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Reef Fish Assemblages and Fisheries in Parque Nacional Del Este, Dominican Republic

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ABSTRACT

Parque Nacional del Este is the second largest protected area in the Dominican Republic, comprising 110 km² of terrestrial habitats located in the southeastern Dominican Republic. Established in 1975, the park delineation did not include the adjacent marine area, despite its long history of commercial fisheries. Since 1994, several U.S. and Dominican partner organizations have conducted scientific investigations of the marine resources of the area. This paper provides data on the status of snapper and groupers reef assemblages and finfish fisheries collected during 1995 - 1997. Methods used in the study included 1) visual transects (20 m x 5 m) of predatory fishes in coral reef habitats and 2) fishermen interviews to obtain data on fishing methods and catch composition. Predatory fishes, particularly groupers and snappers, are rare and generally small (< 30 cm TL). Larger size snappers (*Lutjanus griseus*, *L. analis*) and groupers (*Mycteroperca bonaci*, *M. tigris* and *M. venenosa*) were absent in the visual transect surveys. Only two Nassau grouper (*Epinephelus striatus*) were found in 142 transects among 7 reef areas. Among groupers, red hind (*E. guttatus*), coney (*E. fulvus*) and graysby (*E. cruentatus*) dominated the grouper assemblage in visual transect surveys, as well as in fishermen's catch. Yellowtail snapper (*Ocyurus chrysurus*) was the most abundant snapper species in reefs and in

fishermen's catch. Fishermen interviews (n = 120) showed that hook-and-line, traps, and spears were the most commonly used methods. The catch composition reflects the artisanal nature of the fishery. A significant alteration of the park's fish assemblages due to overfishing is apparent. The designation of zones with different degree of protection (including a no-take zone) is recommended. This plan includes specific regulations on the use of fishing gears, and others regarding minimum size, closed season. These measures should be included in the oncoming Coastal Management Plan, and will allow to:

- i) evaluate the potential for fisheries recovery
- ii) protect what little spawning stock biomass remains in the area, and
- iii) protect nursery grounds important for juvenile stages. There are few data on the potential contribution of up-current areas (Eastern Caribbean) to reef fish recruitment in the park. A research program addressed to this subject is also recommended.

KEY WORDS: Reef fish, fisheries management, marine reserves

INTRODUCTION

Parque Nacional del Este was designated as a national park by the Dominican government on September 16, 1975 (Act No. 1311). The park is located in the southeastern corner of the country and comprises roughly 110 km² of land territory (Figure 1). The adjacent marine area was not included in its jurisdiction, however, the first and only management plan (MP) for the park (Parque Nacional del Este, Plan de Manejo, 1980) recommended the enlargement of the park limits, in order to include the marine areas of the Catuano Channel (between the mainland and Isla Saona), as well as an area out to 500 m from the coast. The management plan also called for the development of snorkeling, diving and sport fisheries to improve the economic situation of the area. Nevertheless, the MP did not discuss the fisheries activities as a significant component of resource usage, this despite a reconnaissance survey in the early 1970s (Towle *et al.*, 1973). This survey, which included descriptions of major habitats and fisheries status, reported that conch, lobster, and finfish resources were severely depleted in many areas of what is now Parque Nacional del Este. The paucity of fishes, such as groupers, was attributed to spear-fishing activities. Towle *et al.* (1973) stated that the most immediate potential management difficulty in the park was the high level of use of fisheries resources. The only other study was conducted by a team from the University of Puerto Rico in 1979 (Williams *et al.*, 1983). Inventories of fish species at Isla Saona and Isla Catalina were made, but no data on abundance and size were provided. At present, fisheries constitute a major economic activity in the three towns within

