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Demersal fish communities may indicate priority areas for marine resources conservation

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Abstract. This study analyses the composition and temporal variation of the fish community from two close coastal marine sites off the central coast of Brazil: Itaoca and Manguinhos, both sites located between 500 and 1000 meters from the coastline**.** The material analysed comprised a total of 6,072 specimens of 66 fish species collected on board a bottom trawl vessel. Greater variability in catch rates and species composition was observed in Manguinhos. Itaoca presented lower level of temporal variability, higher species richness and an important abundance of juveniles in winter. This study shows that these two close marine environments present very different fish communities and play different roles regarding the aspects of diversity, species reproduction and nursery for the young specimens.

Key words: diversity, recruitment, reproduction, temporal variation, Southeastern Atlantic

Resumo. Comunidades de peixes demersais podem indicar áreas prioritárias para a conservação de recursos marinhos. Este estudo analisa a composição e a variação temporal de comunidades de peixes de dois locais costeiros próximos situados na costa central do Brasil. Ambos os locais situam-se entre 500 e 1000 metros da costa. O material analisado compreende um total de 6.072 peixes de 66 espécies, sendo coletados com a utilização de embarcações de arrasto de fundo. Uma maior variabilidade nas taxas de captura e composição das espécies foi observada em Manguinhos. Itaoca apresentou uma menor variabilidade temporal, maior riqueza de espécies e uma grande abundância de espécimes juvenis no inverno. Este estudo mostra que duas áreas costeiras próximas e situadas a distâncias similares da costa podem apresentar comunidades de peixes de características diferentes e que abrigam distintos aspectos de diversidade, reprodução e recrutamento de suas comunidades.

Palavras chave: diversidade, recrutamento, variação temporal, Atlântico Sudoeste

Introduction

Scientists and decision makers are now required to face the difficult task of managing and assessing marine resources in a multi-species context but in a situation where only a handful of species are subject of monitoring (King & McFarlane 2003). There is an increasing necessity of incorporating ecosystem considerations in the assessment of fisheries systems (Gasalla & Soares 2001). To achieve this goal, it is necessary a better understanding of processes and ecological functions of each environment, which would allow the development of conservation programs in a holistic context (Rueda & Defeo 2003).

The protection, conservation and management of habitats have been seen as fundamental for the conservation of species and sustainable exploitation of fisheries resources (Colloca *et al.* 2003). In addition to this, the recovery of functional habitats, which include connected feeding, spawning and nursing areas is necessary to the rehabilitation of fishery systems and effective species conservation (Gillanders *et al*. 2003). In a world where a small portion of marine environments are protected and little investment is directed to the creation and management of protected areas – most conservation programs are focused on charismatic species only –, information that serve as a basis for the classification of these functional habitats is necessary to optimize management actions to preserve ecosystems and species.

However, the present knowledge about coastal ecosystems and their production systems are still fragmented, deficient and out-of-date (Isaac *et al.* 2006). The continental coast is not homogenous and contains an enormous variability of habitats (Malatesta & Auster 1999). Each habitat is biologically and physiologically unique (Rhodes 1998). Hence, the understanding of how the communities are organized along with data on distribution and temporal variation of species represent invaluable information that contributes to the understanding of the functions of each studied environment, allowing for “predictions” of possible anthropogenic impacts, duration of respective effects and subsequent community recovery. Relationships between community and environment provide strong evidences on the importance that several environmental factors have on the determination of species distribution and abundance patterns (Jackson & Harvey 1993).

This study analyses the differences between the demersal fish community structure of two coastal environments and assess the importance of these two environments as reproduction and nursing ground for some of the observed species. The information presented draws attention to the re-evaluation of local fishery management and the choice of future marine protected areas.

Material and Methods

Study area

The study area is located in a transition zone of the Central Coast of Brazil, between tropical and subtropical environments and is characterized by northerly inflows of oligotrophic tropical waters from the Brazil Current and southerly inflows from the South Atlantic Central Waters (Schmid *et al.* 1995). Two different coastal environments off the Espírito Santo state were studied: a central coastal zone (off Manguinhos’ coast) and a south zone (off Itaoca’s coast) (Fig. 1). These two sites were chosen due to distinct environment features (see below). In both zones, the sampled sites were located between 500 and 1000 m from the coastline. The predominant winds in the coastal zone of the Espírito Santo state come from the NE, N and E quadrants. However, S and SE winds are common during winter due to the passage of cold fronts. There is also some seasonal variability in wave heights. In summer, when waters are calmer, small waves (Hs = 1.5 m) predominate. The sea then becomes rough throughout the fall months with increased wave sizes (Hs = 1.8 m), which achieve their maximum in winter (Hs > 2 m) to decrease again in spring (Hs = 1.8 m) (CCAR 2001).

Central coast site: Manguinhos

The sample site off the coast of Manguinhos (20° 11’S; 40° 11’W) is commercially exploited by a small, local prawn fishing fleet (about 4 boats) responsible for an annual catch of 2 t of the shrimp *Xyphopenaeus kroyeri* (Pinheiro & Martins, 2009). The studied site has an average depth of 8 m and substrate formed by mud and bioclastic sand, which is composed predominantly by fragments of calcareous algae, molluscs and bryozoans. The area is surrounded by extensive banks of lateritic formation (enriched in iron), which represent an obstacle to the trawling activities. The continental shelf of this region have a width of about 40 km. This area is considered to be more open and exposed to the influence of waves and currents action (authors personal observation, Fig. 1).

