

# SC/69B/SM/04

**Sub-committees/working group name: SM**

**Trade demand for croaker fish maws threatens small cetaceans and other marine megafauna**

**Brian Smith, Randall Reeves, Lorenzo Rojas-Bracho**



INTERNATIONAL  
WHALING COMMISSION

Papers submitted to the IWC are produced to advance discussions within that meeting; they may be preliminary or exploratory.

It is important that if you wish to cite this paper outside the context of an IWC meeting, you notify the author at least six weeks before it is cited to ensure that it has not been superseded or found to contain errors.

# Trade demand for croaker fish maws threatens small cetaceans and other marine megafauna

Brian D. Smith<sup>1</sup>, Randall R Reeves<sup>2</sup>, Lorenzo Rojas-Bracho<sup>3</sup>

<sup>1</sup>Wildlife Conservation Society, Marine Conservation Program, Bronx, NY, USA

<sup>2</sup> Okapi Wildlife Associates, 27 Chandler Lane, Hudson, Quebec, Canada J0P 1H0 & Committee of Scientific Advisers, Marine Mammal Commission, 4340 East-West Highway, Bethesda, MD, USA

<sup>3</sup> Ocean Wise, 101-440 Cambie St, Vancouver, BC, V6B 2N5, Canada

Keywords: CONSERVATION, FISHERIES, GILLNETS, INCIDENTAL CATCHES, REGULATIONS

## Abstract

Concern about the increasing trade demand for croaker swim bladders (or maws) led to the adoption of a motion at the 2021 IUCN World Conservation Congress for *Controlling and monitoring trade in croaker swim bladders to protect target croakers and reduce incidental catches of threatened marine megafauna*. New information from Bangladesh and Papua New Guinea has revealed that demand for croaker maws is having a major negative impact on small cetaceans and other marine megafauna due to fishery bycatch, primarily in gillnets targeting croakers with high-value maws. An analysis of six threatened croaker species with high-value maws revealed that, taken together, their ranges overlap with eight threatened small cetaceans and numerous threatened shark, ray and marine turtle species. The vaquita (*Phocoena sinus*) faces imminent extinction due to bycatch in illegal fisheries targeting the CITES Appendix I-listed totoaba (*Totoaba macdonaldi*). Dried totoaba maws have been reported as sold illegally at public auctions in China for more than 100,000 USD/kg. This implies that control of trade in other croaker species should come quickly, before more marine megafauna undergo irreversible population declines. A qualitative evaluation indicated that dusky meagres (*Argyrosomus japonicus*), acoupa weakfish (*Cynoscion acoupa*), and blackspotted croakers (*Protonibea diacanthus*) had a moderate potential, and large yellow croakers (*Larimichthys crocea*) and Gulf corvinas (*Cynoscion othonopterus*) had a low potential, for successful listing in CITES Appendix II. The Chinese bahaba (*Bahaba taipingensis*) had no potential for successful listing in Appendix II because it is endemic to China and its trade is domestic. A case study of the blackspotted croaker indicated that it qualifies for CITES Appendix II because trade regulation is needed to prevent it from becoming eligible for inclusion in Appendix I, and to ensure that the harvest of specimens from the wild does not threaten survival of the species.

## BACKGROUND

At the September 2021 IUCN World Conservation Congress, a motion was adopted for *Controlling and monitoring trade in croaker swim bladders to protect target croakers and reduce incidental catches of threatened marine megafauna* (IUCN 2021). This motion (no. 132) highlighted that the increasing trade demand for croaker swim bladders (or maws; referred to in Mexico as buches) was the primary factor driving an illegal gillnet fishery for the totoaba (*Totoaba macdonaldi*; listed as Vulnerable [VU] in the IUCN Red List) in the upper Gulf of California, a fishery that was threatening, and continues to threaten, the Critically Endangered (CR) vaquita (*Phocoena sinus*) due to bycatch. It also brought attention to a similar trade demand for the maws of other large croaker species, threatening the croaker populations and exacerbating the bycatch risk to numerous other regionally and globally threatened marine megafauna, including small cetaceans, sharks, rays, and marine turtles. Among the recommendations of the IUCN motion were that (i) an analysis be produced of the impacts of trade in fish maws on croakers and other threatened marine megafauna and (ii) an evaluation be made of the effectiveness of listing croakers under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

This document summarizes new information on the maw trade in Bangladesh and Papua New Guinea and the spatial overlap between high-value croakers and threatened small cetaceans and other marine megafauna. It then considers the potential for listing additional croaker species with high-value maws in CITES Appendix II and discusses lessons learned from the totoaba-vaquita example. Finally, it presents a brief ‘case study’ to justify listing of the blackspotted croaker (*Protonibea diacanthus*) in CITES Appendix II.

