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RESEARCH ARTICLE OPEN ACCESS

POPULATION STRUCTURE OF THE EPINEPHELUSITAJARA (LICHTENSTEIN 1822) (PERCIFORMES: EPINEPHELIDAE) IN THE MARANHÃO GULF, BRAZIL

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ABSTRACT

Aspects of populational structure of *Epinephelusitajara* were studied with specimens obtained as by-catch of fisheries of the species Tarpon Megalops atlanticus, in coastal and estuarine areas of Maranhão Gulf, Northeastern Brazil (02°05'38"S - 2°10'16"S / 43°34'06"W - 44°23'40"W). Samples were taken monthly between july/2016 and december/2016 from landings in the municipality of Raposa. A total of 14 specimens were analyzed by measuring the following variables: total length (cm) and body weight (Kg). The weight–length relationship was obtained using potential equation Wt = a Ltb, where Wt is the total weight, Lt is the total length, a is the intercept and b is the growth coefficient. The parameters a and b were calculated by least squares method on logtransformed data. The total length ranged 97 cm to 208 cm (160.21 ± 34.81 cm). The total weight varied 14 Kg to 162 Kg (76.32 Kg ± 52.29 Kg). Males were predominant throughout the sampling due the reproductive pattern of the species, characterized by protogynous hermaphroditism. The growth coefficient was higher than three (b > 3), suggesting a positive allometric growth. Coastal areas of Maranhão Gulf are essential habitats for the strategic conservation of endangered species in the Brazilian Northern coast.

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INTRODUCTION

The lack of scientific records about the population dynamics of *Epinephelusitajara* have limited the development and implementation of species-specific management strategies which threatens sustainability and the adoption of protective measures for population recovery (Erauskin-Extramiana, 2017). Groupers (Epinephelinae) are positioned at the top of the marine food chain and represent one of the most important components of artisanal catches worldwide (Craig et al., 2009). Among the commercially important marine fishes, the groupers arise as a particularly vulnerable group of fishes, due their specific biological characteristics, including very large size, slow growth, longevity, late age-at-maturity and spawning aggregations, resulting high uncertainty associated with any predictions for recovery of the species (Craig, 2011, Giglio et al., 2014, Erauskin-Extramiana, 2017). The goliath grouper, Epinephelusitajara, is the largest grouper in the Atlantic Ocean and occurs in subtropical and tropical waters of North America, South America and western Africa (Heemstra et al., 2002). This specie was integrated on IUCN (International Union for Conservation of Nature) as critically endangered (IUCN, 2015) and the knowledge about its habitat use becomes essential for the success of any conservation or sustainable development initiative (Lobato et al., 2016). Decreasing population abundances of *E. itajara* in brazilian waters and lack of reliable population data motivated a complete closure of the fishery by Brazilian Federal Environment Institute (IBAMA) prohibiting the capture, fishing or sale of goliath groupers anywhere in Brazilian coast (Giglio et al., 2017). During this period of protection, it is very important to ensure the continuous evaluation of the conservation

status of the species, and to define the areas appropriate for the management of remaining populations (Benevides et al., 2014). The shortage of scientific records on the biology of species, as well as the urgency of implementing protective measures were strong arguments in the text of IBAMA Ordinance no 121/2002, which established the fishing moratorium for a period of 5 years (extended by the Interministerial Normative Instruction no 13 until October 2023), counted from October 2015, so that research could be carried out to support future conservation strategies of the species. In Brazil, it was the first marine fish subjected to a strict moratorium. Data from *E. itajara* life history are rare in Brazil. Information when available is fragmented and insufficient to satisfactorily assess the status of the population of the Brazilian coast (Gerhardinger et al. 2006). A detailed understanding of all these processes is critical to the development of conservation strategies, in particular for endangered fish species, in which fishing pressures and the destruction of habitats essential to specific phases of the life cycle, may lead to the population declines and risk of biological extinction (Craig, 2011). In Maranhão, marine pollution and illegal fishing of the species which is still recorded along the coast, are some of the main threats that are accentuated from December to May when they occur in greater density. This scenario is aggravated by strong site fidelity to mangrove habitats as juveniles and because of life history, that make its populations vulnerable to the effects of fishing (Sadovy de Mitcheson et al., 2012). Given this context, the present study aimed to investigate aspects of the population dynamics of *E. itajara* in the Maranhão Gulf, providing information to broaden the debate and strengthen actions for the development of policies for the protection and management of this seriously threatened taxon.

MATERIALS AND METHODS

Date were obtained from incidental catch carried out in the coastal and estuarine areas of Maranhão Gulf (02°05'38"S - 2°10'16"S / 43°34'06"W - 44°23'40"W) operating in an area of approximately 3,122,1 Km2 at depths of 10 to 30 meters (Figure 1). Due to the protected status of this species in brazilian waters, we analyzed only fish collected as by-catch of fisheries of the species Megalops atlanticus (PISCES, ELOPIFORMES), according authorization (08/2018) issued by Environment Secretariat and Natural Resources of the State of Maranhão – SEMA. These fisheries catch accidentally other species as sharks, ray and groupers.

