

# Characterization of the queen conch (*Aliger gigas*) artisanal fishing prior and after the five-year ban at Chinchorro Bank Biosphere Reserve, Mexico

## Caracterización de la pesca artesanal del caracol rosado (*Aliger gigas*) antes y después de la veda de cinco años en la Reserva de la Biosfera del Banco Chinchorro, México

### Caractérisation de la pêche artisanale du lambi (*Aliger gigas*) avant et après l'interdiction de cinq ans dans la réserve de biosphere de Chinchorro Bank, Mexique

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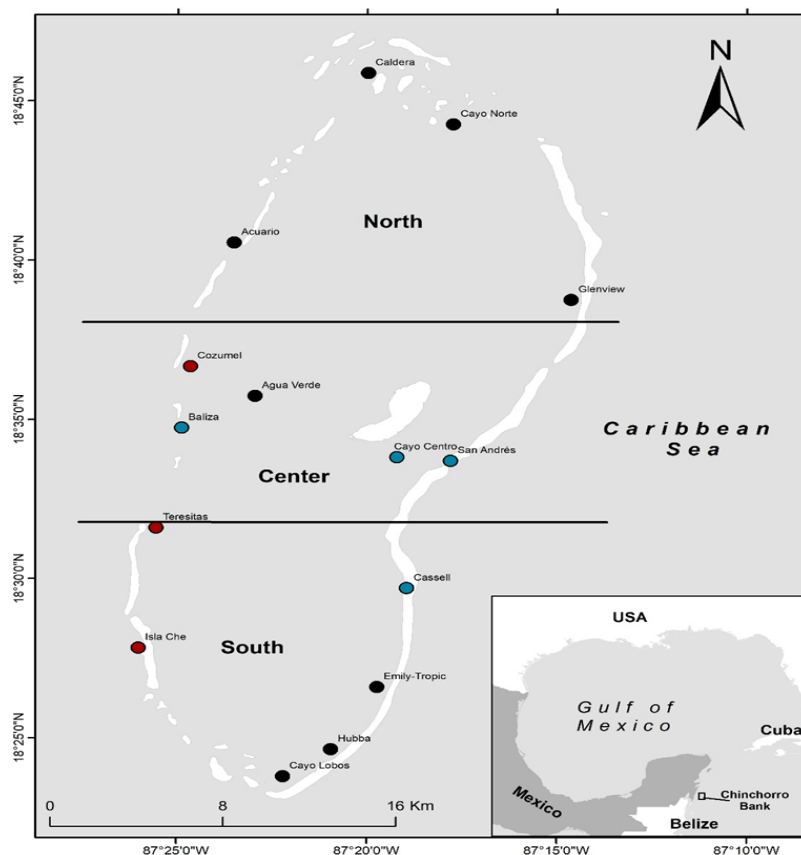
#### EXTENDED ABSTRACT

The queen conch *Aliger gigas* (Linnaeus, 1758), a marine gastropod belonging to the Strombidae family, is an invertebrate of great ecological importance in artisanal fishing and within Caribbean culture (Aldana-Aranda and Brulé-Desmarais, 1994). Presently, an annual production of approximately 7,800 tonnes of conch meat is estimated for the Caribbean, corresponding to approximately \$74 million USD and benefiting approximately 20,000 artisanal fishermen (Prada et al., 2017). During the 1980s, the queen conch was considered one of the most important fishery resources surpassed only by the spiny lobster (Aiken et al., 1999). However, due to the growing exploitation to satisfy commercial demand and an increase in illegal fishing, populations of this species have decreased in several Caribbean countries (Acosta, 2006). By 2011, Chinchorro Bank was the only site in Mexico where legal extraction of *A. gigas* was allowed through catch quotas that were determined annually based on population studies by INAPESCA and conceded to only three fishing cooperatives (Andrés Quintana Roo, Pescadores del Banco Chinchorro and Langosteros del Caribe). Nevertheless, the decrease in population size and densities resulted in a reduction in the catch quota. Due to the latter, the fishing sector proposed a five-year ban (García-Rivas et al., 2012) that went into effect from November 20, 2012 to February 28, 2017 (DOF, 2012). The present study is the first characterization of artisanal fishing of the queen conch during the last fishing season prior to the ban and the second season after the ban in Chinchorro Bank, Mexico.

