

Hydroacoustic surveys on the Yucatan (Mexico) slope as contribution to the study of spawning aggregations of Nassau Grouper (*Epinephelus striatus*)

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Reserva de la biosfera de Banco Chinchorro
 México

INTRODUCTION

In the State of Quintana Roo, the evaluation of the fisheries activities has not been a priority in the research lines of the existing scientific institutions. The main fisheries activity is centred on species like crayfish (*Panulirus argus* Latreille, 1804), the shrimp (*Penaeus schmitti*) and the Queen conch (*Strombus gigas*), which present a high economic value for the fisherman.

The fish in general are in third place of importance, and few work related to them has been developed, and in consequence, most work is on crayfish and Queen conch. This situation shows the importance of opening perspectives and focus work on the evaluation of the fisheries of fish.

The scientific knowledge with respect to the evaluation of fisheries in Mexico is based on the application of analytical and holistic mathematical models, and in very few cases modern methods, such as acoustics, have been applied. For this reason, the present work is important, as it is the first one that uses hydroacoustic methods in shallow waters of the Mexican part of the Caribbean.

The technical performance of modern acoustic instruments allow to apply new methodological approaches in the search of solutions for areas that reach from very shallow waters to the talus, enabling the study of aggregations of fish that live in these areas or that use them as spawning ground (Fig. 3).

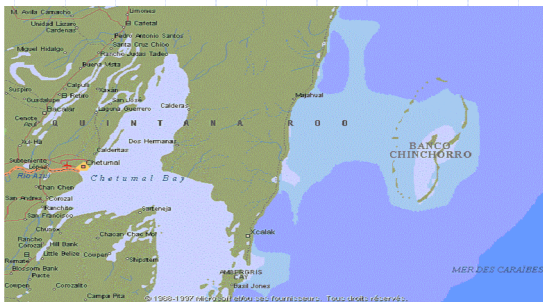


Fig. 1: Map of Banco Chinchorro, off the coast of the Yucatan Peninsula



Fig. 2: Nassau Grouper (*Epinephelus striatus*)

There is poor information on the characteristics of the ecology and fishery of the Nassau Grouper (*Epinephelus striatus*). Comments are available on the fishery at the site of Mahahual (18° 43' N y 87° 42' W, Fig. 1) in its initial phase (Carranza-Fraser 1955, Solís-Ramírez 1966, Miller 1982), and more recent studies deal with the traditional fishery during the spawning aggregations of this species at the same site (Aguilar *et al.* 1994,1998), as well as a preliminary study of the Grouper fishery in the South of Quintana Roo by Sosa-Cordero and Cárdenas-Vidal in 1995.

Biological studies of *E. striatus* (Fig. 2) during three periods in the area of Mahahual (1991-1994) report individuals with lengths between 39 and 88cm, ranging in weight from 1300-9700g, and having a sex ratio male to female of 1,4:1 (Aguilar-Perera and Aguilar-Dávila 1996).

The Nassau Grouper is known for migrating in the Caribbean and concentrates at historic spawning areas for reproduction with variable intervals of 3 to 4 days before or after full moon, during December, January and February.

The fishing activity of this area is considered as artisan fishery, given the degree of development of fishing methods and techniques applied (Miller, 1982; Alcalá Moya,1985; Sosa Cordero, 1995 and Caballero, 1998).

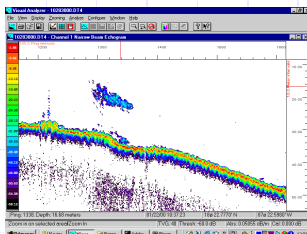


Fig. 3: Echogram showing an aggregation of large sized fish

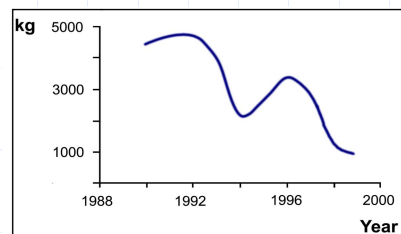


Fig. 4: Evolution of Nassau Grouper (*E. striatus*) captures

The effects of both, artisan and furtive fishery within the aggregations of tropical and reef fish, like in the case of the Nassau Grouper, have led to the partial or even total disappearance of these aggregations at sites used in the past by these fish (Fig. 4), in spite of the regulations for their protection (Aguilar, 1995).

Due to the distribution of the Caribbean reefs, the State of Quintana Roo coast is the only area in Mexico where reef fish aggregate for spawning or reproduction.

