Catches Description of Protected and Unprotected Areas in Martinique (Lesser Antilles)

GERALDINE CRIQUET[1], JESSICA GARCIA[1], PHILIPPE LENFANT[1],
JEAN-PHILIPPE MARECHAL[2], and LIONEL REYNAL[3]

[1]UMR 5244 Center of Tropical and Mediterranean Biology and Ecology University of Perpignan Via Domitia 66860 Perpignan France; [2]OMMM 3, avenue de Condorcet 97200 Fort-de-France Martinique (FWI); [3]IFREMER Station du Robert Pointe Fort 97231 Le Robert Martinique (FWI)

ABSTRACT

Due to littoral ecosystems degradation and overfishing, a decrease of stocks of coastal species with strong economical interest occurred in Caribbean in the last decades. In order to block this process, M.P.A.s have been implemented in different zones in Martinique. Experimental fishing with traps is used in the purpose to assess effects of two M.P.A.s: Ramier Island RI (Caribbean coast) and Bay of Robert BR (Atlantic coast). Here are presented a description of catches of protected areas and surrounding non protected areas occurred in one sampling period in March and April 2007. Biomasses inside both M.P.A.s were respectively at RI and BR 61% and 68% of total catch. 5 families on 23 caught represented 80% of total capture: Acanthuridae, Scaridae, Lutjanidae, Haemulidae and Serranidae. At RI, catches of Scaridae, Lutjanidae and Acanthuridae were higher inside the M.P.A than outside and those of Serranidae and Haemulidae were similar in both areas. At BR, all families had higher catches inside than outside the protected area. Catches rates were quite different between RI and BR. M.P.A.s are an important tool for stocks management but captures composition and abundance are also dependent on habitats.

KEY WORDS: M.P.A., Reef fishes, Martinique

Descripción de las Capturas de Zonas Protegidas y Nones Protegidas en Martinico (Las Antillas Menores)

A causa de la degradación de las ecosistemas litorales y une pesca intensiva, hay en el Caribe desdé algunos decenios una importante bajada de los stocks de especies costeras con fuerte interés comercial. Para oponerse a eso proceso, M.P.A.s fueron creadas en diferentes partes en Martinica. Pescas experimentales con nasas fueron hechas para valorar los efectos de dos zonas protegidas: Isla a Ramier RI (costa caribe) y Baya de Robert BR (costa atlántica). Aquí es presentada una descripción de las capturas de las M.P.A.s y las de las áreas vecinas nones protegidas, relativas a un periodo de

muestreo en marzo y abril 2007. Biomasas dentro ambas M.P.A.s fueron respectivamente a RI y a BR 61% y 68% de la biomasa total. 5 familias sobre 22 capturadas representaron 80% de la captura total: Acanthuridae, Scaridae, Lutjanidae, Haemulidae and Serranidae. A RI, las capturas de Scaridae, Lutjanidae y Acanthuridae fueron superiores dentro la M.P.A. que al exterior, y las de Serranidae y Haemulidae fueron similares en ambas zonas. A BR, todas la familias tuvieron capturas superiores dentro la área protegida. Las tasas de captura fueron distintos entre RI y BR. S.I.G. fue utilizado para cartografiar la distribución espacial de las capturas. M.P.A.s son un herramienta muy importante para la gestión de los stocks pero la composición y la abundancia de las capturas dependen también del biotopo.

PALABRAS CLAVES: M.P.A, pesquería, peces de arrecifes, Martinica,

INTRODUCTION

Artisanal fishery represents the most important activity, as source of incomes and food, in many tropical zones and fishes are an essential resource for populations of these regions. The growing population of those regions induced an increase of the demand of fish proteins and therefore an increase of fishing pressure. According to Pauly (1994), the fish resources of coral reefs are intensively exploited all over the world and in many cases overfishing is apparent. Intensive fishing has a negative effect on structure of fish community (Floeter *et al*. 2006). Overfishing creates changes in populations evolution and a re-organization of fish communities. It has been shown that abundances of target species decline in heavy exploited areas (Pauly *et al*. 2002, Tuya *et al*. 2006), Albaret and Laë (2003) observed a decrease of catches although fishing effort increases at Ebrie Lagoon in Senegal. It has been observed that overfishing induced a decrease of larger body size fishes (Russ NS Alcala 1989, Bianchi *et al*. 2000), a reduction of number of year-classes (Stergiou 2002), a decline of biomass of carnivorous fishes (Friedlander and DeMartini 2002, Dulvy *et al*. 2004) and Hsieh *et al*. (2008) suggest that exploited fishes can be more vulnerable to climate variability.