South coast site: Itaoca

This area is located in the Benevente Bight (20° 57’S; 40° 47’W), 100 km from Manguinhos (Fig. 1). The place is the fishing ground of bottom trawlers that are based at 3 fishing communities (Itaipava, Itaoca and Pontal do Itapemirim) located along the coast. About 50 fishing boats frequent the area and annually catch an average of 96 t of the shrimp *X. kroyeri*. This fleet discards annually an average of 197 t of several non-commercial fish and invertebrate species. (Pinheiro & Martins 2009). The average depth is about 4 meters and the substrate is composed of sand, mud and gravel (calcareous algae) (Pinheiro *et al*. 2009). The continental shelf is larger than in the region of Manguinhos, extending up to 60 km. The sampled site of this region is considered to be sheltered since it is inside the Benevente Bight and there is a physical barrier to the predominant winds and currents provided by rocky reefs and a coastal island located in the north. This area is also probably under the influence (not measured) of the estuary of the River Itapemirim that is located about 10 km from the south of the sampled site.

Sampling protocol

Data collection was performed on board a shrimp trawler similar to the commercial ones used by local fishermen. The period sampled started in October 2003 and ended in September 2004. A total of 10 and 11 monthly samplings were carried out for Itaoca and Manguinhos respectively. There were no samplings in March and April for Itaoca and March for Manguinhos since bottom trawl fishing is prohibited during these months as a measure of effort control for the shrimp fishery. The boat used was a commercial artisanal shrimp vessel hired for this study, including its experienced fisherman crew. It was 6 m long and powered by an 18 cc engine. The net was 10 m long with an opening of 5x3.5 m. The mesh size was 2 cm in the main body and 1 cm in the cod-end.

One to three hauls lasting between 60 and 90 minutes were carried out at every month sampled, totaling 29.3 hours in Manguinhos and 28.7 hours in Itaoca. The total fish catch were separated on board and stored in ice to be transported to the laboratory. A sub-sample of 50 or 25% of total weight of each haul was collected when the fish catches were too large.

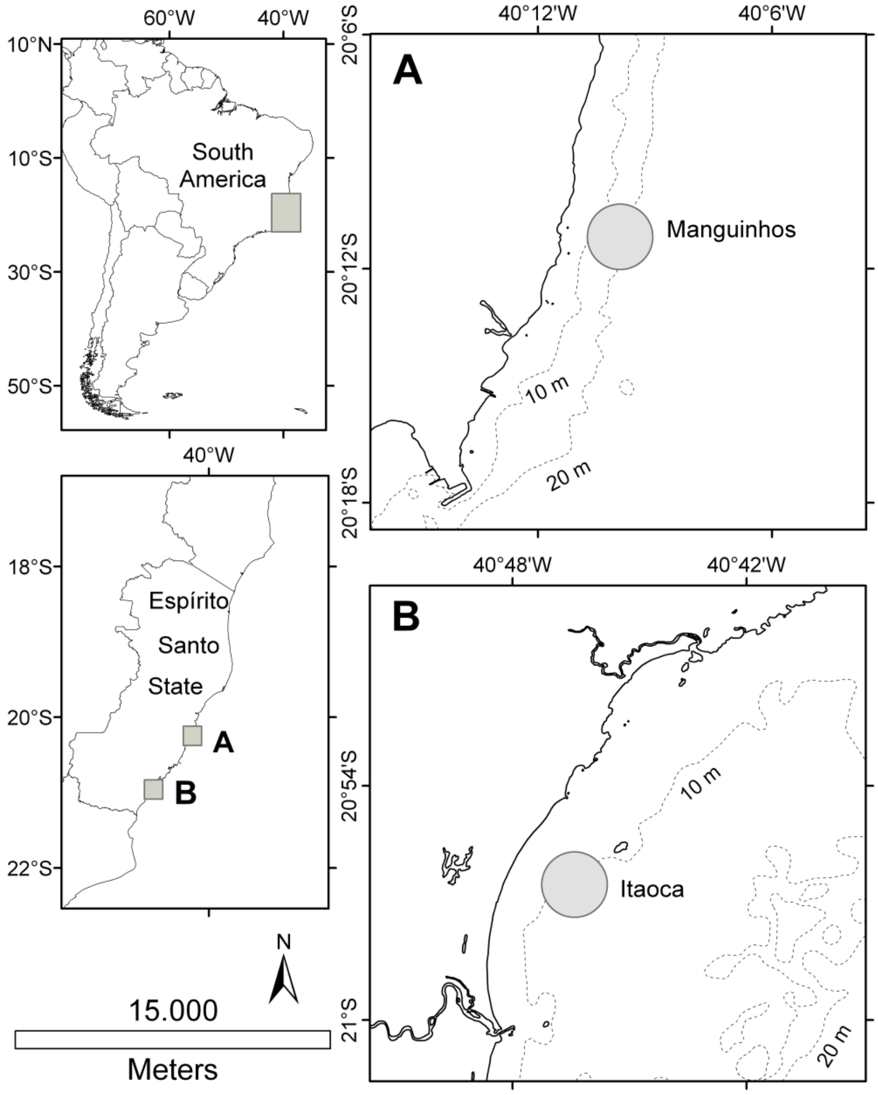

Figure 1. Map of the study areas located off the central coast of Brazil.