In a first intent, acoustic sampling in the area of Mahahual was performed with a commercial FURUNO echosounder, allowing basic observations in the work area.

The objective of this work is to study the aggregations of the Nassau Grouper, as well as the rest of the fish populations associated with the talus of the Mexican Caribbean of the Yucatán peninsula, using hydroacoustic methods, and to establish a methodology that allows the continuation of these studies for the evaluation and a major knowledge of these resources.

MATERIAL AND METHODS

▪ Vessels

In order to realise the acoustic survey, the ship BIP-VIII (Fig. 5), employed by SEMARNAP (Secretaría de Medio Ambiente, Recursos Naturales y Pesca) for the investigation of the protected natural area of Banco Chinchorro (Fig.1), was used.

Characteristics of the vessel:

40 ft (12,2 m) length

14 ft (4,3 m) width

5 ft (1,5 m) draught

Diesel engine (150 HP)



Fig. 5: Research vessel BIP-VIII

In case of the Mahahual survey also small boats with outboard engine were used, depending on the sea state.

▪ Equipment used

In the years 2000 and 2001 data acquisition was performed with a BioSonics DT5000 digital echosounder, using a 130kHz dual beam digital transducer, while in the 2002 survey a BioSonics DT6000 digital echosounder with a 208 kHz split beam digital transducer was deployed.

In 2001, additionally a RESON 6012 multibeam sonar with an operating frequency of 455kHz was used.

▪ Acoustic system calibration

The calibration of the echosounders was performed with a standard target (32mm tungsten carbide sphere), located 3m below the transducer surface. In case of the DT5000 equipment, a difference of -0,5dB with respect to the established standard values was found. This offset was introduced correspondingly into the systems setup. In case of the DT6000, no correction was required.

▪ Study area

The areas selected for the study were the Southern part of Banco Chinchorro and the littoral of Mahahual, both located on the Eastern part of the Yucatan Peninsula, Mexico (Fig.1). In both cases exists a slope beginning at the reef barrier, at about 8m depth, down to about 50m, where the seabed abruptly drops off (Fig. 6).

▪ Methodological aspects

Generally, triangle or "zig-zag" transects were performed in direction to the coastline, with the objective to cut the slope in a perpendicular sense, up to depths around 60m, where the sudden drop off occurs and which is where the particular interest in the knowledge of the abundance of the fish, located specifically here, was founded.

However, some transects were performed parallel to the coastline, trying to maintain roughly a constant bottom depth, with the objective to observe the distribution of the fish at this particular depth.

In areas of possible aggregations of the Nassau Grouper, transects were concentrated, searching the dense shoals reported by the fishermen in other occasions.

For the analysis, the water column was divided into levels (strata) of 10m each, and the reports were established for each 400 pings approximately. The information during processing was collected in one file per transect. TS analysis was restricted to values between -55dB and -20dB. This range corresponds, based on empirical assumptions, basically to the expected size range of the species of interest, *E. stratus*.

The multibeam sonar deployed in the second year of the project was used for searching shoals and mainly while performing transects parallel to the coastline.

In order to verify the existence of the resource divers were used as well as have been realised surveys amongst the fishermen in the area.

In order to obtain the data used for the graphical presentation of the distribution of the resource per strata and the TS (Target Strength), the files with extension *.DTE, generated by Biosonics VisualAnalyzer software during processing, were used.

Data from the survey in 2002 has been partially processed using SonarData Echoview®.

RESULTS

During the recognition phase and the study of the area, two half-landings of the sea bottom are observed, which occur very frequently at depths between 30 and 40m as well as between 50 and 60m. In both cases, this is where the major portion of the areas fish is encountered, mainly in the one between 50 and 60m. In the area of Mahahual in the first strata, at depths between 1 and 5m, a layer possibly consisting of plankton and small fish, that covers the major part of the area, at least during that part of the year, are detected.

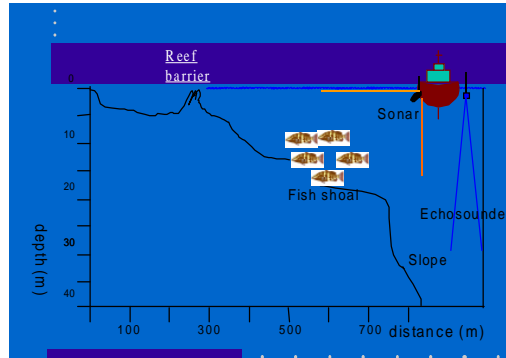


Fig. 6: Schematic view of the sea bottom topography, the applied techniques and the preferred location of the resource.

