

EXPORTATION OF REEF FISH FOR HUMAN CONSUMPTION: LONG-TERM ANALYSIS USING DATA FROM RIO GRANDE DO NORTE, BRAZIL

Francisca Edna de Andrade CUNHA ¹; Roberto Aurélio Almeida de CARVALHO ²; Maria Elisabeth de ARAÚJO ³

ABSTRACT

Marine fisheries constitute a major economic activity. Several species of fish have recently been added to the list of exploited stocks, including reef-dwelling species traded on international markets. The aim of the present study was to outline a profile of local fisheries in terms of species caught, weights exports and import markets, using data obtained from firms operating in the state of Rio Grande do Norte, Brazil. Over the period covered by the study (1996-2008), 3,335.49 metric tons of fish belonging to 32 species (16 genera, 10 families) caught during 7,377 shipped lots for export. The most abundant families were Lutjanidae (36.77%), Scaridae (21.06%), Serranidae (20.57%), Mullidae (12.73%) and Acanthuridae (8.64%). Most of the production was air-shipped fresh to importers in the United States.

Key words: Marine fishes; food; fisheries; stocks exploitation; Brazilian Northeast

EXPORTAÇÃO DE PEIXES RECIFAIS PARA CONSUMO HUMANO: ANÁLISE DE LONGO PRAZO USANDO DADOS DO RIO GRANDE DO NORTE, BRASIL

RESUMO

A pesca marinha constitui uma importante atividade econômica. Várias espécies de peixes foram recentemente adicionadas à lista dos estoques explorados, incluindo-se as espécies recifais comercializadas no mercado internacional. O objetivo do presente estudo foi traçar um perfil da pesca local em termos de espécies capturadas, peso exportado e mercado importador, usando dados obtidos das empresas que operam no Estado Rio Grande Norte, Brasil. No período estudado (1996 - 2008) foram capturadas e exportadas 3.335,49 toneladas de peixes pertencentes a 32 espécies (16 gêneros e 10 famílias), capturadas durante 7.377 lotes embarcados para exportação. As famílias mais abundantes foram Lutjanidae (36,77%), Scaridae (21,06%), Serranidae (20,57%), Mullidae (12,73%) e Acanthuridae (8,64%). A maior parte da produção foi exportada fresca, por via aérea, para importadores nos Estados Unidos.

Palavras chave: Peixes marinhos; alimento; pescarias; exploração dos estoques; nordeste brasileiro

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¹ Professor adjunto I da Universidade Federal do Piauí. Av. São Sebastião, 2819 - Reis Veloso - CEP: 64.202-020 - Parnaíba - PI - Brazil. e-mail: f_edna@yahoo.com.br (corresponding author)

² Professor efetivo do Instituto Federal de Educação Tecnológica do Rio Grande do Norte, Macau - RN - Brazil. e-mail: roberto.carvalho@ifrn.edu.br

³ Professor Titular do Departamento de Oceanografia da Universidade Federal de Pernambuco. Av. Arquitetura, s/n, Campus Universitário - CEP: 50.740-550 - Recife - PE - Brazil. e-mail: betharau08@gmail.com

INTRODUCTION

Reefs form a highly diversified ecosystem rich in natural resources of considerable ecological, economic and social interest, harboring valuable fish stocks and contributing to the subsistence of traditional coastal communities (MMA, 2002). In some developing countries, products from reef environments can represent as much as 25% of the total food supply (KUNZMANN, 2004).

Despite its economic importance, there is little documentation on reef zones and the conservation status of exploited species (DALZELL, 1996; JIDDAWI and STANLEY, 1999; MAPYA *et al.*, 2002; COSTA *et al.*, 2003; FLOETER *et al.*, 2006). However, investigations addressing these issues can provide important information to the management of stocks (KAUND-ARARA *et al.*, 2003). A total of 437 species of reef-dwelling fish are recognized for the coast of Brazil, distributed among 117 genera (3 endemic to the region), among which the families Gobiidae, Serranidae and Carangidae are the most speciose (FLOETER *et al.*, 2008). Reef fish were defined as those with a high degree of ecological association with reef environments in terms of feeding, refuge and shelter necessary to survival (BELLWOOD, 1988).