and adjacent to the park: Bayahibe, Boca de Yuma and Mano Juan (Figure 1). Thirty percent of the residents that have some form of stable work (54% out of a total population of 2 156 in the area) are fishermen (Vega *et al.* , 1997). Tourism is the other important economic activity occurring in the area, with increasing development of snorkeling, SCUBA diving, and other activities, such as beach visitation, primarily occurring in the western half of the park. For the first time, an integrated ecological assessment of the ecosystems and resources of Parque Nacional del Este (Vega *et al.* , 1997), as well as the fisheries activities of the area, were conducted from 1994 through 1997. The Nature Conservancy and its partners, including several Dominican organizations, conducted fish and conch surveys, as well as fishermen interviews. The main goals for fisheries investigations in Parque Nacional del Este were to describe the status of the reef fish and conch resources on shallow-water habitats in the park, as well as the characteristics of the fisheries activities in the area, in order to recommend a plan for the management and restoration of fisheries resources. This paper includes data on the snapper and grouper composition of the reefs located in the western area of the park, as well as information on fisheries landings and operations in that area. These data, together with other information obtained from assessments of water quality, reefs, juvenile fishes, queen conch, will be included in a Coastal Management Plan to be proposed by The Nature Conservancy and its Dominicans partners.

MATERIALS AND METHODS

In 1995 four reefs (17 - 20 m depth) were surveyed for total reef fish composition in the western area of the park: Dominicus, La Raya, Ruben and EL Toro (Figure 1). Two methods were used to obtain information on species richness and abundance. The first method was a semi-quantitative inventory, referred to as the roving diver method, of all species within each general reef area (Schmitt and Sullivan, 1996). Species were identified and abundances were estimated by trained divers. The second method used 20 m x 2 m strip transects. Species, numbers of individuals and size (total length, cm) were recorded for all species encountered in the transects. In March of 1996 and 1997, seven reefs (Figure 1) were surveyed for predator density and total length. Surveys focused on larger carnivorous fishes, such as groupers, snappers, hogfish, and barracuda. This paper includes only data on groupers and snappers. In each reef, at least twenty 20 m x 5 m strip transects were surveyed. No attempt was made to statistically compare the results obtained in both years.

A questionnaire for fisherman was designed to gather information on the number of fishermen per boat, fisher's age, fishing methods used, species usually caught, as well as other anecdotal information related to the fisheries activity in the park. Fish landings of the interviewed fishermen were also

surveyed in order to characterize the species and size composition of catches. One-hundred and thirty-one fishers were interviewed at access points during March 1996 and August 1997. No fishermen were interviewed more than once, and all were from different fishing boats. The surveyors arrived at access points according to fishermen's schedules. Four locations were surveyed: Bayahibe (northeast of the park), Catuano and Mano Juan (on the southern coast of Isla Saona), and Boca de Yuma (northwest of the park) (Figure 1). These towns are the main fishing landing locations in the southeastern Dominican Republic.

