uncertainty, other impacts on the stock, and the potential for increased pressure in the future.

   The management strategy effectively prevents negative population impacts on bycatch species, particularly species of concern.

7. **Avoid negative impacts on the structure, function or associated biota of aquatic habitats where fishing occurs**

The fishery does not adversely affect the physical structure of the seafloor or associated biological communities.

If high-impact gears (e.g. trawls, dredges) are used, vulnerable seafloor habitats (e.g. corals, seamounts) are not fished, and potential damage to the seafloor is mitigated through substantial spatial protection, gear modifications and/or other highly effective methods.

8. **Maintain the trophic role of all aquatic life**

   All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web, as informed by the best available science.

9. **Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts**

   Fishing activities must not result in harmful changes such as depletion of dependent predators, trophic cascades, or phase shifts.

   This may require fishing certain species (e.g., forage species) well below maximum sustainable yield and maintaining populations of these species well above the biomass that produces maximum sustainable yield.

10. **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**

    Any enhancement activities are conducted at levels that do not negatively affect wild stocks by reducing diversity, abundance or genetic integrity.

    Management of fisheries targeting enhanced stocks ensures that there are no negative impacts on the wild stocks, in line with the guiding principles described above, as a result of the fisheries.

    Enhancement activities do not negatively affect the ecosystem through density dependent competition or any other means, as informed by the best available science.

Final Ratings

Ratings Details	C 1 Target Species	C 2 Other Species	C 3 Management	C 4 Habitat	Rating
Common octopus Mexico - Gulf of Mexico - Trolling lines - 1,900 mt	4.284	2.644	2.000	3.464	Yellow (2.976)
Mexican four-eyed octopus Mexico - Gulf of Mexico - Trolling lines - 23,000 mt	2.644	4.284	2.000	3.464	Yellow (2.976)

Summary

The octopus fishery is one of the most important in volume and value in the Gulf of Mexico. Producers in the Campeche Bank target the two main species: common octopus (*Octopus americanus*) and Mexican four-eyed octopus (*Octopus maya*). This report assesses the octopus fisheries in the states of Campeche (comprised mainly of *O. maya*) and Yucatán (≈92% *O. maya* and 3% *O. americanus*) (DOF 2024) using baited trolling lines (known as "jimbas").

Until recently, abundance assessments were conducted by managers only for Mexican four-eyed octopus. The assessments were used to estimate annual harvest quotas for the species. These evaluations were based on a dynamic biomass model (DOF 2014) that estimated the status against the MSY. But in recent years, Roa-Ureta (2021) recommended using the total latent productivity (TLP) as a more appropriate reference point to assess the stock status (Roa-Ureta 2021). In 2024, managers assessed both species using the total latent productivity (TLP) (DOF b 2024). They concluded that neither species showed signs of overfishing (DOF 2024), which differed from the previous evaluation in 2022 (DOF 2022), where the fishery was considered deteriorated (DOF 2022). Because of these conflicting results, a productivity-susceptibility analysis (PSA) complemented the scoring for *O. maya*both species. ,S and species abundance was deemed a "low concern" for *O. americanus* and a "moderate concern" for *O. maya*. Finally, fishing mortality was deemed a "moderate concern," because levels of F are currently unknown.

Octopus trolling lines are highly selective, and no interactions with other species have been reported. Similarly, recent information about using protected species as bait has been released, so overall, the fishery does not raise concerns regarding bycatch.

Concerning management, a federal fishery management plan and a Mexican Official Norm are in place. These management tools contain specifications on the minimum size limit, the annual quota for Mexican four-eyed octopus, and a no-fishing season from December 16 to July 31. These regulations have been partly effective, considering that landings have been relatively steady even though the Mexican four-eyed octopus quota (based on the MSY approach) was surpassed for several years. It is also important to consider that researchers have found misreporting to be an issue, and the current status of the species needs to be monitored closely. In addition, although efforts to improve enforcement and compliance have been promoted by authorities (Gobierno de Mexico 2019) and independent initiatives (Fishery Progress 2024), reports on significant use of illegal gear, noncompliance, and inadequate enforcement actions (Pradilla, A. 2019; El Pais 2023; InSight Crime 2021; Oceana 2024) led the score of this factor as "ineffective."

Finally, the gear used in the octopus fisheries in the Yucatán Peninsula has minimal impact on the benthic habitat because of its contact with the bottom. Still, some spatial regulations are in place to keep those impacts to a minimum. The ecosystem impacts from the trolling lines fishery are considered low. Overall, the fisheries in Campeche and Yucatán that target common octopus (*O. americanus*) and Mexican four-eyed octopus (*O. maya*) are rated yellow.

Introduction

Scope of the analysis and ensuing rating

This Seafood Watch assessment provides recommendations for the common octopus (*Octopus americanus*) and Mexican four-eyed octopus (*Octopus maya*) fisheries in the Campeche Bank, Mexico. The species are targeted by two fleets (a small-scale fleet and a "semi-industrial" fleet that comprises 10 MT of storage vessels that operate as motherships of small-scale ships known as "alijos") in the states of Yucatán and Campeche (DOF 2024). Both fleets use baited lines ("jimbas") that drift on the bottom of the sea from their vessels or alijos (see Figure 2).

Species Overview

Mexican four-eyed octopus (*O. maya*) is an endemic benthic species in shallow waters of the continental shelf of the Yucatán Peninsula (INAPESCA 2014). Its known distribution extends from the waters adjacent to Isla del Carmen in Campeche to Isla Mujeres in Quintana Roo (DOF 2014). Based on genetic studies, one single stock is exploited. This species has been extensively studied in the region because of its high value and importance for the regional economy.

Common octopus, a member of a species complex (*O. vulgaris*) that comprises six species (Maloney et al 2023), was recently renamed *O. americanus*. Its presence along the Yucatán Peninsula continental shelf under this name was confirmed by the genetic results in Avendaño et al. (Avendaño et al. 2020). It is exploited in the Yucatán Peninsula and Veracruz (Figure 1) (DOF 2014).

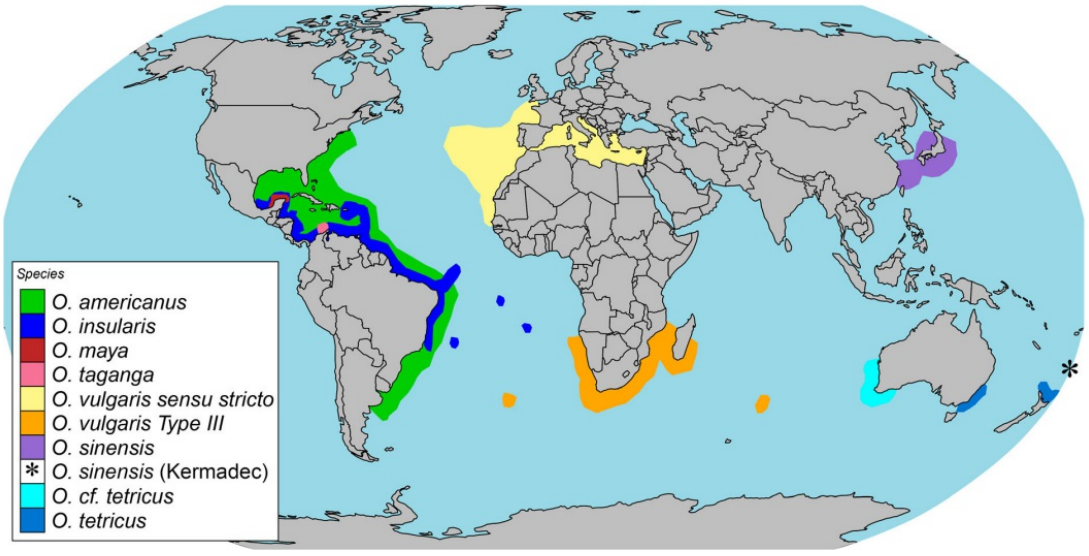

Figure 1: Distribution of the different species of the *O. vulgaris* complex, including *O. americanus*, and *O. maya* (Avendaño et al. 2020).

Once they hatch, Mexican four-eyed octopus juveniles behave like adults, capturing live prey

and remaining hidden when inactive (Santamaría et al. 2023). Reproduction is continuous, with greater intensity toward the end of each year. Fecundity fluctuates between 1,500 and 2,000 eggs per female (Silva et al 2002). Because almost all mature females and those who have spawned are less likely to feed, the fishing method employed in the Yucatán Peninsula is considered highly conservative, because it could capture more males than females (Figure 2) (DOF 2014). Overall, Mexican four-eyed octopus has rapid growth and a short life cycle (Solis-Ramirez and Chavez 1986). The maximum age has been variously estimated at around 12 months and 18 months (Solis-Ramirez and Chavez 1986; Arreguin-Sanchez 1992). Angeles-Gonzalez et al. (2018) analyzed the spatio-temporal variability of the reproductive maturation for *O. maya* and reported that high temperatures (close to and above 27 °C) significantly affect its distribution and spawning (Angeles-Gonzalez et al. 2018). In addition, it has been reported that the reproductive strategy of Mexican four-eyed octopus females ensures that an important fraction of egg hatches, combined with two annual recruitment events, contribute to the population biomass (Duarte et al 2018).

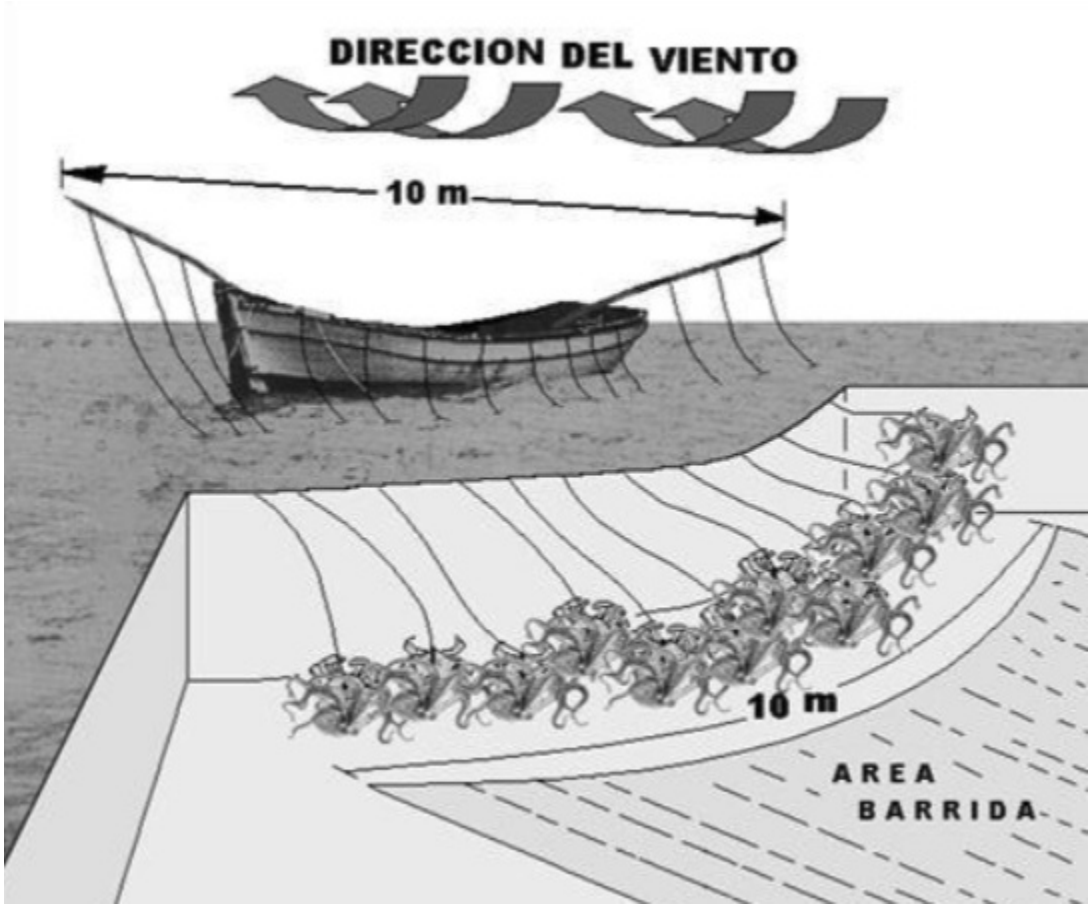

Figure 2: Fishing vessels with jimbas (bamboo sticks) with baited trolling lines (DOF 2014) .