## NEW INFORMATION FROM BANGLADESH AND PAPUA NEW GUINEA

### Bangladesh

A short communication titled “Is the demand for fish swim bladders driving the extinction of globally endangered marine wildlife?” (Smith *et al.* 2023) discussed the conservation impacts of the demand for maws on target croaker populations and bycaught marine megafauna in Bangladesh, and described lessons relevant to other countries where the demand for croaker maws is also high and there are similar concerns about the biodiversity impacts.

During at-sea interviews, nine of 88 fishers in the coastal waters of Bangladesh reported catching Near Threatened (NT) blackspotted croakers, both opportunistically and targeted, using gillnets and longlines (Smith *et al.* 2023). Also, between June 2015 and March 2018, 27 ‘citizen scientist’ gillnetters documented catches of 2,301 croakers, with a total weight of 2,596 kg. They reported that large croakers were sold directly to Chinese buyers for between 3,500 and 6,250 USD each. Although no dolphins or porpoises were reported as being caught, the spatial distribution of blackspotted croakers overlaps with priority habitat of Endangered (EN) Irrawaddy dolphins (*Orcaella brevirostris*), VU Indo-Pacific humpback dolphins (*Sousa chinensis*), and VU Indo-Pacific finless porpoises (*Neophocaena phocaenoides*). Incidental mortality of all three cetacean species has been recorded in this fishery. Sharks were caught in 21.9%, marine turtles in 8.0%, and rays in 2.9% of the gillnet sets that caught croakers. Of greatest concern were catches of 125 CR scalloped hammerhead sharks (*Sphyrna lewini*), 20 VU olive ridley turtles (*Lepidochelys olivacea*), and 13 VU longtail butterfly rays (*Gymnura poecilura*).

A newspaper article published in January 2020, titled “Fish maw no longer worthless!” stated that maw exports from Bangladesh to Hong Kong, China, Vietnam, and the United Arab Emirates earned about two billion BDT or 24 million USD per year (The Business Standard 2020). Although the records were undifferentiated by species, Smith *et al.* (2023) also reported that according to Hong Kong Customs, 42,650 kg, 29,361 kg and 29,356 kg of fish maw were imported from Bangladesh in 2014, 2015, and 2016, respectively.

The trade demand for croaker maws is having a major negative impact on small cetaceans, sharks, rays and marine turtles in Bangladesh (Smith *et al.* 2023). Many species from these taxa were already facing a high risk from bycatch before gillnet fisheries intensified due to the extraordinarily high prices paid to fishers to meet the international trade demand for croaker maws.

## Papua New Guinea

Another paper titled “Maw money, maw problems: A lucrative fish maw fishery in Papua New Guinea” (Amepou *et al.* 2024) linked globalization and the Chinese Belt and Road Initiative to the rapid development of a dedicated gillnet fishery for croakers and other fishes with high-value maws, primarily scaly croakers (*Nibea squamosa*) and barramundi (*Lates calcarifer*). Amepou *et al.* (2024) documented an increase in the prices fishers were paid for dried scaly croaker maws from 2,900 USD/kg in October 2019 to 15,615 USD/kg in August 2022, with Chinese expatriate buyers supplying the nets, boats, and engines to the fishers on the condition that they sell their fishery products only to them.

That paper also highlighted the major impacts the fishery was having on threatened marine megafauna, including 69 fatal entanglements of VU Australian snubfin dolphins (*Orcaella heinsohni*) and VU Australian humpback dolphins (*Sousa sahulensis*), as reported by Beasley (unpublished). Other marine megafauna identified as being potentially caught in this fishery included Indo-Pacific sawfishes (Pristidae), river sharks *Glyphis* sp., three species of hammerhead sharks (winghead *Eusphrya blochii*, scalloped hammerhead *Sphyrna lewini*, and great hammerhead *Sphyrna mokarran*), giant guitarfish (*Glaucostegus typus*), and bottlenose wedgefish (*Rhynchobatus australiae*), all red-listed as either CR or EN.

Amepou *et al.* (2024) suggested that, due to exceptionally high demand, fish traders are targeting fishes with high-value maws in low-income nations where rapid and unregulated exploitation is possible, indicating the need for international systems to detect such situations where capacity and management resources are lacking. They also suggested that listing fishes with high-value maws in CITES Appendix II could improve national fishery management and monitoring.

## SPATIAL OVERLAP OF HIGH-VALUE CROAKERS AND THREATENED SMALL CETACEANS

To prioritize proposals for listing croaker species in CITES Appendix II, six threatened or near-threatened croaker species were selected from Table B1 in Gorman (2020), which lists croaker species with high-value maws that have been recorded as traded internationally. The selected croaker species were the CR Chinese bahaba (*Bahaba taipingensis*) and large yellow croaker (*Larimichthys crocea*), the EN dusky meagre (*Argyrosomus japonicus*), the VU acoupa weakfish (*Cynoscion acoupa*) and Gulf corvina (*Cynoscion othonopterus*), and the NT blackspotted croaker. The overlapping distributions of these croaker species with threatened marine megafauna, indicating elevated bycatch risk, were analyzed using the advanced search feature of the IUCN Red List (<https://www.iucnredlist.org/search>) (Table 1). Results were filtered by matching the countries of occurrence and neritic habitat of each croaker species with the countries of occurrence and neritic habitat of globally threatened small cetaceans, sharks, rays, and marine turtles.