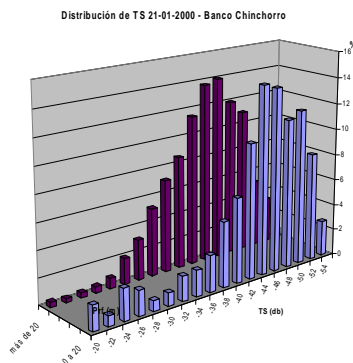


Fig. 7: In 2000 in Banco Chinchorro, mainly smaller fish is observed.

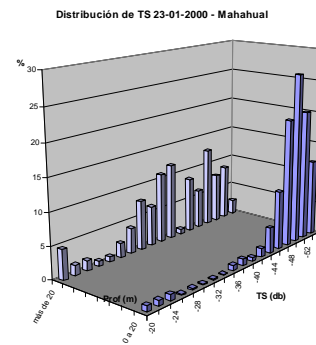


Fig. 8: In Mahahual (2000), smaller fish is observed mainly in the upperlayers (>20m).

- ↳ A quantity of medium and small sized fish with TS smaller than -40dB (Fig. 7), major than that of fish of larger sizes, is recognized in the study area.
- ↳ In the area of Mahahual, the observation that the smallest fish move from the upper layers to deeper layers and back is made, obviously depending on the hour.
- ↳ No significant shoals of fishes with larger sizes that could correspond to *Epinephelus striatus* are detected in Mahahual.
- ↳ In 2001 and 2002, fish are mainly concentrated in the deeper layers (>20m), less fish is observed in the upper layers (<20m) (Fig. 10 and 11), while in 2000 smaller fish was mainly restricted to the upper layers (Fig. 8 and 9).
- ↳ The BioSonics echosounder systems DT5000 and DT6000 are adequate tools for the prospection and for obtaining a better knowledge of the fisheries resources in the areas of the Carribean slope up to depth of 70m.

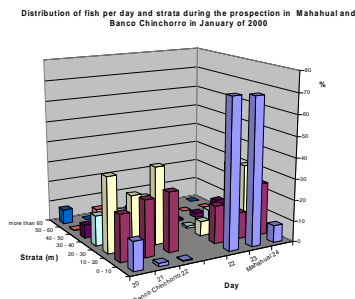


Fig. 9: In 2000, mainly small fish is encountered in the upper layers, while there is generally few fish in deeper layers, especially in Mahahual.

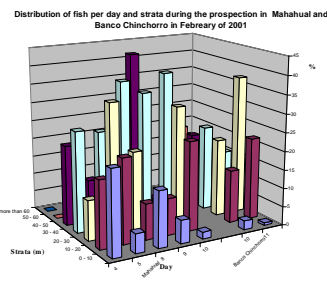


Fig. 10: In 2001, fish in both areas tend to be detected in the deeper layers.

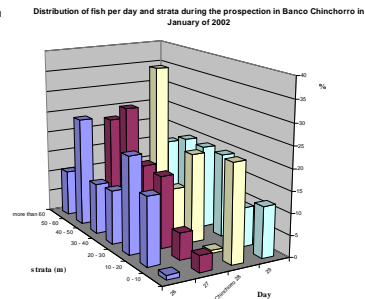


Fig. 11: In 2002, most fish is again detected in deeper layers.

DISCUSSION

While it was difficult to verify the detection of larger targets as coming specifically from *E. striatus*, mainly due to the restrictions related with diving procedures and also due to the fact that other species of the same or similar sizes are common in the area, generally a higher number of fish could be observed in the deeper layers where *E. striatus* is known to aggregate. This is especially true for the 2001 and 2002 surveys, while in the 2000 survey, especially in Mahahual, smaller sized fish was very abundant in the upper layers (<20m).

Although it became clear that hydroacoustic surveys are an adequate tool for the study of spawning aggregations of *E. striatus*, and generally for the fish species present in the study area, a particular problem is the fact that the aggregations only occur during a few days and at very specific locations, which makes it difficult or even impossible to perform a systematic survey. A further and important restriction is the limited number of dives divers can perform in the given time frame. As verification of the observations made through the acoustic system is an essential part of the method, further experience from further surveys is required to develop adequate solutions for this problem.

Still, valuable information on the distribution and size composition of the fisheries resource of the area could be gathered and TS data from the survey in 2002, which has not yet been processed completely, will allow further insight into this still insufficiently studied area.

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