On the other hand, common octopus is a cosmopolitan species distributed in tropical and subtropical waters worldwide. It can be found from the sea surface to a depth of 150 m. It lives in waters with temperatures between 6 °C and 33 °C, being more common between 10 °C and

30 ºC (INAPESCA b 2014). Common octopus reaches its sexual maturity at 8 to 10 months, when it measures 125 mm of mantle length (ML) (Santos-Valencia et al. 2018). But it has been suggested that the size of sexual maturity differs between sexes. In the Gulf of Mexico, Jimenez-Badillo (2008) found the same pattern described in the Mediterranean Sea, where the minimum size of sexual maturity was 248 g in males and 612 g in females (Jimenez-Badillo 2008). On average, most males reach sexual maturity at 110 mm ML with 700 g total weight, while the females reach it at 140 mm ML with 1,400 g total weight (Silva et al 2002). The spawning period is continuous throughout the year in tropical and subtropical waters. A female specimen can deposit between 100,000 and 500,000 eggs during its short lifetime (Perez et al 2007). This high level of fecundity coincides with the reports in the Canary Islands, which found that the real fecundity oscillated between 31 and 106 eggs spawned per gram of female body weight (Hernandez-Garcia et al. 2002). Growth estimates for the Gulf of Mexico suggest slower growth than in the Mediterranean and a maximum age of 2.2 years (Diaz-Alvarez and Jimenez-Badillo 2009).

Production Statistics

In the state of Yucatán, octopus captures have varied over time. From 1998 to 20030, landings remained relatively low, with an estimated average of 7,000metric tonesbetween 14,000 and 15,000 tons (t); from 2001 to 2003, less than 10,000 t per year were recorded. FromDuring the 2004 to 2015, the average landings increased to a 9,600 metric tones –10 period, there was an alternation between low (2005, 2008) and high (2004, 2006, 2009) capture levels. From 2016 to 2023, the average landings increased significantly to up to 16, and the historical maximum landing was reported in 2019 (with ~ 23,000 t) .From 2016 and up to 2023, In 2006 the historical maximum of the series was obtained with around 20,000 t, while the 2009 season was quite close. Based on the official data report, from 2006 to 2021, landings were relatively stable, around 20,000 t starting in 2009 to 2013 and above 24,000 t from 2014 to 2019, with a decrease in 2020 (mostly driven by the COVID-19 pandemic) to reach almost 30,000 t in 2021 (Figure 3) (CONAPESCA 2021). On the other hand, Campeche landings increased steadily from 1998 to 2001, reaching the historical maximum of 8,107 t in 2001. Since 2002, annual catches have remained above 5,000 t, except for the 2008 season, when the catch decreased to 3,946 t. After that year, landings remained around the 20,000 and 25,000 t range (CONAPESCA 2024). According to CONAPESCA data, the catch in Yucatán is ≈60% Mexican four-eyed octopus and 40% other octopus species; Figure 4 shows the proportions of *O. americanus* and *O. maya*. Production in Campeche is dominated by Mexican four-eyed octopus (Figure 5).

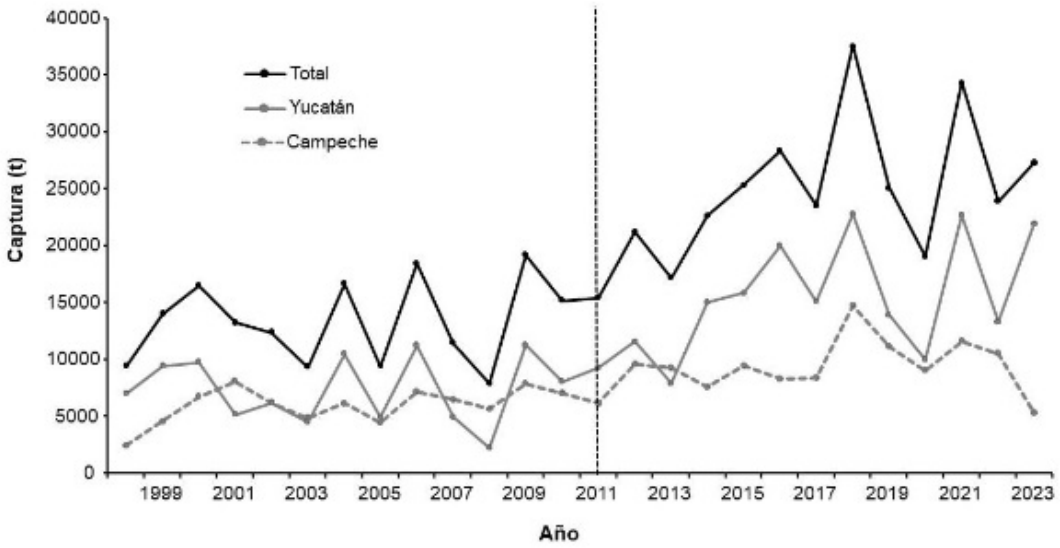

Figure 3: Yucatán and Campeche octopus historical landings (DOF 2024).

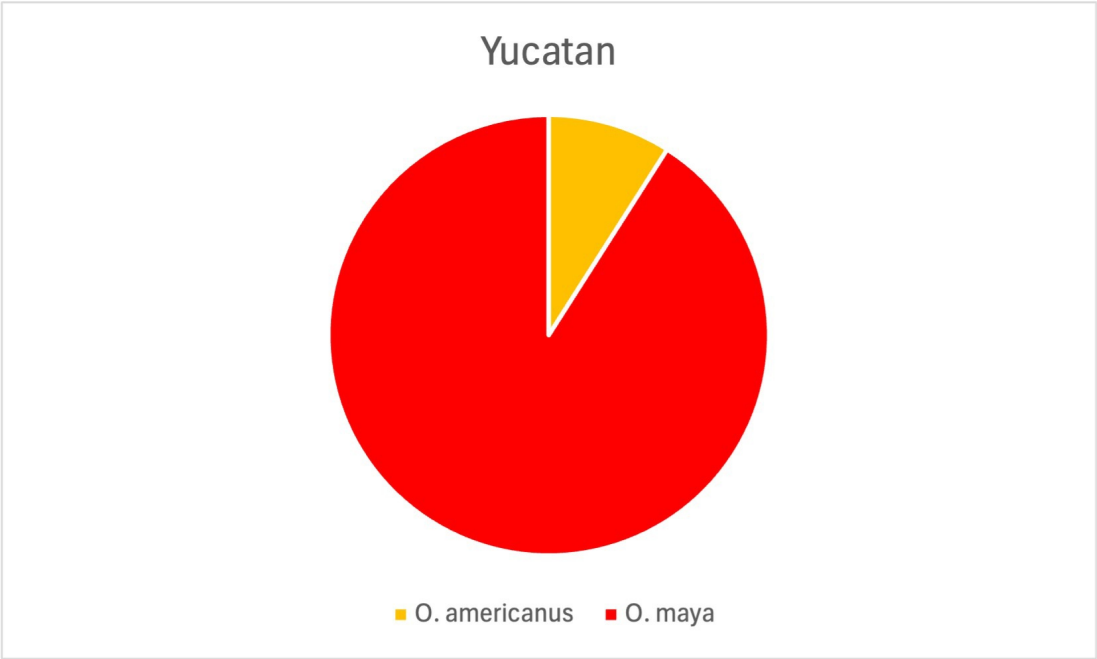

Figure 4: Yucatán octopus species catch proportions in 2024. Built using data from CONAPESCA 2024.

Figure 5: Campeche octopus species catch composition in 2024. Built using data from CONAPESCA 2024.

Importance to the US/North American market

In 2022, Mexico was still among the most important octopus producers in the world, covering around 1.6% of the total export volume in the world (OEC 2024). That year, exports were destined mainly to the United States (43%), Italy (16%), Colombia (13%), Portugal (9%), Greece (7%), and Japan (6%) (OEC 2024). According to NOAA foreign trade data, between 2021 and 2023, an average of 2,293 MT of octopus were imported from Mexico; most of the production from the region is reaching the export market (El Pais 2023).

Table 1

Product	2022	2023	2024
Octopus dried/salted/brined	1,803,789	1,707,051	728,724
Octopus frozen	254,968	234,126	167,488
Octopus NSPF/prepared/preserved	77,300	107,848	18,632

Table 2

Product	2021	2022	2023
Octopus dried/salted/brined	348.7	255.0	234.1
Octopus frozen	2,340.9	1,803.8	1,707.1
Octopus live/fresh	4.8	0.0	0.0
Octopus NSPF/prepared/preserved	1.2	77.3	107.8

Common and market names

Mexican four-eyed octopus (*Octopus maya*) is also known as octopus maya in Mexico or red octopus (Fish Source 2024). *Octopus americanus* is known as octopus common, or "patón" in Mexico, and as common octopus in the United States (FDA 2018).

Primary product forms

Octopus landed in the Yucatán Peninsula is available in the local, national, and international markets (Coronado et al b 2020). Whole octopus, fresh and iced, is marketed domestically. Exported octopus is whole frozen and packed in 20 kg boxes. An organism's size classifies octopuses. Octopus trade is carried out by permit holders, retailers, middlemen in the Yucatán Peninsula, and national seafood traders (Coronado et al. 2020).

Production volume notes

Landings are part of the 2024 official landing information (CONAPESCA 2024) for *O. americanus* and *O. maya* in the states of Campeche and Yucatán.

Summary

The fisheries in Campeche and Yucatán that target common octopus (*O. americanus*) and Mexican four-eyed octopus (*O. maya*) are rated yellow.

Eco-Certification information

The octopus fishery is engaged in two Fishery Improvement Projects (FIP). Engagement in an FIP does not affect the Seafood Watch score per se because we base our assessments on the current situation. But data and information generated by these improvement projects can be used in our assessments.