Taken together, the ranges of these six croaker species overlap with eight threatened small cetaceans, including the CR vaquita, the EN narrow-ridged finless porpoise (*Neophocaena asiaeorientalis*), Irrawaddy dolphin, and Indian Ocean humpback dolphin, and the VU Indo-Pacific finless porpoise, Australian snubfin dolphin, Indo-Pacific humpback dolphin (*Sousa chinensis*), and franciscana (*Pontoporia blainvillei*). Except for the franciscana, which is listed in CITES Appendix II, the other seven small cetacean species are listed in CITES Appendix I. In addition to the cetaceans mentioned above, the ranges of each of the six croakers overlap with an average of 59 threatened shark species, 70 threatened ray species, and four threatened marine turtle species.

## POTENTIAL FOR LISTING CROAKER SPECIES WITH HIGH-VALUE MAWS IN CITES APPENDIX II

A qualitative evaluation was made of the potential for listing the six threatened croaker species with high-value maws in CITES Appendix II (Table 1), which requires the exporting country to submit a Legal Acquisition Finding that the species was obtained according to national protection laws and a Non-Detriment Finding previously approved by the CITES Secretariat. The evaluation was based on a qualitative judgement of international trade demand, IUCN Red List status, overlap with globally threatened and CITES-protected marine megafauna, and the potential for support from range states.

Among the six threatened croakers with high-value maws, dusky meagres, acoupa weakfish, and blackspotted croakers were judged to have a moderate potential and large yellow croakers and Gulf corvinas a low potential for successful listing in CITES Appendix II. The Chinese bahaba was judged to have no potential for successful listing because the species is endemic to China and its trade is domestic, which is not regulated by CITES.

The scaly croaker, identified by Amepou *et al.* (2024) as the highest-value croaker species in PNG and the main factor driving a fishery that kills large numbers of Australian snubfin and humpback dolphins as bycatch, was not included in this analysis because, although information on bycatch may help gain the support of CITES member states, the CITES qualifying criteria for listing species in Appendix I and II are based on the potential impacts of international trade on the target species. The scaly croaker is red-listed as Least Concern, making it extremely unlikely that a proposal to include it in CITES Appendix I or II would be successful.

## **LESSONS LEARNED FROM THE TOTOABA AND VAQUITA**

Trade demand for totoaba maws drives gillnet fisheries that have caused the decline and imminent extinction of the CR vaquita due to bycatch (Rojas-Bracho and Reeves 2013; Taylor *et al.* 2017; Jaramillo-Legorreta *et al.* 2019). In 1976, the totoaba was listed in CITES Appendix I, which prohibits international trade. However, illegal gillnet fisheries targeting totoabas to satisfy international trade demand have remained high (CITES document SC70 Inf. 38).

In October 2020, two seizures of totoaba swim bladders in Hong Kong, totaling 274 kg, were reported to be worth 44 million HKD or 5.6 million USD, or about 20,400 USD/kg (The Standard 2020). Fishermen in Mexico reportedly receive between 3,500 and 5,000 USD/kg for a large totoaba maw, while the retail price in southern China varies between 20,000 and 80,000 USD/kg (Crosta *et al.* 2018). In April 2023, in Nogales, Arizona at the U.S.-Mexico border, U.S. Customs and Border Protection (CBP) seized 270 totoaba swim bladders weighing 242 pounds or 110 kg with an estimated value of 2.7 million USD. In October 2023, at San Luis Port in Arizona, the CBP seized 91 totoaba swim bladders weighing 109 pounds or 50 kg with an estimated value between 910,000 and 1,365,000 USD (<https://www.cbp.gov/newsroom/local-media-release/second-largest-seizure-arizona-protected-totoaba-swim-bladders>).

Although international trade has been illegal since 1976, a report by the Environmental Investigation Agency found that in 2015-16 dried totoaba maws were being sold at public auction in Xiamen and Guangzhou for as much as 110,603 USD/kg (EIA 2016). A more recent report found that online trade was playing an increasing role in selling totoaba maws in China and Malaysia, and that new markets for totoaba maws were emerging in Thailand and Vietnam (EIA 2024).

The trade demand for totoaba maws has also affected another croaker species, the VU Gulf corvina, which is currently overexploited (Chao and Espinosa-Perez 2021). Eighty percent of Gulf corvinas caught have been shorter than the minimum allowable length (65 cm), as authorized in the 2019 Federal Register. The price for Gulf corvina maws increased from about 100 MXN/kg in 2011 to about 272 MXN/kg in 2015, with a maximum price of about 800 MXN/kg in 2016 (EDF 2015, 2016). Organized crime has influenced the fishery for Gulf corvinas and their maws have been used as “camouflage” for totoaba maws being shipped to Asia.