According to Hawkins and Roberts (2004), the intensive artisanal fishing has already transformed the structure of fish and benthic communities of Caribbean reefs. The decrease of biomasses and abundances of species with strong economical interest and the reef complexity reduction have a negative impact on catches. Koslow *et al.* (1988) shown a decline of exploited Lutjanids, Scarids and Serranids in Jamaica and Hawkins and Roberts (2003) found that body size of Scaridae decreases along a gradient of fishing effort in 6 Caribbean islands. Martinique, French island of the Lesser Antilles, has one of the strongest fishing effort of the Caribbean (Munro 1983) and marine products diet of martinican population is one of

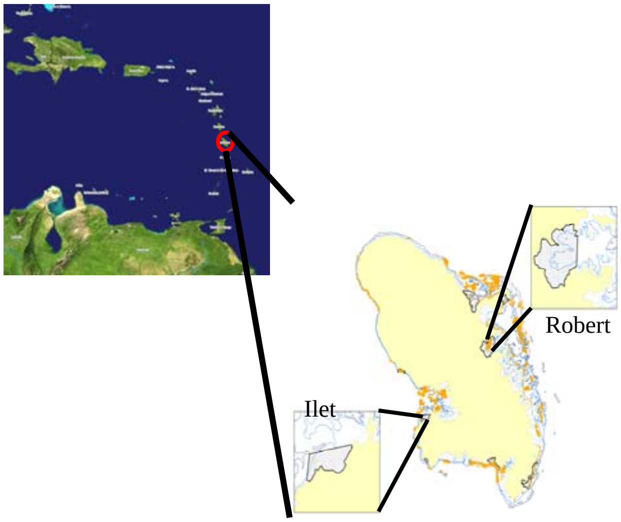

Figure 1. Study area.

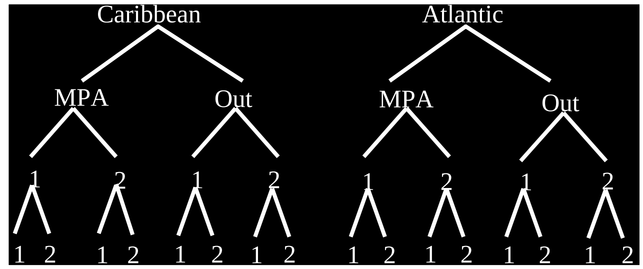

Figure 2. Sampling protocol.

the highest of the world (Ramdine 2004). For Gobert (1991, 2000), most of coastal resources are overexploited. Several MPAs have been created in the 1990s for protecting spawning sites and increasing catches in adjacent areas in order to have a sustainable exploitation of resources and to maintain martinican coastal fisheries. A MPA is defined as "any area of the intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment" (UICN 1988). MPAs have become popular as tools for fisheries management and conservation (Pauly *et al*. 2002). Many authors have studied the effectiveness of marine reserves (Polunin and Roberts 1993, Wantiez *et al*. 1997, Chapman and Kramer 1999, McClanahan *et al*. 1999, Roberts *et al*. 2001, Halpern and Warner 2002, Appeldoorn and Lindeman 2003, Gell and Roberts 2003, Begg, *et al*. 2005, Cho 2005, Almany *et al*. 2007, Friedlander *et al*. 2007, Miller and Ayre 2008, Molloy *et al.* 2008). The expected and/or observed effects of MPAs include increase of target species abundance, size and biomass and enhance of yields in adjacent areas through spillover.

Although MPAs have been created since a decade in Martinique, no data are available on the evolution of fish communities inside the protected areas, on the evolution of catches of professional fishermen in the adjacent areas and on the effectiveness of the protection status on fish populations. So this study represents the first data and the aim was to provide a description of catches both in protected and unprotected areas.

