Seafood Watch

Seafood Report

MONTEREY BAY AQUARIUM®

Gulf of California Seafood Report

Blue spiny lobster *(Panulirus inflatus)*
California two-spot octopus *(Octopus bimaculatus)*
Green spiny lobster *(Panulirus gracilis)*
Gulf corvine *(Cynoscion othonopterus)*
Hubb octopus *(Octopus hubbsorum)*
Jumbo squid *(Dosidicus gigas)*
Red octopus *(Octopus rubescens)*
Sea turtle *(Chelonia mydas agassizi, Eretmochelys imbricate)*
Totoaba *(Totoaba macdonaldi)*

Southwest Region

Final Report
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About Seafood Watch® and the Seafood Reports

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 the Internet (seafoodwatch.org) or obtained from the Seafood Watch® program by emailing seafoodwatch@mbayaq.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 Report. Each report 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." The detailed evaluation methodology is available upon request. In producing the Seafood Reports, 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® Fisheries 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 Seafood Reports 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 Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling (831) 647-6873 or emailing seafoodwatch@mbayaq.org.

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Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science, and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch® program or its recommendations on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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I. Executive Summary

The Gulf of California Seafood Report encompasses six recommendations for species and/or species groups found in this region:

- Gulf corvina (*Cynoscion othonopterus*)
- Octopuses (*Octopus bimaculatus, O. hubbsorum, O. rubescens*)
- Sea turtles (East Pacific green, *Chelonia mydas agassizi*; hawksbill, *Eretmochelys imbricata*; olive ridley, *Lepidochelys olivacea*; loggerhead, *Caretta caretta*; leatherback, *Dermochelys coriacea*)
- Squid (*Dosidicus gigas*)
- Spiny lobsters (*Panulirus interruptus, P. gracilis, P. inflatus*)
- Totoaba (*Totoaba macdonaldi*)

Gulf corvina is endemic to the northern Gulf of California, and its populations have been negatively affected by overfishing and reductions in spawning and nursery habitat quality due to diversions of the Colorado River. Management of the Gulf corvina fishery is deemed ineffective according to Seafood Watch® criteria, and corvina is caught with gillnets and trawls, which result in high bycatch and habitat damage, respectively. Gulf corvina is thus given the overall recommendation of **Avoid**.

Several species of octopuses are caught in the Gulf of California by hand, trap, and diving. While octopuses are caught with these low bycatch methods, there is considerable uncertainty regarding the status of their populations. Like most cephalopods, octopuses are short-lived and reproduce quickly, making them inherently resilient to fishing pressure; however, there is minimal management of the octopus fishery, and thus overall octopus from the Gulf of California is recommended as a **Good Alternative**.

There are five species of sea turtle found in the Gulf of California, all of which are protected under both U.S. and Mexican law. East Pacific green, loggerhead, leatherback, hawksbill, and olive ridley sea turtles are listed under the IUCN Red List of Threatened Species, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and the U.S. Endangered Species Act (ESA). Additionally, these turtles have been protected under Mexican law since 1990. However, sea turtles continue to be consumed in many countries, including Mexico. Sea turtles are given the overall recommendation of **Avoid** due to their protected status.

Jumbo squid, or Humboldt squid, are caught using jig-gear, which is a low bycatch method. Like other cephalopods, squid are short-lived and reproduce at an early age, making them inherently resilient to fishing pressure. However, there is uncertainty associated with the stock status of jumbo squid in the Gulf of California, and management is deemed moderately effective. Jumbo squid is recommended as a **Good Alternative**.

A portion of the spiny lobster (*Panulirus interruptus*) fishery on the Pacific coast of Baja California is certified by the Marine Stewardship Council (MSC). The MSC-certified fishery is well managed and uses traps. However, there are also spiny lobster fisheries in the Gulf of California that use traps, in addition to tangle nets, which result in higher bycatch levels. There

is uncertainty associated with the stock status of the spiny lobster fishery in the Gulf, while stocks in the MSC-certified fishery are deemed healthy. Catch of *P. interruptus* dominates the spiny lobster catch in the Mexican Pacific, thus the overall recommendation for spiny lobster from the Pacific coast of Mexico is **Best Choice**.

Totoaba is a large fish in the croaker family that is endemic to the Gulf of California. Totoaba populations have declined dramatically due to overfishing and reductions in the quality of spawning and nursery habitat in the Colorado River Delta. Totoaba is listed as a "specially protected species" in Mexico, and is considered a species vulnerable to global extinction. Due to the protected status of totoaba, its stock status is considered a critical conservation concern and totoaba is given the overall recommendation of **Avoid**.

II. Introduction to the Gulf of California

The Gulf of California or Sea of Cortez, Mexico is considered a marine biodiversity hotspot (Figure 1) (Roberts et al. 2002 from Sala et al. 2004) and has been identified as a priority conservation area (Morgan et al. 2005). The exploitation of renewable resources has been designated as worsening in four of the five priority conservation areas within the Gulf of California, and unchanged in the upper Gulf (Alto Golfo de California) (Morgan et al. 2005). The Gulf of California, in particular the Upper Gulf, has been identified as a geographic hotspot where several species are at risk (Musick et al. 2000).

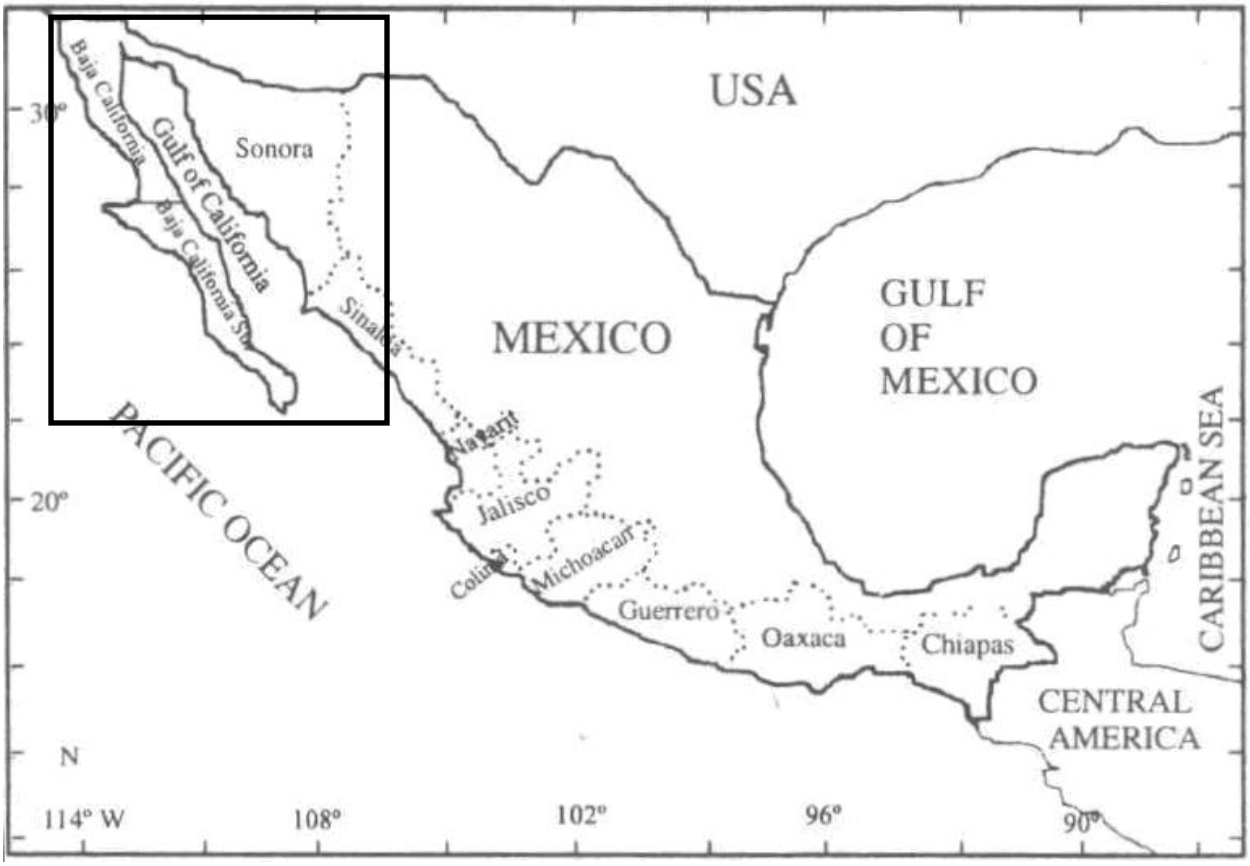


Figure 1. Map of Mexico, showing the Gulf of California and nearby states.
(Figure from Pérez-Gonzáles et al. 2002.)

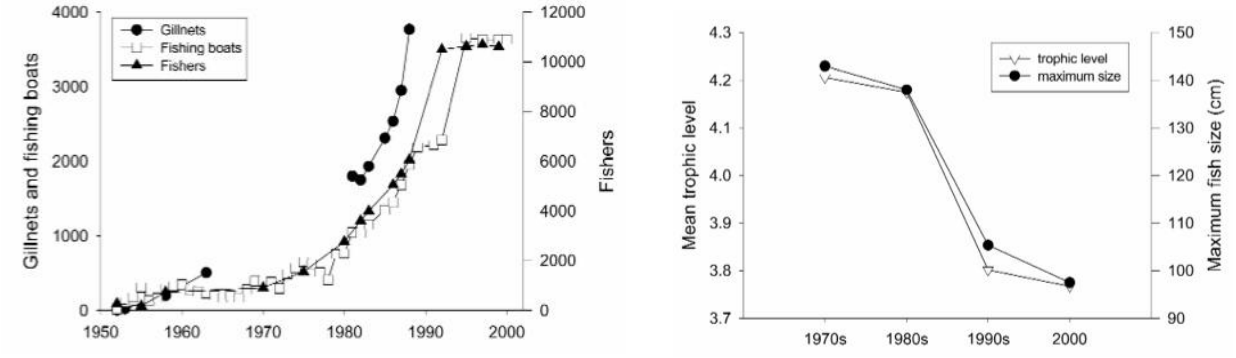
Fisheries in the Gulf of California

The Gulf of California is an important source of Mexico's fisheries, with landings in the Gulf of California exceeding those from the Gulf of Mexico (FAO 2003). Approximately half of Mexico's fishery landings and 90% of shrimp aquaculture production come from the Gulf of California (Robadue 2002). Approximately 40% of the seafood caught by the artisanal fleet in the Gulf of California is exported to California, Korea, China, and Japan (Cudney-Bueno 2000). The intense fishing effort in the Gulf of California has resulted in declines and commercial extinction in a number of species, including totoaba, goliath grouper (*Epinephelus itijara*), rays, sharks, and sea turtles (Robadue 2002; Sáenz-Arroyo et al. 2005a). In fact, interviews with fishermen in the Gulf of California suggest that the abundance and size of large predators has

declined over the past 60 years (Sáenz-Arroyo et al. 2005a; Sáenz-Arroyo et al. 2005b). Six fish species in the Gulf of California are considered threatened or at risk of extinction, including the totoaba and Gulf corvina (Musick et al. 2000). Overall, approximately 59.6% of Mexico's marine fisheries are overexploited, and 24.6% have deteriorated (INP 2000a, b; DOF 2000b in Alvarez-Torres et al. 2002).

Since the 1980s, the number of boats fishing in the southern Gulf of California has increased dramatically (Figure 2) (Sala et al. 2004). Coastal fisheries in the Gulf of California have shifted from targeting large, high trophic level species to small, lower trophic level species (Sala et al. 2004). In addition, catch per unit effort (CPUE) for many species has declined since 1980 despite overall increases in catch, and the maximum length of species caught has declined over the last 20 years (Figure 3) (Sala et al. 2004). Both target species and communities have been affected by fishing impacts in the Gulf (Sala et al. 2004). Coastal fisheries in the Gulf may be unsustainable, and the biological effects of fishing demonstrate the need for the implementation of management measures (Sala et al. 2004). Large predatory fishes declined from the 1970s to 2000 (Sala et al. 2004). According to Sala et al. (2004, pg. 22): "These results indicate that the coastal fisheries in the Gulf of California have had comparatively stronger impacts in the short term than most other fisheries in the world." Spawning aggregations in the Gulf of California should be identified, monitored, and included in marine reserves; it is possible spawning aggregations of large reef fishes have already disappeared as a result of fisheries targeting these aggregations (Sala et al. 2003).

The Gulf of California faces a number of problems in addition to overfishing and the damage caused by trawl gear, such as diversion of the Colorado River, pollution, mining, and the deterioration and loss of coastal wetlands (Robadue 2002; Morgan et al. 2005; Brusca et al. 2006). Almost no water now reaches the Gulf, except in flood years.



Figures 2, 3. Fishing pressure has increased dramatically in the southern Gulf since the 1980s, accompanied by a decrease in the mean trophic level and maximum size of species caught (Figures from Sala et al. 2004).

Catch and Gear Used

In Baja California Sur, the most common gear types used in the artisanal fishery are handlines and gillnets (Sala et al. 2004). The increased use of pangas in the Upper Gulf, in part as a result of increased narco-trafficking, has had a significant impact on small-scale fisheries in the Upper Gulf Biosphere Reserve (Brusca et al. 2001).

Catch data from the Gulf of California are aggregated by taxonomic groups (Sala et al. 2004), thus details on the catch of particular species are rarely available. In addition, catch data for pelagic species are unreported, or misreported, as almost all of these species are, by law, only targeted by recreational fishers (Ramirez 1988 in Sala et al. 2004). In addition, catch data from fishers that are not part of a fishing cooperative are underreported (Sala et al. 2004).

Fisheries Management

At the end of 2000, the Mexican fisheries management institutions were transferred to the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (Secretaría de Agricultura, Ganadería, Desarollo Rural, Pesca, y Alimentación, SAGARPA).

In Mexico, fisheries management planning is done via Sectoral Plans; in the mid-1990s the goal included increasing catches, while the new Fisheries Plan incorporates the precautionary principle as a guideline and includes sustainability as a goal (FAO 2003). The four objectives of the current plan include: (1) exploit fisheries resources in a sustainable way; (2) increase economic and social profitability of fisheries and aquaculture; (3) increase legal certainty in fishing and aquaculture activities; and (4) promote support programs for fishing and aquaculture activities (FAO 2003). Fishing cooperatives exist for many fisheries in Mexico; the cooperatives guarantee fishing permits and access to fishing grounds, as well as a share of the profits (Brusca et al. 2001).