The Chinchorro Bank Biosphere Reserve (CHBBR) is an atoll-like reef complex located south of Quintana Roo, Mexico (18°47'-18°23'N, 87°14'-87°27'W). For the characterization of queen conch artisanal fishing in Chinchorro Bank, interviews and field samplings were carried out before the ban during December 2011 and January 2012. A second sampling period was carried out for three days in the second fishing season after the ban in January 2018. During both fishing seasons, a total of 90 fishing vessels were interviewed (54 prior to the ban and 36 after the ban) to collect data relating to fishing effort (fishing grounds, number of fishermen, fishing hours and fuel in liters) and landings (kg of conch meat at 50% clean). Fishing vessels were randomly selected, and a representative sample of the captured conchs was sampled (mean  $\pm$  standard deviation: 268  $\pm$  117 conchs). The following information was recorded: SL, lip thickness (LT) in mm, and depth in m. The population size structure of *A. gigas* was based on 10 mm SL intervals to compare the size distribution between fishing seasons using Dmax from Kolmogorov-Smirnov (K-S). In addition, the percentage of organisms within the minimum size limit ( $\geq$  200 mm LS) pursuant to the Mexican Official Norm (NOM-013-PESC-1994) and the percentage of mature conchs were estimated following the criteria proposed by Boman et al. (2018), which use LT  $\geq$  15 mm as a reference for both fishing seasons.

A total of 15 fishing sites located mainly within the reef lagoon were recorded, 12 sites were recorded prior to the ban, and seven sites were recorded after the ban (Figure 1). It was observed that fishermen preferred harvesting conchs in the central zone, which accounts for 55% and 80% of the recorded visits in each fishing season, respectively. On average, each fishing vessel prior to the ban operated with 3.8 fishermen for a period of 4.4 hours a day, consuming up to 27.7 L of fuel, while after the ban in 2018, each fishing vessel operated with an average of 3.7 fishermen for 4.9 hours a day and 29.9 L of fuel. Likewise, there were significant differences between the mean CPUE prior to (5.09  $\pm$  2.4 kg of meat conch/fisherman per hour) and after (8.0  $\pm$  4.5 kg of meat conch/fisherman per hour) the ban in the Chinchorro Bank (t-test = -4.06; P = 0.001).

A total of 4882 individuals were collected, of which 4021 were collected prior to the ban in 2011-2012 and 861 were collected after the ban in 2018. Prior to the ban, the SL ranged between 100 and 308 mm (averaging 213.9  $\pm$  21.7 mm), and the LT ranged between 1 and 20 mm (3.7  $\pm$  3.5 mm), while after the ban, the corresponding values were between 160 and 310 mm SL (202.8  $\pm$  17.4 mm) and 1 and 35 mm LT (10.3  $\pm$  6.1 mm). There were significant differences in SL and LT between fishing seasons (W = 1.13; P < 0.01 and W = 2.88; P < 0.01, respectively). There were significant differences



**Figure 1.** Location of study area of the queen conch (*Aliger gigas*) artisanal fishery at Chinchorro Bank Biosphere Reserve, Mexico. Black points indicate fishing sites that only were registered prior the ban, red points indicate sites that only were registered after the ban, and blue points indicate sites that coincide in both fishing seasons. Lines separate the fishing zones .

