http://dx.doi.org/10.1590/1519-6984.06614 Original Article

Marine protected area and the spatial distribution of the gill net fishery in Copacabana, Rio de Janeiro, RJ, Brazil

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Received: April 10, 2014 – Accepted: October 23, 2014 – Distributed: February 29, 2016
(With 4 figures)

Abstract

This study characterizes the gill net fishery at Colônia de Pescadores Z13 (CPZ13), in Copacabana, Rio de Janeiro, and its relationship with the marine protected area 'Monumento Natural do Arquipélago das Ilhas Cagarras – MoNa Cagarras', describing the fleet and fishing gears, identifying fishing spots, species and their associations by gillnet type. From June 2012 to May 2013, every Tuesday to Sunday, gill net landings were monitored and fishers interviewed regarding their catch. Small boats (dory whaleboats) are used to set three types of gillnets: "Corvineira" (target species – whitemouth croaker), "linguadeira" (target species – flounders) and "rede-alta" (target species – bluefish). Fifty-nine species within 37 families were captured at 14 fishing spots, showing association with bottom type and distance from shore. The use of fisher's local ecological knowledge defines gear placement at specific sites targeting fisheries resources. All fishing sites are not within the limits of MoNa Cagarras but would benefit from management plans including an MPA buffering zone.

Keywords: artisanal fisheries, gillnetting, local knowledge, conservation unit, Cagarras Archipelago.

Área marinha protegida e a distribuição espacial da pescaria de rede de emalhe em Copacabana, Rio de Janeiro, RJ, Brasil

Resumo

Este estudo caracteriza a pesca com rede de emalhe na Colônia de Pescadores Z13 (CPZ13), em Copacabana, Rio de Janeiro, e sua relação com a área marinha protegida "Monumento Natural do Arquipélago das Ilhas Cagarras - MoNa Cagarras", descrevendo a frota e artes de pesca, identificando locais de pesca, as espécies e as suas associações por tipo de rede de emalhe. De junho de 2012 a maio de 2013, de terça a domingo, os desembarques foram monitorados e os pescadores entrevistados em relação à sua captura. As pequenas embarcações são usadas para três tipos de redes de emalhe: "corvineira" (espécie-alvo - corvina), "linguadeira" (espécie-alvo - linguados) e "Rede-Alta" (espécies alvo - anchova). Cinquenta e nove espécies dentro 37 famílias foram capturados em 14 locais de pesca, mostrando associação com o tipo de fundo e distância da costa. O uso do conhecimento ecológico local de pescadores define a colocação dos petrechos em locais específicos destinados ao recursos pesqueiros alvo. Nem todos os locais de pesca estão dentro dos limites da MoNa Cagarras, mas se beneficiariam de planos de gestão, incluindo uma zona de amortecimento para a MPA.

Palavras-chave: pesca artesanal, rede de emalhe, conhecimento local, área unidade de conservação, Arquipélago das Cagarras.

1. Introduction

Small-scale artisanal fisheries play an important role worldwide (FAO, 2012) supporting local and regional markets. Their importance in tropical coastal regions is even more dramatic in the context of food security and health since most of the catch is used for consumption (Batista et al., 2014). They are responsible for 40% of the marine fish taken for human food (FAO, 1998) and comprise about 50 million fishers (Berkes et al., 2001). In Brazil, it accounts for nearly 60% of the national fisheries production (Dias Neto, 2010).

Twenty-five artisanal fisheries colonies are distributed along the coast of the State of Rio de Janeiro (Vianna, 2009), and at least three, Itaipu (Z-7), Jurujuba (Z-8) and Copacabana (Z13) are within the limits of metropolitan Rio de Janeiro, one of the largest and most complex urban settings in the Brazilian coast. The fisheries colony Z-13 (Colônia de Pescadores Z13 – CPZ13) is located in the southeastern corner of Copacabana beach, and maintains its artisanal fishing activities from 1923 (Nehrer and Begossi,

2000) until today. Fishing occurs in nearshore waters and coastal islands at several fishing spots or "pesqueiros" (Nehrer and Begossi, 2000; Begossi, 2006). Fishing spots appear to be stable over space and time (Begossi, 2006), despite the changes occurring in these two dimensions due to the urban setting evolution and increased influence of land based activities (pollution, tourism, maritime traffic).