The Mexican agency responsible for fisheries management, monitoring, and enforcement is the National Commission of Aquaculture and Fisheries (Comisión Nacional de Aquacultura y Pesca, CONAPESCA) (FAO 2003). The National Fisheries Institute (Instituto Nacional de la Pesca, INP) assesses the status of national fisheries and evaluates fishing gear (FAO 2003). The INP gives scientific and technical advice, and is divided into 13 Regional Centers of Fisheries Research (Centros Regionales de Investigación Pesquera, CRIPs). Both CONAPESCA and the INP report to the SAGARPA. The Secretariat of Environment and Natural Resources (Secretaría del Medio Ambiente y Recursos Naturales, SEMARNAT) is responsible for the National Fisheries Chart (Carta Nacional Pesquera, CNP), which determines management measures such as closed seasons, and ensures compatibility with resource conservation strategies (FAO 2003). Within SEMARNAT, the Federal Ministry for Environmental Protection (Procuraduría Federal de Protección al Ambiente, PROFEPA) enforces all natural resource laws, including fisheries (Robadue 2002).

More specifically, Mexican Official Standards (Normas Oficiales Mexicnas, NOMs) regulate mesh sizes, types of gear used, area restrictions, etc. (FAO 2003). Up until 2000, only 14 Mexican fisheries were regulated by NOMs, which include management measures such as permit requirements, gear restrictions, time and area closures, size limits, quotas, turtle excluding devices (TEDs), and other bycatch excluding devices (FAO 2003).

While numerous enforcement issues have arisen, including poaching in areas set aside for fishing cooperatives, PROFEPA has supported artisanal fishers working with buyers to determine size limits and the designating of their own enforcement (Robadue 2002). It has been suggested that “significant revisions” to current fisheries management in Mexico are necessary (Alvarez-Torres et al. 2002).

Current management measures for coastal fisheries limit fishing effort, but these measures only restrict fishing zones and specify allowable gear (DOF 2000 in Sala et al. 2004). There are no quotas, and essentially no enforcement of the regulations that are in place (Sala et al. 2004).

Conservation Efforts

Despite the many conservation issues facing the Gulf of California, both Mexican government and non-governmental organizations are working in some capacity to protect the biodiversity of the region (Carvajal et al. 2004). This includes the establishment of biosphere reserves (Brusca and Bryner 2004), and groups working on sustainable fishing practices.

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III. Gulf Corvina

Cynoscion othonopterus

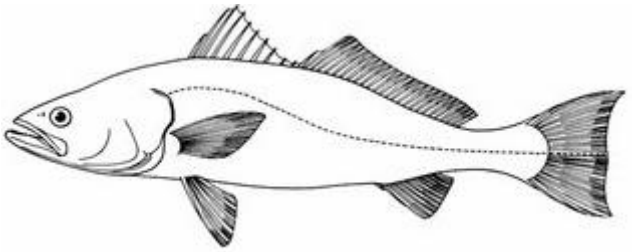

Illustration © FAO (Michel Lamboeuf)

Executive Summary

The Gulf corvina or "corvina golfina," *Cynoscion othonopterus*, is endemic to the northern Gulf of California. Gulf corvina is also sold as white sea bass, a misnomer often applied to its corvina relative, *Atractoscion nobilis*, of the coasts of California and Pacific Baja California, and in the Gulf of California. There is little life history information available for this predatory sciaenid (in the croakers and drums family), and its spawning and nursery habitat in the Colorado River delta (estuary) region has been severely altered due to upstream diversions of the river. Thus, although Gulf corvina is a relatively short-lived species, it is considered moderately vulnerable to fishing pressure according to Seafood Watch® criteria. Severe overfishing of the single population continues essentially unabated and is resulting in decreasing yields, size reduction, and premature maturation of individuals. Although there is no current stock assessment for Gulf corvina, there have recently been dramatic declines in its single population, and it is considered vulnerable to global extinction according to Musick et al. (2000); the stock status of Gulf corvina is thus a high conservation concern. Gulf corvina is mainly caught seasonally during its spawning aggregations by artisanal fisheries using many different gear types, including gillnets, finfish trawls, and handlines. There is little bycatch and negligible habitat impacts from handline gear, while there are serious bycatch and habitat impact concerns with the gillnet and trawl fisheries. Management of the Gulf corvina fishery is minimal, and management measures have not maintained the stock abundance of this species, and are thus considered ineffective. Overall, the preceding suite of criteria results in a recommendation of **Avoid** for Gulf corvina and "white sea bass" caught in the Gulf of California.

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	**Low**	**Moderate**	**High**	**Critical**
Inherent Vulnerability		√		
Status of Stocks			√	
Nature of Bycatch	√ (Handlines)	√ (Trawls)	√ (Gillnets)	
Habitat & Ecosystem Effects	√ (Handlines)	√ (Gillnets)	√ (Trawls)	
Management Effectiveness			√	

About the Overall Seafood Recommendation:

- A seafood product is ranked **Best Choice** if three or more criteria are of Low Conservation Concern (green) and the remaining criteria are not of High or Critical Conservation Concern.
- A seafood product is ranked **Good Alternative** if the five criteria "average" to yellow (Moderate Conservation Concern) OR if the "Status of Stocks" and "Management Effectiveness" criteria are both of Moderate Conservation Concern.
- A seafood product is ranked **Avoid** if two or more criteria are of High Conservation Concern (red) OR if one or more criteria are of Critical Conservation Concern (black) in the table above.

Overall Seafood Recommendation

Best Choice Good Alternative **Avoid**

Introduction

The Gulf corvina, *Cynoscion othonopterus*, known as "corvina golfina" in Mexico, is a relatively large sciaenid endemic to the northern Gulf of California. The species has historically been caught in commercial fisheries in the northern Gulf of California, except for a hiatus during the 1960s to early 1980s when it was absent from commercial finfish catches and was feared extinct. Gulf corvina utilize estuarine habitat in the Colorado River Delta as spawning grounds, and when the already reduced flow from the Colorado ceased in the 1960s the species apparently stopped its spawning migrations in force (Brusca et al. 2001; Brusca and Bryner 2004). When sporadic, yet unsustained, flows temporarily increased, for instance in 1993, corvina catches increased dramatically, and catches have continued to increase steadily since 1993 (Román 1998; Román et al. 1998; Román pers. obs. in Rowell et al. 2005). Although almost certainly unsustainable, this recent revival of the corvina fishery is drawing more fisher families to regional coastal areas with unknown ecological consequences (Brusca et al. 2001; Brusca and Bryner 2004).

Many species of finfish (e.g., corvina species, totoaba) are sold and marketed as "corvina," though this report encompasses only the Gulf corvina. The sparse fishery data collected by Mexican government agencies, however, aggregates catch data by family or group category; thus there is no record of the catch of *Cynoscion othonopterus* alone. For instance, Figures 1 and 2 show data for 15 species of corvinas and croakers caught in the Gulf of California (*corvinas*, *berrugatas*, etc.).

In the Gulf of California, where most corvinas are fished year-round (except for heavy spawning-season fishing for Gulf corvina for domestic and export markets), the catches are consumed locally and regionally (CNP 2004). The states of Sonora and Sinaloa produce 86% of all of the species of corvina caught in Mexico, 47.7% of which comes just from the state of Sonora (Figure 1) (CNP 2004). Corvinas are caught by trawls, gillnets, handlines, and incidentally in the longline fishery (CNP 2004). Shrimp boats are also used in this fishery. The artisanal (*panga*) fleets fish at depths of 7 – 44 meters (m), using gillnets with mesh sizes of 7.6 – 15.2 centimeters (cm), and net lengths of 100 – 500 m (CNP 2004). In the northernmost Gulf of California, nets with mesh sizes of 6 – 10 cm are generally used, but net lengths vary by fishing community, from 367 – 550 m. Fishing time lasts from 30 minutes to one hour, two to four times per day (CNP 2004). When anchored or drift gillnets are used, the nets are set and then retrieved the following day (CNP 2004). Since 1986, the catch of all the various species mixed as "corvinas" has been variable (Figure 2) (CNP 2004), thus leading to little real understanding of the different species catches.

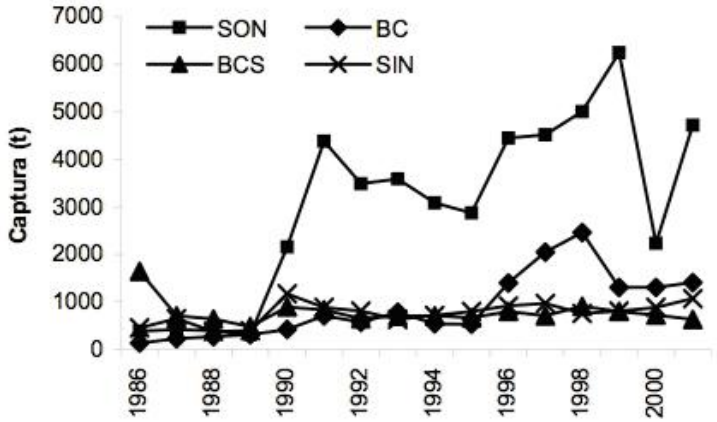

Figure 1. Catch of all "corvinas," including other species of croakers, from 1986 – 2000 in Sonora (SON), Baja California (BC), Baja California Sur (BCS), and Sinaloa (SIN). (Figure from CNP 2004.)

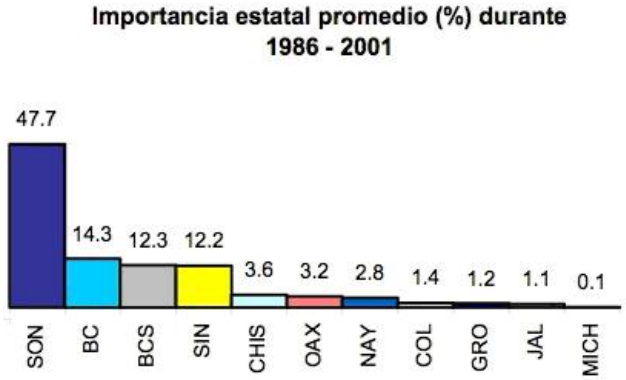

Figure 2. Most species of "corvinas," including Gulf corvina, are caught in Sonora. (Figure from CNP 2004.)

Analysis of Seafood Watch® Sustainability Criteria for Wild-caught Species

Criterion 1: Inherent Vulnerability to Fishing Pressure

Guiding Principle: Sustainable wild-caught species have a low vulnerability to fishing pressure, and hence a low probability of being overfished, because of their inherent life history characteristics.

Gulf corvina is a large species that is not likely to be highly productive (Brusca et al. 2001; Brusca and Bryner 2004). In addition, Gulf corvina is endemic to the Gulf of California, and aggregates to spawn in the northernmost part of the Gulf. These life history characteristics make the species vulnerable to overfishing, as the fishing season coincides with the annual spawning event (Brusca et al. 2001; Brusca and Bryner 2004).

Gulf corvina spawn in the winter and early spring in the Colorado River delta's estuarine waters (Brusca et al. 2001; Brusca and Bryner 2004). However, the quality of the spawning and nursery habitat for Gulf corvina has been degraded as a result of water diversions of the Colorado River in the U.S. (Musick et al. 2000). The decrease in freshwater flow to the Gulf of California and

the ensuing decline in estuarine habitat have been linked to declines in commercial landings of corvina; increases in freshwater flow would likely increase recruitment (Rowell et al. 2005).

The maximum size of Gulf corvina is 70 cm total length (TL), and the maximum published weight is 2,430 grams (g) (Froese and Pauly 2006). The resilience of this species is considered to be moderate, with a minimum population doubling time of 1.4 – 4.4 years (Froese and Pauly 2006).

Table 1. Life history characteristics for Gulf corvina.

Factors Evaluated	Life History Characteristics	SFW Conservation Concern
Intrinsic rate of increase ('r')	Unavailable/Unknown	Not applicable
Age at 1st maturity	Unavailable/Unknown	Not applicable
von Bertalanffy growth coefficient ('k')	Unavailable/Unknown	Not applicable
Maximum age	7 – 9 years	**LOW** (< 11 years)
Fecundity	High reproductive potential	**LOW** (> 100 individuals/year)
Species range	Endemic to the northern Gulf of California	**HIGH** (Narrow, e.g., endemism or numerous evolutionary significant units or restricted to one coastline)
Special behaviors or requirements	Aggregate to spawn	**MODERATE** (1 - 2 behaviors or requirements that increase vulnerability)
Quality of habitat	Lack of freshwater flow from the Colorado River has severely impacted the spawning habitat of corvinas.	**HIGH** (Habitat has been substantially compromised from non-fishery impacts and thus has reduced capacity to support this species, e.g., from dams, pollution, or coastal development)

Evaluation Guidelines

1) Primary Factors
   a) If 'r' is known, use it as the basis for the rank of the Primary Factors.
   b) If 'r' is unknown, then the rank from the remaining Primary Factors (in order of importance, as listed) is the basis for the rank.

2) Secondary Factors
   a) If a majority (2 out of 3) of the Secondary Factors rank as Red, reclassify the species into the next lower rank (i.e., Green becomes Yellow, Yellow becomes Red). No other combination of Secondary Factors can modify the rank from the Primary Factors.
   b) No combination of primary and secondary factors can result in a Critical Conservation Concern for this criterion.

Conservation Concern: Inherent Vulnerability

- **Moderate (Moderately Vulnerable)** 

Criterion 2: Status of Wild Stocks

Guiding Principle: Sustainable wild-caught species have stock structure and abundance sufficient to maintain or enhance long-term fishery productivity.

According to Musick et al. (2000), there has recently been a large decline in the population of Gulf corvina, and this species is considered vulnerable, which is defined as: not endangered or threatened severely but at possible risk of falling into one of theses categories in the near future. The Gulf corvina is considered a species vulnerable to global extinction (Musick et al. 2000).

According to the CNP (2004), the corvina fishery (all corvinas) is at its maximum sustainable yield (MSY).

Table 2. Stock status of corvina.

Factors Evaluated	Stock Status Characteristics	SFW Conservation Concern
Management classification status	Vulnerable (Musick et al. 2000)	**HIGH** (recruitment or growth overfished, overexploited, depleted or "threatened")
Current population abundance relative to B_{MSY}	Unknown	**MODERATE**
Occurrence of overfishing	Unknown	**MODERATE**
Overall degree of uncertainty in stock status	High	**HIGH** (i.e., little or no current fishery-dependent or independent information on stock status OR models/estimates broadly disputed or out-of-date)
Long and short-term trends in population abundance	Large decline	**HIGH** (trend is down)
Current age, size, or sex distribution of the stock relative to natural condition	Unknown	**MODERATE**

Evaluation Guidelines

A "Poor" Stock:

1) Is fully fished AND trend in abundance is down AND distribution parameters are skewed.
2) Is overfished, overexploited, or depleted AND trends in abundance and CPUE are up.
3) Is experiencing overfishing AND stock is not currently overfished.