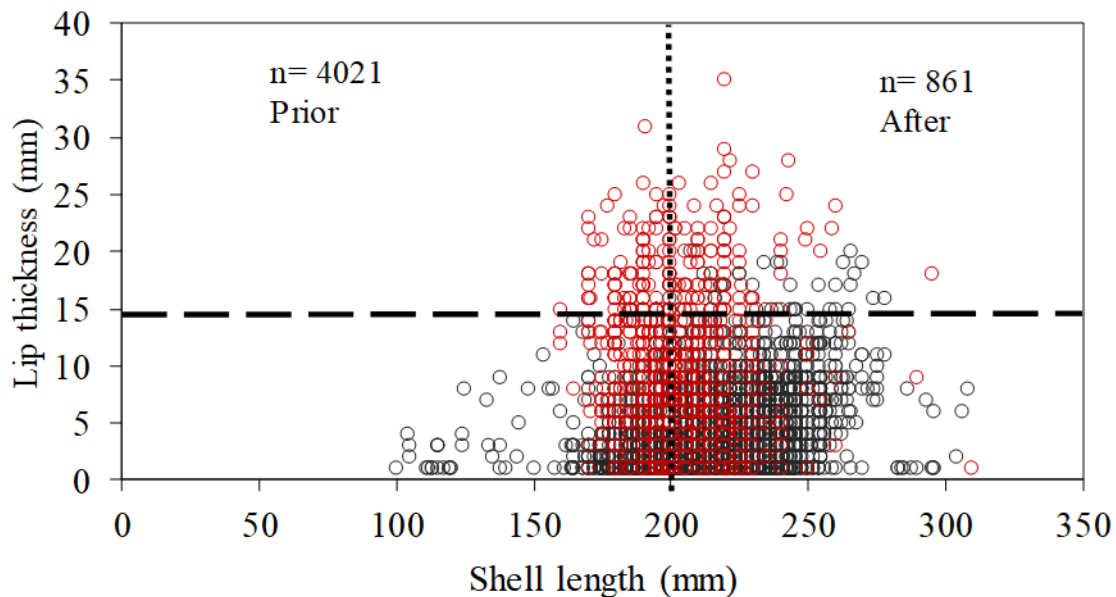
between size structures prior to the ban, where larger sizes were recorded, compared to those from the after ban ( $D_{max} = 8.40$ ;  $P < 0.001$ ).

It was observed that 22.8% and 40.4% of the samples did not meet the criteria for the legal size limit according to NOM-PESC-1994 ( $SL \geq 200$  mm) prior to and after the five-year ban, respectively. However, these percentages represented 19% and 36.1% of the organisms between 180 and 199 mm SL, respectively.

Analysis of the percentage of mature individuals based on lip thickness, reflected that prior to the ban, only 1% of the population reached an  $LT \geq 15$  mm and that the majority of the conchs exceeded 200 mm in SL without reaching 10 mm in LT, while after the ban, the percentage of mature conchs increased to 23% (Figure 2).

This study, in addition to characterizing the artisanal fishing of the queen conch, also evaluated the effectiveness of the temporal ban at the CHBBR. Fishermen try to comply with the minimum size limit requirement established by the CONAPESCA; nevertheless, catches are mostly juvenile conchs that have not attained maturity. Fishing zones are dominated by juvenile organisms and

adult conchs with a significant decrease in SL, probably due to heavy fishing and a decline in adult conch density in shallow waters. A historical decline in catch quotas due to the decline in abundance of conchs in each fishing season was recorded. Additionally, our results show that the five-year ban of queen conchs had a positive effect on the recovery of the population because an increase in CPUE was observed between 2011-2018, indicative of an increase in their relative abundance. Additionally, fishermen concentrated their catch in the central zone, due to the proximity and availability of the resource. Likewise, a significant increase in lip thickness was observed, probably promoted by the sexual maturation of the conchs at smaller sizes. However, the fishing sector mentioned that socioeconomic aspects and bans did not meet the expected objective because the quota remained the same. In addition to the implementation of bans, other strategies could be implemented, such as the use of an LT-based minimum size limit, along with the cessation of illegal fishing and trade. Coordinated management between stakeholders should be implemented to maintain a sustainable queen conch population.



**Figure 3.** Relationship between shell length and lip thickness for the queen conch (*Aliger gigas*) artisanal fishing prior (black) and after (red) the five-year ban at Chinchorro Bank Biosphere Reserve, Mexico. Broken line indicates sexual maturity considering lip thickness = 15 mm (Boman et al., 2018). Dotted line indicates minimum size limit (200 mm shell length); n= number of sampled individuals

**KEYWORDS:** queen conch, Chinchorro Bank, minimum size limit, artisanal fishing, ban

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