One of the most notable characteristics of small-scale artisanal fisheries is its gear type variability and the diversity of resources captured (Berkes et al., 2001; Mangi and Roberts, 2006; Bastos and Petrere Junior, 2010). The multi-gear, multi-species and low discard characteristics of artisanal fisheries often leads to fishing pressure on a wide range of resources, limiting the application of traditional stock assessment tools (Batista et al., 2014).

In 2010, the Cagarras Archipelago Natural Monument (Monumento Natural do Arquipélago das Ilhas Cagarras – MoNa Cagarras) was established to protect the fauna and flora and the scenic patrimony of the islands Cagarras, Palmas, Comprida, Redonda, Filhote da Cagarras and Filhote da Redonda – Lei nº 12.229, de 13 de abril de 2010 (Brasil, 2010). Fishers from the CPZ13 are closest to the marine protected area (MPA) and many of the fishing spots are located close to or within the maritime limits of the MPA (Nehrer and Begossi, 2000; Begossi, 2006), lying at 10m from the perimeter of the islands. Thus, depending on the fishing activity, gear used and target species, fisheries may occur within the MPA.

Several studies have indicated that Marine Protected Areas may be an appropriate tool for rebuilding exploited stocks, preserving biodiversity, and enhancing fisheries yields (Roberts et al., 2001; Halpern, 2003; Kerwath et al., 2013). Nevertheless, the multiplicity of objectives to be achieved by MPAs, often result in improved fish abundance, biodiversity and habitat quality, lacking social benefits for stakeholders, specially small scale fishers (Field et al., 2006). Thus, biological gains become less significant when compared with the social issues raised (Agardy et al., 2003).

Finding ways to resolve socioeconomic issues arising from the implementation of an MPA should be a main priority, even if the benefits from the MPA occur only after a long time frame. Due to fishing restrictions imposed by the MPA, it is important to know where fishing is actually occurring and if there are traditional fishing spots that are located within the MPA, in order to propose management actions. With that in mind, this study aims to characterize the gill net fisheries conducted at CPZ13. This is the most important fishing activity that holds the largest production of CPZ13 (Moraes et al., 2013). Main objectives were to describe the fleet and fishing gears used, to identify fishing spots for gill netting and to identify species and their associations by each type of gill net used by the CPZ13 fishers. Finally, this study aims to address the question as to whether the MoNa Cagarras MPA restricts the gill net fishery or will the gill net fishery benefit from the establishment of the respective MPA.

2. Material and Methods

Data was collected from June 2012 to May 2013 at the fisheries colony (Colônia de Pescadores Z-13 – CPZ13), located in Copacabana beach (22°59'10"S, 43°11'19"W), Rio de Janeiro, Brazil. Landings from the gill net fisheries were monitored daily (except Mondays) from 8:00 to 12:00. After this time no landings occurred. For each landing, species were identified by their common and scientific names following Figueiredo (1977), Figueiredo and Menezes (1978, 1980, 2000), Menezes and Figueiredo (1980, 1985), Rocha and Costa (1999), Amarante (2009), Barbosa and Nascimento (2009) and Froese and Pauly (2014). With the exception of *Diplectrum* spp. and *Sphyrna* spp., all fishes were identified to the species level. Information on the area where fishing occurred, frequency of fishing trips to the fishing spots, and the type of gill net used were also recorded.

Data characterizing the fleet (overall length, beam, building material, propulsion and power of the boats) were obtained from registration documents available at the CPZ13 headquarters.

Gill net identification (type, length, height, mesh size) was obtained through interviews with the fishermen. Later, randomly selected nets were measured to validate the information.

Data was digitized into Excel spreadsheets and stored in the "Projeto Ilhas do Rio" (Instituto Mar Adentro) database.

A matrix of fishing gear type vs. fishing spots was subjected to cluster analysis to identify possible fishing spot groups based on the co-occurrence of gear types. The Ward method was used to increase inter-group differences and minimize intra-group variance. A similar matrix of species vs fishing gear type was subjected to the same analysis to identify species groups co-occurring in one or more fishing gears. Both dendrograms were generated in the free software Paleontological Statistics (PAST) version 2.17 (Hammer et al., 2001).