Between 1995 and 2000, approximately 200,000 marine fish (143 species) - mostly reef species - were officially traded as ornamental fish by firms in the state of Ceará, with 90% of this total destined for exportation (MONTEIRO-NETO *et al.*, 2003).

Besides overfishing due to the trade of ornamental fish, fishing activities for human consumption has also had significant negative effects on the abundance and size of a large number of reef species in Brazil (FLOETER *et al.*, 2006). Reef fish catches have increased gradually over the years as a consequence of food demands in other countries (RIBEIRO, 2004). The study cited is one of the few publications on the commercial exploitation of reef fish for human consumption, but the paper is restricted to technological aspects of trap fishing.

Official data on fishery activities in Brazil are limited by the insufficient number of individuals collecting data, a lack of commitment on the part of the industry to provide information and the

absence of an integral institutional policy aimed at the generation of national fishery statistics (IBAMA, 2008). Analyzing and monitoring the exploitation levels of fishery resources in northeastern Brazil is of fundamental importance to ensuring the conservation of stocks, which are a source of food and income for the fishing community in the region (NÓBREGA and LESSA, 2007).

The lack of precise information impedes any reasonable assessment of the economic, social and environmental impacts caused by the exportation of reef fish for human consumption, thereby rendering the drafting of fishery management policies impossible. However, such policies are necessary to the sustainability of this activity, which generates business opportunities for fishing boat owners as well as employment for a large number of artisanal fishermen. The general objective of the present study was to outline a profile of the commercial exploitation of reef fish for human consumption, using data obtained from firms operating in the state of Rio Grande do Norte, Northeastern Brazil.

MATERIAL AND METHODS

Data on the exportation of reef fish for human consumption (generated by export firms in the state of Rio Grande do Norte, Brazil) were obtained from exportation certificates issued by the Ministry of Agriculture, Livestock and Provisions through the Federal Inspection Service. All fish processing firms are required to be registered with this service and need an exportation certificate for each lot sold. This certificate lists the names of the species, weights per species and name of the firm. Federal inspectors verify the information declared by the export firm. The present study involved certificates issued between 1996 and 2008. The initial year marks the first exportations of reef fish for human consumption in the state of Rio Grande do Norte.

As no permission was requested for the divulgation of the names of all the export firms, each is identified by a letter. Each declaration for each species registered on the exportation document was defined as one catch unit totaling 7,377 lots on period analyzed. Data on exportation weights for species from the families Acanthuridae, Mullidae and Scaridae were

analyzed on the family level due to imprecision in the scientific identification of the species on the part of the export firms.

The scientific names of the species declared by the export firms were checked through the sampling of specimens for a more accurate identification used specific keys at the Ichthyology Laboratory of the Oceanography Department of the Universidade Federal de Pernambuco (Brazil), where voucher specimens are deposited. For such, specific keys were used, such as those proposed by FIGUEIREDO and MENEZES (1978, 1980, 2000); MENEZES and FIGUEIREDO (1980, 1985); HUMANN (1999); MOURA *et al.* (2001); MOURA and LINDEMAN (2007).

Data of rainfall mean monthly were obtained from the Empresa de Pesquisa Agropecuária do Rio Grande do Norte (EMPARN) during the studied period (1996-2008). The information collected about rainfall went to check the existence of relationship between the rainy and dry season with the export weight. Whereas in tropical waters, where seasonal changes in temperature are non-significant, rainfall plays a decisive role in the determination of cycles of fishery productivity. In the rainy season, greater amounts of organic matter and nutrients are carried from the mainland to the ocean, which favors primary productivity and, consequently, the higher trophic levels (TRUJILLO and THURMAN, 2008; FRÉDOU *et al.*, 2009; DANTAS *et al.*, 2012).