The dire situation faced by the vaquita is a potent lesson on the potential impacts of the trade demand for croaker maws on other marine megafauna, especially species that are already threatened with extinction. A key challenge in controlling the trade of totoaba maws is the complexity of the supply chain dominated by organized crime (EIA 2019; Boilevin *et al.* 2023). This implies that efforts to control the trade in other croaker species through international regulatory mechanisms (i.e. CITES) should come early, before criminals take over this trade and populations of small cetaceans and other marine megafauna bycaught in croaker fisheries undergo irreversible declines.

## **BLACKSPOTTED CROAKER: A CASE STUDY FOR POTENTIAL LISTING IN CITES APPENDIX II**

### **Overview**

One croaker species identified in Smith *et al.* (2023) as playing a major role in driving the intensification of gillnet fisheries with worrisome bycatch is the blackspotted croaker. International trade demand for this species has increased dramatically in the last couple of decades due to the high value of their maws, which are consumed as a luxury or status food and for alleged medicinal properties, or purchased as a financial investment, primarily in China, the major demand center for croaker maws (Dutta *et al.* 2014; Akhilesh *et al.* 2022; Smith *et al.* 2023).

Blackspotted croakers are particularly vulnerable to overfishing because (i) adults aggregate predictably at nearshore spawning sites and (ii) there is little or no genetic exchange among local populations (Phelan *et al.* 2008; Semmens *et al.* 2010). Adults, especially large ones, are targeted due to the threefold higher price per kilogram of large versus small maws of the same species (Ghosh *et al.* 2009).

Population declines have been documented or inferred over about one quarter of the range of blackspotted croakers (Sadovy *et al.* 2020), while targeted and opportunistic fisheries catching the species are intensifying due to the extraordinarily high prices being paid to fishers for large individuals (larger fish have larger maws and larger maws fetch higher weight-per-unit prices) (Ghosh *et al.* 2009). For example, fishers in Bangladesh receive 3,500 to 6,250 USD for a single large fish of the species (Smith *et al.* 2023). There has also been an increase in prices paid to fishers for blackspotted croaker maws along the Arabian Sea coast in Gujarat, India, from the early 2000s when fishers received a maximum of 45 USD per kg for wet maws (Chavan *et al.* 2003) to 2009 when they received up to 316 USD per kg for wet maws (Ghosh *et al.* 2009). On the other side of India, along the Bay of Bengal, in 2019, a 28 kg blackspotted croaker sold for about 1,800 USD (Incredible Orissa 2019) while only a year later a 22 kg blackspotted croaker sold for about 2,100 USD (Sambadenglish.com 2020).

The population decline of blackspotted croakers has been following a similar pattern to that of the Chinese bahaba (Liu 2020), which is endemic to southern China and commercially extinct in the wild due to overfishing and a lack of fishery and trade regulations, and the totoaba (Cisneros-Mata *et al.* 2021), which is endemic to the Gulf of California, Mexico, and listed in CITES Appendix I. As the Chinese bahaba declined due to overfishing, trade demand for the totoaba increased (Boilevin *et al.* 2023). As the availability of totoaba maws declined, due to overfishing of the species, and the CITES Appendix I ban on their international trade slowly became better enforced (although see CITES document SC70 Inf. 38), the value of, and international trade in, blackspotted croakers increased dramatically (Akhilesh *et al.* 2022; Smith *et al.* 2023).

Based on the overlap of species occurrence, 215 threatened marine megafauna species (21% CR, 32% EN, and 47% VU) were identified as potentially experiencing greater extinction risk due to targeted and non-targeted catches in fisheries driven in intensity by the windfall profits made from catching blackspotted croakers. These include six small cetaceans (EN = 3, VU = 3), 86 sharks (CR = 15, EN = 26, VU = 45), 118 rays (CR = 29, EN = 39, VU = 50), and four marine turtles (CR = 1, EN = 1, VU = 2).

### **CITES Appendix II Qualifying Criteria**

The blackspotted croaker qualifies for CITES Appendix II, according to Criterion A, as it is known, or can be inferred or projected, that the regulation of trade in the species is necessary to avoid it becoming eligible for inclusion in Appendix I in the near future.

With the exception of the totoaba, which is already listed in CITES Appendix I, international trade in croaker (Sciaenidae) maws is unregulated, even though the import value of the maw trade in Hong Kong has been estimated to exceed that of shark fins by at least 100 million USD per year (Ben-Hasan *et al.* 2021). Blackspotted croakers are among the unregulated sciaenids with highly valued maws. Particularly in the last 20 years, there has been a dramatic increase in trade demand for these fish (Ghosh *et al.* 2009; Sadovy *et al.* 2019; Akhilesh *et al.* 2022) and a rapid expansion of fisheries targeting them (Ghosh *et al.* 2009; Dutta *et al.* 2014). Population declines have been documented or inferred in many parts of their range (Cheung and Pitcher 2008; Ghosh *et al.* 2010; Grubert *et al.* 2013; Sadovy *et al.* 2020).