Assessments

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

Common octopus			
Region / Method	**Abundance**	**Fishing Mortality**	**Score**
Mexico - Gulf of Mexico - Trolling lines - 1,900 mt	3.670 Low Concern	5.000 Low Concern	**Green (4.284)**

Mexican four-eyed octopus			
Region / Method	**Abundance**	**Fishing Mortality**	**Score**
Mexico - Gulf of Mexico - Trolling lines - 23,000 mt	2.330 Moderate Concern	3.000 Moderate Concern	**Yellow (2.644)**

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.*

Common octopus *(Octopus americanus (O. vulgaris))*

1.1 Abundance

Gulf of Mexico - Trolling lines

Low Concern

In 2021, Roa-Ureta released the results of a stock assessment using an alternative model on *O. americanus*, which was recently identified as a distinct species of the *O. vulgaris* complex (Avendaño et al. 2020). The stock assessment used an intra-annual generalized depletion (IAGD) and the Pella-Tominson models to estimate the species biomass and reference points (Roa-Ureta 2021), including the target latent productivity (TLP) as an alternative reference point instead of the "traditional" MSY. The TLP was proposed as a sustainable annual harvest rate for fluctuating stocks by Poot-Salazar et al. (2024).

Based on the results, Roa-Ureta concluded that, although the stock appeared to have a flat trajectory (Figure 6), there was evidence of fluctuations that occur under disturbances (e.g., catches higher than the historical average) (Roa-Ureta 2021). In particular, several start-of-season biomass estimates from IAGD were imprecise, and the stock tended to enter a fluctuating regime under relatively moderate fishing pressure (i.e., annual catches higher than 12,000 to 15,000 t) (ibid). The author stated that MSY estimates were nearly four times higher than the reference point estimated based on latent productivity; however, despite the imprecise estimate of latent productivity, the reference point was much more conservative and considered the fluctuating nature of the stock (ibid).

Most recently, an assessment update was released (with data from the 2022 and 2023 seasons) and included the estimated status of *O. americanus* using the MSY and the TLP as references in Kobe plots (Figure 7). The graphs showed that when MSY is used as a reference point, $B < B_{MSY}$; however, when TLP is used, $B > B_{TLP}$.

Roa-Ureta (2021 and 2024) concluded that the stock of *O. americanus* appears to be underfished (Roa-Ureta 2021) (Roa-Ureta 2024). But whether the assessment underwent a robust, scientific peer review is still being determined. Still, the conclusion aligns with the most recent National Fisheries Chart statement that reported the species has "development opportunities" (DOF 2022).

Finally, in 2024, managers released an update on the stock status using the Roa-Ureta (2024) approach and the TLP as a reference point (Figure 8). Managers concluded that the species biomass is above the reference point and the fishery has "a potential to develop more" (DOF b 2024).

The most recent results from the data-limited assessment completed by managers showed that the species biomass is above the limit reference point appropriate for the

species (TLP) (Poot-Salazar et al 2024), and because there are no conflicting indicators, this factor is scored a "low concern."

Supplementary Information

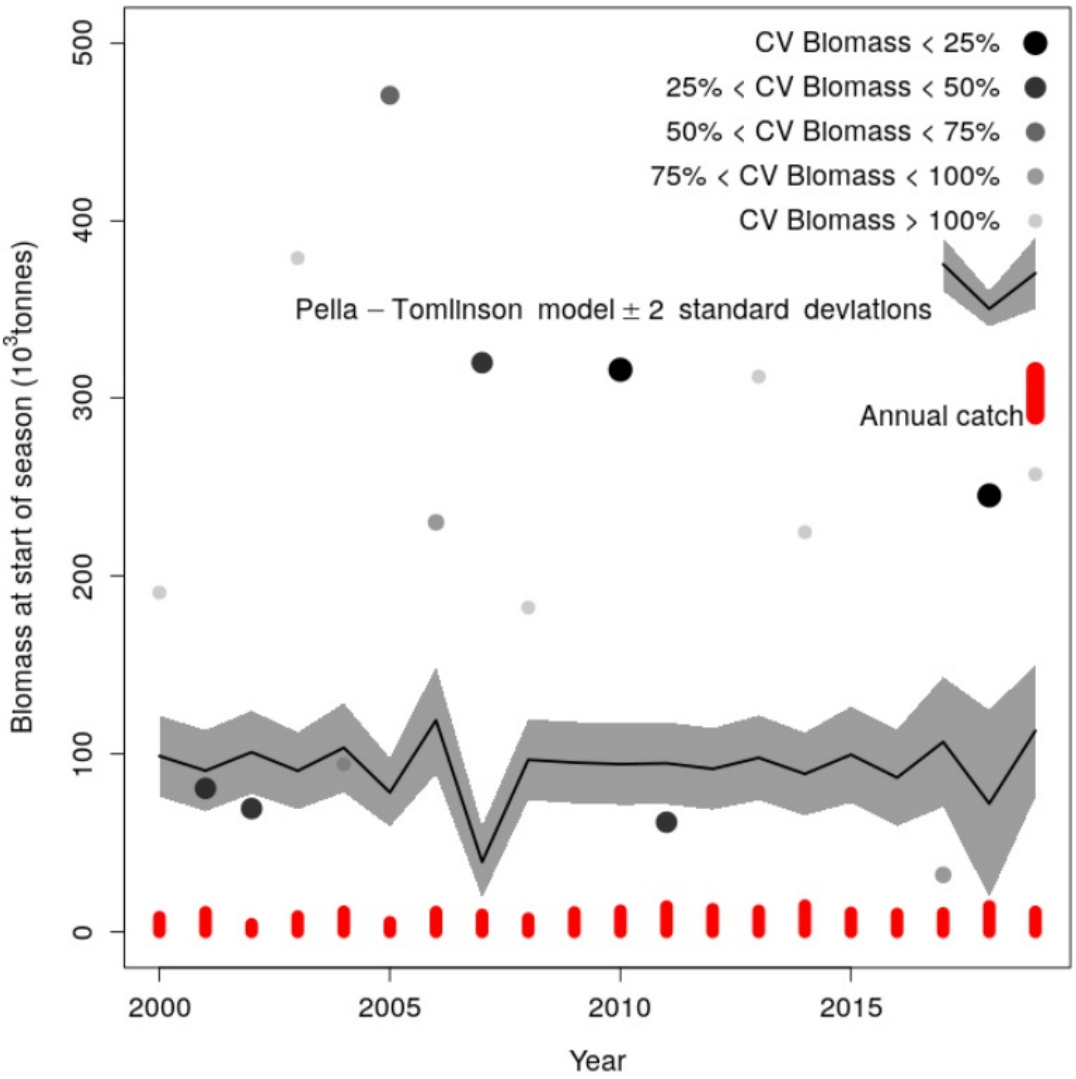

Figure 6: Start of the season biomass for *O. americanus* (*O. vulgaris*) (Roa-Ureta 2021).

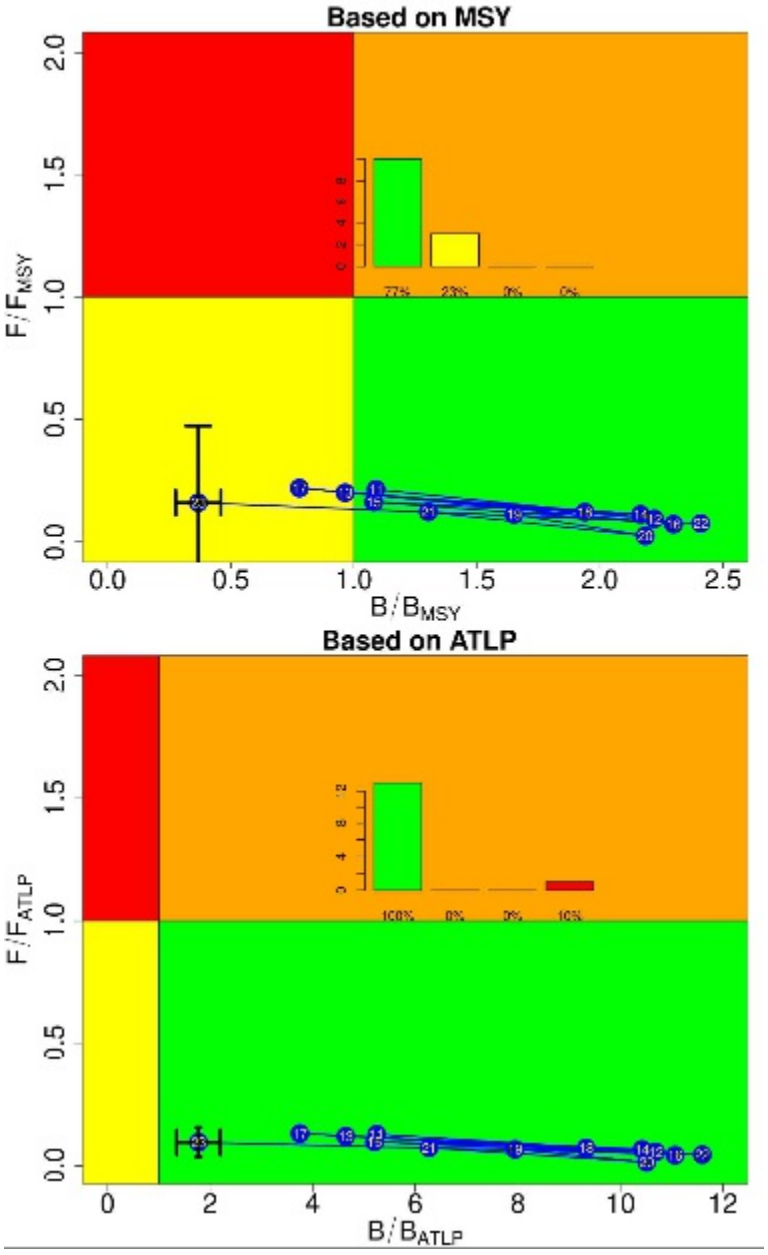

Figure 7: Status of *O. americanus* using the MSY (top) and TLP (bottom) as reference points (Roa-Ureta 2024).