RESULTS

A total of 25 collections of specimens were carried out at the firms between February and June 2007 to check the scientific names declared. Besides the 23 species of reef fish for human consumption declared on the exportation certificates, another nine were identified among the specimens collected for the verification of the scientific names, totaling 32 species distributed among 16 genera and 10 families.

Based on the information obtained from the exportation certificates, only one species was declared for the family Acanthuridae (*Acanthurus chirurgus*). However, it was determined that small quantities of *A. coeruleus* and *A. bahianus* were also exported. Likewise,

only one species from the family Mullidae was registered (*Pseudupeneus maculatus*), but *Mulloidichthys martinicus* was also found. All species of Scaridae were declared as *Sparisoma* sp.. However, during the sampling, three genera and seven species were identified: *Scarus trispinosus*, *Scarus zelindae*, *Sparisoma amplum*, *S. axillare*, *S. frondosum*, *S. radians* and *Nicosina usta* (Table 1). Although it was not the aim of the present study to establish the quantitative participation of each species in this family, there was a clear predominance of *S. axillare* and *S. frondosum* and a small number of *Nicosina usta*.

In the period studied, a total of 3,335.49 tons from 7,377 lots were exported. The family Lutjanidae represented the greatest weight exported (36.77%), followed by Scaridae (21.06%), Serranidae (20.57%), Mullidae (12.73%), Acanthuridae (8.64%); other families only accounted for 0.23% (Table 1). The participation of *Ocyurus chrysurus* and species of the family Scaridae accounted for nearly 43% of the total. Adding those from the family Mullidae (12.73%), this group surpassed half the total amount exported, corresponding to 1,856.34 tons.

In the 13-year evaluation period in the state of Rio Grande do Norte, a total of 10 firms exported reef fish for human consumption. However, four firms alone accounted for 92.8% of the total. Throughout the study period, firms entered and left this activity, reaching a maximum of five firms operating simultaneously in 2008, trading a total of 11 species (Table 2).

The lots weight exported varied throughout the study period. In the first year of this type of trade (1996), only one firm (denominated herein as "B") exported a single species (*Pseudupeneus maculatus*) for human consumption (approximately 70 tons). Little oscillation was observed in the following years. However, the weight exported increased in 2002, at which point production began to fall off, stabilizing at around 500 tons in recent years (Figure 1).

Most of the exports were concentrated in the dry season for northeastern Brazil (September to February). A total of 1,178.38 tons (35.32%) of reef fish were sold in the last trimester of the year and 1,004.19 tons (30.1%) were sold in the first trimester. Exports dropped substantially in the rainy season throughout the period studied (Figure 2).

Table 1. List of species of reef fish declared on exportation certificates in Rio Grande do Norte referring to Total Weights (TW) exported and lots per taxon between 1996 and 2008.