Nodal analysis using the concepts of ecological constancy (the frequency of occurrence of a group of species in a given fishing spot group) and fidelity (how much a group of species is restricted to a certain fishing spot group, when comparing the individual group constancy to the average constancy of all groups) (Boesch, 1977; Monteiro-Neto et al., 2008), was used to express the relationship between species and fishing spot groups. The following arbitrary scale was established, based on Boesch (1977), considering the range of constancy and fidelity values observed: Constancy – high > 0.7; moderate between 0.5-0.7; low < 0.5; Fidelity – high > 2.0; moderate between 1.0-2.0; low < 1.0. Blank represents the absence of species in one fishing spot group.

3. Results

From June 2012 to May 2013, the CPZ13 had ten active fishing boats, of approximately 5.0 m long (average = 4.94 m) and 1.9 m beam. All boats were a dory whaleboat type, with a flat transom, made of fiberglass and powered by a 7 to 9 HP diesel engine. Boats were launched from the beach, across the surf, and usually were crewed by two to three men; the pilot and the net handlers. Fishing occurred every day except Mondays, holydays or when sea conditions were inappropriate.

Three types of gill nets used in the fisheries were identified. The "corvineira" (mesh size = 60 mm between adjacent knots, length = 1500 m, height = 2.5 m, float no. 3) used to catch the whitemouth croaker (*Micropogonias furnieri* (Desmarest, 1823)), the "linguadeira" (mesh size = 110 mm between adjacent knots, length = 2000 m, height = 2.5 m, float no. 3) to catch flatfishes (*Paralychthys* spp.) and "rede-alta" (mesh size = 40 mm between adjacent knots, length = 600 m, height = 3.5 m, float no. 4) often used to catch pelagic mobile species such as bluefish (*Pomatomus saltatrix* Linnaeus, 1776), jacks (*Caranx* spp.) and mackerels (*Scomberomorus* spp.). Gill nets were set stationary, anchored at the bottom, at specific fishing spots. Nets were harvested once a day and usually set again in the same spot. At times, nets were recovered and taken back to shore for mending and cleaning service. Fishers buy commercially available net panels (100 m long) made of 0.4-0.5 mm monofilament nylon, and attach panels to the floating and lead lines at a hanging ratio between 0.5 and 0.6. Several nets are tied together to reach the total gill net length set by each fisher at a certain location.

Fourteen fishing spots where CPZ13 fishers set out their gill nets were identified: 1- Copacabana, 2- Boca da Barra, 3- Largo do Forte, 4- Praia do Diabo, 5- Arpoador, 6- Ipanema, 7- Emissário (Ipanema sewage marine outfall), 8- Leblon, 9- Costão do Vidigal, 10- São Conrado, 11- Cagarras landward, 12- Cagarras, 13- Cagarras seaward, and 14- Ilha Rasa (Figure 1).

Figure 2 shows the frequency at which fishing spots were visited during this study. Largo do Forte, the closest fishing spot to CPZ13, was by far the most visited site, followed by Ipanema and Boca da Barra. Least visited sites included mostly spots near the Cagarras archipelago and more distant rocky coast sites.

Cluster analysis using the Ward method formed five fishing spot groups: A - Boca da Barra and Largo do Forte; B – Arpoador, Leblon, Ipanema and Copacabana; C – Cagarras landward and Emissário); D (São Conrado, Praia do Diabo and Costão do Vidigal) and E (Rasa, Cagarras and Cagarras seaward) (Figure 3). Groups A and B represent areas of sand bottoms associated with sandy beaches, whereas groups C to E represent fishing spots associated with or near rocky reefs on the coast or in the islands. This appears as a primary pattern in the cluster groups (Figure 3).

A total of 59 species and two genera (*Diplectrum* spp. and *Sphyrna* spp.) belonging to 37 families, including Actinopterygii and Elasmobranchii, were identified (Table 1). Cluster analysis formed five species groups, following their occurrence on fishing gears. Group 1 (16 species) included species that occurred on the corvineira. These were mostly demersal (*e.g.*, *Pogonias cromis* (Linnaeus, 1766), *Urophycis brasiliensis* (Kaup, 1858)) and bottom dwelling species (*e.g.*, *Porichthys porossissimus* (Cuvier, 1828), *Prionotus punctatus* (Bloch, 1793), *Menticirrhus americanus* (Linnaeus, 1766)). Group 2 (33 species) included species that occurred on both corvineira and rede-alta. This was by far the most diverse group including a mix