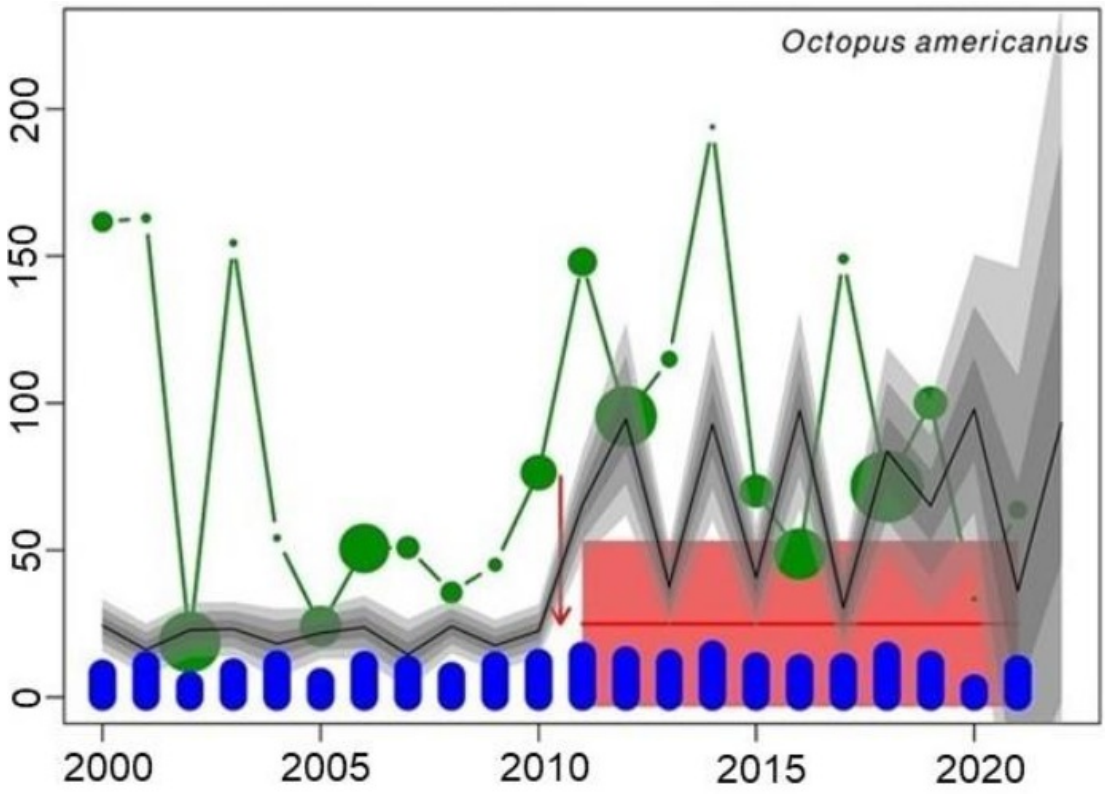

Figure 8: Biomass dynamics (green dots and black lines), landings (blue bars), and sustainable catches (Total Latent Productivity) for common octopus in the Yucatán Peninsula. Areas around the red lines are standard error bands (DOF b 2024).

1.2 Fishing Mortality

Gulf of Mexico - Trolling lines

Low Concern

Fishing mortality reference points have not been set for common octopus in the Gulf of Mexico. According to the 2022 National Fisheries Chart, the fishery is at its maximum and no increase in effort is recommended (DOF 2018; DOF 2022). During the most recent update of the fishery profile, it was reported that 1 medium-scale vessel and more than 1,400 small-scale boats were actively fishing in Campeche, while 441 medium-scale and more than 3,200 small-scale vessels were actively fishing in Yucatán (DOF 2022).

The 2021 stock assessment estimated fishing mortality values for the species from 2000 to 2019 (Figure 9) (Roa-Ureta 2021). The stock assessment defines the instantaneous exploitation rate as the ratio between fishing mortality and natural mortality. The fishing mortality was lower than natural mortality in 2000, 2002, 2003, 2005 to 2010, 2012 to 2016, 2018, and 2019. In 2001 and 2004, the fishing mortality and natural mortality were quite close (Roa-Ureta 2021). It was concluded that the instantaneous exploitation rate for *O. americanus* in Yucatán was within the sustainable regime (Roa-Ureta 2021).

In addition, based on official reports, landings for *Octopus* spp. in Yucatán showed an increasing trend from 2008 (2,436 t) to a maximum of 15,525 t in 2018. In 2020, production was significantly reduced due to the COVID-19 pandemic, and in 2021, landings reached more than 12,000 t (CONAPESCA 2021). Considering that landings have remained relatively stable, that managers reported the species has potential for growth (DOF 2022), and that the analysis developed by (Roa-Ureta 2021) reported similar findings, fishing mortality is a “low concern.”

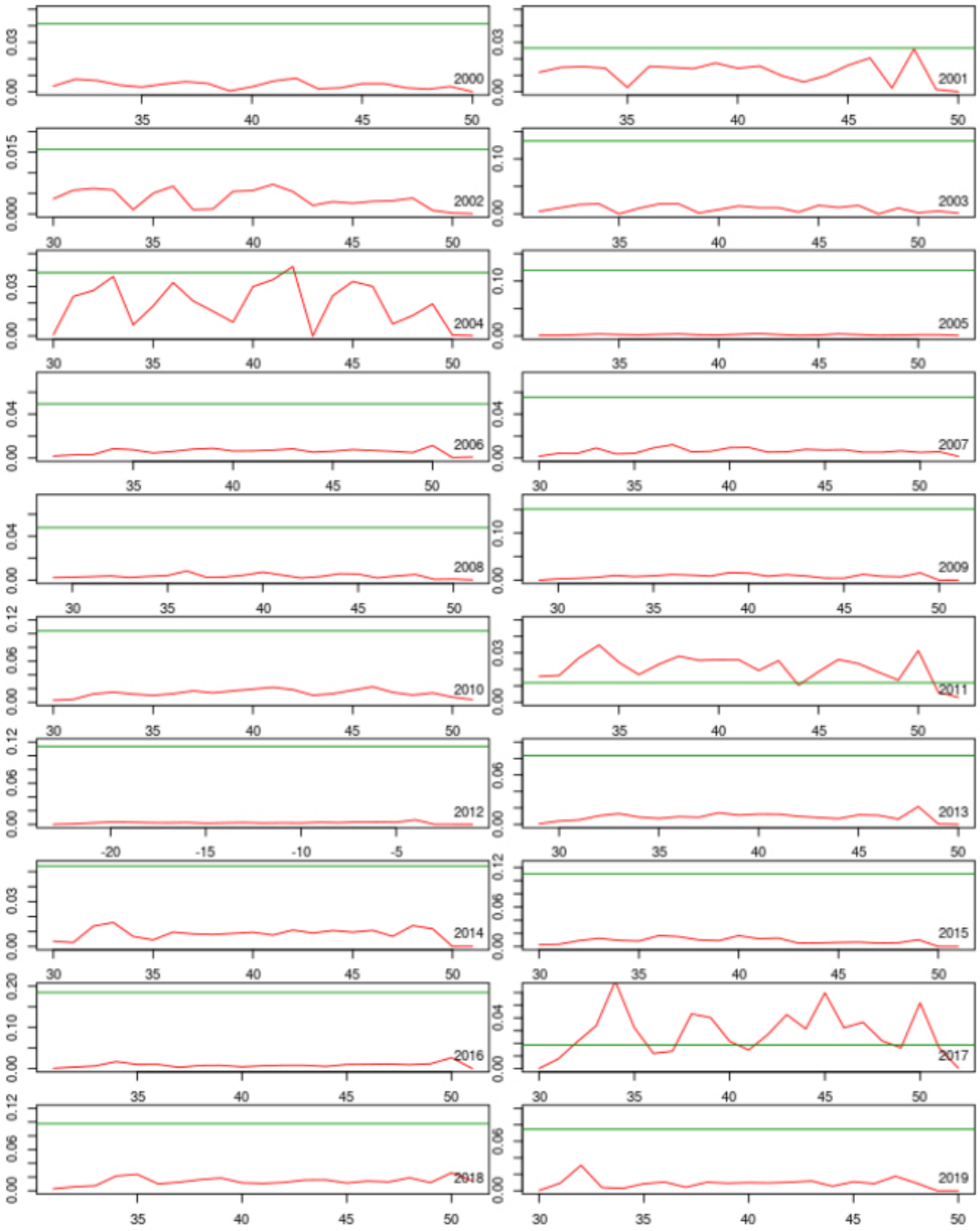

Figure 9: Fishing mortality (red line) and natural mortality (green line) rates estimated from IAGD models for the *O. americanus* stock in the Yucatán Peninsula, Mexico (Roa-Ureta 2021).

Mexican four-eyed octopus *(Octopus maya)*

1.1 Abundance

Gulf of Mexico - Trolling lines

Moderate Concern

Scientific surveys and catch data have been used to estimate the abundance of Mexican four-eyed octopus in the past. Managers have in place annual monitoring programs to assess and suggest annual quotas (DOF 2014). Studies have been completed recently to understand the species' status better.

Avendaño et al. (2019) used four different methodologies to assess the biomass of the species in deeper areas (between 30 and 60 m) of the Campeche Bank. The authors concluded that the fraction of the population that occurs between that depth range consisted mainly of adult organisms that could contribute significantly to the recruitment of the entire population, and the authors recommended that fishing in these depths should be avoided (Avendaño et al. 2019).

Roa-Ureta (2021) completed a stock assessment for *O. maya* for the Gulf of Mexico and the Caribbean, using a detailed database of fishing trips that included quantities of total catch and fishing effort from 2000 to 2019. The author used an alternative model with the intra-annual generalized depletion model (IAGD) to estimate the biomass at the start of the seasons and the Pella-Tomlinson production model to calculate MSY and the total latent productivity (TLP) (Figure 11) (Roa-Ureta 2021). TLP was proposed as a sustainable annual harvest rate for fluctuating stocks by Poot-Salazar et al (2024).

Estimates by Roa-Ureta (2021) for K, MSY, B_{MSY}, and latent productivity (Table 3) were calculated following that approach, and concluded that latent productivity was 50% higher than the mean annual catch over the studied period (2000 to 2019). Latent productivity was quite close to the current harvest rate, which was only exceeded in 2018 (ibid).

Table 3

Parameter	Maximum likelihood estimate	Standard error	Lower bound	Upper bound
r (y–1)	3.382	2.072		
p	1.876	0.474		
k (t)	292,044	66,168		
MSY (t)	225,092	45,179	134,734	315,450
B_{MSY}	142,433	45,094	52,245	232,621
Latent productivity	18,012	7,592	2,827	33,196

In 2024, an assessment update that includes data from the 2022 and 2023 seasons was released, and the estimated status of *O. maya* was included using the MSY and the TLP as reference points in Kobe plots (Figure 12) (Roa-Ureta 2024). The graphs showed that when MSY is used as a reference point, then B < B_{MSY}; however, when TLP is used, then B > B_{TLP}.

Finally, and as part of the 2024 update of the fishery's profile within the National Fisheries Chart, managers released the results of the stock evaluation for *O. maya* using the TLP—suggested by Roa-Ureta (2024)—as a reference point to estimate the status of the species. Managers reported that the species was exploited to its maximum sustainable yield, with biomass above the TLP reference point (Figure 13) (DOF 2024), which was an improvement from the previous update (DOF 2022) where the species was reported to be deteriorated and B_{2019} < B_{MSY} (see Figure 10).

Because there are data-limited assessments (Poot-Salazar et al 2024) (Roa-Ureta 2024) that provide conflicting conclusions (when using MSY and TLP), and the species is not highly vulnerable, abundance is scored a "moderate concern."