Laboratory analysis

Fish species were identified following Figueiredo (1977), Fischer (1978), Figueiredo & Menezes (1978, 1980, 2000) and Menezes & Figueiredo (1980, 1985). The nomenclature of the species followed Menezes *et al.* (2003). For each individual the following data were recorded: total length (TL) measured to the nearest millimetre; total weight (TW) measured to the nearest tenth of gram; sex and maturity stage. Maturity stages [adapted from Martins & Haimovici (2000)] were classified in: I- juveniles/immature, II- resting, III- ripening, IV- ripening 2 (advanced), V- running, VI- spent, VII- recovering. These stages were grouped into adults (II to VII) and juveniles (I) for general comparisons purposes. In this study we used the term recruitment to refer to juveniles that become vulnerable to being caught by the bottom trawl fishing.

Data analysis

Numbers and weight data for each species were converted to numbers and weight caught per hour (CPUE) to be used in subsequent analyses. In cases of large catches, when just a fraction was sampled, total numbers and weight were estimated using a multiplying factor estimated as the whole catch weight divided by the total weight of the sample taken. The frequency of occurrence (FO) of species was obtained using the following equation: FO = Nt/N, where Nt = number of months that the species was recorded and N = months sampled. Resident species were defined as the species present in at least 80% of the sampled months in each locality. The samples were then grouped into Spring (September, October and November), Summer (December, January and February), Fall (March, April and May) and Winter (June, July and August) for the analysis of seasonal variation of adults, juveniles, resident and non-resident species.

A cumulative curve was used to compare the species richness of the two sites, while equitability was assessed with a species rank curve. To analyse the temporal (monthly averages) and spatial patterns (Itaoca x Manguinhos) of community structure, ln (x+1) transformed catch data (numbers/h) of the most abundant species (which represented about 95% of the total catch in numbers) were used in a cluster analyses. The Bray-Curtis similarity index and average group distance were used.

Results

Fish composition. A total of 6,072 fish, representing 66 fish species, were caught from both sampling sites (Table 1). Among these, 31 occurred in the two areas. These species represented between 82% and 95% of the total biomass in Itaoca and Manguinhos, respectively. Twenty-six species occurred only in Itaoca and 9 only in Manguinhos.

Manguinhos

A total of 1,447 fish was caught. These comprised 40 species, 18 families and 8 orders. The Perciformes presented the larger numbers of families (7), followed by Pleuronectiformes (3) . The Sciaenidae family presented 14 species, while Clupeidae was represented by 4 species. The ichthyofauna caught in Manguinhos presented a large temporal variation in its abundance, ranging from 0.3 to 4.9 kg/h (CV = 0.8). The average CPUE was 1.8 (±0.5) kg/h. Fifteen species represented 95% of the total biomass, the remaining 25 just 5%. Eight species were considered rare because they occurred just once and were represented by 1 specimen each. The average length for all specimens from this area was 9.5 (±0.08) cm.

Itaoca

A total of 4,625 fish were caught. These comprised 57 species, 26 families and 10 orders (Table 1). The Perciformes presented the larger number of families (8), followed by Rajiformes (3), Scorpeaniformes (3) and Pleuronectiformes (3). The Sciaenidae had the larger number of species (13), followed by Carangidae (5) and Tetraodontidae (4) (Table I). The abundance of the demersal fish from Itaoca was less variable than in Manguinhos, ranging from 3.6 to 10 kg/h (CV = 0.4). The average CPUE was 4.9 (±0.6) kg/h. Eighteen species represented 95% of the total biomass, the remaining 39 just 5%. Eleven species were considered rare since they occurred just once and were represented by 1 specimen each. The average length for all specimens from this area was 9.5 (±0.07) cm.

Community structure

Itaoca presented a higher species richness than Manguinhos (Fig. 2a). The fish community in Itaoca was also slightly more homogenous than the one of Manquinhos (Fig. 2b). Itaoca presented a pronounced level of recruitment in the fall and winter months, what is evidenced by the lower average fish sizes and large biomass of juveniles (Fig. 3). Regarding the frequency of occurrence of the different species observed, it can be seen that Itaoca presents higher abundance and biomass of resident species than Manguinhos does (Fig. 4). In both localities, the non-resident species were more abundant in summer (Fig. 4).

Spatial-temporal differences in community structure

The Cluster analyses showed that the monthly data sampled from Itaoca are more homogenous than the Manguinhos data (Fig. 5). The observed data for the months of October, November, December and January in Manguinhos were more similar to the Itaoca data than to the other data months sampled in Manguinhos.