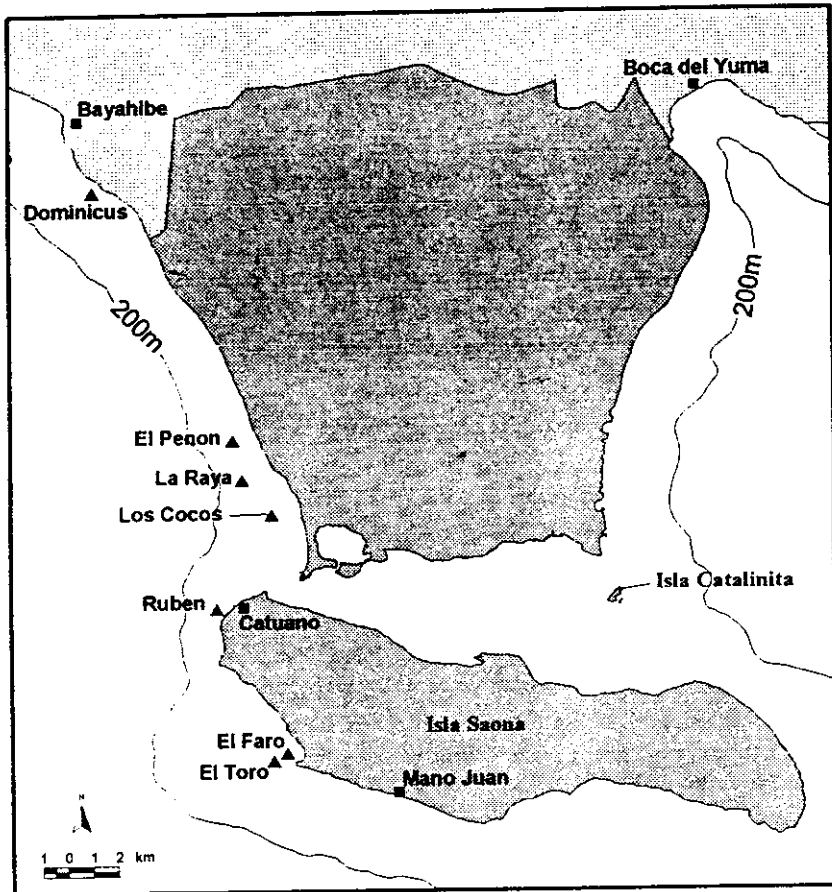


Figure 1. Map of Parque Nacional del Este, southeastern Dominican Republic, showing locations of visual transect surveys (triangles) and fishermen interviews (squares) conducted during 1996-97.

RESULTS

Semi-quantitative (roving diver) and quantitative (transects) surveys during 1995 yielded 110 and 90 species of reef fish in the study area, respectively. The total number of species recorded was 126. Previous surveys reported 108 species from Isla Saona and 117 species from Isla Catalina (Williams *et al.*, 1983). Greater numbers of species were recorded in the park than in that recorded in Puerto Viejo de Azua, in the south-central region of the country (Bouchon *et al.*, in press). However, the latter area is smaller, since the data were obtained from just one 7.5 km reef fringing the mainland coast and the El Morro and Las Primas islands. Reef fish checklists in the Caribbean yielded similar amount of species (Claro, 1990; Claro and García-Arteaga, 1994). Visual surveys of predatory reef fishes were conducted in 20 m x 5 m strip transects at seven reefs during 1996 (N = 142) and 1997 (N = 140). Five species of groupers were found in 1996: *Epinephelus adscensionis*, *E. cruentatus*, *E. fulvus*, *E. guttatus*, and *E. striatus* (Table 1). Of the 298 groupers recorded in 1996, over 75% were *Epinephelus cruentatus*. Other species were *E. fulvus* (14.8%), *E. guttatus* (7.7%), and *E. adscensionis* (1.3%). Only two Nassau grouper (*E. striatus*) were observed; no species of *Mycteroperca* were encountered in the surveys. In 1997, no Nassau grouper or *Mycteroperca* species were found. In the latter year, the species composition changed: *E. cruentatus* (35%) and *E. guttatus* (32%) were almost equally dominant and comprised two thirds of all groupers surveyed. Total grouper density in the park was 2.10 and 2.43 individuals/100 m² in 1996 and 1997, respectively. These densities are greater than those reported by Chiappone *et al.* (this proceeding) at reefs in the Florida Keys, three areas within and adjacent to the Exuma Cays Land and Sea Park (Bahamas) and Guantánamo (Cuba). However, the abundance of larger species in the park was extremely low.

All species of groupers encountered in Parque Nacional del Este, except *E. striatus*, are characterized as dwarf species due to their small maximum size (< 50 cm TL). Small individuals were dominant during 1996 and 1997 surveys (Table 2). Nearly 90% of the groupers observed were less than 30 cm in length. The majority of fishes were 15 - 29 cm.

Only 4 species of snappers were observed in the quantitative transects during March 1996 and 1997: *Lutjanus apodus*, *L. mahogoni*, *L. synagris*, and *Ocyurus chrysurus* (Table 1). No mutton snapper (*L. analis*) and gray snapper (*L. griseus*) were recorded, despite their high abundance, at least historically, in Caribbean reefs. Total snapper density on the 7 reefs was 1.28 and 0.38 individuals/100 m² during 1996 and 1997, respectively (Table 1). In 1996, out of 180 individuals recorded, roughly 50% were yellowtail snapper (*O. chrysurus*). The remaining individuals were distributed among other species as follows: *L. synagris* (32%), *L. mahogani* (9%), and *L. apodus* (8%). In 1997, snapper

density was roughly one-third of that estimated in 1996. The reduction in lane and yellowtail snapper density was notable; these two species were the most abundant in the 1996 surveys. The size-frequency distribution of snappers (size data were collected only in 1996) indicated a dominance by small individuals. No specimens larger than 32 cm TL were found. Over 95% of the individuals observed were less than 30 cm TL.

Table 1. Mean (1 SD) density (no. fish per 100 m²) and relative abundance of groupers and snappers in the reefs of Parque Nacional del Este, Dominican Republic, during 1996 (N = 142 transects) and 1997 (N = 140 transects).