Scientific Name Declared	Common Name Declared	TW (kg)	TW (%)	Lots	%
<i>Ocyurus chrysurus</i> (Bloch, 1791)	Yellowtail snapper	729,076.40	21.86	1,075	14.57
Scaridae	Parrotfish	702,593.20	21.06	1,079	14.63
Mullidae	Spotted goatfish	424,669.40	12.73	1,296	17.57
<i>Epinephelus niveatus</i> (Valenciennes, 1828)	Snowy grouper	344,460.40	10.33	74	1.00
Acanthuridae	Doctorfish	288,038.00	8.64	967	13.11
<i>Lutjanus synagris</i> (Linnaeus, 1758)	Lane snapper	216,996.60	6.51	745	10.10
<i>Mycteroperca bonaci</i> (Poey, 1860)	Black grouper	212,971.90	6.39	256	3.47
<i>Lutjanus purpureus</i> (Poey, 1867)	Southern red snapper	145,639.70	4.37	252	3.42
<i>Cephalopholis fulva</i> (Linnaeus, 1758)	Coney	115,391.20	3.46	715	9.69
<i>Lutjanus analis</i> (Cuvier, 1828)	Mutton snapper	89,030.60	2.67	563	7.63
<i>Lutjanus jocu</i> (Bloch and Schneider, 1801)	Dog snapper	40,651.40	1.22	190	2.58
<i>Epinephelus morio</i> (Valenciennes, 1828)	Red grouper	7,196.00	0.22	8	0.11
<i>Epinephelus nigritus</i> (Holbrook, 1855)	Warsaw grouper	6,268.00	0.19	4	0.05
<i>Lutjanus vivanus</i> (Cuvier, 1828)	Silk snapper	3,572.00	0.11	58	0.79
<i>Scomberomorus cavalla</i> (Cuvier, 1829)	King mackerel	2,691.20	0.08	12	0.16
<i>Scomberomorus brasiliensis</i> (Collette, Russo and Zavala-Camin, 1978)	Serra Spanish mackerel	2,205.00	0.07	20	0.27
<i>Lutjanus apodus</i> (Walbaum, 1792)	Schoolmaster snapper	1,649.80	0.05	54	0.73
<i>Malachantus plumieri</i> (Bloch, 1786)	Sand tilefish	1,165.00	0.03	2	0.03
<i>Haemulon plumieri</i> (Lacepède, 1802)	White grunt	1,070.00	0.03	2	0.03
<i>Haemulon melanurum</i> (Linnaeus, 1758)	Cottonwick grunt	100.00	0.00	2	0.03
<i>Carangoides bartholomaei</i> (Cuvier, 1833)	Yellow jack	26.00	0.00	1	0.01
<i>Selene setapinnis</i> (Mitchill, 1815)	Atlantic moonfish	13.00	0.00	1	0.01
<i>Centropomus undecimalis</i> (Bloch, 1792)	Common snook	13.00	0.00	1	0.01
TOTAL		3,335,487.80	100.00	7,377	100.00

Table 2. Lots, Total Weights (TW) and percentage of reef fish exports for human consumption by firms in Rio Grande do Norte from 1996 to 2008.

Exporting firms	TW(tons)	(%)	Lots	(%)	Period of exportation
A	1,734.89	52.02	4213	57.12	2001-2003,2006-2008
B	777.47	23.31	1565	21.22	1996-2006 and 2008
C	351.23	10.54	261	3.54	2001-2003
D	232.32	6.97	630	8.55	2005
E	122.22	3.66	319	4.32	2008
F	83.17	2.49	151	2.05	2007
G	24.17	0.72	161	2.18	2007 and 2008
H	7.49	0.22	52	0.70	2004
I	2.09	0.06	20	0.27	2007
J	0.43	0.01	4	0.05	2008
TOTAL	3,335.49	100.00	7,377	100.00	

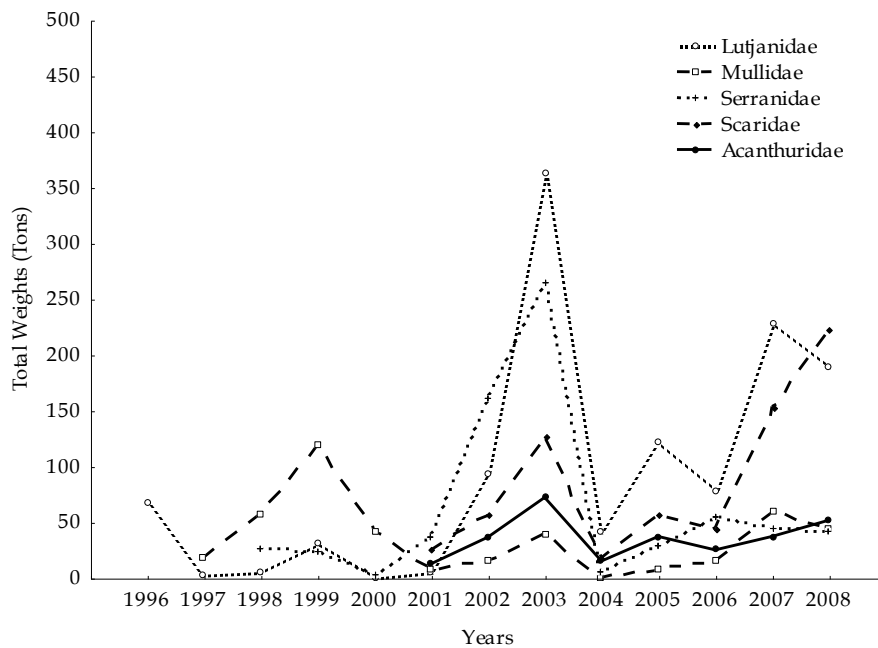


Figure 1. Variations in total weights (in tons) of reef fish main families exported for human consumption by firms in Rio Grande do Norte between 1996 and 2008.