Study region and description of local fisheries: The state of Maranhão has the second largest coast of Brazil, with 640 kilometers long, and the largest hydrographic basin in the Northeast, generating a combination of large tides and large perennial rivers. The Maranhão western coast includes the area between the mouth of the Gurupi River and the Maranhão Gulf, forming a system called ReentrânciasMaranhenses, characterized by the conformation of a fairly trimmed coastline, consisting of an expressive set of islands, peninsulas and bays, cut by rivers, streams and tidal channels filled with clay and silt which foster the development of mangroves (El-Robrini et al., 2006; Rebelo-Mochel and Ponzoni, 2007). The Maranhão Gulf is located in the northern sector of the Brazilian continental shelf and is considered as a center of high biological production, supported by a dense mangrove forest. According to the Köppen climate classification, the westernmost part of the northeastern Brazilian coast is an Am (tropical wet climate) region (Lefèvre et al., 2017). The São Marcos Bay and the São José Bay form the Maranhão Gulf which includes estuaries, straits, many islands and a large mangrove forest that covers about 5,414 km2 (Souza-Filho, 2005). The two main rivers draining the catchment area (9 x 104 km2) into the system are the Pindaré and Mearim. They flow into the Bay of São Marcos with a discharge of 10 km3.yr-1 (Jennerjahn et al. 2010). The tidal range is about 8 m, which represents an important forcing driving the exchanges between ocean and coastal waters. The maximum discharge occurs in March-April at the peak of the wet season that takes place from January to July.

Data Collection: Samples were taken monthly between july/2016 and december/2016 from landings in the municipality of Raposa. In the laboratory, a total of 14 specimens were identified based on Heemstra& Randall, 1993, Fischer et al., 1990, Cervigon et al., 1992. Basic morphological measurements were taken for each specimen, including total length (cm) and body weight (Kg). Total Length (TL) determined in centimeters (cm), from the initial end (mouth) to the final end (end of the caudal fin), on the ichthyometer; and their Total Weight (TW) determined in quilograms (Kg) on the balance (precision 0.1 kg). The specimens were then dissected through a longitudinal incision in the ventral region to remove the entire digestive tract and facilitate gender identification. The length amplitude for grouped sexes was obtained through the difference of the largest total length and the lowest total length of each individual. The definition of class intervals followed a recommendation in which the class interval of length groups for a length frequency distribution generally depends on maximum and minimum fish lengths and the number of individuals measured (Zale et al., 2012). The weight–length relationship was obtained using potential equation Wt = aLtb, where Wt is the total weight, Lt is the total length, a is the intercept and b is the angular/allometric coefficient. The parameters a and b were calculated by means of a linear regression on transformed data (lnWt = ln a + b lnLt).

RESULTS

A total of 15 specimens were registered between july and december/2016 being 13 males and only 02 female (Table 1). The total length ranged 97 cm to 208 cm (mean ± standart deviation = 160.21 ± 34.81 cm).

Table 1. Number de individuals and sex of *E. itajara* sampling from july/2016 to december/2016

Month	Nº Individuals	Date	Total Lenght (cm)	Total Weight (kg)	Sex
july	1	19/07/2016	185	116	M
	2	19/07/2016	97	14	F
	3	28/07/2016	139	16	M
august	4	16/08/2016	182	100	M
	5	25/08/2016	153	66	M
september	6	05/09/2016	175	86	M
	7	05/09/2016	110	16	M
	8	07/09/2016	176	127	M
	9	07/09/2016	198	133	M
	10	23/09/2016	145	16	M
	11	23/09/2016	208	130	M
	12	29/09/2016	150	54	M
octuber	13	10/10/2016	202	162	M
december	14	11/12/2016	126	33	F
	15	11/12/2016	139	35	M