Blackspotted croakers are particularly vulnerable because adults are overfished at spawning sites (Semmens *et al.* 2010; Taillebois *et al.* 2017; Sadovy *et al.* 2020) and their maws (especially those from large adults) are extremely valuable, some selling for more than 5,000 USD per kilogram (Gorman 2020). Therefore, international trade in blackspotted croakers needs to be regulated through listing in CITES Appendix II to prevent the species from becoming eligible for inclusion in Appendix I in the near future. The totoaba provides a compelling example of how unregulated international trade in a croaker species with high-value maws can result in a steep population decline and the need for listing in Appendix I.

The blackspotted croaker also qualifies for CITES Appendix II, according to Criterion B, as it is known, or can be inferred or projected, that regulation of trade is required to ensure that the harvest of specimens from the wild is not reducing the wild population to a level at which its survival might be threatened by continued harvesting or other influences.

Blackspotted croakers have exhibited an average documented decline of about 94% over about a quarter of their range. While population trends over the remaining three quarters of their range are unknown, the species is likely declining in many other areas (Sadovy *et al.* 2020). It is particularly vulnerable to overfishing because large concentrations of sexually mature individuals predictably occur at spawning aggregations which make them relatively easy for fishers to find and catch (Semmens *et al.* 2010; Taillebois *et al.* 2017; Sadovy de Mitcheson *et al.* 2020).

The worsening conservation status of blackspotted croakers is being driven by the extraordinarily high prices being paid to fishers for their maws, which are exported, primarily to Hong Kong and mainland China, where they are consumed as a luxury or status food or for their alleged medicinal properties, or are purchased as a financial investment (Ghosh *et al.* 2009; Sadovy *et al.* 2019; Akhilesh *et al.* 2022). The increased demand and worsening status of blackspotted croakers are expected to continue as the availability of other croaker species with high-value maws, such as the totoaba, is reduced (Smith *et al.* 2023).

## CONCLUSION

As reported in Amepou *et al.* (2024) and Smith *et al.* (2023), the extraordinary demand for croaker maw as a luxury food, primarily in China, is exacerbating the already high risk to small cetaceans and other marine megafauna from fishery bycatch, particularly in gillnets. Listing the blackspotted croaker, and possibly other sciaenids with high-value maws, in CITES Appendix II could regulate international trade and encourage effective national management, with conservation benefits not only for the croaker species and populations but also for threatened small cetaceans and other marine megafauna.

## REFERENCES

- Amepou, Y., Chin, A., Foale, S., Sant, G., Smailes, O. and Grant, M.I. 2024. Maw money, maw problems: A lucrative fish maw fishery in Papua New Guinea highlights a global conservation issue driven by Chinese cultural demand. *Conservation Letters* p.e13006.
- Akhilesh, K.V., Nakhawa, A.D., Bhendekar, S.N., Chellappan, A., Kizhakudan, S.J. and Zacharia, P.U., 2022. Fish swim-bladder trade in India. *Marine Fisheries Information Service, Technical and Extension Series, (251)*, pp. 29-32.
- Ben-Hasan, A., de Mitcheson, Y.S., Cisneros-Mata, M.A., Jimenez, E.A., Daliri, M., Cisneros-Montemayor, A.M., Nair, R.J., Thankappan, S.A., Walters, C.J. and Christensen, V. 2021. China's fish maw demand and its implications for fisheries in source countries. *Marine Policy* 132: p.104696.
- Boilevin, V., Crosta, A. and Hennige, S.J., 2023. Addressing Illegal Transnational Trade of Totoaba and Its Role in the Possible Extinction of the Vaquita. *Journal of International Wildlife Law & Policy* 26(2): 104-134.
- Chavan, B.B., Waghmare, K.B. and Kalbate, B.G., 2003. Unusual landings of ghol, *Protonibea dicanthus* in dol net at Bassien Kolliwada (Vasai) landing centre. *Marine Fisheries Information Service [India], Technical and Extension Series, 175*, pp.10-11.

Cheung, W.W. and Pitcher, T.J., 2008. Evaluating the status of exploited taxa in the northern South China Sea using intrinsic vulnerability and spatially explicit catch-per-unit-effort data. *Fisheries Research* 92(1): 28-40.

Chao, L. & Espinosa-Perez, H. 2021. *Cynoscion othonopterus*. The IUCN Red List of Threatened Species 2021: e.T183682A130934237. <https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T183682A130934237.en>. Accessed on 23 March 2024.

Cisneros-Mata, M.Á., True, C., Enriquez-Paredes, L.M., Sadovy, Y. and Liu, M. 2021. *Totoaba macdonaldi*. The IUCN Red List of Threatened Species 2021: e.T22003A2780880. <https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T22003A2780880.en>. Accessed on 02 November 2023.