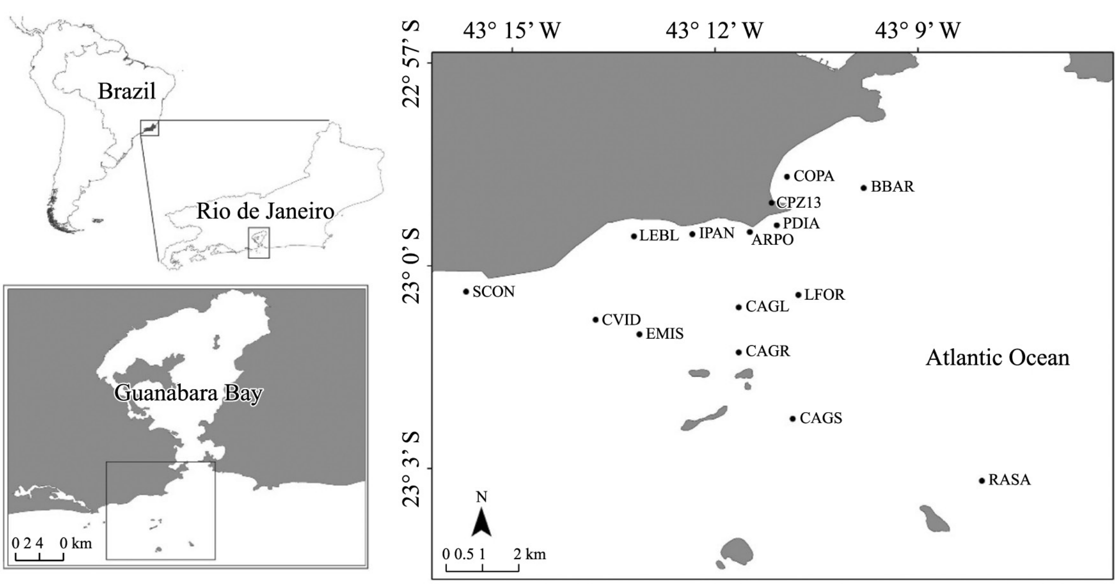

Figure 1. Distribution of gill net fishing spots used by fishers at CPZ13. ARPO – Arpoador; BBAR – Boca da Barra; CAGL – Cagarras landward; CAGR – Cagarras; CAGS – Cagarras seaward; COPA – Copacabana; CVID – Costão do Vidigal; EMIS – Emissário; IPAN – Ipanema; LEBL – Leblon; LFOR – Largo do Forte; PDIA – Praia do Diabo; RASA – ilha Rasa; SCON – São Conrado. Inset shows the map of Brazil and Rio de Janeiro state.

of demersal or bottom dwelling (*e.g.*, *Syacium micrurum* Ranzani, 1842, *Syacium Papillosum* (Linnaeus, 1758), *Dactylopterus volitans* (Linnaeus, 1758)) and pelagic (*e.g.*, *Trichiurus lepturus* Linnaeus, 1758, *Albula vulpes* (Linnaeus, 1758), *Scomberomorus brasiliensis* Collette, Russo and Zavala-Camin, 1978, *Trachinotus carolinus* (linnaeus, 1766), *Brevoortia aurea* (Spix and Agassiz, 1829)) species. The whitemouth croaker, *Micropogonias furnieri* occurred in this group along with other demersal sciaenid fishes (*Paralonchurus brasiliensis* (Steindachner, 1875), *Stellifer rastrifer* (Jordan, 1889), *Umbrina canosai* Berg, 1895, *Cynoscion microlepidotus* (Cuvier, 1830)). Group 3 (7 species) included flatfishes (*Paralichthys* spp.) and several elasmobranchs (*Dasyatis* spp., *Squatina Guggenheim* Marini, 1936, *Rinobatos percellens* (Walbaum, 1792)). Group 4 was composed of two pelagic species, *Kyphosus sectatrix* (Linnaeus, 1758) and *Mugil curema* Valenciennes, 1836, occurring only on rede-alta, whereas group 5 was formed by a single species, *Atlantoraja castelnaui* (Miranda-Ribeiro, 1907), caught solely on the linguadeira (Table 1).

Nodal analysis looking at the constancy and fidelity of species groups (1-5) across fishing areas (A-E) indicated that species occurring in corvineira catches (Group 1) showed high constancy in area A, and moderate in areas B and C. Group 2, including species that occurred in both corvineira and rede-alta showed high constancy in areas A and B, and moderate in area C. Species group 3 showed only moderate constancy at areas A and B. Groups 4 (two species) and 5 (one species) showed moderate and high constancy in species areas A and B, and only high constancy in area A respectively. Fidelity ranged between moderate to low for all species groups across areas (Figure 4).