Supplementary Information

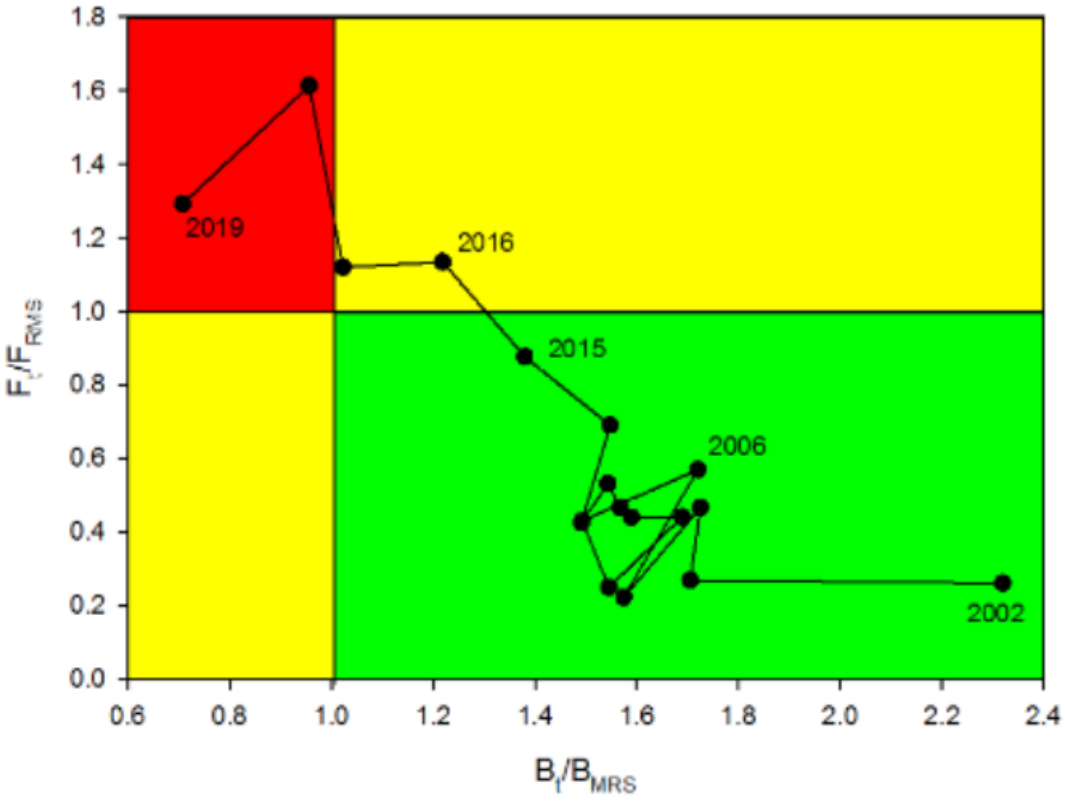

Figure 10: Kobe plot for *O. maya* in the Yucatán Peninsula (DOF 2022).

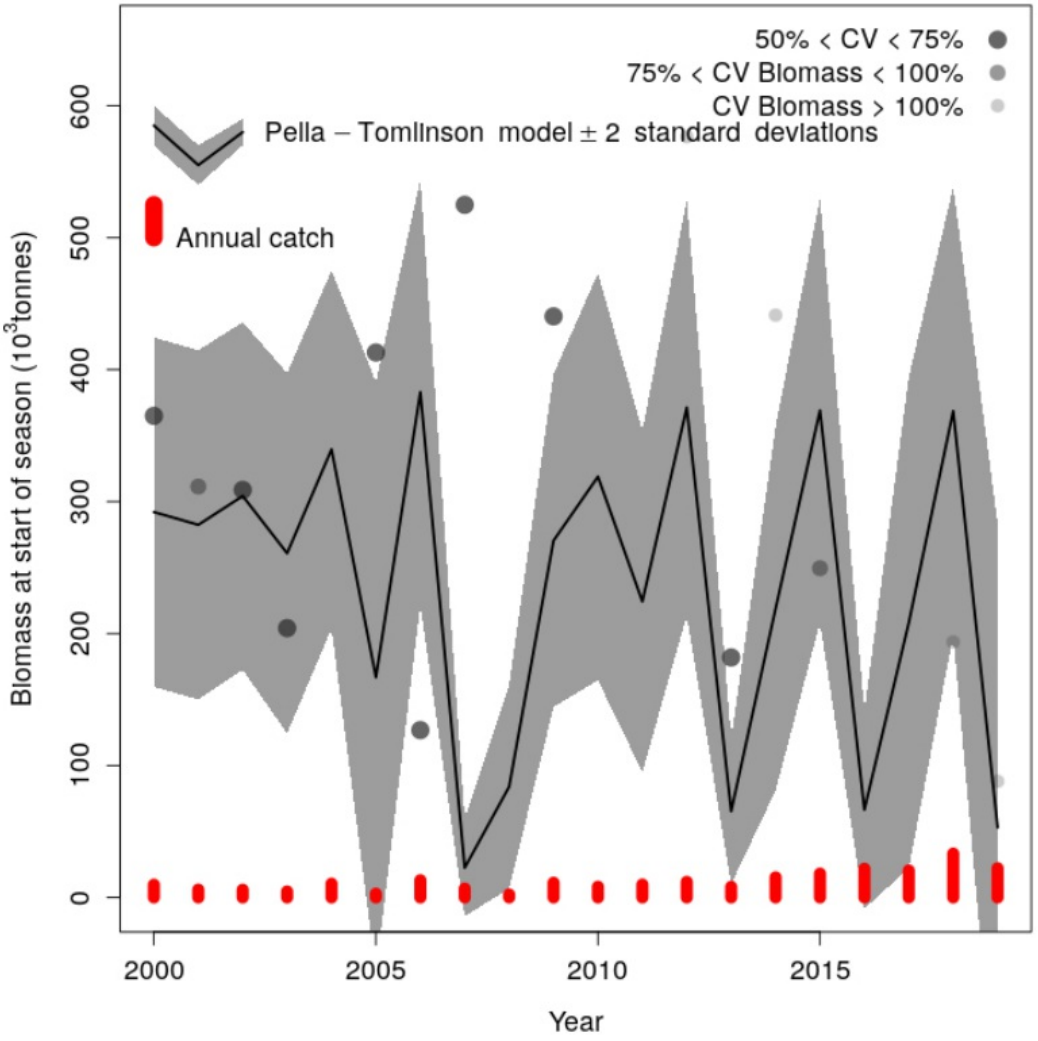

Figure 11: Start-of-season biomass population dynamics of *O. maya* in the Yucatán Peninsula. Dots of varying size and grayness are estimated from IAGD models (Roa-Ureta 2021).

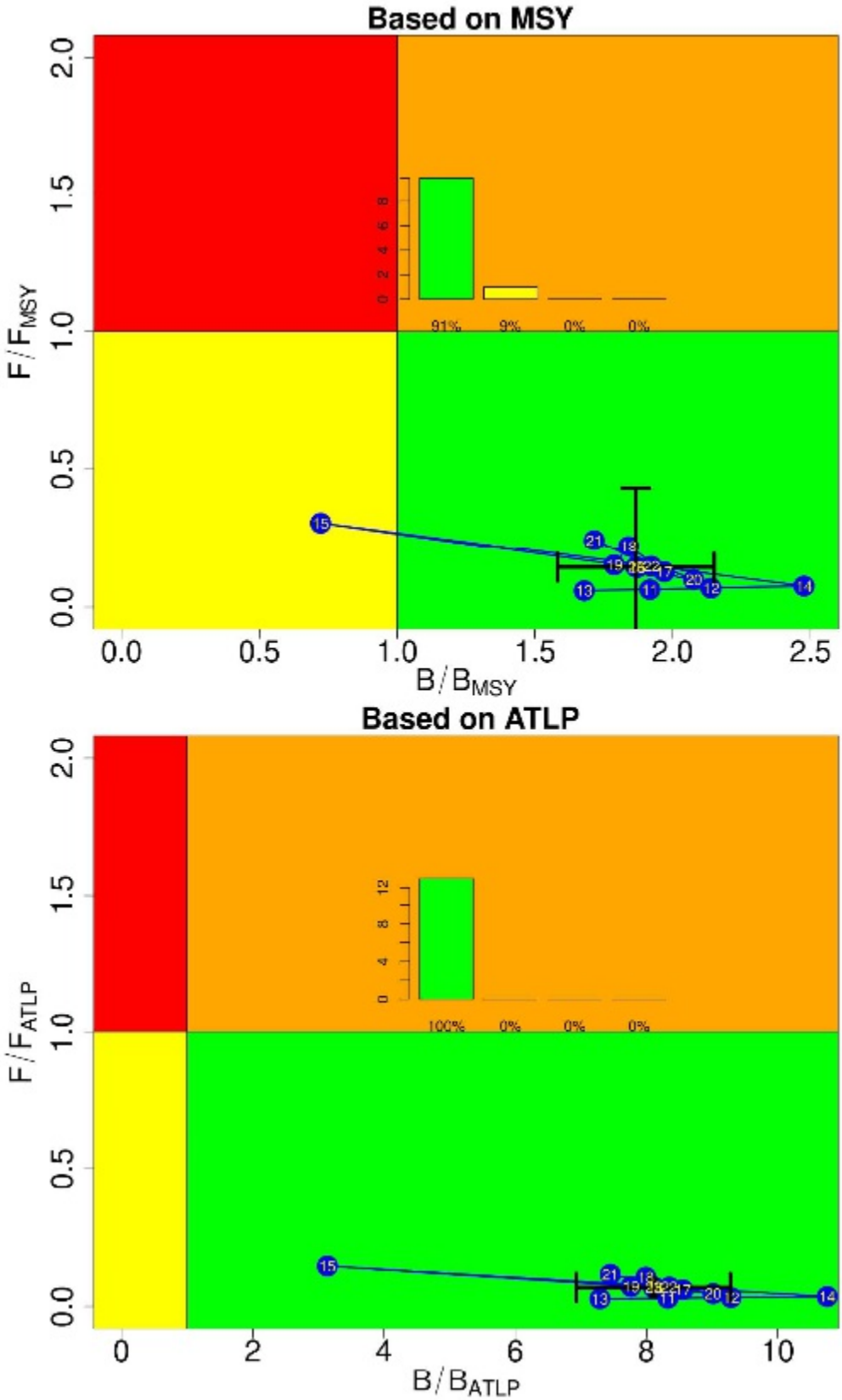

Figure 12: *O. maya* status using MSY (top) and TLP (bottom) estimated by (Roa-Ureta 2024).