Conservation Concern: Status of Stocks

- **High (Stock Poor)** 

Criterion 3: Nature and Extent of Bycatch

Guiding Principle: A sustainable wild-caught species is captured using techniques that minimize the catch of unwanted and/or unmarketable species.

There are several gear types used to catch corvinas in the Gulf of California, including gillnets (the primary gear used), trawls, and handlines. Gulf corvina is also caught incidentally in the longline fishery. There are no readily available data that identify the bycatch associated with these gear types in the Gulf of California. The exception is bycatch of the critically endangered vaquita (*Phocoena sinus*) in the gillnet fisheries (D'Agrosa et al. 2000). Although zero vaquita mortalities were observed in the corvina fishery from 1993 – 1995 by D'Agrosa et al. (2000), only 7 fishing trips targeting corvinas were observed during this time period. D'Agrosa et al. (2000) estimated that vaquita mortalities from just one fishing community (El Golfo de Santa Clara) resulted in 39 mortalities per year, which is greater than 17% of the total population. With fishing pressure from other regional communities and non-gillnet fisheries, this bycatch is pushing the vaquita toward extinction.

Due to the establishment of the Upper Gulf of California and Colorado River Delta Biosphere Reserve in 1993, gillnet fishing pressure in this area has been somewhat reduced (Román Rodríguez and Hammann 1997), but the bycatch of vaquita has not been reduced to the point where its survival as a species is even partially ensured.

Table 3. Bycatch characteristics of the Gulf corvina fishery.

Factors Evaluated	Bycatch Characteristics	SFW Conservation Concern
Quantity of bycatch, including any species of "special concern" (i.e., those identified as "endangered," "threatened," or "protected" under state, federal, or international law)	Gillnet: protected species bycatch Handline: unknown, but likely low Trawl: many species of seafloor organisms, including juvenile corvinas and totoaba (L. Findley, pers. comm.)	Gillnet, trawl: **HIGH** (Quantity of bycatch is high—> 100% of targeted landings on a per number basis—OR bycatch regularly includes threatened, endangered, or protected species) Handline: **LOW** (Quantity of bycatch is low—< 10% of targeted landings on a per number basis—AND does not regularly include species of special concern)
Population consequences of bycatch	Gillnet: gillnet bycatch in the Gulf of CA contributing to decline of the vaquita Handline: bycatch low, so not thought to be any population consequences Trawl: unknown	Gillnet: **HIGH** (Evidence indicates quantity of bycatch is a contributing factor in driving one or more bycatch species toward extinction OR is a contributing factor in limiting the recovery of a species of "special concern") Handline: **LOW** (Evidence indicates quantity of bycatch has little or no impact on population levels) Trawl: **MODERATE** (Unknown)

Factors Evaluated	Bycatch Characteristics	SFW Conservation Concern
Trend in bycatch interaction rates (adjusting for changes in abundance of bycatch species) as a result of management measures (including fishing seasons, protected areas and gear innovations)	Gillnet, trawl: Unknown Handline: Not applicable because bycatch is low	Gillnet, trawl: **MODERATE** (Unknown) Handline: Not applicable
Evidence that the ecosystem has been or likely will be substantially altered (relative to natural variability) in response to the continued discard of the bycatch species	Unknown	**MODERATE** (Unknown)

Evaluation Guidelines

Bycatch is "Minimal" if the quantity of bycatch is <10% of targeted landings AND bycatch has little or no impact on population levels.

Bycatch is "Moderate" if:

1) Quantity of bycatch is 10 – 100% of targeted landings.
2) Bycatch regularly includes species of "special concern" AND bycatch has little or no impact on bycatch population levels AND the trend in bycatch interaction rates is not up.
3) Bycatch is unknown.

Bycatch is "Severe" if:

1) Quantity of bycatch is > 100% of targeted landings.
2) Bycatch regularly includes species of "special concern" AND evidence indicates bycatch rate is a contributing factor toward extinction or limiting its recovery AND trend in bycatch is down.

Conservation Concern: Nature and Extent of Discarded Bycatch

Handline:

- **Low (Bycatch Minimal)**

Trawl:

- **Moderate (Bycatch Moderate)**

Gillnets:

- **High (Bycatch Severe)**

Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems

Guiding Principle: Capture of a sustainable wild-caught species maintains natural functional relationships among species in the ecosystem, conserves the diversity and productivity of the surrounding ecosystem, and does not result in irreversible ecosystem state changes.

Handlines have a negligible impact on bottom habitat, bottom-set gillnets have a moderate impact, and trawls are considered to have a high impact (Chuenpagdee et al. 2003). While there are no data specifically related to habitat damage from fishing gear in the Gulf of California, generalizations can be made from data on these gear types in other regions.

Table 4. Habitat and ecosystem effects of the Gulf corvina fishery.

Factors Evaluated	Fishing Practices Characteristics	SFW Conservation Concern
Known (or inferred from other studies) effect of fishing gear on physical and biogenic habitats	Gillnet: some habitat impacts Handline: minimal damage Trawl: great damage	Gillnet: **MODERATE** Handline: **LOW** Trawl: **HIGH**
For specific fishery being evaluated, resilience of physical and biogenic habitats to disturbance by fishing method	Gillnet, trawl: Habitat types in the Gulf of CA range from somewhat to not resilient to fishing gear Handline: Not applicable because damage is minimal	Gillnet, trawl: **MODERATE** (e.g., shallow or deep water mud bottoms, or deep water sandy habitats) – **HIGH** (e.g., shallow or deep water corals, shallow or deep water rocky bottoms) Handline: Not applicable because damage is minimal
If gear impacts are moderate or great, spatial scale of the impact	Gillnet, trawl: Small scale fishery Handline: Not applicable because damage is minimal	Gillnet, trawl: **LOW** (small, artisanal fishery) Handline: Not applicable because damage is minimal
Evidence that the removal of the targeted species or the removal/deployment of baitfish has or will likely substantially disrupt the food web	Unknown	**MODERATE**
Evidence that the fishing method has caused or is likely to cause substantial ecosystem state changes, including alternate stable states	Unknown	**MODERATE**

Evaluation Guidelines

The effect of fishing practices is "Benign" if:

1) Damage from gear is minimal AND resilience to disturbance is high AND both Ecosystem Factors are not red.

The effect of fishing practices is "Moderate" if:

1) Gear effects are moderate AND resilience to disturbance is moderate or high AND both Ecosystem Factors are not red.
2) Gear results in great damage AND resilience to disturbance is high OR impacts are small scale AND both Ecosystem Factors are not red.

The effect of fishing practices is "Severe" if:

1) Gear results in great damage AND the resilience of physical and biogenic habitats to disturbance is moderate or low.
2) One or more Ecosystem Factors are red.

Conservation Concern: Effect of Fishing Practices on Habitats and Ecosystems

Handline:

- **Low (Fishing Effects Benign)** 

Gillnet:

- **Moderate (Fishing Effects Moderate)** 

Trawl:

- **High (Fishing Effects Severe)** 

Criterion 5: Effectiveness of the Management Regime

Guiding Principle: The management regime of a sustainable wild-caught species implements and enforces all local, national and international laws and utilizes a precautionary approach to ensure the long-term productivity of the resource and integrity of the ecosystem.

There is minimal management of the corvina fishery; the only management measures in place are 1) a requirement for a general finfish commercial fishing permit, and 2) from February to April, gillnets cannot be used during the three days surrounding the new and full moons (CNP 2004). In addition, necessary measures will be taken if the annual catch of all corvinas falls below the following levels: 100 mt in Nayarit, 700 mt in BCS and Sinaloa, 200 mt in Chiapas, 100 mt in Guerrero and Oaxaca, 25 mt in Jalisco, 2,000 mt in Sonora, 1,300 mt in Baja California (CNP 2004). Gulf corvina is found only in Baja California and Sonora. If the annual catch is below these numbers, the INP will perform an analysis to determine the causes, and recommend corrective actions where required (CNP 2004).

Table 5. Management effectiveness of the Gulf corvina fishery.

Factors Evaluated	Management Characteristics	SFW Conservation Concern
Stock Status: Management process utilizes an independent scientific stock assessment that seeks knowledge related to the status of the stock	No stock assessment available now and none is planned in the near future	**HIGH**
Scientific Monitoring: Management process involves regular collection and analysis of data with respect to the short and long-term abundance of the stock	Regular collection of fishery-dependent data only	**MODERATE**
Scientific Advice: Management has a well-known track record of consistently setting catch quotas beyond those recommended by its scientific advisors and other external scientists	Not enough information available to evaluate OR not applicable because little or no scientific information is collected	Not applicable
Bycatch: Management implements an effective bycatch reduction plan	Gillnet, trawl: No bycatch plan implemented or bycatch plan implemented but not meeting its conservation goals (deemed ineffective); Upper Gulf Reserve was established in part to reduce the bycatch of vaquita and totoaba Handline: Not applicable because bycatch is low	Gillnet, trawl: **HIGH** Handline: Not applicable
Fishing practices: Management addresses the effect of the fishing method(s) on habitats and ecosystems	Trawl: No mitigative measures in place Handline, gillnet: Not applicable because habitat impacts are benign or moderate	Trawl: **HIGH** Handline, gillnet: Not applicable
Enforcement: Management and appropriate government bodies enforce fishery regulations	Regulations not regularly or consistently enforced	**HIGH**
Management Track Record: Conservation measures enacted by management have resulted in the long-term maintenance of stock abundance and ecosystem integrity	Management measures have not maintained stock productivity	**HIGH**

Evaluation Guidelines

Management is deemed to be "Ineffective" if three individual management factors are red, especially those for Stock Status and Bycatch.

Conservation Concern: Effectiveness of Management

- **High (Management Ineffective)** 

Overall Evaluation and Seafood Recommendation

The Gulf corvina, *Cynoscion othonopterus*, is endemic to the northern Gulf of California. It is also sold as white sea bass. There is little life history information available for Gulf corvina, and its spawning and nursery habitat in the Colorado River Delta has been severely altered due to diversions of the Colorado River. Thus, although Gulf corvina is a short-lived species, it is considered moderately vulnerable to fishing pressure. Although there is no current stock assessment for Gulf corvina, there have recently been dramatic declines in the population of this species, and it is considered vulnerable to global extinction; the stock status of Gulf corvina is thus a high conservation concern. Gulf corvina is caught in artisanal fisheries using many different gear types, including gillnets, finfish trawls, and handlines. There is likely little bycatch and negligible habitat impacts from handline gear, while there are moderate bycatch and habit impact concerns with the gillnet and trawl fisheries, respectively. Management of the Gulf corvina fishery is minimal, and management measures have not maintained the stock abundance of this species. Management is thus considered ineffective. Overall, the poor stock status, damaging gear, and poor management of the fishery results in a recommendation of **Avoid** for Gulf corvina.

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IV. Octopus

Octopus hubbsorum, O. vulgaris, O. macropus, O. rubescens, O. bimaculatus

Illustration © Monterey Bay Aquarium

Executive Summary

While there are several species of octopus that are targeted in the Gulf of California (*Octopus hubbsorum, O. rubescens, O. bimaculatus*), the predominant species found in the market are *O. bimaculatus* and *O. hubbsorum*. Cephalopods are generally considered inherently resilient to fishing pressure due to life history characteristics such as an early age at maturity, rapid growth, and a short lifespan. There is a paucity of data concerning the stock status of octopus in the Gulf of California, and specifically for *O. bimaculatus*, which is the primary species targeted and marketed in this region. Octopus is caught with traps, diving, and by hand. These catch methods have minimal bycatch concerns. The habitat impacts of traps rank as a moderate conservation concern, while diver and hand-caught methods have no appreciable habitat effects. Management of the octopus fishery, however, is considered ineffective, as the only management measure in place is a commercial fishing permit and a prohibition on the use of chemicals and chlorinated compounds. Overall, octopus is recommended as a **Good Alternative**.

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	**Low**	**Moderate**	**High**	**Critical**
Inherent Vulnerability	√			
Status of Stocks		√		
Nature of Bycatch	√			
Habitat & Ecosystem Effects	√ (Diving/by hand)	√ (Traps)		
Management Effectiveness			√	

About the Overall Seafood Recommendation:

- A seafood product is ranked **Best Choice** if three or more criteria are of Low Conservation Concern (green) and the remaining criteria are not of High or Critical Conservation Concern.
- A seafood product is ranked **Good Alternative** if the five criteria "average" to yellow (Moderate Conservation Concern) OR if the "Status of Stocks" and "Management Effectiveness" criteria are both of Moderate Conservation Concern.
- A seafood product is ranked **Avoid** if two or more criteria are of High Conservation Concern (red) OR if one or more criteria are of Critical Conservation Concern (black) in the table above.

Overall Seafood Recommendation

Best Choice | **Good Alternative** | Avoid

Introduction

There are several species of octopus that are targeted by commercial fisheries in the Mexican Pacific: Hubb's octopus (*O. hubbsorum*); Pacific red octopus (*O. rubescens*); and two-spotted octopus (*O. bimaculatus*). The predominant species targeted in the Gulf of California and found in the market is *O. bimaculatus*; thus, this report encompasses the species listed above and focuses on *O. bimaculatus*.

In the Gulf of California, *pangas* with two to three fishermen per boat are used to catch octopus (CNP 2004). Octopus is caught by hookah divers using air hoses instead of SCUBA gear, and at least one person stays on the boat as the "life point," or *cabo de vida*, to ensure that the air compressor is working (van der Helden 2001). There may be a third person on board responsible for driving the boat, known as the *motorista* (CNP 2004). In the states of Sonora, Sinaloa, Nayarit, and northern Jalisco, divers use gaffs to catch octopus in the intertidal zone instead of by boat (CNP 2004). Catch of octopus has been variable, and is generally highest in Jalisco (Figures 1, 2) (CNP 2004). In Baja California Sur, octopus is caught in traps (5 – 50 per boat); this fishing occurs in the rocky zones 2 – 50 m in depth and the number of traps used depends on the species and the fishing area (CNP 2004). *O. bimaculatus* is caught during the winter, while *O. hubbsorum* and *O. rubescens* is caught during the summer (CNP 2004).

In the Pacific and Gulf of California, there are 1,188 small boats and 12 large boats fishing for octopus, with much of the catch coming from Jalisco (CNP 2004). In Baja California Sur, there are 302 small boats fishing under 70 permits (CNP 2004).

Common names for *O. bimaculatus* include *pulpo manchado*, California two-spot octopus, and two-spotted octopus; *O. rubescens* is known as *pulpo rojo*.