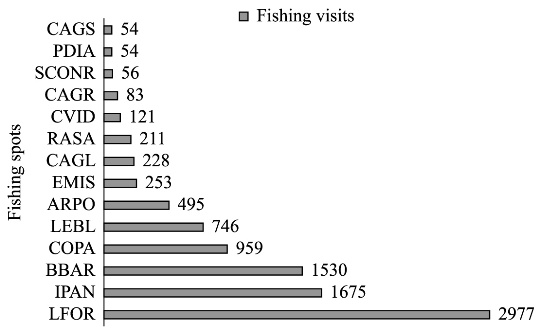

Figure 2. Frequency of fishing visits at mapped fishing spots from June 2012 to May 2013 ARPO – Arpoador; BBAR – Boca da Barra; CAGL – Cagarras landward; CAGR – Cagarras; CAGS – Cagarras seaward; COPA – Copacabana; CVID – Costão do Vidigal; EMIS – Emissário; IPAN – Ipanema; LEBL – Leblon; LFOR – Largo do Forte; PDIA – Praia do Diabo; RASA – ilha Rasa; SCONR – São Conrado.

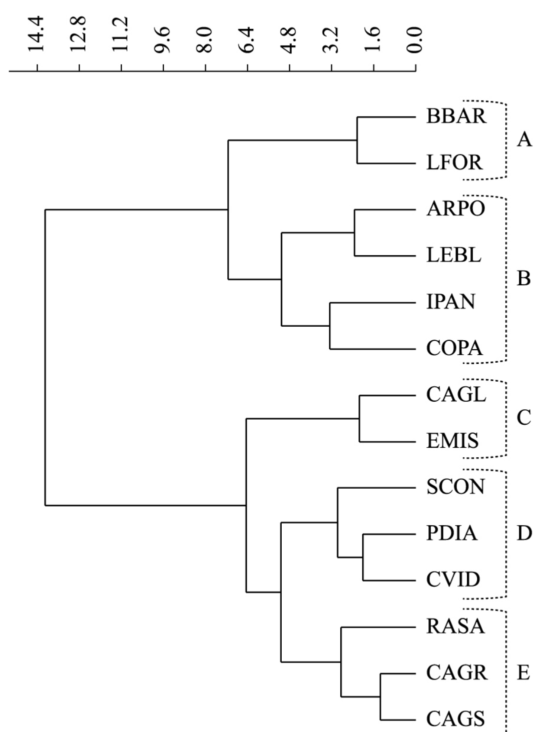

Figure 3. Cluster analysis of fishing spots indicating the formation of five groups: Group A – Boca da Barra and Largo do Forte; Group B – Arpoador, Leblon, Ipanema and Copacabana; Group C – Cagarras landward and Emissário; Group D – São Conrado, Praia do Diabo and Costão do Vidigal, and Group E – Rasa Island, Cagarras and Cagarras seaward.

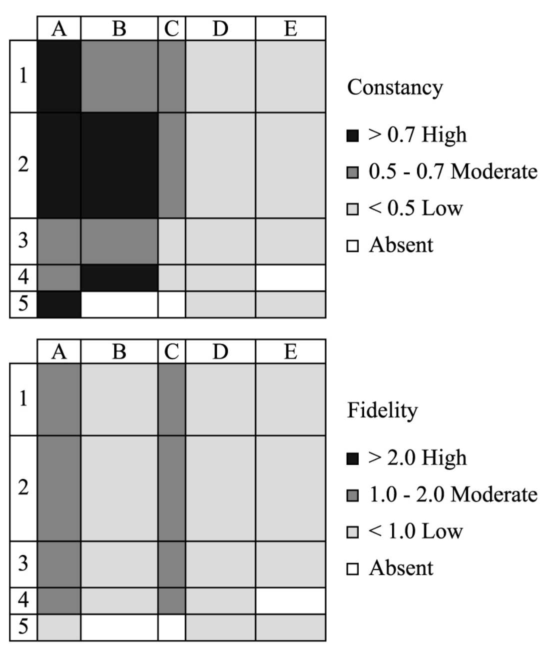

Figure 4. Nodal constancy and fidelity between species groups (1-5) occurring in gill nets and fishing spot groups (A-E). Group widths are proportional to the number of components within each group.