Crosta, A., Sutherland, K., Talerico, C., Layolle, I. and Fatacci, B. 2018) Operation fake gold: The totoaba supply chain – From Mexico’s totoaba cartels to China’s totoaba maw wholesalers – an illegal trade killing the vaquita. Elephant Action League. Available at <https://earthleagueinternational.org/wp-content/uploads/2018/07/EAL-Operation-Fake-Gold-Final.pdf> [Accessed 9 February 2023].

Dutta, S., Giri, S., Dutta, J. and Hazra, S. 2014. Blackspotted croaker, *Protonibea diacanthus* (Lacepède, 1802): A new dimension to the fishing pattern in west Bengal, India. *Croatian Journal of Fisheries* 72(1):41-44.

EDF (Environmental Research Fund) 2015. Resultados Económicos de la Temporada de Curvina Golfina, 2015. Reporte elaborado por: José A. Fraire Cervantes, coordinador del Programa de Evaluación de EDF (jfraire@edf.org), con la colaboración de Rafael Ortiz, Director de Pesquerías, y Héctor Licón y Silvia Yee, consultores de EDF. [https://mexico.edf.org/sites/default/files/resulteconcurvina2015\\_final\\_rev.pdf](https://mexico.edf.org/sites/default/files/resulteconcurvina2015_final_rev.pdf)

EDF (Environmental Research Fund) 2016. Resultados Económicos de la temporada de Curvina Golfina, Golfo de Santa Clara 2016. Reporte elaborado por: José A. Fraire Cervantes, coordinador del Programa de Evaluación de EDF (jfraire@edf.org), con la colaboración de Rafael Ortiz, Director de Pesquerías, y Héctor Licón y Silvia Yee, consultores de EDF. <https://mexico.edf.org/sites/default/files/resultados-economicos.pdf>

EIA (Environmental Investigation Agency) 2016. Collateral damage: how illegal trade in totoaba swim bladders is driving vaquita to extinction. Environmental Investigation Agency. Available at <https://eia-international.org/wp-content/uploads/EIA-Collateral-Damage-FINAL-mr.pdf>

EIA (Environmental Investigation Agency) 2019. CITES’s Last Chance: Stop the Illegal Totoaba Trade to Save the Vaquita: Briefing to the 18th Conference of the Parties to CITES and the 71st Standing Committee (London, EIA, 2019). Available at <https://eia-international.org/wp-content/uploads/EIA-report-citess-last-chance-single-pages-for-print.pdf>.

EIA (Environmental Investigation Agency) 2024. On Borrowed Time The ongoing illegal totoaba trade driving the critically endangered vaquita to extinction. Available at <https://eia-international.org/report/on-borrowed-time/>

Ghosh, S., Mohanraj, G., Asokan, P.K., Dhokia, H.K., Zala, M.S. and Bhint, H.M. 2009. Flourishing trade of air bladders at Okha, Gujarat. *Marine Fisheries Information Service, Technical and Extension Series* 201:21-22.

Ghosh, S., Mohanraj, G., Asokan, P.K., Dhokia, H.K., Zala, M.S., Bhint, H.M. and Anjani, S. 2010. Fishery and population dynamics of *Protonibea diacanthus* (Lacepede) and *Otolithoides biauritus* (Cantor) landed by trawlers at Vanakbara, Diu, along the west coast of India. *Indian Journal of Fisheries* 57(2):15-20.

Gorman, C.E. 2020. Global Conservation Status of Croaker and Drum (Family: Sciaenidae) and Role of the Maw Trade. Master of Science, Thesis, Biological Sciences, Old Dominion University. <https://doi.10.25777/f0mz-z2vaquita5>

Incredibleorissa.com. (2019) "Odisha fisherman sells rare 28-kg ghol fish for Rs 1.5 lakh". 30 March 2019. Retrieved 3 July 2023.



IUCN 2021. 132 - Controlling and monitoring trade in croaker swim bladders to protect target croakers and reduce incidental catches of threatened marine megafauna. Available at <https://www.iucncongress2020.org/motion/132>. [Accessed 9 February 2023].

Jaramillo-Legorreta, A.M., Cardenas-Hinojosa, G., Nieto-Garcia, E., Rojas-Bracho, L., Thomas, L., Ver Hoef, J.M., Moore, J., Taylor, B., Barlow, J. and Tregenza, N. 2019. Decline towards extinction of Mexico's vaquita porpoise (*Phocoena sinus*). *Royal Society open science*, 6(7): p.190598.

Liu, M. 2020. *Bahaba taipingensis*. The IUCN Red List of Threatened Species 2020. Available at <https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T61334A130105307.en>. [Accessed 9 February 2023].