Family and species	1996		1997	
	Density	N (%)	Density	N %
Serranidae	2.10 (0.86)	2 300 (100)	2.43 (0.79)	187 (100)
<i>E. adscensionis</i>	0.03 (0.06)	3 (1)	0.43 (0.01)	6 (3.2)
<i>E. cruentatus</i>	1.60 (1.03)	225 (75)	0.86 (0.64)	121 (65)
<i>E. fulvus</i>	0.30 (0.36)	47 (15.6)	0.35 (0.42)	49 (26.2)
<i>E. guttatus</i>	0.16 (0.18)	23 (7.7)	0.79 (0.12)	11 (5.9)
<i>E. striatus</i>	0.01 (0.03)	2 (0.7)	0 (0)	0(0)
<i>Mycteroperca bonaci</i>	0 (0)	0 (0)	0 (0)	0 (0)
<i>M. tigris</i>	0 (0)	0 (0)	0 (0)	0 (0)
<i>M. venenosa</i>	0(0)	0(0)	0(0)	0(0)
Lutjanidae	1.28 (2.25)	177 (100)	0.38 (0.36)	53 (100)
<i>Lutjanus apodus</i>	0.11 (0.29)	15 (8.5)	0.09 (0.22)	12 (22.6)
<i>L. mahogoni</i>	0.11 (0.22)	16 (9.0)	0.15 (0.18)	21 (39.6)
<i>L. synagris</i>	0.41 (0.74)	58 (32.0)	0.09 (0.17)	13 (24.5)
<i>O. chrysurus</i>	0.65 (1.74)	88 (49.7)	0.05 (0.10)	7 (13.2)

The data collected during the fishermen interviews showed that 38% of the fishers target only finfishes (Figure 2). Roughly one-third (37%) target finfish, lobster and conch, while the remaining fishermen (22%) only target lobster and/or conch and other species such as octopus. This pattern is similar in the three landing locations, although fishermen from Boca de Yuma (see Figure 1) primarily target finfish. The fishing methods used reflect the artisanal nature of the fishery (Figure 3). Over 50% of the interviewees use hook-and-line. Fish traps and spear guns are used by 22 and 32 percent of the fishermen, respectively. Fishermen also use SCUBA and compressor (hookah) for fishing fish, conch and lobster, either by hand or using speargun or hook. Seventy-eight percent of the fishermen use SCUBA and/or compressor, and 10% of them use exclusively SCUBA and compressors (Figure 4).

The composition of landings (Figure 5) shows that most of the individuals caught are snappers (Lutjanidae), followed by grunts (Haemulidae), parrotfishes (Scaridae), groupers (Serranidae), leatherjacks (Balistidae), and jacks

(Carangidae). A large percentage (29% in number of individuals, 38% in biomass) is represented by varied fish families: Pomacentridae, Acanthuridae, Labridae, Sparidae, Coryphaenidae, Scombridae, Holocanthidae, Kyphosidae, Holocentridae, Lactophoridae, Mullidae and Isthiphoridae.

Table 2. Grouper and snapper sizes in coral reef habitats (10-20 m depth) of Parque Nacional del Este, Dominican Republic, as determined from visual transect (20 m x 5 m) surveys in 1996 (N = 142) and 1997 (N = 140).

Family/species	Total length (cm)	
	1996 Mean (range)/N	1997 Mean (range)/N
Serranidae	21.8 (7.0-50.0)/300	21.3 (5.0-36.0)/194
<i>E. adscensionis</i>	14.8 (12.0-17.5)/3	25.0 (23.0-27.0)/2
<i>E. cruentatus</i>	21.1 (7.0-40.0)/225	18.4 (5.0-30.0)/129
<i>E. fulvus</i>	19.3 (7.0-40.0)/47	18.7 (10.0-36.0)/52
<i>E. guttatus</i>	20.5 (14.0-50.0)/23	23.0 (13.0-32.0)/11
<i>E. striatus</i>	33.5 (30.0-37.0)/2	
Lutjanidae	22.1 (8.0-32.0)/177	
<i>Lutjanus apodus</i>	21.8 (17.0-30.0)/15	
<i>L. mahogoni</i>	23.0 (17.0-32.0)/16	
<i>L. synagris</i>	18.1 (8.0-25.0)/58	
<i>Ocyurus chrysurus</i>	25.4 (16.0-30.0)/88	