Table 1. Species list and their respective families, grouped by their occurrence on the types of fishing gear and fishing spots within fishing areas, following the results of cluster analysis.

Scientific Name	Family	Fishing Areas													
		A		B				C		D			E		
		BBAR	LFOR	ARPO	LEBL	IPAN	COPA	CAGL	EMIS	SCON	PDIA	CVID	RASA	CAGR	CAGS
1- CORVINEIRA															
Astroscopus y-graecum (Cuvier, 1829)	Uranoscopidae	X	X	X	X	X	X			X		X			X
Selene setapinnis (Mitchill, 1815)	Carangidae	X	X	X	X	X	X	X	X		X	X			
Cynoscion guatucupa (Cuvier, 1830)	Sciaenidae	X	X	X	X	X	X	X	X				X	X	
Pogonias cromis (Linnaeus, 1766)	Sciaenidae	X	X	X	X	X	X	X		X					
Menticirrhus americanus (Linnaeus, 1758)	Sciaenidae	X	X	X	X	X	X			X	X	X			
Lutjanus analis (Cuvier, 1828)	Lutjanidae	X	X	X	X	X	X	X	X	X			X		
Balistes capriscus Gmelin, 1788	Balistidae	X	X	X		X	X	X	X				X		
Percophis brasiliensis Quoy & Gaimard, 1825	Percophidae	X	X	X	X	X	X	X							
Porichthys porosissimus (Cuvier, 1829)	Batrachoididae	X	X	X	X	X	X	X							
Prionotus punctatus (Bloch, 1793)	Triglidae	X	X			X	X						X	X	
Peprilus paru (Linnaeus, 1758)	Stromateidae	X	X	X		X	X	X				X		X	
Urophycis brasiliensis (Kaup, 1858)	Gadidae	X	X			X		X				X	X		
Scorpaena isthmensis Meek & Hildebrand, 1928	Scorpaenidae	X	X			X		X			X	X	X		
Archosargus probatocephalus (Walbaum, 1792)	Sparidae	X	X		X				X					X	
Fistularia petimba Lacepéde, 1803	Fistulariidae		X		X										
Pagrus pagrus (Linnaeus, 1758)	Sparidae		X		X					X			X		X
2- CORVINEIRA + REDE ALTA															
Cynoscion jamaicensis (Vaillant & Bocourt, 1883)	Sciaenidae	X	X	X	X	X	X	X	X	X	X	X	X		
Diapterus rhombeus (Cuvier, 1829)	Gerreidae	X	X	X	X	X	X	X	X	X	X	X	X		X
Genidens barbus (Lacépède, 1803)	Ariidae	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Micropogonias furnieri (Desmarest, 1823)	Sciaenidae	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Scomber colias Gmelin, 1789	Scombridae	X	X	X	X	X	X	X	X		X		X	X	X
Pomatomus saltatrix (Linnaeus, 1766)	Pomatomidae	X	X	X	X	X	X	X	X			X	X	X	X
Trachinotus carolinus (Linnaeus, 1766)	Carangidae	X	X	X	X	X	X	X	X		X	X	X	X	X
Thyrsitops lepidopoides (Cuvier, 1832)	Gempylidae	X	X	X	X	X	X	X	X		X		X	X	X
Mugil liza Valenciennes, 1836	Mugilidae	X	X	X	X	X	X		X		X				
Chloroscombrus chrysurus (Linnaeus, 1766)	Carangidae	X	X	X	X	X	X	X			X				
Brevoortia aurea (Spix & Agassiz, 1829)	Clupeidae	X	X	X	X	X	X	X	X		X				
Centropomus undecimalis (Bloch, 1792)	Centropomidae	X	X	X	X	X	X	X	X		X	X			
Priacanthus arenatus Cuvier, 1829	Priacanthidae	X	X	X	X	X	X	X	X		X	X	X		
Merluccius hubbsi Marini, 1933	Merlucciidae	X	X		X	X		X	X				X	X	X
Carangoides crysos (Mitchill, 1815)	Carangidae	X	X	X	X	X	X	X	X				X		X

Table 1. Continued...