Phelan, M.J., Gribble, N.A. and Garrett, R.N., 2008. Fishery biology and management of *Protonibea diacanthus* (Sciaenidae) aggregations in far Northern Cape York Peninsula waters. *Continental Shelf Research*, 28(16):2143-2151.

Rojas-Bracho, L. and Reeves, R.R. 2013. Vaquitas and gillnets: Mexico's ultimate cetacean conservation challenge. *Endangered Species Research*, 21(1):77–87.

Rojas-Bracho, L., Gulland, F.M.D., Smith, C.R., Taylor, B., Wells, R.S., Thomas, P.O., Bauer, B., Heide-Jørgensen, M.P., Teilmann, J., Dietz, R. and Balle, J.D. 2019. A field effort to capture critically endangered vaquitas *Phocoena sinus* for protection from entanglement in illegal gillnets. *Endangered Species Research*, 38:11-27.

Rojas-Bracho, L., Taylor, B.L. and Jaramillo-Legorreta, A. 2022. *Phocoena sinus*. *The IUCN Red List of Threatened Species* 2022: e.T17028A214541137. <https://dx.doi.org/10.2305/IUCN.UK.2022-1.RLTS.T17028A214541137.en>. Accessed on 13 December 2023.

Sadovy de Mitcheson, Y., To, A.W.L., Wong, N.W., Kwan, H.Y. and Bud, W.S. 2019. Emerging from the murk: threats, challenges and opportunities for the global swim bladder trade. *Reviews in Fish Biology and Fisheries* 29:809-835.

Sadovy, Y., Janekikarn, S., Chao, L., Mok, H.-K., Sasaki, K., Liu, M., Hoshino, K., Sakai, T., Nguyen Van, Q., Santos, M., Yang, C.-H., Chen, M.-H., Yeh, H.-M. and Liu, S.-H. 2020. *Protonibea diacanthus*. The IUCN Red List of Threatened Species 2020: e.T49188717A49227587. <https://dx.doi.org/10.2305/IUCN.UK.2020-1.RLTS.T49188717A49227587.en>. Accessed on 08 November 2023.

Sambadenglish.com 2020. "Prize Catch for Odisha Fisherman; Fish Sold at Whopping Rs 1.77 Lakh". 2 October 2020. Retrieved 3 July 2023. 23–30.

Semmens, J.M., Buxton, C.D., Forbes, E. and Phelan, M.J. 2010. Spatial and temporal use of spawning aggregation sites by the tropical sciaenid *Protonibea diacanthus*. *Marine Ecology Progress Series*, 403, pp.193-203.

Smith, B.D., Mansur, E.F., Shamsuddoha, M. and Billah, G.M. 2023. Is the demand for fish swim bladders driving the extinction of globally endangered marine wildlife? *Aquatic Conservation: Marine and Freshwater Ecosystems*, 33(12):1615-1620.

Taillebois, L., Barton, D.P., Crook, D.A., Saunders, T., Taylor, J., Hearnden, M., Saunders, R.J., Newman, S.J., Travers, M.J., Welch, D.J. and Greig, A., 2017. Strong population structure deduced from genetics, otolith chemistry and parasite abundances explain vulnerability to localized fishery collapse in a large Sciaenid fish, *Protonibea diacanthus*. *Evolutionary Applications*, 10(10):978-993.

The Business Standard 2020. Fish maw no longer worthless. Available at <https://www.tbsnews.net/economy/trade/fish-maw-no-longer-worthless-39401>. [Accessed 9 February 2023]

The Standard 2020. Customs seized HK\$18 million worth of fish air bladders. Available at [https://www.thestandard.com.hk/breaking-news/section/4/158312/Customs-seized-HK\\$18-million-worth-of-fish-](https://www.thestandard.com.hk/breaking-news/section/4/158312/Customs-seized-HK$18-million-worth-of-fish-)

air-bladders?fbclid=IwAR3yTjhouJshwV4Hg1LuJhceY7gfYBfojjtg8YYjKkSPwpbdicEkbapT7c [Accessed 9 February 2023]

**Table 1.** Globally threatened croaker species that have been recorded as traded internationally in Table B1 of Gorman (2020), with information on their IUCN Red List status (CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened); countries of occurrence; relative selling price in USD (low, ≤1000/kg; med, 1,001–10,000/kg; high, >10,000/kg); a preliminary evaluation of their potential for listing in CITES Appendix II; range overlaps with small cetaceans along with their IUCN Red List status and CITES Appendix listing; and number of CR, EN or VU shark, ray, and marine turtle species that overlap in range with each croaker species.