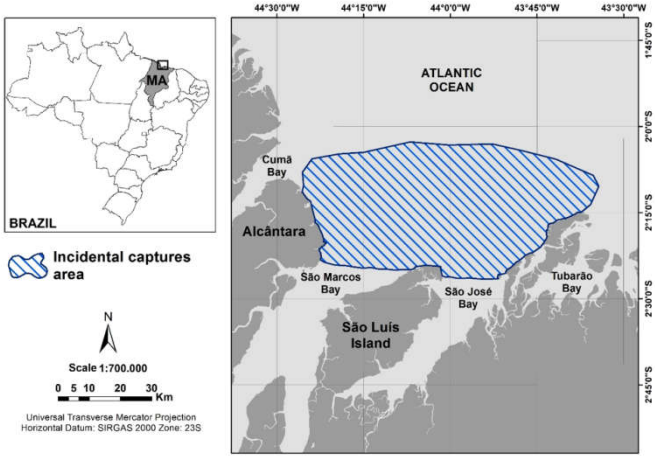

Figure 1. Incidental captures areas of goliath grouper along the Maranhão Gulf

The total weight varied 14 Kg (july/2016) to 162 Kg (october/2016) with mean of 76.32 Kg ± 52.29 Kg (standart deviation). Males were predominant throughout the sampling period due the reproductive pattern of most Epinephelus species, characterized by protogynous hermaphroditism wherein male maturation is attained through sex reversal of a functional female. The length frequency distribution showed the highest number of individuals in the class of 169 -193 cm with 04 individuals, account for 29% of sampling (Figure 2). The length-weigth relationship (LWR) were estimed for fourteen individuals producing the following equation: ln Wt= -14.059 + 3.576 ln Lt. The growth coefficient was higher than three (b > 3), indicating that *E. itajara* shows a positive allometric growth (Figure 3).

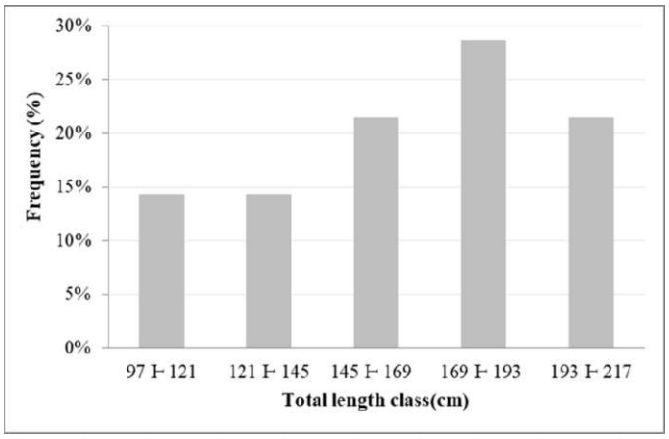

Figure 2. Lenght frequency distribution of *E. itajara* collected in Maranhão Gulf between july/2016 and december/2016

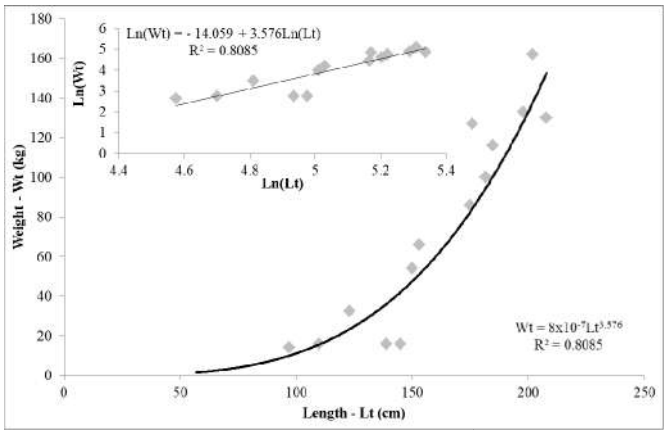

Figure 3. Length-weight relationships of *E. itajara* collected in Maranhão Gulf

DISCUSSION

King (1995) points out that marked variability in estimates of b is usually observed among different populations of the same species, or within the same population at different times. These differences may reflect changes in the condition of individuals related to feeding, reproductive or migratory activities. In the determination of the length-weight relationships, factors related to sampling (fishing gear used, number of samples, sampling site, etc.) and development phase of the fish can interfere in the results (Froese, 2006). In this way, larger samples, obtained over a long period and which comprise a larger number of size classes, make more consistent estimates of the parameters of this relationship possible. Nevertheless, the results obtained for Maranhão Gulf species can be considered representative and reliable, as they were estimated based sizes within the ranges of variation cited in most scientific articles published in the literature. Froese (2006) warns that the discussion of the coefficient (b) of a single length-weigth relationship, reflects the difference of the condition of the fish from only the area and moment of collection. This same author states that consistent patterns of allometric growth are rare, and should be supplemented by an analysis of the phases of growth and discussions of the potential evolutionary benefits associated with the ontogenetic changes in the body proportions. It is noteworthy that in the study present, in seasonal terms, there is still insufficient sampling to allow more consistent inferences about the biological behavior of this species, since it was not possible to register individuals during the rainy months. However, the results already indicate some information of great relevance to populations of *E. itajara* from of Amazonian coastal zone, such as size patterns, growth type, possible presence of hermaphroditism, bringing new information on the life history, as well as for the establishment of strategic conservation polices for the species investigated. There is a clear need quantitative studies that provide the scientific basis for developing conservation measures. The difficulty of obtaining large samples is widely recognized, imposing limitations for development and implementation of species-specific management strategies.

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