Scientific Name	Family	Fishing Areas													
		A			B			C			D			E	
		BBAR	LFOR	ARPO	LEBL	IPAN	COPA	CAGL	EMIS	SCON	PDIA	CVID	RASA	CAGR	CAGS
Diplodus argenteus (Valeciennes, 1830)	Sparidae	X	X	X	X	X	X	X	X				X	X	X
Cynoscion microlepidotus (Cuvier, 1830)	Sciaenidae	X	X	X	X	X	X	X	X	X				X	
Orthopristis ruber (Cuvier, 1830)	Haemulidae	X	X	X	X	X	X		X					X	
Stellifer rastrifer (Jordan, 1889)	Sciaenidae	X	X	X	X	X	X	X					X		
Anisotremus virginicus (Linnaeus, 1758)	Haemulidae	X	X	X	X		X							X	
Lagocephalus laevigatus (Linnaeus, 1766)	Tetraodontidae	X	X		X		X	X						X	
Paralonchurus brasiliensis (Steindachner, 1875)	Sciaenidae	X	X	X	X	X	X								
Stephanolepis hispidus (Linnaeus, 1766)	Monacanthidae	X	X	X	X	X	X								
Trichiurus lepturus Linnaeus, 1758	Trichiuridae	X	X	X	X	X	X								
Euthynnus alleteratus (Rafinesque, 1810)	Scombridae	X	X	X	X	X	X				X	X	X		
Umbrina canosai Berg, 1895	Sciaenidae	X	X	X		X	X					X			
Syacium micrurum Ranzani, 1842	Paralichthyidae	X	X	X	X	X	X								X
Opisthonema oglinum (Lesueur, 1818)	Clupeidae	X	X	X		X	X								
Acanthurus chirurgus (Bloch, 1787)	Acanthuridae	X	X		X	X					X				
Dactylopterus volitans (Linnaeus, 1758)	Dactylopteridae	X			X	X	X								
Syacium papillosum (Linnaeus, 1758)	Paralichthyidae	X			X	X	X								
Albula vulpes (Linnaeus, 1758)	Albulidae	X		X			X								
Scomberomorus brasiliensis Collette, Russo & Zavala-Camin, 1978	Scombridae		X	X			X		X		X				
3- CORVINEIRA + LINGUADEIRA															
Rhinobatos percellens (Walbaum, 1792)	Rhinobatidae	X	X	X	X	X	X	X	X	X		X	X		X
Paralichthys orbignyanus (Valenciennes, 1839)	Paralichthyidae	X	X	X	X	X	X		X	X	X	X			
Paralichthys patagonicus Jordan, 1889	Paralichthyidae	X	X	X	X	X		X				X	X	X	X
Chaetodipterus faber (Broussonet, 1782)	Ephippidae	X	X	X	X	X	X								
Dasyatis say (Lesurur, 1817)	Dasyatidae	X	X			X	X			X	X				
Squatina guggenheim Marini, 1936	Squatinidae	X	X					X					X		
Dasyatis guttata (Bloch & Schneider, 1801)	Dasyatidae						X			X					
4- REDE ALTA															
Kyphosus sectatrix (Linnaeus, 1758)	Kyphosidae	X	X	X		X	X	X			X				
Mugil curema Valenciennes, 1836	Mugilidae			X	X	X	X				X				
5- LINGUADEIRA															
Atlantoraja castelnaui (Miranda-Ribeiro, 1907)	Rajidae	X	X							X			X		

4. Discussion

Artisanal fishers of CPZ13 in Copacabana, still hold traditional fishing methods to produce their catch. Similar fishing gear has been described in the fishing villages of Itaipu (CPZ8) (Tubino et al., 2007) and Arraial do Cabo (CPZ5) (Britto, 1999), suggesting that such gill nets are predominant among artisanal fishers targeting similar resources. Fishers hold the traditional local ecological knowledge (LEK) about their fishery, linking the comprehension of natural changes and environmental states (*e.g.*, passage of frontal systems, swell, tidal movements, bottom type, habits of certain species of fish, etc) to make prognosis on where and how to set their gear to realize a specific catch (Lima and Pereira, 1997). According with Begossi (2004), fishers do not seek their prey at random, but look at the specific locations or "fishing spots", where certain fish species may be found. Which nets to be used, where should they be placed and which species to be captured are questions that must be answered each time fishers go out fishing. Moraes et al. (2013), studying the fisheries around the Cagarras Archipelago Natural Monument, observed that smaller nets (300 m – 1.000 m length, 40 mm mesh) might be used at nearshore fishing spots. In fact, our observations showed that the rede-alta, showing such characteristics, might be appropriate at these lower depths for catching both bottom dwellers and pelagic species.

