

# **Temporal Changes in a Small-scale Artisanal Reef Fishery in Brazil: Management Efficiency and Technological Transformations**

## **Cambios Temporales en una Escala Pequeña de Pesca Artesanal en Brasil: Eficiente Manejo y Transformaciones Tecnológicas**

## **Variations Temporales d'une Pêche Récifal à Petite Échelle au Brésil: L'effet de Gestion et Transformations Technologiques**

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### **EXTENDED ABSTRACT**

#### **Introduction**

Small-scale fisheries represent half of global catches, employing more than 90% of the world's fishers and fisher workers therefore being fundamental supplements to the livelihood of millions (FAO 2015), and in Brazil the scene does not differ. The small-scale artisanal reef fishery of Tamandaré is characterized by its great variety of gears and fishing strategies as well as its economic, social, cultural, and ecological relevance in the area. The municipality is located in the northeastern coast of Brazil, 110 km south of Recife, and is inserted in the Costa dos Corais Environmental Protection Area. This EPA was established in 1997 and is the largest federal MPA in Brazil, extending for approximately 120 km of coast. It holds the first No-Take Zone set in 1999 and has great environmental, social and economic value, with approximately 80% of commercially relevant species of reef associated species (Ferreira et al. 2001). In Tamandaré, fishing is the most important exploratory activity as its products represent the main income source of nearby fisher communities (Ferreira et al., 1998). Data on fisher effort and catch composition was collected from 1999 to 2004 with data collection restarting in 2015 and conducted until present. The historical database presented an excellent opportunity for small-scale reef fishery evaluation in a context of intense transformations that included a central management measure that was the establishment of a no-take zone as well as socio-economic transformations including Brazilian's rapid economic growth, which allowed for a consequent increase in the populations' acquisitive power, and tourism expansion in the area. The objective of this work is to compare the fishery occurring during two distinct periods in Tamandaré.

#### **Methodology**

The period of July 1999 – June 2000, when no-take zone was just implemented but measures were not yet effective, and July 2016 – June 2017, when pilot studies had been concluded and data collection readjusted, were compared in order to evaluate these two distinct scenarios. Data collection was performed by researchers and field agents members of the fishing community. The study area was divided into four sub-areas: Mamucabas, Baía de Tamandaré, Igreja de São Pedro and Carneiros. Counting of fishers was done primarily during low tide, when most fishers were at sea, and data on fisher effort by gear, vessel and propulsion by region and specific reef was registered. At landing sites, fishers were interviewed and their occupation, level of fishing experience, time of entry and exit of sea as well as species captured, total catch weight and fish size were recorded. Fishing effort data was standardized on a surveys per week basis with a total of 87 days in each period with a total of 1,192 fisher interviews in 1999/2000 and 888 interviews in 2016/2017. Distribution of capture composition was analyzed through measured fish (8,000 individuals in 1999/2000 and 4,505 individuals in 2016/2017).

### **RESULTS AND DISCUSSION**

Results revealed structural changes in the fleet including the massive substitution of traditional sailing “jangadas” by small, affordable outboard motors as the main propulsion strategy to access to fishing grounds farther from the coast. The traditional jangadas, characteristic of Northeastern Brazil are valuable cultural heritage from African, indigenous and Portuguese cultures. To outcome the cultural loss, presently an initiative from local fishers tries to restore it as a touristic attraction. Regarding fishing gears, line and spear maintained the dominance on shallow areas, with replacement of rudimentary makeshift spears by more potent pressure spear guns as a crucial technological innovation.

Two-way ANOVAs were performed to test differences in total fishing effort as well as effort by most used gears of spear and line. No significant differences between periods or regions was observed for total effort however there was an interaction within regions: fisher effort increased in Baía de Tamandaré while decreased in Mamucabas and Igreja de São Pedro and remained the same in Carneiros. Total spear fishing effort was significantly higher in 2016 - 2017 but there is no

significant difference between regions except for a decline in Carneiros beach, a possible effect of tourism expansion, as the intense boat traffic in the area poses risk to divers fishing nearby. Total line fishing has not varied significantly however, line by foot varied significantly within regions with a significant increase in Baía de Tamandaré, where high beach occupation density and easier accessibility to shallow reefs promotes opportunistic fishing, specially of amateur fishers. An increase in the number of non-professional fishers, which currently exceeds the number of professionals, was observed.

Considering its multi-specific nature, analysis of catch per unit effort (CPUE) used directed fishery data. There was a significant increase in CPUE (kg/fisher/day) both for when all gears were considered and for spear fishing, indicating an increased efficiency in the innovative spear guns.

Regarding fishery resources, the grey parrotfish *Sparisoma axillare* remained as the main component of the catch although a small decrease in percent frequency was observed, possibly due to the vanishing of the species traditional directed fishery ("bobozeiros"). Reef species such as *Epinephelus adscensionis*, *Holocentrus adscensionis*, *Cephalopholis fulva* and *Haemulon aurolineatum* increased its representativeness in the catches. This result agrees with previous visual census data inside and outside the no-take zone that shows significant abundance increases inside the no-take zone for the first three species, indicating a possible spillover, whereas *Haemulon aurolineatum*'s abundance is greater outside the zone, indicating a possible cascade effect when an increase of predators inside the no-take zone could have moved them out of the zone. An increase in the representativeness of *Haemulon aurolineatum* in the catch can also be attributed to the increase of amateur opportunistic fishers in Tamandaré which have little regard for fish size and will take even the smaller species.

Length frequency distributions of *Sparisoma axillare* showed distinct trends according to type of fishing gear. There was a shift to the left in the length distribution of fish caught by line, showing higher frequencies of smaller size classes and smaller frequencies of large classes in the catch in 2016 - 2017 that can also be attributed to inexperienced opportunistic fishers and vanishing line fishers focused in *Sparisoma axillare* fishery. On the contrary, length distributions of fish caught by spear fishing shows a greater frequency of larger fish indicative of gear evolution.

## Conclusions

Overall, trends in catches reveal consequences of fishery innovation and management measures, but also an increase in opportunistic fishing associated with larger coastal population. Even though the no-take zone represents approximately 10% of Tamandaré's coastal zone, there are no indications of negative impacts to the local fishery (i.e., reduction in catches due to increase in effort by area through redistribution), but rather that this management measure was effective in order to maintain catches stable throughout the period. Results showed technological advances that allowed for a greater power of capture and possible effects of no-take zone species spillover. Although

the no-take zone is effectively monitored, to what extent this management measure is able to buffer the unregulated entry of people in the activity in the common area, and lack of control over gear efficiency and fishing strategy evolution in order to maintain this fragile equilibrium is questionable. On the bright side, there is a growing fisher engagement in Tamandaré for co-management and auto-monitoring initiatives in an environment that is extremely favorable to marine spatial planning implementation.

**KEYWORDS:** Artisanal fishery, reef fishery management, Brazil, fishery evaluation

## LITERATURE CITED

- FAO. 2015. *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication*. Food and Agriculture Organization of the United Nations. Rome, Italy.
- Ferreira, B.P., F. Cava, and A. Ferraz. 1998. Relações morfométricas em peixes recifais da zona econômica exclusiva brasileira, região nordeste. *Boletim Técnico Científico Cepene, Tamandaré* 6(1):61-76.
- Ferreira, B.P., M. Maida, and F. Cava. 2001. Características e perspectivas para o manejo da pesca na APA marinha Costa dos Corais. Pages 50-58 in: *Proceedings II Congresso Brasileiro de Unidades de Conservação*, Campo Grande, Brazil.