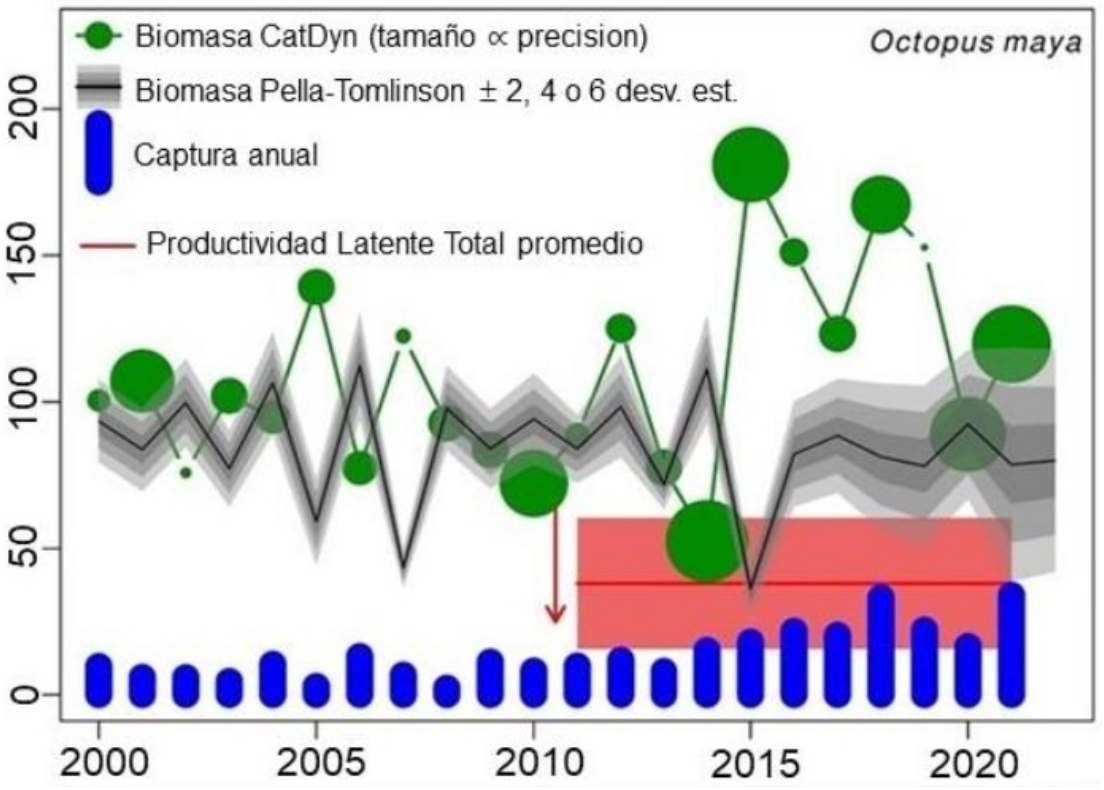

Figure 13: Biomass dynamics (green dots and black lines), landings (blue bars), and sustainable catch rates (TLP) of *O. maya* in the Yucatán Peninsula (DOF b 2024). The red arrow indicates the year when changes in biomass dynamics parameters occur: the symmetry of the production function (p) in *O. maya* (red areas around the red line are standard error bands).

Productivity-Susceptibility Analysis for *O. maya*

Table 4

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	< 1 year (Rosas et al. 2014)	1
Average maximum age	12 months (Rosas et al. 2014)	1
Fecundity	> 100,000 oocytes (Avila-Poleda et al. 2016)	1

Average maximum size (fish only)	N/A	
Average size at maturity (fish only)	N/A	
Reproductive strategy	Small hatchlings with pelagic paralarvaes (Lima et al. 2014)	2
Trophic level	≈3.74	3
Density dependence (invertebrates only)	Unlikely (highly mobile species) (Salas et al. 2009)	2
Habitat Quality	N/A	
Total Productivity (average)		**1.66**

Table 5

Susceptibility Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (Considers all fisheries)	The species distributes along the Yucatán Peninsula in the Gulf of Mexico (considered an endemic species) (Sealife Base 2024). Considering the importance of the species and the available data regarding fishing grounds (DOF 2022), > 30% of the species is fished.	3
Vertical overlap (Considers all fisheries)	According to (Hochberg and Camacho-García 2009), the species ranges from 0 to 100 m. According to managers, the small-scale fleets that target octopuses in Campeche and Yucatán reach to 37 m depth (DOF 2014), and for these reasons, this factor scores as medium risk.	2
Selectivity of fishery (Specific to fishery under assessment)	Mexican federal legislation established a minimum legal size of 11 cm of mantle length (DOF 2016). For this reason, it is believed that all organisms within the landings are adults; therefore, individuals smaller than size at maturity are not regularly caught.	2

Post-capture mortality (Specific to fishery under assessment)	*O. maya* is targeted using live bait that guarantees that undersized organisms can be returned alive (DOF 2014). But there is no evidence of a post-capture release; for this reason, this factor scores as medium risk.	2
Total Susceptibility (multiplicative)		**1.58**

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

V = $\sqrt{(1.66^2 + 1.58^2)}$

V = 2.50

1.2 Fishing Mortality

Gulf of Mexico - Trolling lines

Moderate Concern

For *Octopus maya*, managers set quotas that are typically based on the maximum sustainable yield (MSY) (DOF 2022). But there are no set values related to F_{MSY}. Within the 2022 update on the fishery's profile, managers reported that, as of 2019 (the last year assessed by managers), fishing mortality was above F_{MSY} (Figure 14). This has also been the case for the 2016 to 2018 period (DOF 2022).

During the most recent update to the fishery's profile, managers stated that *O. maya* is exploited within the maximum sustainable yield; however, there were no estimates related to F (DOF 2024). According to official landings (see the Introduction), during the most recent season, landings did not reach the authorized quota (DOF b 2024). Because current levels of F are unknown, this factor is scored a "moderate concern."

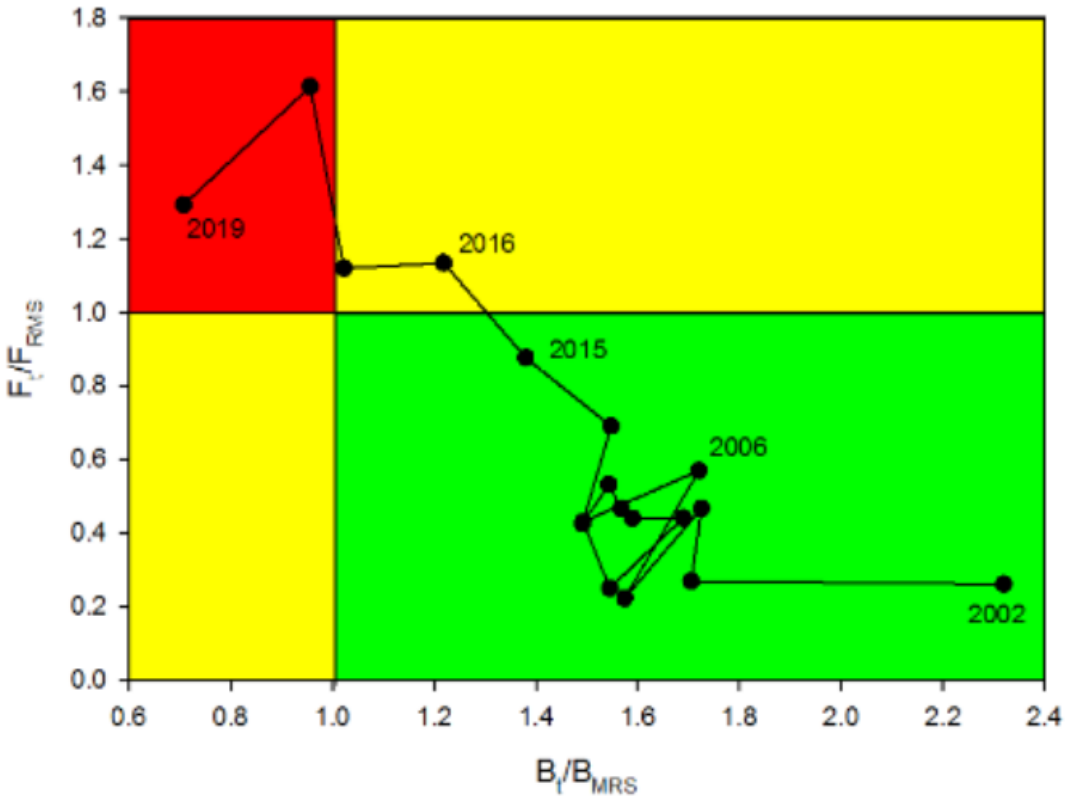

Figure 10: Kobe plot for *O. maya* in the Yucatán Peninsula (DOF 2022).

Criterion 2: Impacts on Other Species

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

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

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

Guiding principles

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

Criterion 2 Summary

Criterion 2 score(s) overview

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

Common octopus			
Region / Method	**Sub Score**	**Discard Rate/Landings**	**Score**
Mexico - Gulf of Mexico - Trolling lines - 1,900 mt	2.644	1.000: < 100%	Yellow (2.644)

Mexican four-eyed octopus			
Region / Method	**Sub Score**	**Discard Rate/Landings**	**Score**
Mexico - Gulf of Mexico - Trolling lines - 23,000 mt	4.284	1.000: < 100%	Green (4.284)

Criterion 2 main assessed species/stocks table(s)

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

Gulf of Mexico - Trolling lines			
Sub Score: 2.644	**Discard Rate: 1.000**		**Score: 2.644**
Species	**Abundance**	**Fishing Mortality**	**Score**
Mexican four-eyed octopus	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Common octopus	3.670: Low Concern	5.000: Low Concern	Green (4.284)

Octopus fishing is done exclusively during the day, using a fishing technique known as "gareteo," which consists of leaving the boat drifting and dragging lines where bait is held (Figure 16) (DOF 2014). According to the Octopus Management plan, the fishing method is practically exclusive for capturing the target species, and confirmed that there is no incidental fishing during octopus capture operations (ibid). The most common species used as bait in the Mexican four-eyed octopus fishery are mainly crabs (*Callinectes* spp.) and spider crab (*Libinia dubia*) (DOF 2014).

For that reason, no bycatch species are included in the recommendation. Because the octopus species in this report are sometimes caught together, each is included as a Criterion 2 species for the other octopus species.

Although it has been reported that one of the species used as bait is the endangered horseshoe crab (Smith et al 2017), which is protected under Mexican federal legislation (NOM-059), the level of impact on horseshoe crab from this fishery is unclear, so it is not included in the assessment.