MATERIALS AND METHODS

Study Area

Martinique is located in Lesser Antilles in South of the Caribbean island arc (Figure 1). This is a volcanic island characterized by mountainous relief and narrow shelves. We focused on 2 MPAs (Figure 1): Ilet à Ramier (IR) located on the Caribbean coast. It was created in 1999 and has a surface of 184 ha; Robert Bay (R) is on the Atlantic side, was created in 2000 and stretches on 953 ha. Both zone are characterized by depth less 20 m and a homogeneity of habitats occurs between inside and outside the MPAs.

Sampling

Unbaited double funnel Antillean-Z traps were used for experimental fishing: 2 x 0.6 x 0.3 m with a mesh size of 31 mm. Traps are the most used fishing gear and produce around 60% of total benthic catches (Gobert 1990). Trap fishing was conducting in March and April 2007. A total of 16 traps were set following the sampling protocol illustrated in Figure 2: eight traps on each side (Caribbean and Atlantic), four traps for each of the two localities (MPA and Out) per side and two traps for each of the two sites per locality. Sites were chosen randomly and changed at each haul, and soak time was five days. For each trap set information on date, GPS position, depth and problem occurring if any was taken.

Data analysis

Since data were non-normally distributed (Kolmogorov and Smirnov tests) and variance was heterogeneous (Bartlett test), non-parametric tests were done (Mann-Whitney test). Mean biomass was compared between MPA and Out and between Atlantic and Caribbean side at total catches level, between MPA and Out for each side at family level. Mean fish length were compared between MPA and Out for each side.

RESULTS

Total Catches

A total of 73 species belonging to 23 families were caught during the experimental fishing. Total catches are higher on Caribbean coast than on Atlantic coast both for MPA and adjacent fished area (Figure 3). But the difference between IR protected area (11.95 ± 3 kg) and R protected area (6.77 ± 2 kg) was not significant (Table 1,

Table 1. p-value of comparisons (Mann-Whitney test) of total catches

IRMPA-RMPA	NS
IROut-Rout	0.017
IRMPA-IROut	0.047
RMPA-Rout	0.02

NS) while biomass of unprotected areas (IROut = 4.67 ± 0.8 kg and Rout = 1.95 ± 0.3 kg) was significantly different (Table 1, p = 0.017). Biomass of MPA was around twice as high as Out at IR (Figure 3, x 2.45) while at R it was nearly four times higher than Out (Figure 3, x 3.55). Mann-Whitney test (Table 1) have shown a significant difference between MPA and adjacent fished area at both IR (p = 0.047) and R (p = 0.02).

Family Catches

Five families, Acanthuridae, Scaridae, Lutjanidae, Serranidae and Haemulidae represent 80% of the total catches. Scarids are the dominant group of the Caribbean coast (Figure 4). Their biomass achieved 5.2 ±2 .5 kg inside the MPA and 0.73 ± 0.4 kg Out while catches of the others families were less than 1 kg except for Acanthuridae inside the protected area. Acanthuridae and Scaridae had biomass significantly different (Table 2, p_A = 0.041 and p_{Sc} = 0.014) between MPA (A_{MPA} = 1.01 ± 0.4) and Out (A_{Out} = 0.34 ± 0.09). On the other hand, Mann-Whitney test didn't show any significant difference between MPA and Out in the cases of Lutjanidae, Serranidae and Haemulidae (Table 2). On the Atlantic coast, Acanthuridae are the dominant group (Figure 5). Their biomass achieved 2.4 ± 1.02 kg inside MPA and 0.44 ± 0.2 kg Out following by Scaridae with 1.4 ± 0.94 kg inside MPA and 0.44 ± 0.16 kg Out. The catches of the others families was less than 1 kg both inside and outside MPA. The only significant difference between MPA and Out was in the case of Acanthuridae (Table 2, p = 0.02).