Table I. List of species collected from Manguinhos and Itaoca between October 2003 and September 2004. Families are in filogenetic order. The average CPUE (n/h) and SE, average total weight (TW) in grams (g) (of each individual) and SE, the range of individual total length (TL) and the frequency of occurrence also are presented.

	Itaoca				Manguinhos			
Family Species	CPUE (n/h)	Average TW (g)	TL cm Range	FO	CPUE (n/h)	Average TW (g)	TL cm Range	FO
Achiridae								
Achirus declivis Chabanaud 1940	4 (3)	12 (1.9)	4-12	0.4	0.1 (0.1)	4	6	0.1
Achirus lineatus Linnaeus 1758	4 (1)	27 (2)	7-16	0.9	<0.1 (0)	30 (10.6)	10-13	0.1
Ariidae								
Cathorops spixii (Agassiz 1829)	1 (1)	71 (9)	8-23	0.3				
Notarius grandicassis (Valenciennes 1840)					0.1	100	21	0.1
Aspistor luniscutis (Valenciennes 1840)	<1 (0)	82	22	0.1				
Batrachoididae								
Porichthys porosissimus (Cuvier 1829)					0.1	4	9	0.1
Carangidae								
Caranx crysos (Mitchill 1815)	<1 (0)	4	7	0.1				
Caranx latus Agassiz 1831	<1 (0)	26	13	0.1				
Chloroscombrus chrysurus (Linnaeus 1766)	1 (1)	3 (0.6)	6-10	0.2	0.3 (0.3)	0 (0)	2-3	0.1
Selene setapinnis (Mitchill 1815)	<1 (0)	7 (1)	6-9	0.1	0.1 (0.1)	2 (0.2)	4-6	0.1
Selene vomer (Linnaeus 1758)	1 (0)	14 (2.5)	7-13	0.4				
Clupeidae								
Chirocentrodon bleeckerianus (Poey 1867)	30 (11)	6 (0.1)	6-13	1	1.4 (0.8)	5 (0.2)	7-12	0.3
Harengula clupeola (Cuvier 1829)	<1 (0)	16	12	0.1				
Odontognathus mucronatus Lacèpede 1800	4 (2)	10 (0.7)	7-17	0.7	5.8 (3.2)	5 (0.5)	6-15	0.4
Pellona harroweri (Fowler 1917)	86 (30)	4 (0.1)	4-14	1	45.3 (21)	4 (0.1)	3-13	0.9
Sardinela janeiro (Eigenmann 1894)**					0.2 (0.2)	42 (3.1)	17-18	0.1
Cynoglossidae								
Symphurus plagusia (Block & Schneider 1801)	1 (0)	12 (1.4)	9-14	0.5	0.1 (0)	19	13	0.1
Symphurus tessellatus (Quoy & Gaimard 1829)	4 (1)	20 (1.7)	10-18	0.8	0.1 (0.1)	5 (1.4)	8-10	0.1
Dactylopteridae								
Dactylopterus volitans (Linnaeus 1758)	1 (1)	43 (27)	6-34	0.3				
Dasyatidae								
Dasyatis guttata (Block & Schneider 1801)	<1 (0)	214	65	0.1				
Diodontidae								
Cyclichthys spinosus (Linnaeus 1758)	21 (10)	32 (2.4)	4-21	1	2 (1.8)	25 (1.3)	6-9	0.3
Engraulidae								
Anchoa filifera (Fowler 1915)	3 (2)	7 (0.4)	9-13	0.7	<0.1	5 (1.4)	8-10	0.1
Anchoa spinifer (Valenciennes 1848)	1 (1)	19 (4.8)	9-19	0.5	2.6 (1.6)	15 (2.7)	8-20	0.5
Cetengraulis edentulus (Cuvier 1829)	<1 (0)	25 (0.7)	14-15	0.2				