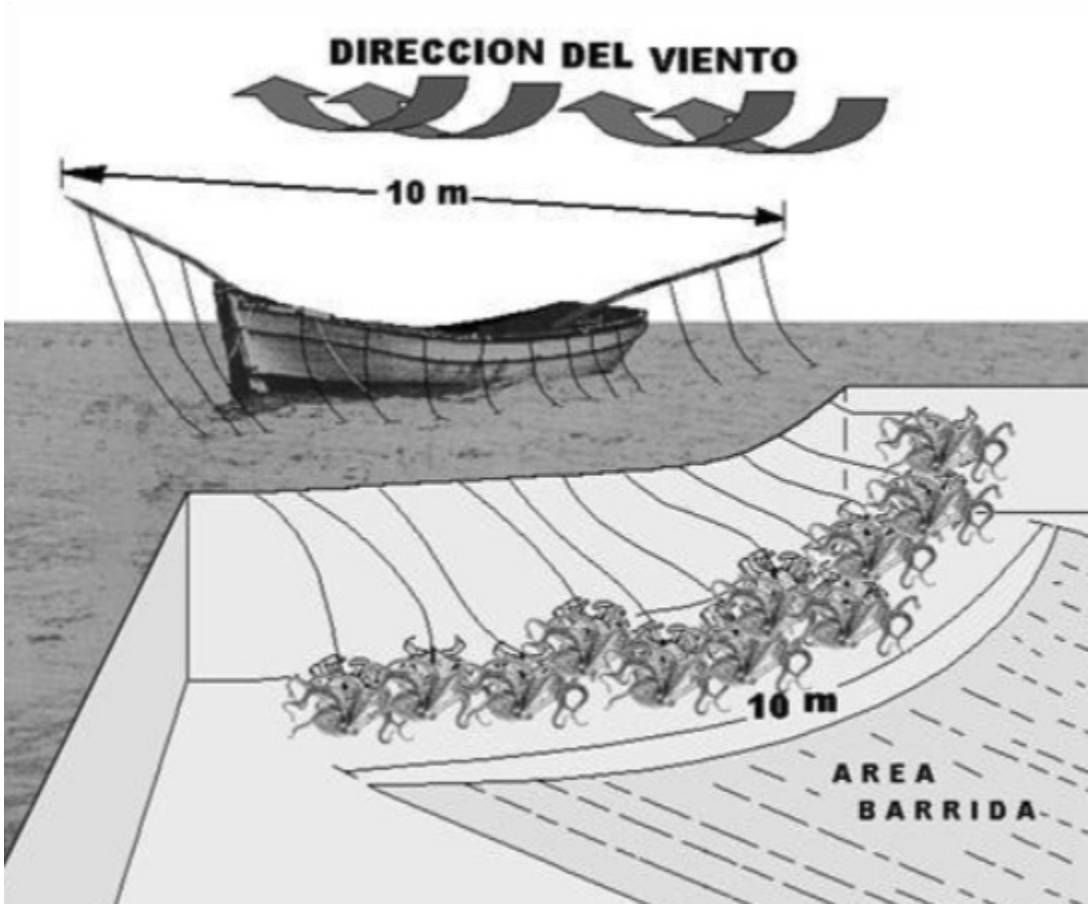

Figure 16: Fishing vessels with jimbas (bamboo sticks) with baited trolling lines (DOF 2014).

Criterion 2 Assessment

Scoring Guidelines

Factor 2.1 - Abundance

(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality

(same as Factor 1.2 above)

Factor 2.3 - Modifying Factor: Discards and Bait Use

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

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

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

2.3 Discard Rate/Landings

Gulf of Mexico - Trolling lines

< 100%

The fishing technique used in the octopus fishery is highly selective, and no incidental catch is recorded. According to the management plan, several crab species are the main groups used as bait (DOF 2014).

One of the fishery improvement projects (FIP) has a monitoring program that reports on production and collects relevant information regarding bait use. Data recorded by the FIP include the 2021, 2022, and 2023 seasons. Results indicate that the fishery uses three main species as bait, with mangrove crab (*Ucides cordatus*) as the most important (averaging ≈70%). Spider crab (*Libinia dubia*) (≈18%) and Chesapeake blue crab (*Callinectes sapidus*) (≈12%) complete the list of the species most used as bait (Barajas et al. 2022) (Ibarra-García et al. 2023) (Barajas et al. 2024).

One of the bait species mentioned in the literature was horseshoe crab (*Limulus polyphemus)*, a protected species under Mexican legislation, within the NOM-059. Although recent information to corroborate this was not available, according to Smith et al. {2017}, there were increasing reports of small-scale poaching of horseshoe crab adults used solely as an alternative to commercial bait species in the artisanal octopus fishery of Campeche and Yucatan. In addition, Munguia-Vega et al. (2023) conducted a study using DNA barcoding to identify species used as bait from 12 localities during 2022 (Munguia-Vega et al. 2023). The authors reported nine crustacean species. Of these, the mangrove crab was the most frequent (61%), followed by spider crab (14%) and Caribbean spiny lobster (*Panulirus argus*, 8%). The report confirmed that the American horseshoe crab (*Limulus polyphemus*) was absent in the samples. During the last reported seasons, the amount of bait used relative to total landings was significantly below the catches (Table 6). For this reason, this factor is scored as < 100.

Table 6

Season	2021	2022	2023
# of logbooks registered	1,883	1,340	3,429
Octopus production (kg)	1,407,700	986,523	788,687
Bait used (kg)	86,330	29,129	52,473
Octopus species	*O. maya* and *O. americanus*	*O. maya* and *O. americanus*	*O. maya* and *O. americanus*
Bait species used	*U. cordatus*, *L. dubia*, and *C. sapidus*	*U. cordatus*, *L. dubia*, and *C. sapidus*	*U. cordatus*, *L. dubia*

Criterion 3: Management Effectiveness

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

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

The Criterion 3 rating is determined as follows:

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

Rating is Critical if Management Strategy and Implementation is Critical.

Guiding principle

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

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

Criterion 3 Summary

Fishery	Management Strategy And Implementation	Bycatch Strategy	Scientific Data Collection and Analysis	Enforcement of and Compliance with Management Regulations	Stakeholder Inclusion	Score
Gulf of Mexico - Trolling lines	Moderately Effective	Highly effective	Moderately Effective	Ineffective	Highly effective	Red (2.000)

Criterion 3 Assessment

Scoring Guidelines

Factor 3.1 - Management Strategy and Implementation

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

Factor 3.2 - Bycatch Strategy

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

Factor 3.3 - Scientific Research and Monitoring

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

Factor 3.4 - Enforcement of Management Regulations

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

Factor 3.5 - Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process?

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

3.1 Management Strategy And Implementation

Gulf of Mexico - Trolling lines

Moderately Effective

The current management strategies for the octopus fishery are based mostly on Mexican four-eyed octopus data and scientific information. A limited amount of information (e.g., landing data) is collected for common octopus, and the recently identified variant of *O. insularis*. Access is controlled with the use of fishing licenses, and there is a minimum size limit of 110 cm, which applies to all octopus species in the Gulf of Mexico and Caribbean (DOF 2016). The exception is for *O. americanus* females within the Veracruz Reef National Park, where the minimum size limit is set at 140 mm; this measure aims to allow organisms to breed or reproduce before they are caught (DOF 2014; DOF 2015; DOF 2016). The federal Red and Common Octopus Fishery Management Plan (OFMP) includes an annual closed fishing season that runs from December to July (DOF 2014; DOF 2016).

In addition, for *Octopus maya*, an estimated and suggested quota is determined based on adult abundance, recruitment, and growth data estimates (INAPESCA 2014; INAPESCA b 2014; Perez et al 2007). According to managers, these quotas are typically set based on the maximum sustainable yield (MSY), a level of fishing that allows the population to persist. The goal is to allow 50% of the population to escape the fishery and survive to reproduce (INAPESCA b 2014). Managers followed scientific recommendations, and quotas coincided with what was advised until 2014, 2020, and 2022 (DOF b 2024). As of 2001, the catch quota was assigned according to an annual abundance assessment and has varied between 10,000 t and 13,000 t, with 10,000 t (INAPESCA 2014) (Figure 14figure below). We created a graph to present official landing data alongside set limits, visualizingbuilt a graph to present official landing data versus set limits to visualize production against the recommended quota (Figure 14). It is also important to consider that, according to (Suasnávar-Imán et al 2021), the decisions on the quota have not incorporated elements from population dynamics necessary for sustainable exploitation. Based on the available data, the quota seems to have been surpassed several times (see Figure 14). In addition, no catch quotas are set for the other species.

Finally, in terms of the volume of landings, *O. maya* represented roughly 90% of the fishery's main targeted species. The current management plan (DOF 2014), as well as the Federal Official Norm (DOF 2015), are currently based on this species' biology, and the measures are expected to be effective. In recent years, the limit quota has been constantly surpassed, so there is a need for increased precaution. As part of these efforts, a monitoring program has been in place that follows landings, and updates are publicly available (FIP Pulpo Yucatan 2024); once the fishery reaches the quota, the fishery will close. But it is unclear what effective mechanisms are in place to close the fishery effectivelyto effectively close the fishery, and if these are effective. For these reasons, this factor is scored a "moderate concern."

Supplementary Information

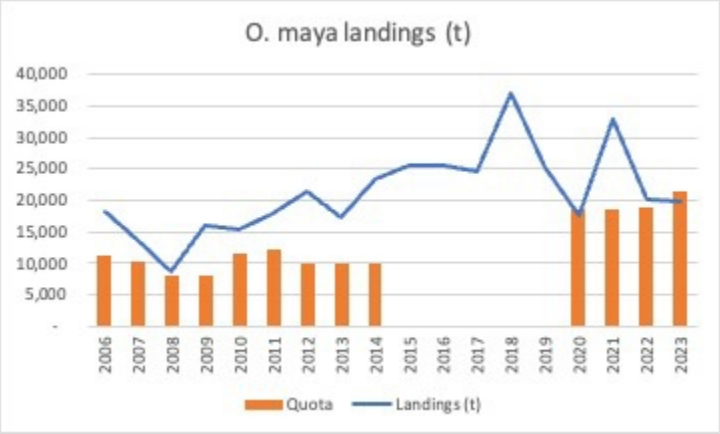

Figure 14: *O. maya* landings and quota between 2006 and 2023 (CONAPESCA 2021; Gobierno de Mexico 2024; INAPESCA b 2014; INAPESCA 2014).

3.2 Bycatch Strategy

Gulf of Mexico - Trolling lines

Highly effective

According to the information available, the trolling lines or *jimbas* have no interaction with other species, so a bycatch strategy is unnecessary. This factor is scored "highly effective."

3.3 Scientific Data Collection and Analysis

Gulf of Mexico - Trolling lines

Moderately Effective

The fishery considers the three octopus species as target species, O. maya, O. americanus, and O. insularis (DOF 2022). However, theBoth management instruments (the fishery management plan and the Mexican official norm (DOF 2014; DOF 2015)) consider only two of the species within their scope (*O. maya* and *O. americanus*). In addition, the efforts to estimate biomass and assign quotas have only been developed for *O. maya* (DOF 2022). These are calculated by managers at the Mexican Center for Research on Fisheries and Aquaculture (IMIPAS) who use CPUE data to fit a Schaefer surplus production model (Roa-Ureta 2021). The CPUE is generated from producers' landing tickets.

Based on these efforts, managers at CONAPESCA recommended measures in line with a reduction of effort, an increase in monitoring, control, and enforcement, and ensuring the implementation of the management plan (DOF 2022). Still, it was concluded that, for *O. americanus*, the fishery has the potential to develop even further within the 36 to 150 m range of depth (DOF 2022). However, the document did not provide details on how this

conclusion was derivedBut the document did not share details on how this conclusion was generated.

In the case of *O. maya*, some stock abundance and health data are collected and analyzed (DOF 2022), which are used to monitor and maintain the stock using appropriate data-limited assessment methods (surplus production model) and management strategies. For *O. americanus* and *O. insularis*, minimal data are collected or analyzed (landings and potential use of CPUE), and management methods are similar to those applied for *O. maya*. Overall, management relies on a single strategy that requires minimal monitoring (CPUE from landing tickets).

O. maya has historically been the main driver of the fishery, in terms of proportion of the catch (DOF 2014). Abundance estimates have been analyzed and quotas have been generated for the species. Recently, data on landings were also used to estimate the status of *O. maya and O. americanus* (Roa-Ureta 2024). Considering that *O. maya* represents > 70% of the catch, this score remains "moderately effective."

