Combining local fishers' and scientific ecological knowledge: Implications for comanagement

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ABSTRACT

This study was conducted in the fishing community of the Cabedelo municipality (NE Brazil, Paraíba) and characterized the socioeconomic profile of the fishers, their local ecological knowledge and their main usage of fish species. Overall, 80 fishers were interviewed. Snowball, direct observation, guided tours, free interviews and structured and semi-structured questionnaires were used for data collection, which occurred from December 2010 to June 2011 in fortnightly visits to the city of Cabedelo. Most fishers ranged from 36 to 45 years, with low education and low income levels, and approximately 87% fished in the municipality. At least 33 fish species were recorded as important for family consumption and trade. The most commonly caught fish families were Carangidae, Mugilidae, Lutjanidae and Scombridae. The fishes most used for commerce were Lutjanidae, Scombridae, and Serranidae. Fishers demonstrated a high knowledge about the temporal distribution of fishes and categorized them as "fishes of summer", "fishes of winter" and "fishes around all year"; fishes' vertical distributions were categorized as either "bottom fish" or "water flower". Fishers also classified eating habits, some types of behavior and reproduction of most exploited species. Fishermen's understanding of the fish stocks distribution and fish ecology is potentially imperative for scientific knowledge and future shared management plans.

1. Introduction

Archaeological records have shown that the use of marine wildlife resources was critical to the survival of humans during the Middle Pleistocene period (125,000 years ago; Marean et al., 2007). This dependence and interaction produced, accumulated and organized a formidable knowledge, called Traditional Ecological Knowledge (TEK), Local Ecological Knowledge (LEK), Indigenous Ecological Knowledge (IEK) and Fishers' Knowledge (FK) (Silvano, 1997; Olsson and Folke, 2001; Berkes et al., 2006; Lauer and Aswani, 2008; Davis and Ruddle, 2010; Ruddle and Davis, 2013).

Fishers' knowledge (FK) comprises the body of experiential knowledge including ecological, resource-based, ecosystem, fishing practices, fishing communities and livelihoods, governance and markets, and their dynamic relationships. This knowledge is developed in a social-cultural and geographical context (Fischer et al., 2015). According to Orensanz et al. (2015), the FK definition is broader than those of TEK, LEK and IEK, since that knowledge may not be traditional in the sense of being transmitted for generations or by cultural transmission, and can instead be shared or not, since the main distinguishing feature of FK

is that it is experience-based.

In Brazil, FK studies have encompassed behavioral aspects (social, reproductive and trophic), habitat types, habitat mapping, spatial and temporal distribution, ethnotaxonomy, migratory routes, territoriality, feeding areas, tidal movements, winds type sand fishing techniques (Mourão et al., 2002, 2003, 2006; Silvano et al., 2006; Begossi and Silvano, 2008; Gerhardinger et al., 2009; Nunes et al., 2011; Bezerra et al., 2012; Rocha et al., 2012; Silvano and Begossi, 2012; Pinto et al., 2013; Teixeira et al., 2013; Previero et al., 2013; Ferreira et al., 2014; Herbst and Hanazaki, 2014; Pinto et al., 2015; Ramires et al., 2015).

The incorporation of the FK in fisheries co-management plans is key to decentralize governmental and institutional power, thus ensuring greater representation of fishers in public policies (Begossi, 2006, 2008). Fishers' participation may range from government discussions, advisory councils formation, cooperation in planning and monitoring, to the full community control in the management of an area or fishery (Berkes et al., 2006).

The FK has been used in combination with contemporary fisheries data to identify temporal changes in the structure of populations and examine historical trends of exploited species abundance (Ames, 2007;

Ainsworth et al. 2008). Uncertainties are reduced and evaluations become more convincing for users of resources when LEK is used with scientific validation (Neis et al., 1999).

The FK is an important tool in building co-management, as it provides space for negotiation between multiple users, allows the emergence of policies with better chances of sustainability and a better understanding of ownership rights (Azevedo and Apel, 2004; Begossi, 2006; Gutiérrez et al., 2011). Our main goal was to record and analyze the FK of fishermen in the municipality of Cabedelo and compare their FK with ecological information available in the literature, which we saw as important in helping the implementation of future co-management plans in this municipality.

2. Methods

2.1. Study location

The study was conducted in the municipality of Cabedelo (area 31.42 km^2; population 57,944), which is part of the metropolitan region of João Pessoa, PB. Cabedelo is a resort town, and its population almost quadruples to about 200,000 visitors and vacationers during the warm season (Mendes-Filho et al., 2010). The local economy is based on port activities, tourism, and fishing. Cabedelo is located in the geoenvironmental unit of the Coastal Tablelands. This unit follows the coast of the whole Brazilian Northeast (average altitude of 50–100 m).

Cabedelo has more than 1000 registered fishers, and fishing is carried out both in the estuary and in the marine region. Fishing is mostly directed to crabs, shellfish and Mugilidae, Scianidae, Geriidae, Serranidae and Carangidae (Nascimento et al., 2016a, b). Fishers practice various fishing techniques and use different types of nets, named according to the targeted catch. For example the "tainheira, mullet net" (for Mullet - *Mugil curema*), the "agulheira, needle net" (for Common Halfbeak *Hyporhamphus unifasciatus*). Other fishing gear is also used, such as "trawling", " throw net", and "facheado".