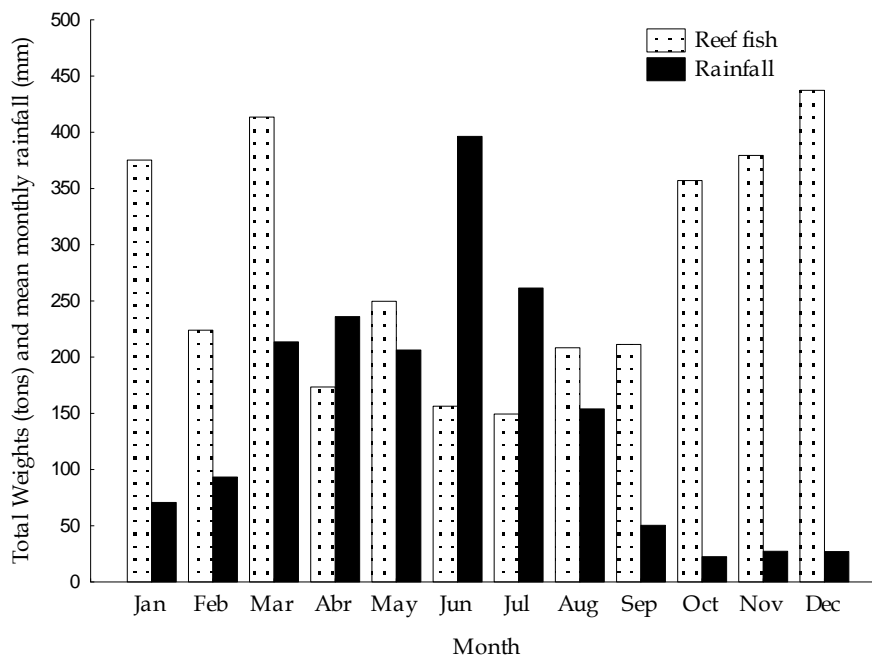


Figure 2. Total weights (in tons) of reef fish exported in Rio Grande do Norte for human consumption and mean monthly rainfall for the city of Natal between 1996 and 2008.

The exports were destined for seven countries. The United States of America was the main importer (2,739.49 tons), accounting for 82.13% of the total amount exported in the study period. Countries of Europe also participated in this market, such as England (285.55 tons), Spain (231.09 tons) and France (73.73 tons). Italy and Canada imported only 300 kg and 27 kg, respectively.

DISCUSSION

The records of the exportation of specimens of species not declared on the exportation certificates demonstrate the difficulty firms have in precisely identifying species and the fragility of monitoring by the Ministry of Agriculture. Firms tend to declare only one predominant species in some families, as occurred with representatives of Acanthuridae, Mullidae and Scaridae.

The occurrence of *Acanthurus bahianus*, *A. chirurgus* and *A. coeruleus* coincides with findings described by RIBEIRO (2004) for trap fishing on the coast of the states of Rio Grande do Norte and Pernambuco (northeastern Brazil). However, the author reports a predominance of *A. bahianus*, whereas *A. chirurgus* was predominant in the present study. NÓBREGA and LESSA (2007) recorded *A. bahianus* and *A. chirurgus* in artisanal fisheries in northeastern Brazil and also report a predominance of *A. chirurgus*. These divergences may be related to the distinct characteristics of the study areas in each investigation, especially with regard to vegetal cover, which is the main food source for the three species (RISK, 1998; DIAS *et al.*, 2001). *Acanthurus coeruleus* and *A. bahianus* are among the 16 most exported species in Brazil as ornamental fish (ARAÚJO and ALBUQUERQUE-FILHO, 2005). According to DIAS *et al.* (2001), fish from the family Acanthuridae are visually important in reef environments in Brazil and juveniles are subject to sale as ornamental fish, whereas, to a lesser extent, adults are sold for human consumption. However, the results of the present study demonstrate that the adults of these species are currently an important part of catches directed at exportation for human consumption by firms in the state of Rio Grande do Norte and this activity can be considered the main source of pressure on stocks in the state.