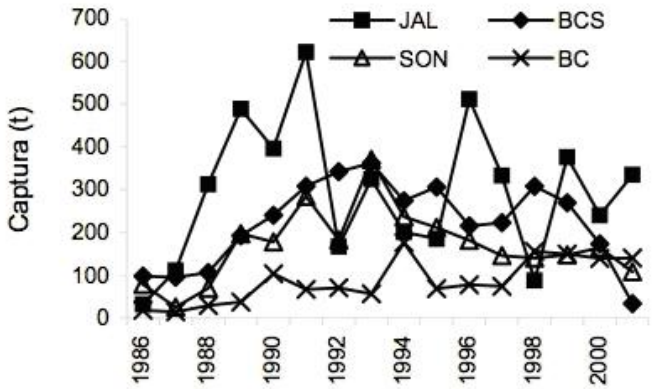

Figure 1. Catch of octopus in the Mexican Pacific. JAL = Jalisco, BCS = Baja California Sur, SON = Sonora, BC = Baja California. (Figure from CNP 2004.)

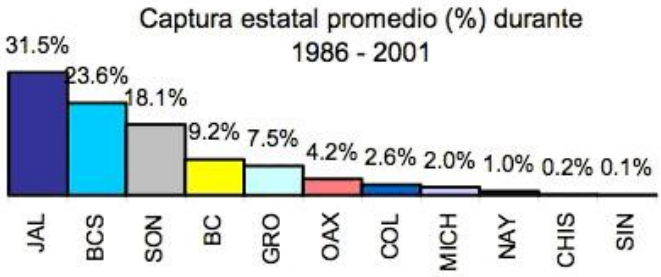

Figure 2. Octopus catch is highest in the state of Jaliso. (Figure from CNP 2004.)

Analysis of Seafood Watch® Sustainability Criteria for Wild-caught Species

Criterion 1: Inherent Vulnerability to Fishing Pressure

Guiding Principle: Sustainable wild-caught species have a low vulnerability to fishing pressure, and hence a low probability of being overfished, because of their inherent life history characteristics.

The two-spotted octopus ranges from Santa Monica, CA, USA south to Jalisco, Mexico (Hendrickx et al. 2005). *O. bimaculatus* prefers rocky-bottom habitats, and is a moderately sized octopus that prefers temperate waters (Ambrose 1988). Like other cephalopods, octopus exhibit life history characteristics that make them resilient to fishing pressure, including rapid growth, an early age at first maturity, and a short lifespan. In general, cephalopods live approximately one year and die after spawning (Boyle and Boletzky 1996). Although *O. bimaculatus* has been observed mating throughout the year in southern California, there is also seasonality in mating frequency (Ambrose 1988).

Environmental factors affect the distribution of octopus, as they leave the areas where they are normally caught during La Niña events and move closer to shore during El Niño events, making them more vulnerable to the fishery (CNP 2004). Both environmental factors and commercial fishing are likely to impact cephalopod populations (Boyle and Boletzky 1996). In fact, cephalopod populations have been shown to increase as a result of decreases in finfish (Boyle and Boletzky 1996). *O. bimaculatus* has been shown to be non-transient, and shelters may limit the size of octopus populations (Ambrose 1982).

In the northern part of Baja California Sur, female octopuses show stages of sexual maturity from February to April, and in the southern part of the state from July to September (CNP 2004). The maximum length reported for the two-spotted octopus is 20 cm mantle length (ML); the maximum length for *O. hubbsorum* is 9 cm (CephBase 2005). It has been estimated that *O. bimaculatus* settles at 5 mm ML, and grows to 50 mm ML over the next 8 – 10 months (Ambrose 1988). The average estimated lifespan for *O. bimaculatus* is 19 – 22 months (Ambrose 1988). The life history characteristics of cephalopods may make them susceptible to overfishing, but capable of rapid recovery (Pierce and Guerra 1994).

Table 1. Life history characteristics of octopus.

Factors Evaluated	Life History Characteristics	SFW Conservation Concern
Intrinsic rate of increase ('r')	Unavailable/unknown	Not applicable
Age at 1st maturity	Less than 1 year	**LOW** (< 5 years)
Von Bertalanffy growth coefficient ('k')	Unavailable/unknown	Not applicable
Maximum age	Approximately 1 year	**LOW** (< 11 years)
Fecundity	High reproductive potential	**LOW** (> 100 individuals/year)
Species range	Eastern Pacific only (along the coast of the U.S. and Mexico)	**HIGH** (Restricted to one coastline)
Special behaviors or requirements	No special behaviors or requirements that increase ease of capture	**LOW**
Quality of habitat	No evidence that habitat degradation has affected octopus	**LOW** (Habitat is robust)

Evaluation Guidelines

1) Primary Factors
   a) If 'r' is known, use it as the basis for the rank of the Primary Factors.
   b) If 'r' is unknown, then the rank from the remaining Primary Factors (in order of importance, as listed) is the basis for the rank.

2) Secondary Factors
   a) If a majority (2 out of 3) of the Secondary Factors rank as Red, reclassify the species into the next lower rank (i.e., Green becomes Yellow, Yellow becomes Red). No other combination of Secondary Factors can modify the rank from the Primary Factors.
   b) No combination of primary and secondary factors can result in a Critical Conservation Concern for this criterion.

Conservation Concern: Inherent Vulnerability

- **Low (Inherently Resilient)** 

Criterion 2: Status of Wild Stocks

Guiding Principle: Sustainable wild-caught species have stock structure and abundance sufficient to maintain or enhance long-term fishery productivity.

In the Pacific and Gulf of California, octopus catch-per-unit-effort (CPUE) ranges from a low number of kg to 48 kg per working day (CNP 2004). CPUE in Baja California Sur ranges from 10 – 100 kg/day; from 1989 – 1999, an average of 267 mt were caught in this state annually (Figure 3) (CNP 2004).

There is little information known about the stock status of octopus in the Gulf of California, resulting in a Seafood Watch® ranking of Unknown. In general, cephalopod recruitment is an important stock assessment parameter (Pauly 1985 in Pierce and Guerra 1994). In southern California, population declines were observed in the fall following low recruitment, while there was no decline following high recruitment (Ambrose 1988).

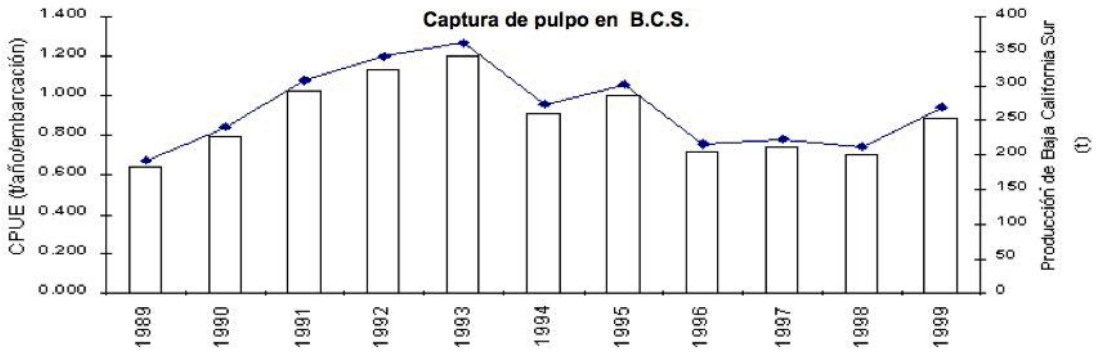

Figure 3. CPUE for octopus in Baja California Sur. (Figure from CNP 2004.)

Table 2. Stock status of octopus.

Factors Evaluated	Stock Status Characteristics	SFW Conservation Concern
Management classification status	Unknown	MODERATE
Current population abundance relative to B_{MSY}	Unknown	MODERATE
Occurrence of overfishing	Unknown	MODERATE
Overall degree of uncertainty in stock status	High	HIGH
Long and short-term trends in population abundance	Unknown, but thought to be declining	MODERATE
Current age, size or sex distribution of the stock relative to natural condition	Unknown	MODERATE

Evaluation Guidelines

A "Moderate" Stock:

1) Has a biomass at 50-100% of B_{MSY} AND overfishing is not occurring.
2) Is recovering from overfishing AND short-term trend in abundance is up AND overfishing is not occurring AND stock uncertainty is low.
3) Has an Unknown status because the majority of primary factors are unknown.

Conservation Concern: Status of Stocks

- **Moderate (Stock Unknown)** 

Criterion 3: Nature and Extent of Bycatch

Guiding Principle: A sustainable wild-caught species is captured using techniques that minimize the catch of unwanted and/or unmarketable species.

In the Gulf of California, octopus is caught by hand (by diving or in the intertidal), and with traps. There is minimal bycatch associated with these catch methods.

Table 3. Bycatch characteristics of the octopus fishery.

Factors Evaluated	Bycatch Characteristics	SFW Conservation Concern
Quantity of bycatch, including any species of "special concern" (i.e., those identified as "endangered", "threatened" or "protected" under state, federal, or international law)	Bycatch is not a concern, as octopus is caught by hand and with traps	**LOW** (< 10% of targeted landings on a per number basis AND does not regularly include species of special concern)
Population consequences of bycatch	No evidence of population impacts	**LOW** (Evidence indicates quantity of bycatch has little or no impact on population levels)
Trend in bycatch interaction rates (adjusting for changes in abundance of bycatch species) as a result of management measures (including fishing seasons, protected areas, and gear innovations)	Not applicable because bycatch is low	Not applicable
Evidence that the ecosystem has been or likely will be substantially altered (relative to natural variability) in response to the continued discard of the bycatch species	Unknown	**MODERATE**

Evaluation Guidelines

Bycatch is "Minimal" if the quantity of bycatch is <10% of targeted landings AND bycatch has little or no impact on population levels.

Conservation Concern: Nature and Extent of Discarded Bycatch

- **Low (Bycatch Minimal)** 

Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems

Guiding Principle: Capture of a sustainable wild-caught species maintains natural functional relationships among species in the ecosystem, conserves the diversity and productivity of the surrounding ecosystem, and does not result in irreversible ecosystem state changes.

Pots and traps are generally considered to have low biological habitat impacts and moderate physical habitat impacts (Chuenpagdee et al. 2003). Dive methods and intertidal collection have no appreciable impact on the bottom habitat.

Table 4. Habitat and ecosystem effects of the octopus fishery.

Factors Evaluated	Fishing Practices Characteristics	SFW Conservation Concern
Known (or inferred from other studies) effect of fishing gear on physical and biogenic habitats	Diving/by hand: No damage Traps: Moderate damage	Diving/by hand: **LOW** (e.g., pelagic longline, midwater gillnet, midwater trawl, purse seine, hook and line, or spear/harpoon) Traps: **MODERATE** (e.g., bottom gillnet, bottom longline or pots/ traps)
For specific fishery being evaluated, resilience of physical and biogenic habitats to disturbance by fishing method	Diving/by hand: Not applicable because gear damage is minimal Traps: High resiliency to disturbance	Diving/by hand: Not applicable Traps: **LOW** (e.g., shallow water, sandy habitats)
If gear impacts are moderate or great, spatial scale of the impact	Diving/by hand: Not applicable because gear damage is minimal Traps: Small scale fishery	Diving/by hand: Not applicable Traps: **LOW** (e.g., small, artisanal fishery or sensitive habitats are strongly protected)
Evidence that the removal of the targeted species or the removal/deployment of baitfish has or will likely substantially disrupt the food web	Unknown	**MODERATE**
Evidence that the fishing method has caused or is likely to cause substantial ecosystem state changes, including alternate stable states	Unknown	**MODERATE**

Evaluation Guidelines

The effect of fishing practices is "Benign" if damage from gear is minimal AND resilience to disturbance is high AND both Ecosystem Factors are not red.

The effect of fishing practices is "Moderate" if:

1) Gear effects are moderate AND resilience to disturbance is moderate or high AND both Ecosystem Factors are not red.
2) Gear results in great damage AND resilience to disturbance is high OR impacts are small scale AND both Ecosystem Factors are not red.

Conservation Concern: Effect of Fishing Practices on Habitats and Ecosystems

Diving/by hand:

- **Low (Fishing Effects Benign)** 

Trap:

- **Moderate (Fishing Effects Moderate)** 

Criterion 5: Effectiveness of the Management Regime

Guiding Principle: The management regime of a sustainable wild-caught species implements and enforces all local, national, and international laws and utilizes a precautionary approach to ensure the long-term productivity of the resource and integrity of the ecosystem.

The commercial divers that catch octopus in Puerto Peñasco have taken the initiative to participate in the management of their fishery and petitioned the government to delay the opening of the octopus season by a month to allow for increased recruitment (Cudney-Bueno 2000). The only federal management measure in place for octopus in the Pacific and Gulf of California is a commercial fishing permit (CNP 2004). Reference points include taking the necessary measures if catch declines to lower than 200 mt in Jalisco, lower than 100 mt in Sonora, Baja California, and Baja California Sur, and lower than the average of the last five years for the other states (CNP 2004). The fishery is at its maximum sustainable yield (CNP 2004). The CNP (2004) recommends that fishing effort for octopus not increase, and for the areas of Baja California Sur where there are possibilities to develop the fishery, the increase in fishing effort will be determined by a technical planning report.

Management strategies include increasing biological studies. Between May and July in Jalisco and Colima, females have been observed with maximum gonadal development (CNP 2004). A closed season by region needs to be validated with more studies (CNP 2004). In addition, a minimum catch size should be studied to ensure that juveniles are not caught (CNP 2004). Young octopus should not be caught, and it is prohibited to kill octopus using chlorinated compounds and other types of chemicals (CNP 2004). Enforcement, however, is minimal. For management to be considered "Moderately Effective" according to Seafood Watch® criteria, management would need to be characterized by regular collection of data and adequate enforcement, and the management process would need to utilize a scientifically independent stock assessment.

Table 5. Management effectiveness of the octopus fishery.

Factors Evaluated	Management Characteristics	SFW Conservation Concern

Stock Status: Management process utilizes an independent scientific stock assessment that seeks knowledge related to the status of the stock	No stock assessment available	**HIGH**
Scientific Monitoring: Management process involves regular collection and analysis of data with respect to the short and long-term abundance of the stock	No regular collection or analysis of data	**HIGH**
Scientific Advice: Management has a well-known track record of consistently setting catch quotas beyond those recommended by its scientific advisors and other external scientists	Not enough information available to evaluate OR not applicable because little or no scientific information is collected	Not applicable
Bycatch: Management implements an effective bycatch reduction plan	Not applicable because bycatch is low	Not applicable
Fishing practices: Management addresses the effect of the fishing method(s) on habitats and ecosystems	Not applicable because fishing method is moderate or benign; the use of chlorinated compounds and chemicals is prohibited	Not applicable
Enforcement: Management and appropriate government bodies enforce fishery regulations	Regulations not regularly and consistently enforced	**HIGH**
Management Track Record: Conservation measures enacted by management have resulted in the long-term maintenance of stock abundance and ecosystem integrity	Unknown	**MODERATE**

Evaluation Guidelines

Management is deemed to be “Ineffective” if three individual management factors are red, especially those for Stock Status and Bycatch.