3.4 Enforcement of and Compliance with Management Regulations

Gulf of Mexico - Trolling lines

Ineffective

Participation in the fishery is controlled by permits that provide access to the species to the holders (DOF 2022). The enforcement of regulations is carried out by CONAPESCA officials (via federal officers), who are in charge of patrolling the coastline of more than 11,000 km. But in recent years, the number of federal inspectors has decreased from approximately 210 in 2012 to 161 in 2022 (Oceana 2024), which may be an insufficient number of agents for this amount of coastline (IMCO 2012) (Oceana 2024).

In 2020, the Mexican organization Causa Natura released the "Effectiveness Index for the Fishery Inspection and Enforcement in Mexico" (Pescando Datos 2020). The authors measure the effectiveness of fisheries surveillance in each state of the Mexican Republic using information on the level of actions deployed, the resources invested in inspection and surveillance, and how these were reflected in the results obtained. The authors built an index that included information from the National Aquaculture and Fisheries Commission (CONAPESCA). The report concluded that, for Yucatán, the index was 0.37 in the scale of 0 to 1 (Pescando Datos 2020). In 2021, the state reported a "slight" improvement in the index value (0.552) (Pescando datos 2021), although still reporting improvement in areas related to better enforcement actions (Pescando datos 2021) (Figure 15).

In a similar approach, Oceana Mexico released a report analyzing official information related to five elements of enforcement actions in Mexico. These elements were:

- the number of federal enforcement agents

- the number of enforcement actions (in water and land)
- the amount of fish products and gears retained as part of enforcement actions
- the level of coverage of the VMS system (for industrial fleet)
- the number of sanctions and infractions applied.

Based on the analysis of the information on those five components, the report concluded that, in the best of cases, there has been a stagnation of adequate enforcement actions by the authorities. In contrast, in the worst case, the results represent an apparent disregard for the state to fulfill its duties (Oceana 2024).

In addition, news outlets have recently released special reports that focused on the octopus fishery and the lack of effective enforcement, the increase in illegal activities that include using unauthorized gear (diving or cement bricks), and the consensus from researchers, activists, and fisher representatives that better enforcement and compliance are needed (InSight Crime 2021; El Pais 2023; Balam, L. 2023).

This information contrasts with the official announcements for a collaboration agreement formalized between the Navy and the Ministry of Agriculture and Rural Development in 2019 (Gobierno de Mexico b 2019). The program aimed to strengthen inspection and surveillance tasks related to poaching fishing, which has since increased the surveillance capacity at sea and the coast.

Finally, one of the two fishery improvement projects designed and launched a community sanction mechanism for noncompliance (Fishery Progress 2024). The FIP managers reported that the mechanism is considered to have a dissuasive and practical effect on FIP participants. Also, a monitoring, control, and surveillance mechanism was in place during the 2022 fishing season, which was audited and resulted in a "Satisfactory compliance" as proof of effective compliance (Ecomorphoses 2023; Fishery Progress 2024). In addition, FIP participants have held workshops in coordination with government agencies, academic institutions, and the fishing sector to reinforce knowledge about octopus fishing management tools (Gamboa-Álvarez-Barajas-Girón b 2024) (Gamboa-Álvarez & Barajas-Girón 2024), although specific actions to improve enforcement are not currently in place.

Further, these results only apply to the FIP participants, which, according to the FIP profile, cover ≈14% of the fishery production (landings) but only around 3.7% of small-scale and 8.3% of mid-scale vessels (171 and 37, respectively) according to the FIP vessel list—compared to the active fleet reported by managers (4,707 small-scale and 442 mid-scale vessels) (Fishery Progress 2024).

Overall, enforcement actions are in place to promote management benefits. But based on the reports and existing evidence, this might be inadequate for the scale of the fishery, and there seems to be constant poor compliance. For these reasons, this factor is scored "ineffective."

Supplementary Information

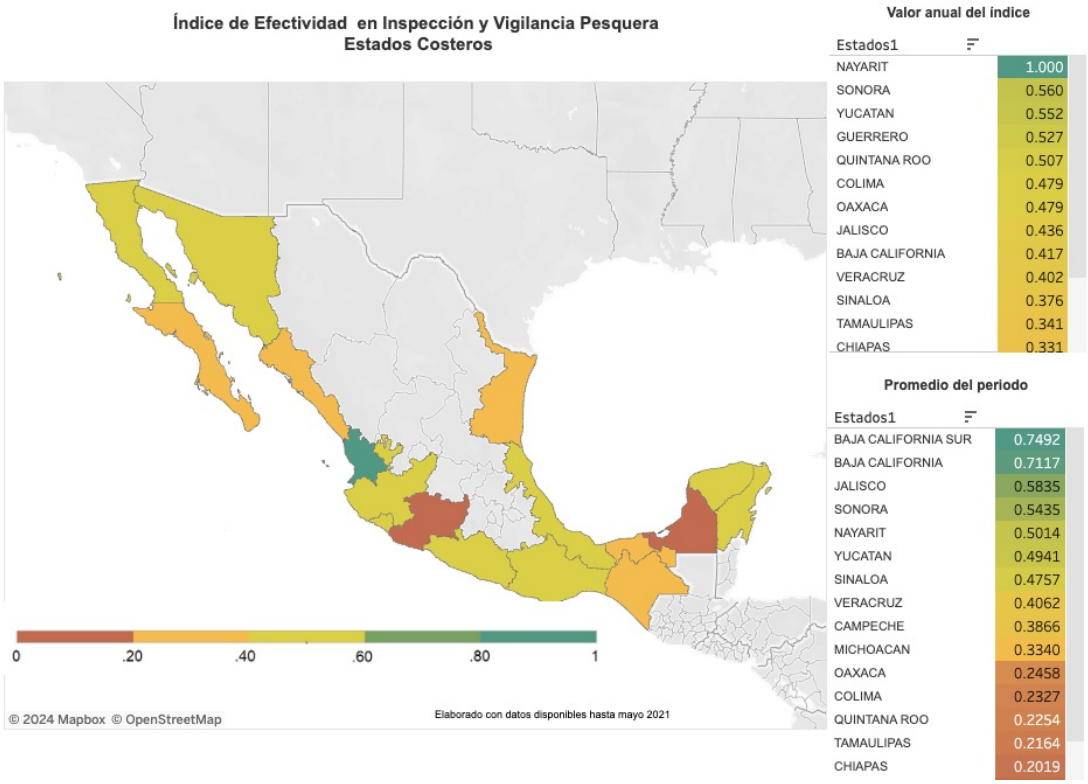

Figure 15: Enforcement Effectiveness Index values for Mexican states in 2021 (including Yucatán) (Pescando datos 2021).

3.5 Stakeholder Inclusion

Gulf of Mexico - Trolling lines

Highly effective

The Comite Estatal Sistema Producto (CESP) was created for the octopus fishery in Yucatán (Por Esto! 2019). The CESP is a legal body recognized by managers that coordinates planning, communication, and builds agreements between the various participants in the fishery and supply chain (CONAPESCA 2016). Legal entities (e.g., civil associations) and other fishery stakeholders actively participate in the CESP meetings and create strategic planning instruments (e.g., master programs, guiding plans, and multiyear planning sheets) to improve their competitiveness and expand market participation (CONAPESCA 2016). One example of this collaboration was the management plan (DOF 2014) and the update to the official norm (DOF 2016) developed in coordination with scientists and other stakeholders, including the CESP.

In addition, and as part of one of the active FIPs, workshops were held with the fishing sector of Campeche and Yucatán to provide feedback on the Octopus Fisheries Management Plan (PMPP) and management measures. This workshop focused on

reinforcing knowledge about the management tools in the Campeche Bank fishery, Mexico, as well as developing strategies to implement actions to ensure their compliance (Gamboa-Álvarez & Barajas-Girón 2024). Because of the successful involvement of diverse stakeholder groups in fishery management, this factor is scored “highly effective.”

Criterion 4: Impacts on the Habitat and Ecosystem

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

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

Guiding principles

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

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

Fishery	Physical Impact of Fishing Gear on the Habitat/Substrate	Modifying Factor: Mitigation of Gear Impacts	Ecosystem-based Fisheries Management	Score
Gulf of Mexico - Trolling lines	Score: 4	Score: 0	Moderate Concern	Green (3.464)

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.*

4.1 Physical Impact of Fishing Gear on the Habitat/Substrate

Gulf of Mexico - Trolling lines

Score: 4

The octopus fishery in the Gulf of Mexico uses trolling lines or *jimbas* that have minimal impact on the bottom. The bait normally comes in contact with the seafloor (DOF 2016; DOF 2014). Fishing lines are pulled in by hand, so the gear has no mechanical elements. Considering that the different species of octopus prefer either seagrass, rocky, and coral reef habitats, fishing may occur over these areas (DOF 2014); however, because the gear does not damage bottom habitats, this factor is scored a 4, based on the SFW Fisheries Standard.

4.2 Modifying Factor: Mitigation of Gear Impacts

Gulf of Mexico - Trolling lines

Score: 0

In the Gulf of Mexico and the Mexican Caribbean, there are protected areas (under different categories; e.g., National Park or Biosphere Reserves) with differing levels of protection; in some instances, certain fishing gears are banned or fishing may be prohibited. But no specific restrictions are in place for the octopus fishery beyond those included in the NOM and the Management Plan. For these reasons, no mitigation credit is awarded.

4.3 Ecosystem-based Fisheries Management

Gulf of Mexico - Trolling lines

Moderate Concern

Octopus species that are actively targeted have high trophic levels, and have a primarily carnivorous diet (e.g., crabs, mollusks, and fish). All three species are also an important food source for other species in the ecosystem, like groupers and snappers (Arreguin-Sanchez et al. 2000; DOF 2016).

Commercially important spiny lobster and red grouper share habitat with octopus; these species are all connected through the food web. Octopuses are an important prey item for red grouper, and both red grouper and octopus are predators of spiny lobster. Fishing and management regulations for any of these species will likely have some effect on the others (Lasseter 2006) (Arreguin-Sanchez et al. 2000). Unfortunately, the roles of the octopus species in the food web are not well studied. Also, there has been no assessment of the fishery's effects on resources commonly used for bait (e.g., crabs). Because there is no management or assessment of ecosystem impacts but octopuses are not considered to

play an exceptionally large role in the ecosystem, this factor is rated a “moderate concern.”

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

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Appendix A: Review Schedule

This report was reviewed in March 2025 and updated from version 3 of the Fisheries Standard to version 4. The changes are as follows:

- *O. insularis* was removed from the recommendation, considering the limited proportion of its catch (0.1%) in the fishery.
- Criterion 1: Abundance for *O. maya* and *O. americanus* upgraded to a "moderate concern" based on a recent evaluation conducted by managers to assess the status of the stocks.
- Criterion 2: The removal of *O. insularis* from this criterion and the lack of bycatch associated with this fishery improved the scoring from red to yellow.
- The overall rating for the fishery improved from red to yellow for both species that remained.