Common & name	IUCN Red List status	Countries and territories of occurrence	Relative selling price	Preliminary evaluation of potential for CITES Appx. II listing	Range overlap with small cetaceans	Number of other threatened marine megafauna species that overlap with croaker species		
						Sharks	Rays	Marine turtle
Chinese bahaba <i>Bahaba taipingensis</i>	CR	China, Hong Kong & Macao	High	<b>None</b> – Species endemic to China and its territories and trade is within China.	Indo-Pacific finless porpoise (VU/I) Narrow-ridged finless porpoise (EN/I) Indo-Pacific humpback dolphin (VU/I)	48 species (CR = 8, EN = 18, VU = 22; CITES Appx. I = 0, Appx. II = 27)	54 species (CR = 7, EN = 18, VU = 29; CITES Appx. I = 2, Appx. II = 10)	3 species (CR = 1, EN = 1, VU = 1; All 3 listed in Appx. I)
Large yellow croaker <i>Larimichthys crocea</i>	CR	China, Hong Kong, Japan, Macao, Republic of Korea, Taiwan & Viet Nam	Low	<b>Low</b> – Species range limited mostly to states engaged in the croaker maw trade that may not support CITES listings.	Indo-Pacific finless porpoise (VU/I) Narrow-ridged finless porpoise (EN/I) Irrawaddy dolphin (EN/I) Indo-Pacific humpback dolphin (VU/I)	49 species (CR = 8, EN = 19, VU = 22; CITES Appx. I = 0, Appx. II = 25)	53 species (CR = 8, EN = 17, VU = 28; CITES Appx. I = 2, Appx. II = 14)	4 species (CR = 1, EN = 1, VU = 2; All 4 listed in CITES Appx. I)
Dusky meagre <i>Argyrosomus japonicus</i>	EN	Australia, China, Hong Kong, India, Indonesia, Iran, Japan, Macao, Mozambique, Oman, Pakistan, Republic of Korea, South Africa, Sri Lanka, Taiwan, United Arab Emirates & Viet Nam	?	<b>Moderate</b> –. Range includes states that might support a CITES Appx. II listing. Range overlap with numerous threatened (224) and CITES protected (79) marine megafauna species.	Indo-Pacific finless porpoise (VU/I) Narrow-ridged finless porpoise (EN/I) Irrawaddy dolphin (EN/I) Australian snubfin dolphin (VU/I) Indo-Pacific humpback dolphin (VU/I) Indian Ocean humpback dolphin (EN/I)	92 species (CR = 14, EN = 29, VU = 49; CITES Appx. I = 0, Appx. II = 35)	122 species (CR = 29, EN = 41, VU = 52; CITES Appx. I = 4, Appx. II = 28)	4 species (CR = 1, EN = 1, VU = 2; All 4 listed in CITES Appx. I)

Acoupa weakfish <i>Cynoscion acoupa</i>	VU	Brazil, French Guiana, Guyana, Suriname & Venezuela	Med	<b>Moderate</b> –Range includes states that might support an Appx. II listing. Range overlap with a large number of CR and CITES protected marine megafauna.	Franciscana (VU/II)	43 species (CR = 13, EN = 11, VU = 19; CITES Appx. I = 0, Appx. II = 14)	40 species (CR = 11, EN = 16, VU = 13; CITES Appx. I = 2, Appx. II = 8)	4 species (CR = 1, EN = 1, VU = 2; All 4 listed in CITES Appx. I)
Gulf corvina <i>Cynoscion othonopterus</i>	VU	Mexico	Med	<b>Low</b> – Mexico may not support after their experience with the totoaba. However, a major overlap of this species with the vaquita may be contributing to gillnet fishing pressure in the upper Gulf of CA.	Vaquita (CR/I)	36 species (CR = 8, EN = 11, VU = 17; CITES Appx. I = 0, CITES Appx. II = 14)	32 species (CR = 2, EN = 10, VU = 20; CITES Appx. I = 2, CITES Appx. II = 13)	4 species (CR = 1, EN = 1, VU = 2; All 4 listed in CITES Appx. I)
Blackspotted Croaker <i>Protonibea diacanthus</i>	NT	Australia, Bangladesh, Brunei Darussalam, Cambodia, China, Hong Kong, India, Indonesia, Iran, Japan, Malaysia, Myanmar, Oman, Pakistan, Papua New Guinea, Philippines, Republic of Korea, Singapore, Sri Lanka, Taiwan, Thailand & Viet Nam	Med	<b>Moderate</b> – IUCN Red List status as NT but elevated vulnerability at aggregation sites. Documented high trade demand and a range that overlaps with the greatest number of CR (45) and CITES Appx. I & II (79) marine megafauna species.	Indo-Pacific finless porpoise (VU/I) Narrow-ridged finless porpoise (EN/I) Irrawaddy dolphin (EN/I) Australian snubfin dolphin (VU/I) Indo-Pacific humpback dolphin (VU/I) Indian Ocean humpback dolphin (EN/I)	86 species (CR = 15, EN = 26, VU = 45; CITES Appx. I = 0, CITES Appx. II = 35)	118 species (CR = 29, EN = 39, VU = 50; CITES Appx. I = 4, CITES Appx. II = 30)	4 species (CR = 1, EN = 1, VU = 2; All listed in Appx. I)