Fish Size

The mean length of 4 species was compared between inside and outside MPA: *Acanthurus bahianus* (Acanthuridae) at both Ilet Ramier and Robert Bay, *Sparisoma aurofrenatum* (Scaridae) and *Cephalopholis*

Table 2. p-value of comparisons (Mann-Whitney test) of families. A : Acanthuridae, Sc: Scaridae, L: Lutjanidae, S: Serranidae, H: Haemulidae

	A	Sc	L	S	H
IRMPA-IROut	0.041	0.014	NS	NS	NS
RMPA-ROut	0.027	NS	NS	NS	NS

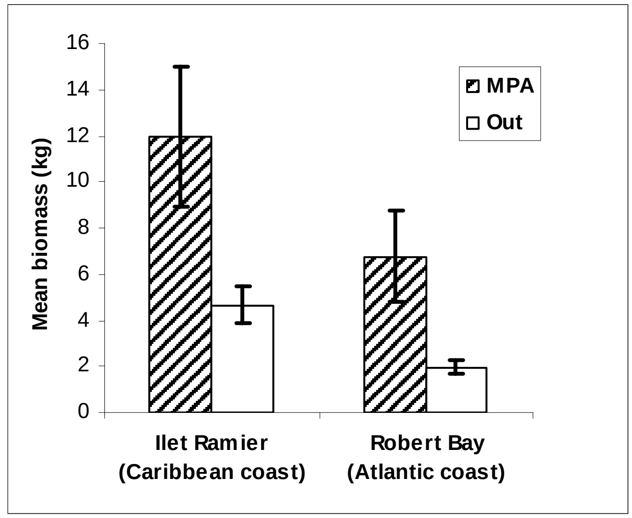

Figure 3. Total catches.

fulvus (Serranidae) at Ilet Ramier and *Lujanus synagris* (Lutjanidae) at Robert Bay (Table 3). The size of A was higher in MPA than Out at both Atlantic and Caribbean coast, but the difference was significant (A_{MPA} = 13 ± 0.2 cm and A_{Out} = 11.5 ± 0.2 cm, p = 0.05) only in the case of Atlantic coast. SA length was significantly higher inside than outside MPA (SA_{MPA} = 19.2 ± 0.17 cm and SA_{Out} = 16.3 ± 0.3 cm, p = 0.023). LS length was higher in protected area than in unprotected area but not significantly. Mann-Whitney test showed a significant difference between MPA and Out for CF length (CF_{MPA} = 22.5 ± 1.2 cm and CF_{Out} = 19 ± 0.3 cm, p = 0.032).

DISCUSSION

The present study provided the first data on fish communities of marine protected area and unprotected area although survey is required to evaluate MPAs achievement of establishment target (Claudet and Pelletier 2004). We proposed to analyze catches composition of experimental fishing conducted simultaneously in two MPAs and surrounding areas. The first observation was that Caribbean side is more productive than Atlantic side. Habitats and environmental conditions are widely different. On the opposite of Ilet Ramier, Robert Bay is a shallow and heavy silt up bay (Gobert and Stanisière 1997) and Bouchon – Navaro *et al*. (2005) indicated that silt reduces coral reefs density, specific richness and fish abundances. We finally found a protection effect through total catches at both Ilet Ramier and Robert Bay. In fact, total biomass was significantly higher inside that outside MPA at both sides. The result is consistent with many studies wherein MPAs enhance density and biomass of fish assemblages (Polunin and Roberts 1993, Roberts 1995, Kaunda – Arara and Rose 2004, Micheli *et al*. 2004, Pelletier *et al*. 2005) and Halpern and Warner (2002) noticed that protection effects could rapidly occur. Acanthuridae and Scaridae were the