The spotted goatfish (*Pseudupeneus maculatus*) has been exploited in coastal regions with reefs and is an emerging fishery resource of considerable importance in artisanal fishing activities in the state of Pernambuco. This fish is sold on the international market, with substantial demands from the United States and France (CAMPOS and OLIVEIRA, 2001). *Pseudupeneus maculatus* was the only representative of the family Mullidae in trap fishing operations in the states of Rio Grande do Norte and Pernambuco recorded by RIBEIRO (2004) and the species with the greatest production. In the present study, besides *P. maculatus*, *Mulloidichthys martinicus* was also exported, but in clearly smaller numbers.

There are currently 10 species belonging to the family Scaridae with known occurrence on the Brazilian coast and have been confused with congener species in the Caribbean province (MOURA *et al.*, 2001). In a recent publication involving data from the REVIZEE program, NÓBREGA and LESSA (2007) did not consider the revision of the family proposed by MOURA *et al.* (2001), which hinders the use of the data for comparisons with findings from other studies. Another source of doubt in the identification of some species of this family on the part of the firms is the accentuated variation in the color pattern between individuals of the same species. It is not within the scope of the present study to discuss taxonomic issues, although the consequences lead to practical problems, especially when the description of a species is based on its coloration, as occurs with Scaridae. However, as importers do not require fish from this family to be packaged separately and given the difficulties of identification on the species level, export firms declared the seven species identified herein (belonging to the genera *Scarus*, *Sparisoma* and *Nicosina*) as "*Sparisoma* spp". The predominance of *S. frondosum* and *S. axillare* found in the present study is in partial agreement with findings described by RIBEIRO (2004), in which *S. frondosum* was the predominant species in reef environments in the state of Rio Grande do Norte.

Recently, fishing efforts have been directed at species that occupy lower trophic levels (FLOETER *et al.*, 2006) due to the decline in populations of some of the more traditional piscivorous species. It is not possible to predict the

precise consequences of the exploitation of these species to the reef environment. Therefore, studies should be carried out to determine safe levels of this exploitation.

The exportation of fish from the families Scaridae, Acanthuridae and Mullidae has created a demand for species that were not previously the main targets of artisanal fisheries in the state. The exploitation of these resources was rapidly taken up by small fleets and fishing boats owners that previously targeted other species. Some boats began to work exclusively with this activity, whereas others target reef fish only during periods of low productivity or during the closed seasons of priority targets (September to February), coinciding with the highest weight of fish exported. The change in fishing efforts applied to populations of reef fish is generally alternatively lobster fishing, such that efforts targeting reef fish are low or even null during the peak the lobster season (RIBEIRO, 2004). In the rainy season, there is an intensification of trade winds and marine currents, which has a negative effect on the efficiency of the traps. Fishing boat skippers report that the currents do not allow the traps to remain fixed in the best position, leading to the loss of material and hindering fishing operations, with a consequent reduction in fishing efforts. The results demonstrate that the months with the largest weight exported catches are those in which there is less rainfall. However, this pattern results from the characteristics of the main fishing gear employed (traps) rather than the abundance of fish.

The most representative families in the exports in order of importance were Lutjanidae, Scaridae, Serranidae, Mullidae and Acanthuridae, which are the same families reported by RIBEIRO (2004). While fish from the family Haemulidae did not accumulate substantial values in the export, the skippers of the vessels report that *Haemulon plumieri* and *H. melanorum* are an important part of trap catches and are mostly sold on the domestic market. The entrepreneurs state that species from this family have a low value and are only sold when their value increases on the international market.