Table I *(Cont.)*

Ephippididae								
Chaetodipterus faber (Broussonet 1782)	<1 (0)	52 (18.3)	7-14	0.3	0.2 (0.2)	73 (3.5)	12-13	0.2
Gymnuridae								
Gymnura altavela (Linnaeus 1758)	<1 (0)	454	25	0.1				
Haemulidae								
Conodon nobilis (Linnaeus 1758)	4 (2)	27 (3)	9-17	0.8	3.3 (1.3)	20 (2.6)	7-17	0.6
Orthopristis ruber (Cuvier 1830)	1 (0)	16 (3.8)	6-14	0.4				
Muraenidae								
Gymnothorax ocellatus Agassiz 1831	2 (1)	78 (7.9)	29-44	0.8				
Narcinidae								
Narcine brasiliensis (Olfers 1831)					0.1 (0)	82	18	0.1
Ogcocephalidae								
Ogcocephalus vespertilio (Linnaeus 1758)	<1 (0)	3	6	0.1				
Ophichthidae								
Ophichthus gomesii (Castelnau 1855)	<1 (0)	133 (9.1)	19-59	0.2				
Paralichthyidae								
Citharichthys macrops Dresel 1885	1 (0)	23 (2.4)	11-15	0.2	<0.1 (0)	5	8	0.1
Citharichthys spilopterus Günther 1862	2 (1)	26 (3.2)	6-18	0.4				
Polynemidae								
Polydactylus oligodon (Günther 1860)					0.1 (0)	19	13	0.1
Polydactylus virginicus (Linnaeus 1758)	<1 (0)	50 (8.8)	15-19	0.3	0.7 (0.4)	24 (5.3)	11-16	0.4
Rhinobatidae								
Rhinobatos horkelii Müller & Henle 1841*	<1 (0)	518	42	0.1				
Rhinobatos percellens (Walbaum 1792)	<1 (0)	447 (240.6)	39-72	0.2				
Zapteryx brevirostris Müller & Henle 1841)	<1 (0)	389	41	0.1				
Sciaenidae								
Bairdiella ronchus (Cuvier 1830)					1.1 (0.7)	13 (2.1)	7-15	0.4
Ctenosciaena gracilicirrhus (Metzelaar 1919)	10 (5)	11 (0.4)	8-14	0.4	4.6 (4.1)	18 (1.2)	6-20	0.2
Cynoscion jamaicensis (Vaillant & Bocourt 1883)	14 (6)	12 (0.5)	4-15	0.5	2.5 (1.4)	14 (1.8)	4-18	0.5
Cynoscion leiarchus (Cuvier 1830)	<1 (0)	124	24	0.1				
Cynoscion microlepidotus (Cuvier 1830)					<0.1	1 (0.3)	5-6	0.1
Cynoscion virescens (Cuvier 1830)	<1 (0)	189 (22.7)	26-33	0.2	0.2 (0.2)	25 (13.7)	12-20	0.1
Isopisthus parvipinnis (Cuvier 1830)	21 (8)	14 (0.7)	3-22	0.9	5.2 (1.6)	12 (1.8)	5-18	0.9
Larimus breviceps (Cuvier 1830)	15 (3)	24 (1.6)	4-18	1	10.2 (2.8)	15 (1.1)	4-17	1
Macrodon ancylodon (Block & Schneider 1801)**					0.6 (0.3)	189 (46.7)	17-31	0.3

Table I *(Cont.)*

Menticirrhus americanus (Linnaeus 1758)	2 (1)	36 (7.6)	6-26	0.7	1.4 (0.3)	30 (5.5)	8-20	0.9
Micropogonias furnieri (Desmarest 1823)**					0.8 (0.5)	22 (5.8)	8-16	0.3
Nebris microps Cuvier 1830	<1 (0)	174	26	0.1				
Paralonchurus brasiliensis (Steindachner 1875)	18 (3)	24 (1.7)	2-23	1	6.3 (2.3)	34 (4.4)	4-23	0.8
Stellifer brasiliensis (Schultz 1945)	32 (7)	13 (0.4)	4-16	1	27.3 (8.5)	13 (0.7)	6-18	1
Stellifer rastrifer (Jordan 1889)	43 (7)	9 (0.6)	3-19	1	21.4 (4.4)	11 (0.8)	4-20	1
Stellifer naso (Jordan 1889)	<1 (0)	45 (7)	13-16	0.2				
Umbrina coroides Cuvier 1830	<1 (0)	33 (21.2)	11-19	0.1	0.5 (0.5)	10 (1.3)	8-11	0.1
Scorpaenidae								
Scorpaena isthmensis Meek & Hildebrand 1928	<1 (0)	9	8	0.1				
Serranidae								
Diplectrum formosum (Linnaeus 1766)	1 (0)	41 (1.7)	14-16	0.2				
Stromateidae								
Peprilus paru (Linnaeus 1758)	1 (0)	8 (1.9)	3-10	0.4	0.3 (0.3)	1 (0.4)	3-5	0.2
Syngnathidae								
Microphis brachyurus lineatus (Kaup 1856)	<1 (0)	1	12	0.1				
Tetraodontidae								
Lagocephalus laevigatus (Linnaeus 1766)	<1 (0)	22 (10.4)	8-13	0.3	0.5 (0.3)	19 (9.6)	5-16	0.3
Sphoeroides greeleyi Gilbert 1900	1 (0)	57 (14.7)	8-17	0.3				
Sphoeroides pachygaster (Müller & Troschel 1848)	<1 (0)	74 (59.4)	9-20	0.1				
Sphoeroides testudineus (Linnaeus 1758)	<1 (0)	18	10	0.1	0.7 (0.6)	91 (11.7)	12-20	0.2
Trichiuridae								
Trichiurus lepturus Linnaeus 1758	1 (0)	32 (8.1)	8-54	0.5	2.3 (1.1)	6 (1.2)	15-34	0.4
Triglidae								
Prionotus punctatus (Block 1793)	<1 (0)	8 (2.4)	6-11	0.1	<0.1 (0)	19	12	0.1

* Species threatened of extinction; **Species threatened of over-exploitation.

Discussion

The coast of Brazil can be considered a complex area with a diversity of marine habitats, presenting different aspects in terms of geological genesis, which include coral reefs, lateritic reefs, rocky reefs and rocky coasts (crystalline basement) and extensive coastal plains related to the large rivers mouths (Martins & Doxsey 2006). The Espírito Santo state is situated in the middle of this huge area. The sampled areas have some different characteristics, which can have a direct effect on the observed species abundance and composition. Different authors sustain that the habitat heterogeneity affects assemblage structure (Araujo & Azevedo 2001, Vega-Cendejas & Santillana 2004, Chagas *et al.* 2006).