The area contains approximately 15 km of coast with urbanized beaches, mangroves, a national forest (Floresta Nacional da restinga de Cabedelo or Mata do Amém, or FLONA), and a state marine park (Areia Vermelha). There are projects for the creation of an environmental protection area (APA). All these characteristics support the creation of a co-management plan to preserve and assist the existing conservation units (FLONA and marine state park) and to regulate and organize the extraction of natural resources activities, as well as to ensure sustainable tourism.

The main ecosystem is a sandy "restinga" (small sandy area of forest next to a river) located on the Paraíba coastal plain. It is located approximately between 6° 58′ 21″and 7°04′29″ S and 34° 50′ 18″ and 34°51′20″ W (Souza, 2000), and bounded on the North and East by the Atlantic Ocean, on the West by the Paraíba River and South by the Jaguaribe River (Fig. 1). The vegetation is predominantly of the evergreen forest type, with parts of semideciduous forest (Brasil, 2005). The regional climate is tropical rainy with dry summers. The rainy season begins in the fall, starting around April or May and ends in October (average annual rainfall of 1634.2 mm).

The estuary of Paraíba Norte River (ERPN) is located between 6° 54′ 14″- 7° 7′ 36″ S and 34° 58′ 16″- 34° 49′ 31 W (Lower Paraíba), and drains the cities of João Pessoa, Bayeux and Santa Rita and close to Cabedelo municipality (Nishida et al., 2008). The river mouth is about 2.2 km wide and borders the municipalities of Cabedelo and Lucena. The portion of Cabedelo bathed by the estuary includes the Port of Cabedelo and an area of high tourist interest, Jacaré Beach (Nishida, 2000). The ERPN is bordered throughout its length by a lush mangrove forest, with some areas partially fouled, particularly near the urban centers (Marcelino et al., 2005).

The study area is similar to other neighboring fishing communities, like those of the Estuary of the Mamanguape River (Mourão and Nordi, 2002). The fishing communities studied in Cabedelo were Jacaré Beach,

Jardim Manguinhos, Camalaú and Ponta de Mato, all located on the banks of the ERPN. They were chosen for the following reasons: i) important artisanal fishing area; ii) local population that has proven very receptive to this type of research; iii) high biological and cultural diversity; and iv) ease of access to fishing communities as they are part of the metropolitan region of João Pessoa.

2.2. Study design

Field work was carried out from December 2010 to June 2011 in fortnightly visits to the fishing community of Cabedelo.[1] The first contacts with communities were mediated by several Community Health agents of the locality and community leaders, such as the president of the fishers' colony, all of whom were informed about the purpose and importance of the work. Ten fishers were selected after a first round of interviews and considered as "key informants". These were people who had a deep and detailed knowledge of the fisheries resources and who were recognized among their peers as having experience in fishing. Moreover they were still fully engaged in fishing activities (they still fished for food or for sale) and had detailed and extensive ecological knowledge of fishes (Alexiades, 1996).

The sampling design of this study followed the snowball technique (Bailey, 1982). This is a non-probabilistic method where informants are intentionally chosen; the aim is to work only with "local experts", individuals locally recognized as having particular knowledge about a certain topic, in this case fishing (Albuquerque et al., 2010a). The participants (n = 80) in the study were all fishers engaged in a fishing activity and most had been fishing for at least 15 years. Ten fishers were interviewed on Jacaré beach, 21 in Camalaú, 22 fishers in Jardim Manguinhos and 27 in the community of Ponta de Mato. The key informants assisted with routine questions that arose during the research.

Data collection was conducted through free lists, semi-structured interviews, participatory observations, field diaries and guided tours (Spradley and McCurdy, 1972).

The free list was based on the question "Please tell us about the fishes you know" (Sutrop, 2001) and from this, respondents listed the elements of a given field of fishing culture in the order recalled (Quinlan, 2005). It was assumed that the most important species were the most frequently named and that they were arranged in order of importance (Albuquerque et al., 2010b).

The semi-structured interview maintains increased focus on the topic discussed; however, it also provides flexibility in responding, allowing the deepening of issues that may arise during the interview (Amorozo and Viertler, 2010; Albuquerque et al., 2010b). This technique is guided by a road map formulated by the researcher, consisting of a list of topics that are discussed during the meeting (Huntington, 2000).

In the present study, semi-structured forms about the FK included ecological aspects, feeding, spatial-temporal distribution and types of habitat, behavior, and reproduction. When it was necessary to confirm the consistency and validity of certain answers, questions were repeated, creating synchronic (the same question posed to different people, shortly afterwards) and diachronic (same question posed to the same person, at a later time) situations.

The purpose of the participatory observation is to obtain data on the behavior of individuals in the community through direct contact and to keep distortions resulting from the investigator being an outsider to a minimum (Kluckhohn, 1940). All observations were recorded in a field diary, organized chronologically, and all information and perceptions were transcribed during the same working day (Jackson, 1983; Albuquerque et al., 2010b). The advantage of this technique is to increase the amount of information as participants see the researcher as

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[1] The research was submitted and approved by the Research Ethics Committee of the State University of Paraíba (protocol number 0578/14) prior to implementation.