Conservation Concern: Effectiveness of Management

- **High (Management Ineffective)** 

Overall Evaluation and Seafood Recommendation

Octopuses are considered inherently resilient to fishing pressure due to life history characteristics such as an early age at maturity, rapid growth, and a short lifespan. However, there is a paucity of data concerning the stock status of octopus in the Gulf of California, particularly for the two-spotted octopus, which is the primary species targeted and marketed in this region. Octopus is caught with traps, diving, and by hand. These gear methods have minimal bycatch concerns. The habitat impacts of traps rank as a moderate conservation concern, while diver and hand-caught methods have no appreciable habitat effects. Management of the octopus fishery, however, is considered ineffective, as the only management measure in place is a commercial fishing permit and a prohibition on the use of chemicals and chlorinated compounds. Overall, the two-spotted octopus is recommended as a **Good Alternative**.

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V. Sea Turtles

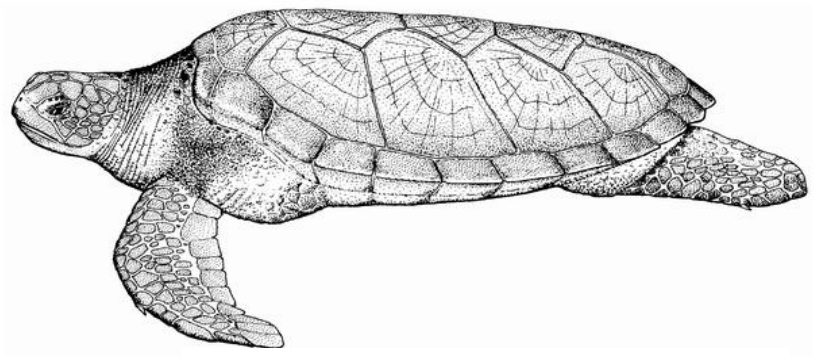
East Pacific green
Chelonia mydas agassizii

Hawksbill
Eretmochelys imbricata

Olive ridley
Lepidochelys olivacea

Loggerhead
Caretta caretta

Leatherback
Dermochelys coriacea



Chelonia mydas © FAO

Executive Summary

Five sea turtle species (East Pacific green, *Chelonia mydas agassizi*[1]; hawksbill, *Eretmochelys imbricata*; olive ridley, *Lepidochelys olivacea*; loggerhead, *Caretta caretta*; leatherback, *Dermochelys coriacea*) are found in the Gulf of California. These species are all listed under the IUCN Red List of Threatened Species, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and the U.S. Endangered Species Act (ESA), and have been protected under Mexican law since 1990 (Table 1).

Table 1. Protected status of sea turtles. Data from MTSG 1996; Red List 1996a, 1996b; Sarti Martinez 2000; Seminoff 2004; FWS 2006.

Species	Status under IUCN Red List	Status under U.S. ESA
Green	Endangered	Endangered[2], Threatened
Hawksbill	Critically endangered	Endangered
Olive Ridley	Endangered	Endangered[2], Threatened
Loggerhead	Endangered	Threatened
Leatherback	Critically endangered	Endangered

Despite the protected status of sea turtles, they continue to be consumed in many countries, including Mexico (Gardner and Nichols 2001; Seminoff et al. 2003).

[1] *Chelonia mydas agassizii* is a subspecies of *Chelonia mydas*.
[2] The breeding population of green turtles off of Florida and the Pacific coast of Mexico are Endangered. All other green turtle populations are Threatened; the breeding population of olive ridleys off the Pacific coast of Mexico are Endangered and all other olive ridleys are Threatened.

From Aguirre et al. 2006:

> In Latin America, sea turtles have historically been considered a delicacy served on special occasions such as weddings, Christmas, Mother's Day, and Easter (Caldwell 1963; Felger and Moser 1987; Garcia-Martinez and Nichols 2000). In Mexico, where Catholicism is the predominant religion, the consumption of sea turtle meat and eggs increases during Lent. Many Mexican Catholics observe religious restrictions against the consumption of red meat, and consume sea turtles due to the belief that these species are fish (Nichols et al. 2003). In addition to being a valuable food source, the use of this resource is highly ingrained as part of various regions' cultural heritages and sea turtle consumption has thus gained traditional importance (Clifton et al. 1982; Figueroa et al. 1992). Recent work in four small communities in Baja California Sur, Mexico, indicates that on average approximately one-fourth of local residents consume sea turtle approximately once monthly. Given the local population of 7,280 (INEGI 2000), sea turtle is consumed approximately 20,000 times annually in just this single coastal area. However, sea turtle consumption in this region is primarily due to taste preferences, rather than traditional uses or economic necessity (Delgado 2005).

Due to the endangered status of sea turtles, the stock status of these species is considered a critical conservation concern and thus sea turtles automatically receive the recommendation of **Avoid**. A complete evaluation using the Seafood Watch® criteria is not warranted because of the status of this single criterion.

Overall Seafood Recommendation

Best Choices | Good Alternatives | **Avoid**

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VI. Jumbo squid

Dosidicus gigas

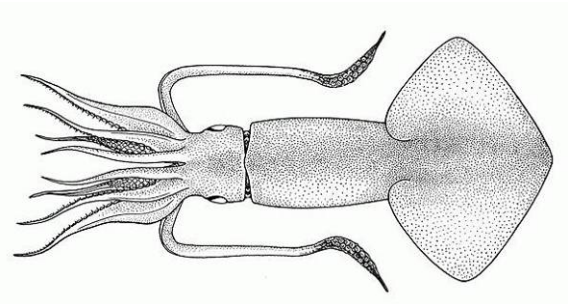

Illustration © FAO

Executive Summary

Jumbo squid, *Dosidicus gigas*, is the largest squid that is targeted in any commercial fishery. Like other cephalopods, jumbo squid exhibit life history characteristics that make them resilient to fishing pressure, including rapid growth, an early age at first maturity, and a short lifespan. Jumbo squid migrate into the Gulf of California for feeding and breeding, where they are caught with jig gear by various fleets. There are negligible bycatch and habitat concerns associated with the jumbo squid fishery, as jig gear catches the squid one at a time, and does not come into contact with the seafloor. However, there is moderate uncertainty associated with the stock status of jumbo squid in the Gulf of California, as there is no stock assessment for this species. It has been estimated that proportional escapement (the number of spawners alive at the end of the fishing season as a proportion of those that would have been alive with no fishing) is above the management target. The number of unknown factors related to the stock status of jumbo squid results in a moderate conservation concern according to Seafood Watch® criteria. The jumbo squid fishery is managed by permits, effort limits, and a quota. However, enforcement of these regulations is minimal, and there is no stock assessment for this species, resulting in a moderate conservation concern for management effectiveness. Overall, the preceding suite of criteria results in a recommendation of **Good Alternative** for jumbo squid from the Gulf of California.

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	**Low**	**Moderate**	**High**	**Critical**
Inherent Vulnerability	√			
Status of Stocks		√		
Nature of Bycatch	√			
Habitat & Ecosystem Effects	√			
Management Effectiveness		√		

About the Overall Seafood Recommendation:

- A seafood product is ranked **Best Choice** if three or more criteria are of Low Conservation Concern (green) and the remaining criteria are not of High or Critical Conservation Concern.
- A seafood product is ranked **Good Alternative** if the five criteria "average" to yellow (Moderate Conservation Concern) OR if the "Status of Stocks" and "Management Effectiveness" criteria are both of Moderate Conservation Concern.
- A seafood product is ranked **Avoid** if two or more criteria are of High Conservation Concern (red) OR if one or more criteria are of Critical Conservation Concern (black) in the table above.

Overall Seafood Recommendation

Best Choice | **Good Alternative** | Avoid

Introduction

Common names for jumbo squid include jumbo flying squid, Humboldt squid, giant squid, *jibia gigante* (CephBase 2002), and *calamar gigante*. Fishermen also refer to jumbo squid as red devils, or *diablos rojos*.

In the Gulf of California, the fishery for jumbo squid began in the mid-1970s, and consisted of artisanal fleets fishing from *pangas* during the summer months when the squid were close to shore (Ehrhardt et al. 1983). Fishermen use lights to attract jumbo squid, which are then caught with jig gear either by hand or with a machine with a variable number of jigs per line (CNP 2004). After a high biomass of squid occurred in the Gulf of California in the late 1970s, additional fleets began targeting jumbo squid, including a Japanese jig fleet, and a vessel fleet of shrimp trawlers with six to 10 fishermen with hand jigs (Morales-Bojórquez et al. 2001a). However, the fishery dissipated in the mid-late 1980s due to low squid abundance (Morales-Bojórquez et al. 2001a). The decline of the fishery between 1983 and 1987 has been attributed to both environmental conditions and recruitment overfishing (Klett 1996 in Morales-Bojórquez et al. 2001b). In 1996, the fishery once again became prominent following a high abundance scenario, with approximately 140,000 mt of jumbo squid caught by the shrimp trawl fleet and two artisanal fleets (Morales-Bojórquez et al. 2001a).

Catch data from the Gulf of California show a low, stable trend in catches until the mid-1990s when catches increased dramatically (Figure 1) (Nevárez-Martínez et al. 2000). Catch was at its highest levels from 1995 to 1999, with a peak catch of 144,200 mt in 1997 (CNP 2004). Catch of jumbo shrimp increases during the summer months when the shrimp fishery for brown and blue shrimp is closed (Morales-Bojórquez and López-Martínez 1999).

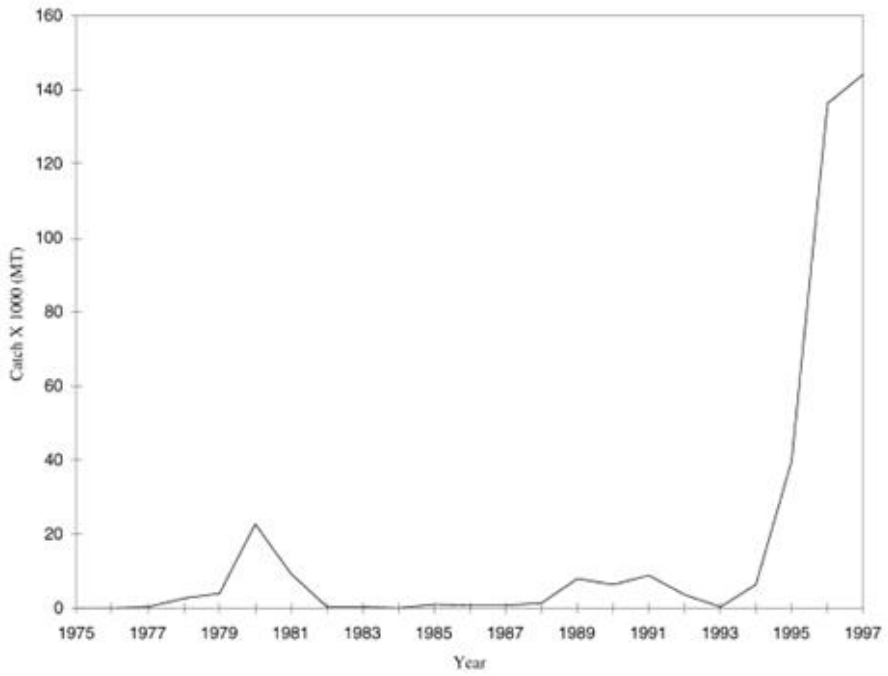

Figure 1. Annual catch of jumbo squid in the Gulf of California. (Figure from Nevárez-Martínez et al. 2000.)

The fishery has a seasonal component, with the Baja California Sur fishery occurring in spring and summer and the Sonora fishery occurring during fall and winter (Hernández-Herrera et al. 1998). Jumbo squid can be found in the central Gulf year-round, while the fishery occurs off of Guaymas from November to May (Markaida et al. 2005). Fishing effort increases from May to September due to the presence of the shrimp fleet (Hernández-Herrera et al. 1998). The Guaymas basin in the central Gulf is the source of 95% of the jumbo squid landings in Mexico (Markaida et al. 2005). Fishing effort is variable due to the availability and abundance of the resource (CNP 2004).

Analysis of Seafood Watch® Sustainability Criteria for Wild-caught Species

Criterion 1: Inherent Vulnerability to Fishing Pressure

Guiding Principle: Sustainable wild-caught species have a low vulnerability to fishing pressure, and hence a low probability of being overfished, because of their inherent life history characteristics.

The jumbo squid is largely pelagic and may migrate long distances (Mangold 1976 in Markaida et al. 2005). Small-scale migrations also occur within the Gulf of California (Markaida et al. 2005). Squid populations are highly variable in Mexican waters and are affected by large scale environmental conditions such as El Niño (Morales-Bojórquez 2002; Nevárez-Martínez et al. 2002; CNP 2004). Jumbo squid migrations are related to water temperature and feeding (Ehrhardt 1991), and the Gulf of California is likely a feeding ground based on the predominance of mature males in the population (Markaida and Sosa-Nishizaki 2001).

In the Gulf of California, there is one cohort of jumbo squid that recruits in May; this cohort supports the fishery throughout the year (Hernández-Herrera et al. 1998). The spawning season for jumbo squid lasts from February to May (Hernández-Herrera et al. 1998). Off of Guaymas, jumbo squid 6 months of age are reproductive (at mantle lengths between 24 and 50 cm); Hernández-Herrera et al. (1996) found the length at first maturity for females was 42.2 cm and for males was 51.6 cm. Large females and males mature later, at 1 year and 10 months of age, respectively (Markaida et al. 2004). Like other cephalopods, jumbo squid live approximately one year and die after spawning; this and other life history characteristics make jumbo squid inherently resilient to fishing pressure (Table 1). The life history characteristics of cephalopods may make them susceptible to recruitment overfishing, but capable of rapid recovery (Pierce and Guerra 1994).

Table 1. Life history characteristics of jumbo squid.

Factors Evaluated	Life History Characteristics	SFW Conservation Concern
Intrinsic rate of increase ('r')	Unavailable/unknown	Not applicable
Age at 1st maturity	4 – 6 months (females), 2 – 3 months (males)	**LOW** (< 5 years)
Von Bertalanffy growth coefficient ('k')	0.8/year with Linf = 87 cm mantle length	**LOW** (> 0.16)
Maximum age	Approximately 1 year	**LOW** (< 11 years)
Fecundity	High reproductive potential	**LOW** (> 100 individuals/year)
Species range	Eastern Pacific from British Columbia to Argentina	**HIGH** (Restricted to one coastline)
Special behaviors or requirements	Hunt and migrate in schools	**MODERATE** (1 – 2 behaviors or requirements that increase vulnerability)
Quality of habitat	No evidence that habitat degradation has affected squid	**LOW** (Habitat is robust)

Evaluation Guidelines

1) Primary Factors
   a) If 'r' is known, use it as the basis for the rank of the Primary Factors.
   b) If 'r' is unknown, then the rank from the remaining Primary Factors (in order of importance, as listed) is the basis for the rank.