Exposition to winds, waves and currents can influence the distribution of larvae, recruits and juveniles, carrying them from one place to another, and then influence the community patterns (Callaway *et al.* 2002). The low variation in the community structure of Itaoca and the high abundance of resident species could be related to the higher stability of this shallower and more sheltered area (Colloca *et al.* 2003). Some species that occurred only in Itaoca are associated with substrates that have some degree of complexity, such as gravels and reefs (*D. volitans, D. formosum, G. ocellatus, G. altavela, O. vespertilio, O. gomesii, O. ruber, Scorpaena sp., S. greeleyi* e *S. pachygaster*; Froese & Pauly 2009), what suggests a higher presence of microhabitats in this area.

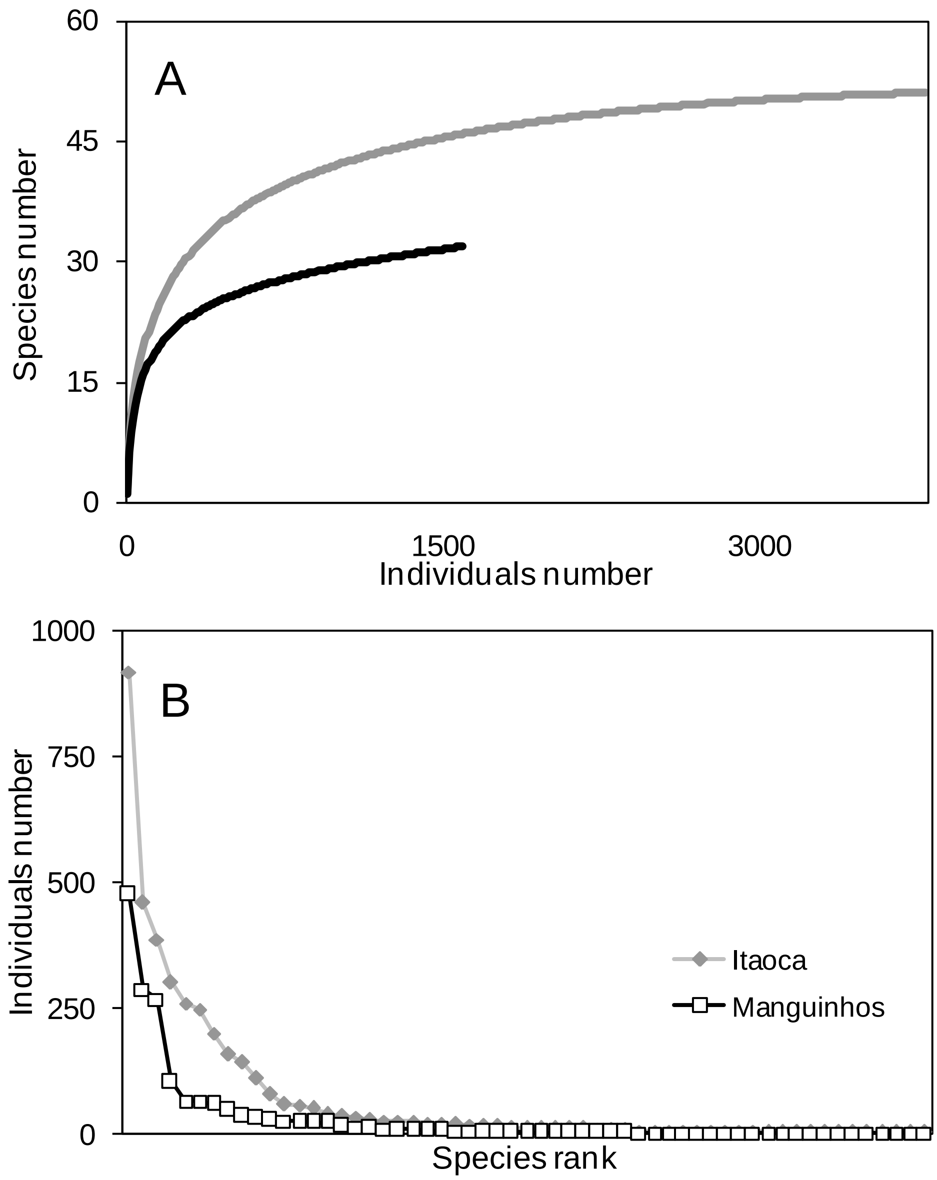

Figure 2. Richness (species number) and species rank from Manguinhos and Itaoca between October 2003 and September 2004.

The region of Manguinhos, despite of hosting an important spawning biomass in summer, had no signs of recruitment. The low abundance of resident species in the fall and winter months results in the dissimilarity among the data months collected from Manguinhos. Probably, it can occur due to the action of currents and waves, which become stronger during the winter season (CCAR 2001).

The summer oceanographic conditions, when the sea is more stable, can be related to the similarity among data sets from the two environments studied. Some features, such as the larger biomass of adults and higher frequency of non-resident species occurred during the summer month in both areas. These kinds of seasonal changes also are related with reproductive habits of species in different areas of world (Ansari *et al.* 1995).