The small boats used at CPZ13, indicate that fisheries occur at close range from the shore. Nehrer and Begossi (2000) observed that small sized boats of low technology limit fisher mobility across fishing spots in a sense that, most of them may be located at a closer range to the operation base. Despite the fact that the authors cited that some distant fishing spots might be visited at times, our observations in the course of this study at CPZ13 indicated that fishers never went beyond ilha Rasa (RASA) and São Conrado (SCON) the furthest fishing spots from CPZ13.

According with Nehrer and Begossi (2000), fishermen of CPZ13 used a total of 98 fishing spots for several fishing activities (e.g., gill netting, hand lining, spearfishing). A report by ECOMAR (2009) listed 18 fishing spots used by CPZ13 fishers, with most important fishing areas concentrated at Largo do Forte, Boca da Barra and several nearshore sites at the beaches of Copacabana, Ipanema and Leblon. The present study showed that the 14 fishing spots herein identified were consistent throughout the year, matching to a certain extent, the general fishing areas previously proposed for gill netting.

Fishing spot groups, based on the occurrence/co-occurrence of fishing gears apparently reflected some intrinsic environmental characteristics. Group A included fishing spots characterized by sandy bottoms away from nearshore waters and receiving a greater influence of Guanabara bay waters. Group B is represented by nearshore spots located off the surf zone of sandy beaches (e.g. Copacabana, Ipanema). Group C including Cagarras landward and Emissário, reflected the influence of the Ipanema submarine sewage outfall within the limits of the Monumento Natural das Ilhas Cagarras (van Weerelt et al., 2013). Groups D and E reflected areas off rocky shores and insular habitats respectively. Similar findings were previously observed (ECOMAR, 2009), indicating that the use of fisher's LEK defines gear placement at specific sites targeting fisheries resources.

The results herein presented indicate that the gill net fishery at CPZ13 occurs in areas outside the limits of the Monumento Natural do Arquipélago das Ilhas Cagarras MPA. In fact, sandy bottom areas were the most constantly visited by fishers at CPZ13, suggesting that predominant fisheries resources (e.g. *Micropogonias furnieri*) are distributed across sandy bottom fishing spots, or that such spots are more readily accessible to fishers most of the time. For instance, the artisanal fishery at Itaipu (CPZ8) concentrates its gill net fishing effort over similar sandy bottom habitats, capturing mostly *M. furnieri* (Tubino et al., 2007; Monteiro-Neto et al., 2008).

The knowledge about the species landed by the gill net artisanal fishery at CPZ13 provides an important tool to assess the fish fauna occurring within the MoNa Cagarras that may be protected by this conservation unit. About half of the species captured by the gill net fishery occur within the MPA, but these represent only 13,7% of the total species recorded by Monteiro-Neto et al. (2013) within the MoNa Cagarras. Nevertheless, target species such as *M. furnieri* and *Paralychthys* spp. were not listed within the MPA. This suggests that regulations concerning fishing operations within the MPA may have a limited impact for gill netting at CPZ13, and such regulations will not have conservation effects for the most sought after species. Fishers may be reticent about the negative impacts of marine protected areas in their catch, due to potential restrictions and regulations (Agardy et al., 2003; Pita et al., 2011). In fact, top down interventions to protect threatened species and habitats may intensify clashes between fishers and conservationists (Batista et al., 2014; McGoodwin, 2001). Nevertheless, Kerwath et al. (2013) provided rare empirical evidence that the establishment of an MPA rapidly increased fisheries yields without measurable disadvantages for fishers. These findings support actions towards the establishment of a buffering zone around the MoNa Cagarras in order to protect resources used by the CPZ13 gill net fishery. These actions are currently under way.

Acknowledgements

We thank the collaboration of fishers from the Colônia de Pescadores Z13, Copacabana. Thanks to the ECOPESCA Laboratory (UFF) research team for their help and suggestions. This research is part of a Masters Dissertation presented to 'Programa de Pós Graduação em Biologia Marinha – Universidade Federal Fluminense', and was partially funded by 'Projeto Ilhas do Rio, Instituto Mar Adentro', under the program 'Petrobras Ambiental'. R.B.A. received a Masters Degree scholarship granted by CAPES. C.M.N. holds a Research Fellowship from CNPq.

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