2) Secondary Factors
   a) If a majority (2 out of 3) of the Secondary Factors rank as Red, reclassify the species into the next lower rank (i.e., Green becomes Yellow, Yellow becomes Red). No other combination of Secondary Factors can modify the rank from the Primary Factors.
   b) No combination of primary and secondary factors can result in a Critical Conservation Concern for this criterion.

Conservation Concern: Inherent Vulnerability

- **Low (Inherently Resilient)** 

Criterion 2: Status of Wild Stocks

Guiding Principle: Sustainable wild-caught species have stock structure and abundance sufficient to maintain or enhance long-term fishery productivity.

Several individual studies have estimated jumbo squid biomass and proportion escapement. Catch data are the only data available showing any long-term trend. Using catch and effort data from October 1995 to March 1996, Morales-Bojórquez et al. (2001a) estimated the jumbo squid population at 82,000 mt with a proportional escapement of 66%, which is above the management

target of 40% proportional escapement. Other assessments, using data from a biomass survey in October 1996, estimated the proportional escapement at 27 – 40%, with a remaining biomass of 34,890 – 65,560 mt in May (Hernández-Herrera et al. 1998). The estimated total abundance was 171,150 mt (Hernández-Herrera et al. 1998). Additional estimates of biomass abundance based on a 20-day research cruise in May/June 1996 ranged from 85,513 – 118,170 mt depending on the assessment method used (Nevárez-Martínez et al. 2000). Due to the high number of licenses requested for this fishery, a precautionary approach for management would use a biomass estimate of 79,613 – 93,413 mt (Nevárez-Martínez et al. 2000). Research cruises conducted from 1996 – 1999 show that squid biomass was variable: 94,000 mt in May 1996; 171,000 mt in October 1996; 36,000 mt in November 1997; 3,000 mt in December 1998; and 30,000 mt in May 1999 (Nevárez-Martínez et al. 2002). The CPUE trend was variable in the 1995/96, 1996/97, and 1997/98 fishing years (Morales-Bojórquez et al. 2001b). A biomass model has been developed that allows for some estimate of squid biomass (Morales-Bojórquez et al. 2001b).

There is no government stock assessment or official classification for jumbo squid in the Gulf of California; thus it is unknown if the stock is overfished or if overfishing is occurring (Table 2). Ehrhardt et al. (1983) suggested that the fishery was approaching MSY. In general, cephalopod recruitment is an important stock assessment parameter (Pauly 1985 in Pierce and Guerra 1994).

Table 2. Stock status of jumbo squid.

Factors Evaluated	Stock Status Characteristics	SFW Conservation Concern
Management classification status	Unknown	**MODERATE**
Current population abundance relative to target proportional escapement (40%)	1.65 (most recent data estimated proportional escapement at 66%)	**LOW** (At or above management target)
Occurrence of overfishing	Unknown	**MODERATE** (No estimate of F and no management target)
Overall degree of uncertainty in stock status	High	**HIGH** (Estimates are out of date)
Long-term and short-term trends in population abundance	Highly variable due to environmental conditions	**MODERATE** (Trend is variable)
Current age, size or sex distribution of the stock relative to natural condition	Unknown	**MODERATE**

Evaluation Guidelines

A "Moderate" Stock:

1) Has a biomass at 50-100% of B_{MSY} AND overfishing is not occurring
2) Is recovering from overfishing AND short-term trend in abundance is up AND overfishing not occurring AND stock uncertainty is low
3) Has an Unknown status because the majority of primary factors are unknown.

Conservation Concern: Status of Stocks

- **Moderate (Stock Moderate)**

Criterion 3: Nature and Extent of Bycatch

Guiding Principle: A sustainable wild-caught species is captured using techniques that minimize the catch of unwanted and/or unmarketable species.

As jumbo squid are caught with highly selective jig gear, there is minimal bycatch associated with this fishery. Jig fisheries are generally considered to have "very low to negligible discard rates" (Kelleher 2004). Worldwide, the weighted average discard rate for squid jig fisheries is low, at 0.1% (Kelleher 2004).

Evaluation Guidelines

Bycatch is "Minimal" if the quantity of bycatch is <10% of targeted landings AND bycatch has little or no impact on population levels.

Conservation Concern: Nature and Extent of Discarded Bycatch

- **Low (Bycatch Minimal)** 

Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems

Guiding Principle: Capture of a sustainable wild-caught species maintains natural functional relationships among species in the ecosystem, conserves the diversity and productivity of the surrounding ecosystem, and does not result in irreversible ecosystem state changes.

Jig gear does not come into contact with the seafloor, thus there are no effects on the biogenic and physical habitat in the jumbo squid fishery (Chuenpagdee et al. 2003). In addition, Chuenpagdee et al. (2003) conclude that gears with low collateral impacts are less of a management priority than more damaging gears, unless protected species interact with the fishery. There is no evidence of any ecosystem impacts associated with the jumbo squid fishery.

Evaluation Guidelines

The effect of fishing practices is "Benign" if damage from gear is minimal AND resilience to disturbance is high AND both Ecosystem Factors are not red.

Conservation Concern: Effect of Fishing Practices on Habitats and Ecosystems

- **Low (Fishing Effects Benign)** 

Criterion 5: Effectiveness of the Management Regime

Guiding Principle: The management regime of a sustainable wild-caught species implements and enforces all local, national, and international laws and utilizes a precautionary approach to ensure the long-term productivity of the resource and integrity of the ecosystem.

Management measures for the jumbo squid fishery include commercial fishing permits, effort controls, and an annual quota based on evaluations of the vulnerable biomass by the INP (Instituto Nacional de la Pesca) (Table 3) (CNP 2004). There are currently permits for 180 large vessels and 2,000 small vessels in the Gulf of California jumbo squid fishery (CNP 2004).

The reference point to maintain for jumbo squid is a minimum escapement of 40% of the adult biomass at the end of the fishing season (CNP 2004). Escapement is defined as the number of spawners alive at the end of the fishing season as a proportion of those that would have been alive with no fishing (Hernández-Herrera et al. 1998). According to the CNP (Carta Nacional Pesquera) (2004), the jumbo squid fishery has development potential, subject to the seasonal variability in squid biomass due to their migration pattern and rapid growth. According to Hernández-Herrera et al. (1998, p. 217), management decisions in the jumbo squid fishery involve three risks: 1) fishing without a license; 2) changes in catchability, selectivity, and accessibility to the fishing fleets; and 3) changes in natural mortality due to migration and reproduction.

Overall, management of the jumbo squid fishery is considered moderately effective according to Seafood Watch® criteria due to the lack of a management plan and a government stock assessment, and minimal enforcement.

Table 3. Management effectiveness of the jumbo squid fishery.

Factors Evaluated	Management Characteristics	SFW Conservation Concern
Stock Status: Management process utilizes an independent scientific stock assessment that seeks knowledge related to the status of the stock	Some fishery-dependent assessments have been conducted	MODERATE
Scientific Monitoring: Management process involves regular collection and analysis of data with respect to the short and long-term abundance of the stock	Regular collection of fishery-dependent data only	MODERATE
Scientific Advice: Management has a well-known track record of consistently setting catch quotas beyond those recommended by its scientific advisors and other external scientists	Not enough information available	Not applicable
Bycatch: Management implements an effective bycatch reduction plan	Bycatch is low	Not applicable

Factors Evaluated	Management Characteristics	SFW Conservation Concern
Fishing practices: Management addresses the effect of the fishing method(s) on habitats and ecosystems	Fishing method is benign	Not applicable
Enforcement: Management and appropriate government bodies enforce fishery regulations	Regulations are not regularly and consistently enforced	**HIGH**
Management Track Record: Conservation measures enacted by management have resulted in the long-term maintenance of stock abundance and ecosystem integrity	Management measures include permits, effort controls, and a quota. It is unknown if these measures have resulted in the long-term maintenance of stock abundance.	**MODERATE**

Evaluation Guidelines

Management is deemed to be "Moderately Effective" if:

1) Management factors "average" to yellow
2) Management factors include one or two red factors

Conservation Concern: Effectiveness of Management

- **Moderate (Management Moderately Effective)** 

Overall Evaluation and Seafood Recommendation

Like other cephalopods, jumbo squid have a short life span, an early age at first maturity, and exhibit rapid growth. These characteristics make jumbo squid resilient to fishing pressure. As jumbo squid are caught with jig gear, there are no bycatch or habitat concerns associated with this fishery. However, squid abundance is highly variable in response to environmental conditions, and there is no stock assessment for jumbo squid in the Gulf of California, thus the stock status is a moderate conservation concern. The only information available concludes that proportional escapement (currently 66%) is greater than the management reference point (40%). While there are some management measures in place for the jumbo squid fishery, there is minimal enforcement and no comprehensive management plan. Management of the fishery is thus considered a moderate conservation concern. Overall, jumbo squid caught in the Gulf of California is considered a **Good Alternative** due to the suite of factors discussed above.

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VII. Spiny lobster

Panuliris interruptus, P. inflatus, P. gracilis

Illustration © Monterey Bay Aquarium

Executive Summary

There are three species of spiny lobster that are the primary targets of a commercial fishery along the Pacific coast of Mexico. Off the western coast of the Baja peninsula *Panulirus interruptus* is the primary species targeted, and the fishery in the central fishing zone of the coast (from Isla Cedros to Punta Abreojos) is certified to the Marine Stewardship Council (MSC) standard. *P. interruptus* is moderately vulnerable to fishing pressure, and there is adequate information showing that the stock status of this species is acceptable. This portion of the fishery is caught with traps, which have little bycatch and moderate habitat concerns. Management of the fishery is considered highly effective due to management measures and sufficient compliance and enforcement. The other two species caught in the Mexican Pacific are *P. gracilis* and *P. inflatus*; these species are caught primarily in the Gulf of California. There is generally less information known about the status of these stocks, and management is considered moderately effective due to problems with compliance and enforcement. In addition to traps, these two species are also caught with tangle nets and by hand. The bycatch associated with the tangle net fishery is a high conservation concern. Overall, *P. interruptus* is recommended as a **Best Choice**, and *P. gracilis* and *P. inflatus* are recommended as **Good Alternatives**. Catch of *P. interruptus* dominates the spiny lobster catch in the Mexican Pacific, thus the overall recommendation for spiny lobster from the Pacific coast of Mexico is a Best Choice.

Look for the MSC logo to identify MSC-certified seafood. The detailed MSC report on the certification of the Mexican red rock lobster fishery can be found at: http://www.msc.org/assets/docs/mexican_baja_lobster/Final_%20BC%20Lobster_032704.pdf.

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	**Low**	**Moderate**	**High**	**Critical**
Inherent Vulnerability		√		
Status of Stocks	√ (*P. interruptus*)	√ (*P. gracilis, P. inflatus*)		
Nature of Bycatch	√ (Traps)		√ (Tangle nets)	
Habitat & Ecosystem Effects		√		
Management Effectiveness	√ (*P. interruptus*)	√ (*P. gracilis, P. inflatus*)		

About the Overall Seafood Recommendation:

- A seafood product is ranked **Best Choice** if three or more criteria are of Low Conservation Concern (green) and the remaining criteria are not of High or Critical Conservation Concern.
- A seafood product is ranked **Good Alternative** if the five criteria "average" to yellow (Moderate Conservation Concern) OR if the "Status of Stocks" and "Management Effectiveness" criteria are both of Moderate Conservation Concern.
- A seafood product is ranked **Avoid** if two or more criteria are of High Conservation Concern (red) OR if one or more criteria are of Critical Conservation Concern (black) in the table above.

Overall Seafood Recommendation

***P. interruptus* (MSC-certified):**

Best Choice Good Alternative Avoid

***P. gracilis* and *P. inflatus*:**

Best Choice **Good Alternative** Avoid

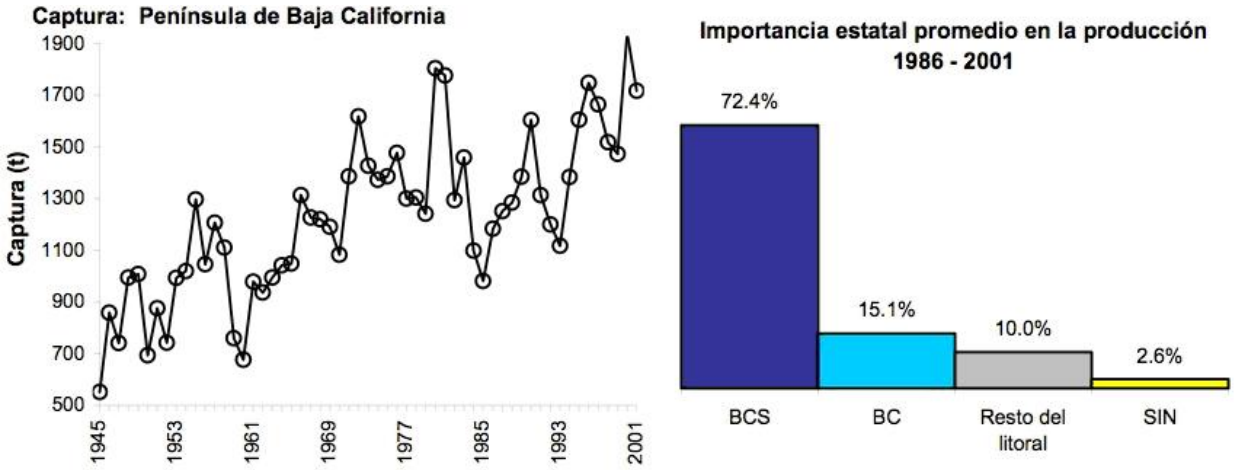
Introduction

Three species of spiny lobster are caught off Mexico's Pacific coast; *Panulirus interruptus* is the primary species caught off the western coast of the Baja peninsula, and *P. gracilis* and *P. inflatus* are the primary species caught in the Gulf of California. *P. interruptus* accounts for the majority of catch in this region of Mexico, and a portion of the fishery is certified to the Marine Stewardship Council (MSC) standard. The MSC certification program evaluates the sustainability of a fishery before labeling the product, signifying "…environmentally responsible fishery management and practices" (MSC 2004). There is generally more information available on this fishery.