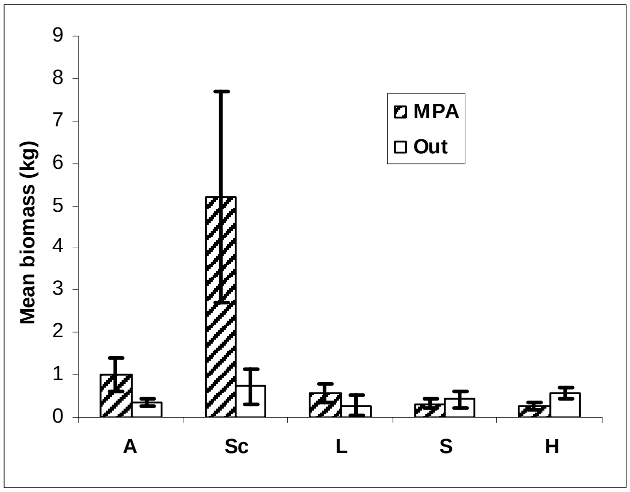

Figure 4. Families catches at Ilet Ramier. A: Acanthuridae, Sc: Scaridae, L: Lutjanidae, S: Serranidae, H: Haemulidae

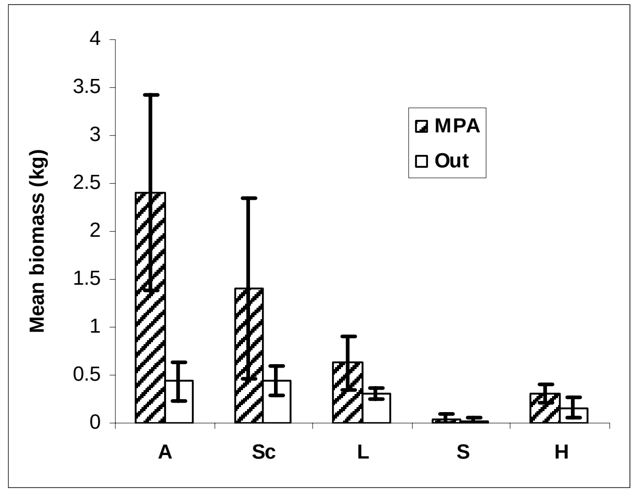

Figure 5. Families catches at Robert Bay. A : Acanthuridae, Sc : Scaridae, L : Lutjanidae, S : Serranidae, H : Haemulidae

most abundant species. This result is consistent with the fact that Scaridae are the most caught family with 13.7% and Acanthuridae represent 4% of total benthic catches in Martinique (Gobert 1990). Biomasses of these 2 families at Ilet Ramier and Acanthuridae at Robert Bay were inside MPA than Out. None protection effect was detected for the others families at both Caribbean and Atlantic side. Acanthuridae and Scaridae are herbivorous fishes with a strong site-attachment (Chapman and Kramer 2000) permitting to benefit from reserve protection. On the opposite, Lutjanidae and Haemulidae are more mobile species. And it is well know that species mobility/home range affects response to protection (Kulbicki *et al*. 2007). Ilet Ramier and Robert Bay are small protected areas, respectively 1.84 km^2 and 9.53 km^2, in comparison with median size of overall marine reserves achieved around 16 km^2. Parnell *et al*. (2005) observed that San Diego-La Jolla Ecological Reserve (California), 2.16 km^2, protects a widely small % (O.8%) of the kelp forest and boulder reefs, and thus protects sessile and highly residential species. Claudet *et al*. (2008) indicated that response to protection is dependent to the reserve size. We observed a protection effect on larger body size fishes, Serranidae and Scaridae (Table 3). Russ and Alacala (1998) obtained similar results.

In conclusion, the MPAs studied appear to be efficient to manage and maintain artisanal fishery in Martinique. Habitats, species life history and reserve size influence the response to protection and the evolution of the fish communities. The experimental fishing will be reproduce in October 2007 and at the two same periods in 2008 in order to evaluate spatial (protection and coast levels) and temporal (season and year levels) variations.

Table 3. Mean length and p-value of comparisons (Mann-Whitney test) of species. AB: *Acanthurus bahianus*, SA: *Sparisoma aurofrenatum*, LS: *Lutjanus synagris*, CF: *Cephalopholis fulvus*.

	AB	SA	LS	CF
IRMPA	16.3±1.58	19.2±0.17	-	22.5±1.2
IROut	15.2±0.37	16.3±0.3	-	19±0.3
RMPA	13.±0.2	-	19.5±0.6	-
ROut	11.5±0.2	-	18.5±O.4	-
IRMPA-IROut	NS	0.023	-	0.032
RMPA-ROut	0.05	-	NS	-

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