The region next a big river mouth, Itaoca, presented a huge quantity of juveniles, and could be seen a nursing area (Pinheiro *et al.* 2009). In fact, freshwater discharges generally increase the productivity of coastal shallow waters and these habitats are considered as nursing grounds by various authors (Bennett 1989, Paterson & Whitfield 2000, Lassari *et al* 2003). This area, as some other coastal regions (Methven *et al.* 2001), is used as reproductive and growth habitat by several species.

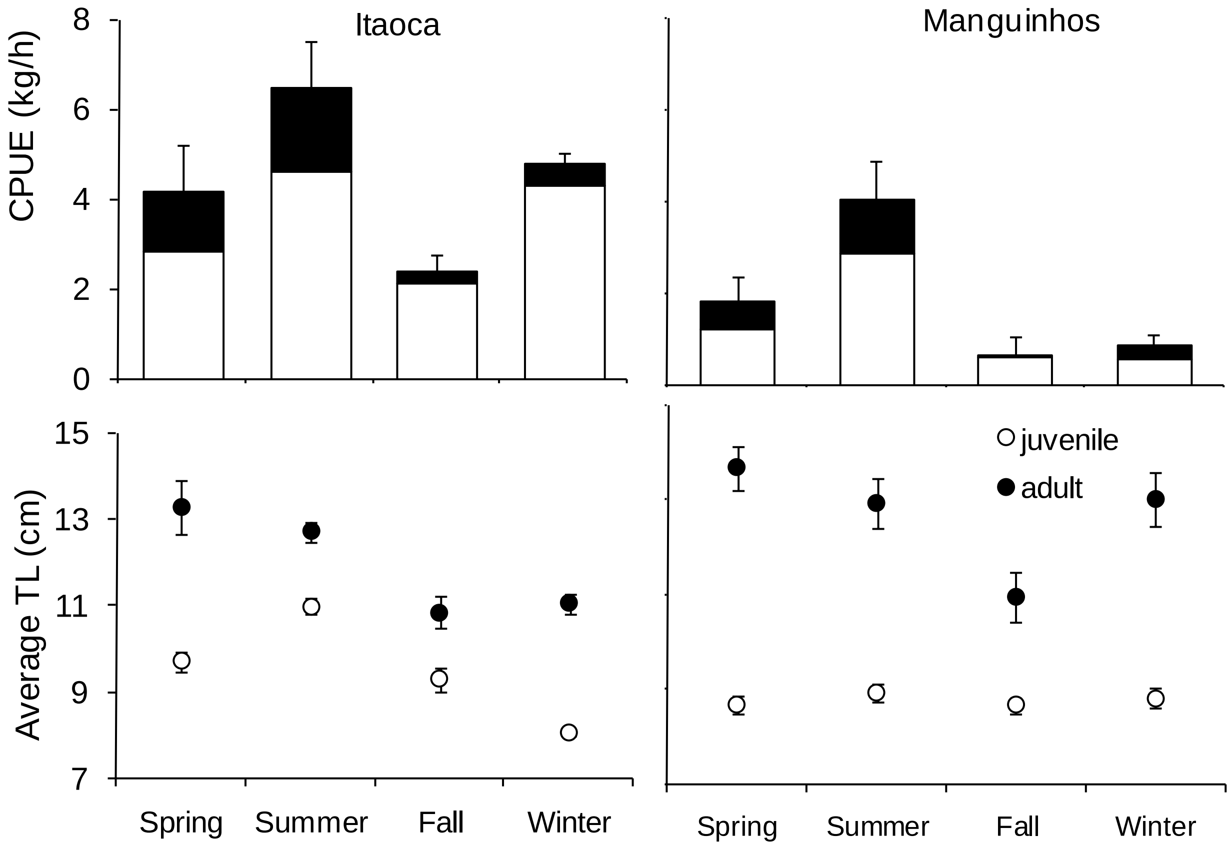

Figure 3. Seasonal CPUE and average sizes for adult and juvenile specimens data collected from Manguinhos and Itaoca between October 2003 and September 2004.