The Mexican fisheries for tropical spiny lobster developed in the mid-1970s (Peréz-González et al. 2002a). Over the last 13 years, the catch of *P. gracilis* and *P. inflatus* has averaged 132 mt per year (Peréz-González et al. 2002a). *P. gracilis* is a high-value species landed in Guaymas (Arvizu-Martínez 1987). The trend in landings is variable, with low periods often followed by a period of high abundance, related to environmental conditions (Peréz-González et al. 2002a). In the 1980s and 1990s, catch of spiny lobster increased as a result of increased demand from the growing tourism industry (Peréz-González et al. 2002a). Overall, *P. interruptus* catch has increased since the 1940s, with a maximum catch of 1,973 mt observed in 2000/01 (SCS 2004, 2005). For the Baja California peninsula, catch has increased over the same time period, with Baja California Sur accounting for the majority of the catch (Figures 1a,1b) (CNP 2004).

The spiny lobster fishery is primarily an artisanal fishery, and there is little statistical data related to the *P. gracilis* and *P. inflatus* fishery in the Gulf of California (Peréz-González et al. 2002a). Illegal fishing for these species is also thought to occur (Peréz-González et al. 2002a). Catch data varies seasonally, with the highest catch rates occurring from November to February. Many methods are used to catch *P. gracilis* and *P. inflatus*, including traps, bottom-set tangle nets (gillnets) called *chinchorros langosteros*, SCUBA diving, skin diving, and hooking (using a J-shaped hook to pull lobsters out of crevices) (Peréz-González et al. 2002a). Traps are the only gear used to catch *P. interruptus* in the MSC-certified fishery.

P. interruptus is known as Mexican spiny lobster, red lobster, California lobster, or *langosta mexicana*. *P. inflatus* is known as blue spiny lobster, *prieta*, Cortez spiny lobster, or red spiny lobster. *P. gracilis* is known as green spiny lobster, *arenera*, or *playera* spiny lobster.



Figures 1a, 1b. Catch increases in Baja California since the mid-1940s; Baja California Sur accounts for the majority of spiny lobster catch (Figures from CNP 2004).

Analysis of Seafood Watch® Sustainability Criteria for Wild-caught Species

Criterion 1: Inherent Vulnerability to Fishing Pressure

Guiding Principle: Sustainable wild-caught species have a low vulnerability to fishing pressure, and hence a low probability of being overfished, because of their inherent life history characteristics.

The three species evaluated in this report are found on the Mexican Pacific coast (Table 1) (Peréz-González et al. 2002a). Tropical spiny lobsters are inshore, shallow-dwelling species, and the fishery occurs at depths of less than 35 meters (m) (Peréz-González et al. 2002a). *P. inflatus* lives in rocky bottom habitat, while *P. gracilis* lives in rocky and gravel-sand bottom habitat (Peréz-González et al. 2002a).

The abundance of juvenile and adult *P. inflatus* and *P. gracilis* varies with depth, and in general these species are found in depths from 8 – 18 m (Peréz-González et al. 2002a). *P. inflatus* and *P. gracilis* have multiple broods throughout the year (Peréz-González et al. 2002a). Important parameters such as growth, mortality, age at maturity, and recruitment measures need to be re-evaluated (Peréz-González et al. 2002a). For *P. inflatus* and *P. gracilis*, size at first maturity is 47.5 – 49.4 mm and 47.5 – 53.0 mm carapace length, respectively (Peréz-González et al. 2002a). The age at first maturity for *P. interruptus* is estimated at 3 – 4.5 years for males and 5 – 6 years for females (SCS 2004). Due to this age at first maturity, spiny lobsters are considered moderately vulnerable to fishing pressure. Maximum age for *P. interruptus* is 20 years for females and 30 years for males (CADFG 2001).

Migrations of spiny lobsters have been observed along the coast of Sinaloa (Peréz-González et al. 2002a). *P. interruptus* is considered highly fecund (Tapia-Vázquez and Castro-González 2000).

Table 1. Life history characteristics of spiny lobsters.

Factors Evaluated	Life History Characteristics	SFW Conservation Concern
Intrinsic rate of increase ('r')	Unavailable/unknown	Not applicable
Age at 1st maturity	*P. interruptus*: 3 – 4.5 years for males, 5 – 6 years for females	Males: **LOW** (< 5 years) Females: **MODERATE** (5 – 10 yrs)
von Bertalanffy growth coefficient ('k')	*P. inflatus*: Linf = 320.6 TL, k = 0.268 *P. gracilis*: Linf = 296.6 TL, k = 0.381	**LOW** (> 0.16)
Maximum age	Male *P. interruptus* can live up to 30 years, females up to 20 years	**MODERATE** (11 – 30 yrs)
Fecundity	Average number of eggs for *P. interruptus* is 265,487	**LOW** (> 100 individuals/year)
Species range	Mexican Pacific coast	**HIGH** (Restricted to one coastline)
Special behaviors or requirements	Spiny lobsters have been observed to migrate along the coast	**MODERATE** (1 – 2 behaviors or requirements that increase vulnerability)
Quality of habitat	No evidence that habitat degradation has affected spiny lobster populations	**LOW** (Habitat is robust)

Evaluation Guidelines

1) Primary Factors
   a) If 'r' is known, use it as the basis for the rank of the Primary Factors.
   b) If 'r' is unknown, then the rank from the remaining Primary Factors (in order of importance, as listed) is the basis for the rank.

2) Secondary Factors
   a) If a majority (2 out of 3) of the Secondary Factors rank as Red, reclassify the species into the next lower rank (i.e., Green becomes Yellow, Yellow becomes Red). No other combination of Secondary Factors can modify the rank from the Primary Factors.
   b) No combination of primary and secondary factors can result in a Critical Conservation Concern for this criterion.

Conservation Concern: Inherent Vulnerability

- **Moderate (Moderately Vulnerable)**

Criterion 2: Status of Wild Stocks

Guiding Principle: Sustainable wild-caught species have stock structure and abundance sufficient to maintain or enhance long-term fishery productivity.

Over the last three decades, the mean size of *P. gracilis* and *P. inflatus* has declined steadily in the southeastern Gulf of California, suggesting a lack of compliance with regulations and a lack of enforcement (Peréz-González et al. 2002a). It is possible that fishing pressure has caused a decrease in the age at first maturity and an increase in fecundity, as female spiny lobsters with eggs are sometimes kept and not released (Peréz-González et al. 2002a). There is little information available concerning the stock status of these species and thus stock status is considered unknown.

Vega et al. (2000) concluded that the current biomass of *P. interruptus* is above the optimum level; however, an increase of 20% above the mean catch would result in biomass declines, and catch should not exceed 1,239 mt for the central region of the coast. CPUE for *P. interruptus* in the central fishing zone has increased over the past 20 years (Ramade et al. 1994, Espinoza-Castro 1999, both in SCS 2004). The INP conducts a scientific stock assessment that uses MSY as a management objective; however, the stock assessment conducted by Armando Vega has not been reviewed and accepted by the INP (SCS 2004, 2005).

The main portion of the *P. interruptus* stock occurs along the Pacific coast of Baja from Isla Cedros to Punta Abreojos, most of which is part of the Vizcaíno Biosphere Reserve (SCS 2004). The central zone of the *P. interruptus* fishery accounts for approximately 80% of the total production of spiny lobster in Baja (SCS 2005). Reference points used in the fishery include actual population biomass (42% of the virgin population), spawning biomass (67% of the actual biomass), and potential egg production (39% of the virgin level) (CNP 2004). In the central region, the fishery is exploited at MSY, while areas north and south of the Baja peninsula show signs of a declining stock (SCS 2005).

Table 2. Stock status of spiny lobster.

Factors Evaluated	Stock Status Characteristics	SFW Conservation Concern
Management classification status	*P. interruptus:* Exploited at MSY *P. gracilis* & *P. inflatus:* Unknown	*P. interruptus:* **MODERATE** (Fully fished) *P. gracilis* & *P. inflatus:* **MODERATE** (Unknown)
Current population abundance relative to B_{MSY}	*P. interruptus*: Current biomass is above the optimum level *P. gracilis* & *P. inflatus:* Unknown	*P. interruptus:* **LOW** (At or above management target) *P. gracilis* & *P. inflatus:* **MODERATE** (Unknown)
Occurrence of overfishing	*P. interruptus*: Unknown, no estimate of F_{MSY} *P. gracilis* & *P. inflatus:* Unknown	**MODERATE** (Unknown)
Overall degree of uncertainty in stock status	*P. interruptus*: Low *P. gracilis* & *P. inflatus:* High	*P. interruptus:* **LOW** (Reliable long-term fishery-dependent data available) *P. gracilis* & *P. inflatus:* **HIGH** (little or no current fishery-dependent or independent info. on stock status)
Long and short-term trends in population abundance	*P. interruptus*: Variable based on CPUE *P. gracilis* & *P. inflatus:* Unknown	*P. interruptus:* **MODERATE** *P. gracilis* & *P. inflatus:* **MODERATE**

Factors Evaluated	Stock Status Characteristics	SFW Conservation Concern
Current age, size or sex distribution of the stock relative to natural condition	*P. interruptus*: No evidence that stock distribution is skewed *P. gracilis* & *P. inflatus:* Mean size has declined steadily	*P. interruptus:* **LOW** (Distribution(s) is(are) functionally normal) *P. gracilis* & *P. inflatus:* **HIGH** (Distribution(s) is(are) skewed)

Evaluation Guidelines

A "Healthy" Stock:

1) Is underutilized (near virgin biomass).
2) Has a biomass at or above B_{MSY} AND overfishing is not occurring AND distribution parameters are functionally normal AND stock uncertainty is not high.

A "Moderate" Stock:

1) Has a biomass at 50 – 100% of B_{MSY} AND overfishing is not occurring.
2) Is recovering from overfishing AND short-term trend in abundance is up AND overfishing is not occurring AND stock uncertainty is low.
3) Has an Unknown status because the majority of primary factors are unknown.

Conservation Concern: Status of Stocks

P. interruptus:

- **Low (Stock Healthy)** 

P. gracilis and *P. inflatus*:

- **Moderate (Stock Unknown)** 

Criterion 3: Nature and Extent of Bycatch

Guiding Principle: A sustainable wild-caught species is captured using techniques that minimize the catch of unwanted and/or unmarketable species.

The traps used to catch *P. gracilis* and *P. inflatus* are designed for the conditions in the Gulf of California, and differ from the traps used to catch *P. interruptus* on the Pacific coast of Baja (Peréz-González et al. 2002a). Since the 1980s, the use of *chinchorros* has increasingly replaced the use of traps in the Gulf of California, particularly in Sinaloa (Peréz-González et al. 2002a).

Nine fishing cooperatives are part of the MSC certification process, and set plastic-covered wire traps from *pangas*; the use of *chinchorros* is not permitted in Baja California (SCS 2004). The traps are equipped with escape gaps in order to allow the smaller spiny lobsters to escape, which reduces the catch of undersized spiny lobsters in this fishery (SCS 2004).

When tangle nets (*chinchorros*) are used to catch spiny lobster, the nets often soak for a period of 24 hours (Peréz-González et al. 2002a). The longer the nets soak, the more fishes, crustaceans, and mollusks get stuck in the net, attracting spiny lobsters to these immobile prey (Peréz-González et al. 2002a). Mesh size of these nets ranges from 10.16 – 15.24 cm (4 – 6 in) (Peréz-González et al. 2002b).

In the portion of the fishery using *chinchorros*, bycatch is estimated to compose almost 70% of the catch in the spiny lobster fishery (Peréz-González et al. 1999 in Peréz-González et al. 2002b). Fishes are the main bycatch species, and are often kept and sold or used for personal consumption; crustaceans may also be kept and sold as curios to tourists (Peréz-González et al. 2002b). In the *P. interruptus* fishery, bycatch species include finfishes, moray eels, small sharks, abalone, pismo clam, algae, top shell, crabs, octopus, and sea cucumber (SCS 2004).

While 20% of lobster traps are replaced each year, it is unknown what percentage of these are lost at sea; however, ghost fishing is thought to be minimal in this fishery (SCS 2004).

Table 3. Bycatch characteristics of the spiny lobster fishery.

Factors Evaluated	Bycatch Characteristics	SFW Conservation Concern
Quantity of bycatch, including any species of "special concern" (i.e., those identified as "endangered," "threatened," or "protected" under state, federal, or international law)	Trap: No known interactions with threatened and endangered species Net: Up to 70% of total catch	Trap: **LOW** (<10% of targeted landings on a per number basis AND does not regularly include species of special concern) Net: **HIGH** (Quantity of bycatch is high at >100% of targeted landings on a per number basis)
Population consequences of bycatch	No evidence of population impacts	**LOW** (Evidence indicates quantity of bycatch has little or no impact on population levels)
Trend in bycatch interaction rates (adjusting for changes in abundance of bycatch species) as a result of management measures (including fishing seasons, protected areas, and gear innovations)	Trap: Not applicable because bycatch is low Net: Unknown	Trap: Not applicable Net: **MODERATE**
Evidence that the ecosystem has been or likely will be substantially altered (relative to natural variability) in response to the continued discard of the bycatch species	Unknown	**MODERATE**

Evaluation Guidelines

Bycatch is "Minimal" if:

1) Quantity of bycatch is <10% of targeted landings AND bycatch has little or no impact on population levels.

Bycatch is "Severe" if:

1) Quantity of bycatch is >100% of targeted landings.
2) Bycatch regularly includes species of "special concern" AND evidence indicates bycatch rate is a contributing factor toward extinction or limiting its recovery AND trend in bycatch is down.

Conservation Concern: Nature and Extent of Bycatch

Traps and by hand:

- **Low (Bycatch Minimal)** 

Tangle nets:

- **High (Bycatch Severe)** 

Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems

Guiding Principle: Capture of a sustainable wild-caught species maintains natural functional relationships among species in the ecosystem, conserves the diversity and productivity of the surrounding ecosystem, and does not result in irreversible ecosystem state changes.

In the *P. interruptus* fishery, traps are set on rocky and sandy bottoms where there are no hard coral species (SCS 2004). Pots and traps are generally considered to have low biological habitat impacts and moderate physical habitat impacts (Chuenpagdee et al. 2003).

There have been few studies examining the possible ecosystem impacts of the spiny lobster fishery, and such studies have thus far not been deemed necessary (SCS 2004). The baitfishes used in the fishery include sardines, mackerel, and bonito, and are not thought to come from problematic fisheries (SCS 2004). A condition stated in the MSC-certification report requires that a strategy must be incorporated into the management system that addresses the ecosystem impacts of the fishery (SCS 2004).

Table 4. Habitat and ecosystem effects of the spiny lobster fishery.