The large weight of species of Lutjanidae in the exports and the predominance of *Ocyurus*

chrysurus was expected, as the importance of this family in fisheries of northeastern Brazil has been known since the 1960s, when the main species exploited were snappers. Since 1978, the yellowtail snapper (*O. chrysurus*) has been the species with the greatest production in this family (RESENDE *et al.*, 2003). However, *O. chrysurus* and *Lutjanus analis* are considered endangered due to overexploitation (NÓBREGA and LESSA, 2007). The fishing situation for Lutjanidae in the region indicates a decreasing tendency in the stock. Age, growth and mortality studies on the five most important species in the Exclusive Economic Zone on the coast of northeastern Brazil report that the stocks cannot support high fishing mortality rates (RESENDE *et al.*, 2003).

In 1996, there was only one firm, which exported 67.9 tons of a single species of reef fish for human consumption. At the end of the study period (2008), five firms exported 549.4 tons distributed among 11 species. This growth in the annual weight exported, number of export firms and number of species exploited demonstrates that this is an expanding activity of considerable importance to the fishing industry in the state of Rio Grande do Norte.

The variation in the exchange rate of the US dollar has had a huge impact on the profit margins of export firms. The high weight exported in 2003 (868.9 tons) likely resulted from the increased value of the American currency in this year, when the dollar reached a maximal exchange rate in relation to the Brazilian currency (US\$ 1.00 = R\$ 3.57) and the highest mean value (R\$ 3.11) of the period (1996 to 2008). Variations in exports appear to be mainly related to commercial parameters and it is not possible to assess the current situation of the stocks based on the data obtained.

Although exportation is carried out by large and medium-sized firms, more than 63% of the catches come from artisanal fishing, according to data from 2006 for the state of Rio Grande do Norte (IBAMA, 2008). This fishing modality is characteristic of tropical regions, where there is a high degree of species richness and low specific biomasses (NÓBREGA and LESSA, 2007). While artisanal fishing has a lesser impact on stocks than industrial activities, the intensification of artisanal

operations could have a profound effect on communities of reef fish (HAWKINS and ROBERTS, 2004).

In a number of countries, the capturing of reef fish for human consumption has been diminishing due to legal restrictions for the purposes of conservation or simply due to the depletion of stocks stemming from overfishing and an increase in activities such as tourism (KOSLOW *et al.*, 1988; ROBERTS, 1995; ALCALA and RUSS, 2002). A number of fish processing firms have begun to encourage activities targeting reef fish on the part of the artisanal fleet by ensuring the purchase of the entire production, which is destined for the international market.

Up to 1989, the Brazilian Institute of Geography and Statistics published fishery statistics with data on national production by species and fishing modality for all states in the country. Beginning in 1990, the divulgation of these data was interrupted due to financial and operational problems (IBAMA, 2008). Data on extractive marine fishing in the state of Rio Grande do Norte are gathered by the *Estatpesca* program developed by the Brazilian environmental agency IBAMA (IBAMA, 2008). These data exhibit a limitation when one wishes to access the species composition of the catches, as a number of species are grouped together under the generic name of "minnows" or "others". These two multi-species groupings accounted for 2,468 tons in 2006, representing 25.7% of the total fish production from artisanal extractive marine fishing activities (IBAMA, 2008).

The information from the present study constitutes a contribution toward a better understanding of this important activity, which generates employment and income in fishing communities on the northeastern coast. Like any other extractive activity, fishing should use natural resources in an environmentally and economically sustainable manner. For such, further studies are needed, along with a management plan for regulating the activity in the reef environment.

CONCLUSIONS

The activity of catching reef fish for human consumption is expanding both in amount and

number of fish species exploited commercially, thus expanding the possibilities of operation of fishermen and exporting companies. The increase in the number of target species and the fishing efforts redirection for species that were not part of the fisheries are trends on the world market, resulting mainly from the decline of traditionally exploited stocks which were subjected to excessive effort. Knowledge about this activity is urgent and necessary, mainly to assess the means of sustainable exploitation of these new target species.

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