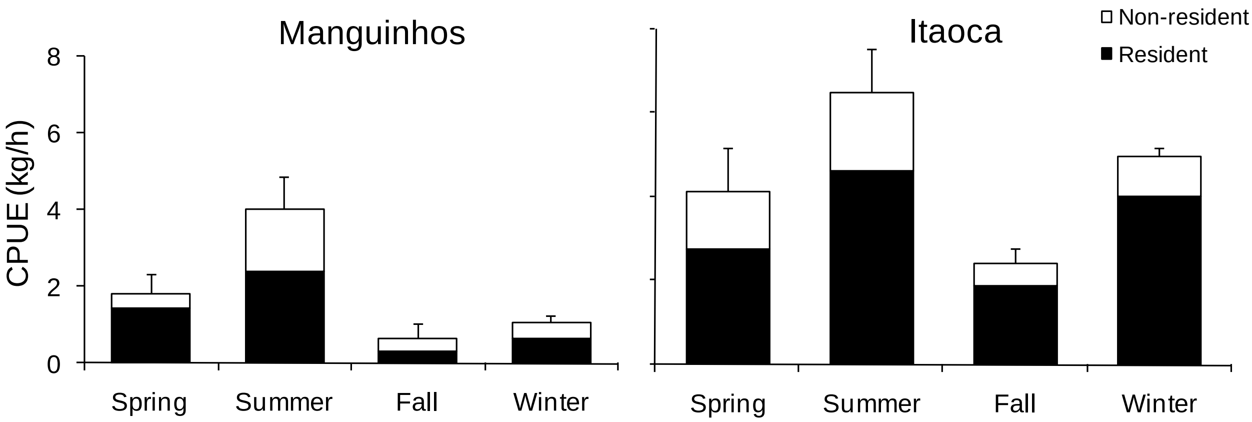

Figure 4. Average catch rates (CPUE kg/h) and SE of resident and non-resident species collected from Manguinhos and Itaoca between October 2003 and September 2004.

Conservation Issues

The locality of Itaoca, considered here as a nursing area, besides of having higher species richness, saw the occurrence of an elasmobranch species (*Rhinobatos horkelii*) threatened with extinction in Brazil (IBAMA 2003). The conservation of habitats that are essential for the life cycle of several species, such for this elasmobranch, is of utmost importance for their long-term preservation (Lange 2003). However, destructive activities, such as bottom trawling for shrimp, continue to be carried out daily in many important marine ecosystems. The physical action of bottom trawl can destroy the main features of marine habitats (Malatesta & Auster 1999) and induce ecological changes in community structure (Cabral *et al.* 2002, Colloca *et al.* 2003, Hall & Mainprize 2004).

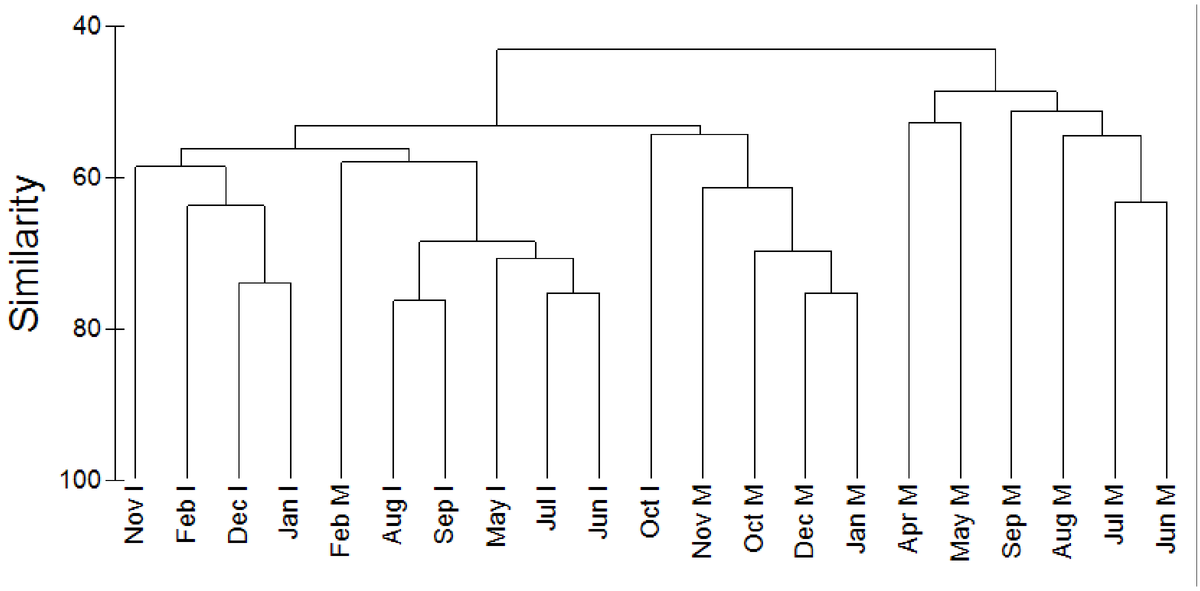

Figure 5. The Cluster analyses showing the distribution of the sampled months from Itaoca and Manguinhos in relation to the abundance of the species accounted for 95% of the samples. Abbreviations used are: Jan=January, Feb=February, Apr=April, Jun=June, Jul=July, Aug=August, Sep=September, Oct=October, Nov=November, Dec=December; note that abbreviation months finished in "I" are the sampled in Itaoca and the finished in "M" are the sampled months of Manguinhos.

In reality, marine ecosystems are in need of more investments in conservation (Pister 2003). Although many marine protected areas are increasingly being created around the world to protect ecosystems and habitats, to aid the recovery of threatened areas, to protect spawning stocks and to provide recruits to neighbour areas (Planes *et al.* 2000), the coast of Brazil still has extensive areas (500-1500 km) between protected ones that continue to be open to fishing (Floeter *et al.* 2006). This study draws attention to the issue of the determination of habitats and periods that should be given priority in the Brazilian context of low investments in the management of marine life. The determination and connection of protected functional habitats, such as reproductive and nursing areas, are proposals that aim to guarantee the sustainability of fisheries activities.

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