Factors Evaluated	Fishing Practices Characteristics	SFW Conservation Concern
Known (or inferred from other studies) effect of fishing gear on physical and biogenic habitats	Moderate damage	**MODERATE** (e.g., bottom gillnet, bottom longline or pots/ traps)
For specific fishery being evaluated, resilience of physical and biogenic habitats to disturbance by fishing method	High resiliency to disturbance	**LOW** (e.g., shallow water, sandy habitats)
If gear impacts are moderate or great, spatial scale of the impact	Small scale fishery	**LOW** (e.g., small, artisanal fishery or sensitive habitats are strongly protected)

Factors Evaluated	Fishing Practices Characteristics	SFW Conservation Concern
Evidence that the removal of the targeted species or the removal/ deployment of baitfish has or will likely substantially disrupt the food web	Unknown	MODERATE
Evidence that the fishing method has caused or is likely to cause substantial ecosystem state changes, including alternate stable states	Unknown	MODERATE

Evaluation Guidelines

The effect of fishing practices is "Moderate" if:

1) Gear effects are moderate AND resilience to disturbance is moderate or high AND both Ecosystem Factors are not red.
2) Gear results in great damage AND resilience to disturbance is high OR impacts are small scale AND both Ecosystem Factors are not red.

Conservation Concern: Effect of Fishing Practices on Habitats and Ecosystems

- **Moderate (Fishing Effects Moderate)** 

Criterion 5: Effectiveness of the Management Regime

Guiding Principle: The management regime of a sustainable wild-caught species implements and enforces all local, national, and international laws and utilizes a precautionary approach to ensure the long-term productivity of the resource and integrity of the ecosystem.

P. interruptus

Regulation of the *P. interruptus* fishery includes a minimum legal size, restrictions on keeping egg-bearing females, and restrictions on fishing gear and rights in specific zones and areas (SCS 2004). In the western coast of Baja, the fishery is managed through stepped closures based on latitudinal variations in the reproductive cycle of the species (SCS 2004). The control rule for *P. interruptus* is to: "Maintain the fishery at a level to harvest the maximum surplus production while maintaining the population biomass at values above the $B_0/2$ biomass estimate (B_0, the estimated virtual population biomass)" (SCS 2004, p. 35), or maintain the stock above half of its original condition.

There are also annual quotas for the *P. interruptus* fishery that 95% of the fishermen are regulated by (SCS 2004). In the MSC-certified portion of the *P. interruptus* fishery, occurring in the central fishing zone, illegal fishing is virtually non-existent (SCS 2004). Compliance with regulations in this fishery is thought to be high (SCS 2004).

P. gracilis* and *P. inflatus

Better management of these spiny lobster fisheries is necessary due to increased demand (Peréz-González et al. 2002a). Management of the spiny lobster fisheries in the Gulf of California is complicated, as managers have tended to favor short-term yields rather than long-term benefits, and there is a lack of long-term assessments and biological studies of these species (Sala and Torres 1997 in Peréz-González et al. 2002a). In general, there is little regulatory compliance and no strict enforcement of spiny lobster fisheries in the Gulf of California (Peréz-González et al. 2002a).

While the different fishing cooperatives have different management measures, the main regulations include a closed system, a minimum legal size (82.5 mm carapace length in the southwest coast of Baja, 75 mm carapace length from Michoacan to Chiapas), and a prohibition on keeping egg-bearing females (Peréz-González et al. 2002a). Despite these regulations, the egg-bearing females and lobsters below the minimum size are often kept (Peréz-González et al. 2002a). There are no regulations concerning the size and type of traps or *chinchorros*, limits on fishing effort, catch quotas, or regulations concerning the dive fishery (Peréz-González et al. 2002a). Enforcement varies by region, as some fishing cooperatives have their own enforcement agreements (Peréz-González et al. 2002a).

Overall, the management measures in place for the MSC-certified portion of the *P. interruptus* fishery is considered to have highly effective management, while the *P. gracilis* and *P. inflatus* fisheries are considered to have moderately effective management due to enforcement and compliance issues.

Table 5. Management effectiveness of the spiny lobster fishery.

Factors Evaluated	Management Characteristics	SFW Conservation Concern
Stock Status: Management process utilizes an independent scientific stock assessment that seeks knowledge related to the status of the stock	*P. interruptus*: stock assessment complete *P. gracilis* & *P. inflatus*: unknown	*P. interruptus*: **LOW** (Stock assessment complete and robust) *P. gracilis* & *P. inflatus*: **MODERATE**
Scientific Monitoring: Management process involves regular collection and analysis of data with respect to the short and long-term abundance of the stock	For the MSC-certified *P. interruptus* fishery, catch and fishing effort statistics are recorded daily and commercial sampling has been conducted since 1989, and an assessment method has been used since 1990 to identify depleted stocks	*P. interruptus*: **LOW** (Regular collection and assessment of both fishery-dependent and independent data) *P. gracilis* & *P. inflatus*: **MODERATE** (Regular collection of fishery-dependent data only)
Scientific Advice: Management has a well-known track record of consistently setting catch quotas beyond those recommended by its scientific advisors and other external scientists	Not enough information available to evaluate	Not applicable

Factors Evaluated	Management Characteristics	SFW Conservation Concern
Bycatch: Management implements an effective bycatch reduction plan	*P. interruptus:* Bycatch is deemed low in the trap fishery, thus no bycatch reduction plan is necessary *P. gracilis* & *P. inflatus*: No bycatch reduction plan for the tangle net fishery	Trap fishery for all species: Not applicable *P. gracilis* & *P. inflatus*: **HIGH** for the tangle net portion of the fishery
Fishing practices: Management addresses the effect of the fishing method(s) on habitats and ecosystems	Habitat and ecosystem effects of the fishery are moderate, thus mitigative measures are not necessary	Not applicable
Enforcement: Management and appropriate government bodies enforce fishery regulations	There is thought to be compliance with *P. interruptus* fishery regulations, but not with the *P. gracilis* & *P. inflatus* fisheries in the Gulf of CA	*P. interruptus*: **LOW** (Regulations regularly enforced by independent bodies, including logbook reports, observer coverage, dockside monitoring, and similar measures) *P. gracilis* & *P. inflatus*: **HIGH** (Regulations not regularly and consistently enforced)
Management Track Record: Conservation measures enacted by management have resulted in the long-term maintenance of stock abundance and ecosystem integrity	*P. interruptus*: Management has maintained stock productivity over time *P. gracilis* & *P. inflatus*: Unknown	*P. interruptus*: **LOW** *P. gracilis* & *P. inflatus*: **MODERATE**

Evaluation Guidelines

Management is deemed to be "Highly Effective" if the majority of management factors are green AND the remaining factors are not red.

Management is deemed to be "Moderately Effective" if:

1) Management factors "average" to yellow
2) Management factors include one or two red factors

Conservation Concern: Effectiveness of Management

P. interruptus:

- **Low (Management Highly Effective)** 

P. gracilis and *P. inflatus*:

- **Moderate (Management Moderately Effective)** 

Overall Evaluation and Seafood Recommendation

All three spiny lobster species captured along Mexico's Pacific coast (*Panulirus interruptus*, *P. gracilis*, and *P. inflatus*) are moderately vulnerable to fishing pressure due to their age at first maturity. The most common catch method for spiny lobster is traps, and other gears such as tangle nets and hand methods are also used to catch *P. gracilis* and *P. inflatus*. There is minimal bycatch associated with trap-caught spiny lobsters, and habitat impacts are considered moderate for this gear type. There is, however, high bycatch associated with the tangle net fishery for *P. gracilis* and *P. inflatus*. Information on the stock status of *P. interruptus* indicates that stocks of this spiny lobster are healthy. The status of *P. gracilis* and *P. inflatus* is unknown. There is adequate compliance and enforcement of regulations for the *P. interruptus* fishery, but not for *P. gracilis* and *P. inflatus*. Management effectiveness is thus deemed highly effective for the former, and moderately effective for the latter. Overall, the MSC-certified *P. interruptus* fishery is recommended as a **Best Choice**, and the *P. gracilis* and *P. inflatus* fisheries are recommended as **Good Alternatives**.

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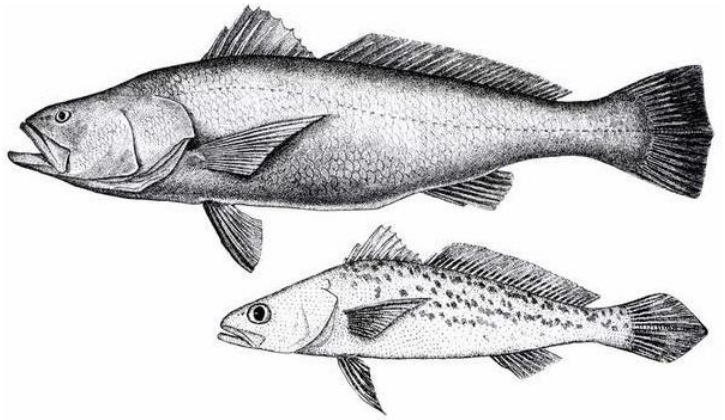
VIII. Totoaba

Totoaba macdonaldi



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Executive Summary

The totoaba, *Totoaba macdonaldi*, is a sciaenid, and the largest fish in this family, with a maximum reported length of 2 m and a maximum reported weight of 100 kg (Barrera-Guevara 1990). Totoaba is also known as Mexican giant bass (Román-Rodríguez and Hammann 1997). It is listed as a "specially protected species" in Mexico, and is considered a species vulnerable to global extinction (Musick et al. 2000). The totoaba was listed as a protected species in 1976 under the CITES endangered species list (Barrera-Guevara 1990), and is listed as critically endangered under the IUCN Red List of Threatened Species (Contreras-Balderas and Almada-Villela 1996). Totoaba was added to the U.S. Endangered Species Act in 1979 to stop imports, thereby reducing the demand and poaching of this species (Cisneros-Mata et al. 1995); the fishery for totoaba was banned by the Mexican government in 1975 (Román Rodríguez and Hammann 1997; Brusca et al. 2001; Brusca et al. 2004). However, an illegal fishery for totoaba continues, often using gillnets, which also catch the endangered vaquita (*Phocoena sinus*) (Vidal 1995 in Brusca et al. 2001; D'Agrosa et al. 2000; Brusca et al. 2004). Totoaba was found in U.S. and Mexican restaurants as recently as 1992 (Anderson and Herman 1993 in Cisneros-Mata et al. 1995).

Totoaba is endemic to the Gulf of California, exhibits low productivity, and migrates annually in schools (Cisneros-Mata et al. 1995; Musick et al. 2000). Totoaba spawn near the Colorado River Delta on soft, shallow bottoms (Barrera-Guevara 1990; Cisneros-Mata et al. 1995); individuals spawn once per year (Barrera-Guevara 1992). The mean age at first maturity for totoaba is 6 years for males and 7 years for females (Cisneros-Mata et al. 1995). The maximum age of totoaba has been estimated at greater than 24 years (Román Rodríguez and Hammann 1997). The quality of spawning and nursery habitat in the Delta has been degraded as a result of water diversions in the Colorado River in the U.S. (Musick et al. 2000); the declines in freshwater flow from the Colorado resulted in concomitant declines in totoaba (Figure 1) (Cisneros-Mata et al. 1995). These life history characteristics make totoaba inherently vulnerable to overfishing.

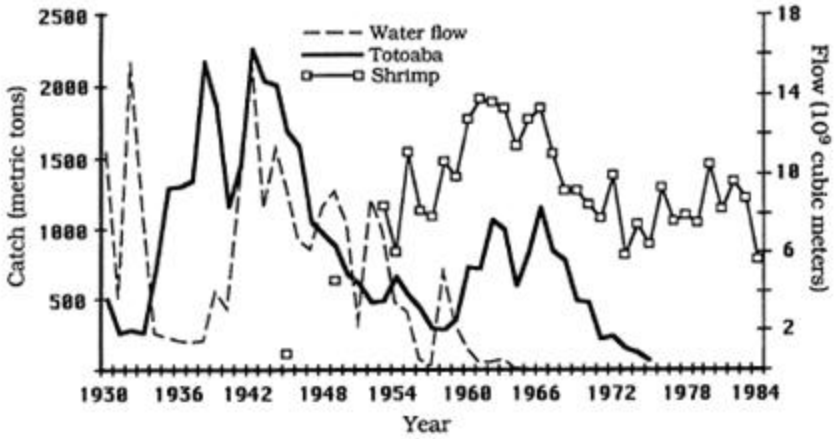

Figure 1. Annual catch of adult totoaba and shrimp in the Gulf of California, and water flow from the Colorado. Totoaba and shrimp data are from Rosales-Juárez and Ramírez-González 1987 and Magallón-Barajas 1987; water flow data are from Flanagan and Hendrickson 1976. (Figure from Cisneros-Mata et al. 1995.)

The totoaba fishery began in the early 1900s (Arvizu-Martinez 1987), and by the 1960s totoaba populations in the Gulf of California were decimated due to the targeting of spawning aggregations in the Colorado River Delta (Brusca et al. 2001; Brusca et al. 2004). Totoaba were first targeted for their stomachs for the Chinese market, in addition to the oil from their livers (Arvizu-Martinez 1987), and much of the commercial catch was exported to the U.S. (Barrrera-Guevara 1990). Catch of totoaba declined from 2,261 metric tons (mt) in 1942 to 58 mt in 1975 (Barrrera-Guevara 1990). A 1989 workshop concluded that illegal fishing and bycatch of juvenile totoaba continue to affect the totoaba population, with the latter factor considered to be most adversely affecting the population (Barrera-Guevara 1990). At completion of the 1989 workshop, 92% of juvenile totoaba were estimated as mortalities in the shrimp trawl fishery in the nursery area of the upper Gulf (Barrera-Guevara 1990). However, the creation of the Upper Gulf of California and Colorado River Delta Biosphere Reserve protects the spawning and nursing habitat of many fish species, including totoaba, and fishing pressure from shrimp trawls and gillnets has been greatly reduced (Román-Rodríguez and Hammann 1997). Strict enforcement in this region since 1993 is likely to have resulted in a decline in totoaba poaching (Cisneros-Mata et al. 1995). In the past, totoaba was subject to overfishing in the gillnet fisheries (Cisneros-Mata et al. 1995 in Musick et al. 2000), and juvenile totoaba continue to be caught as bycatch in the shrimp trawl fisheries (Arvizu-Martinez 1987; L. Findley pers. obs. in Musick et al. 2000). Habitat restoration and the elimination of both growth and recruitment overfishing are critical to increasing the population size of totoaba (Cisneros-Mata et al. 1995).

Due to the endangered status of totoaba, the stock status of this species is considered a critical conservation concern; thus, totoaba automatically receives a recommendation of **Avoid**. A complete evaluation using the Seafood Watch® criteria is not warranted because of the status of this single criterion.

Overall Seafood Recommendation

Best Choice | Good Alternative | **Avoid**

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