Among snappers species (Figure 6), yellowtail snapper (*Ocyurus chrysurus*) dominated (70% of individuals) the catch in the park. This species also comprised roughly one-third of the total snapper biomass fished. However, the few mutton snappers caught (6% of the total snappers) contributed about the same proportion of the biomass (37%), as their sizes were notably larger than the yellowtail snappers. The other snappers comprised less than 8% of the total number of individuals and 30% of the total snapper biomass. Mutton (*L. analis*), cubera (*L. cyanopterus*) and red (*L. campechanus*) snappers are large-sized and comprised altogether 8% of the snappers caught. They were fished mostly in depths greater than 30 m.

Among grouper species (Figure 7), the dwarf species (*Epinephelus guttatus*, *E. fulvus* and *E. cruentatus*) were dominant in the number of individuals (32, 25 and 22%, respectively) and comprised altogether 80% of the total grouper biomass landed during the surveys. The few, large *Mycteroperca* surveyed contributed 35% of the total grouper biomass landed. No Nassau grouper were recorded during the interviews.

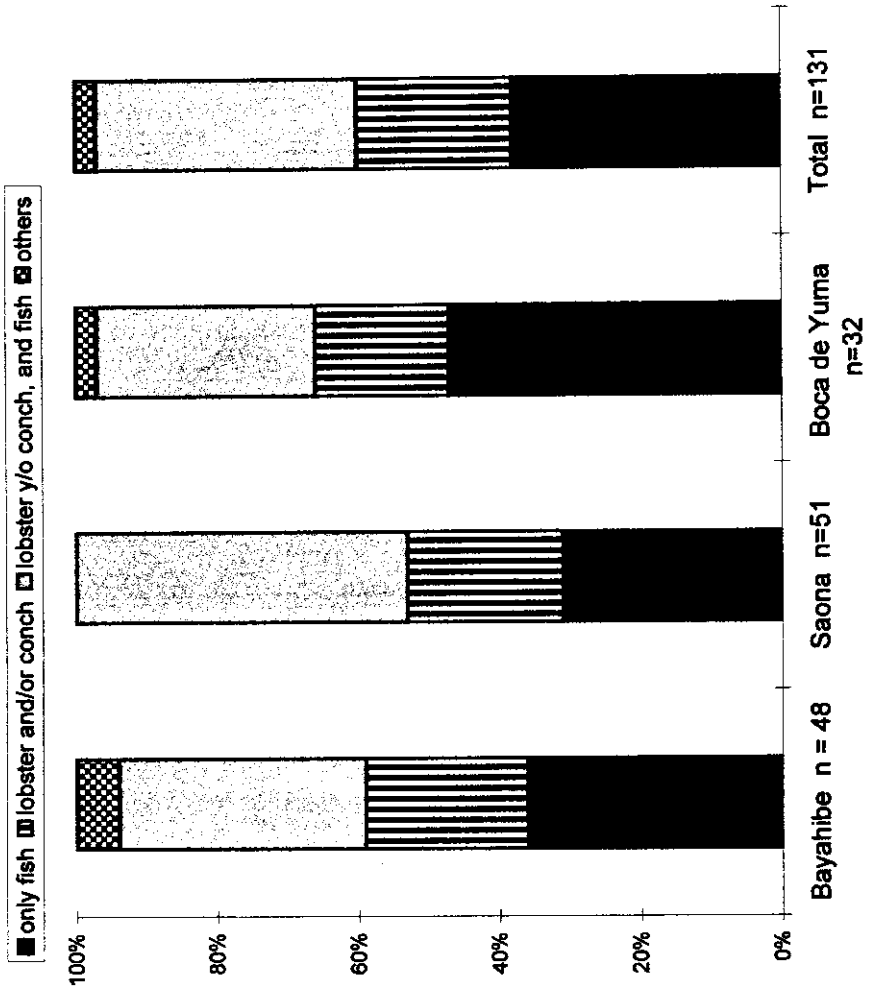


Figure 2. Relative abundance of fishery target species in different landing locations in and adjacent to Parque Nacional del Este.

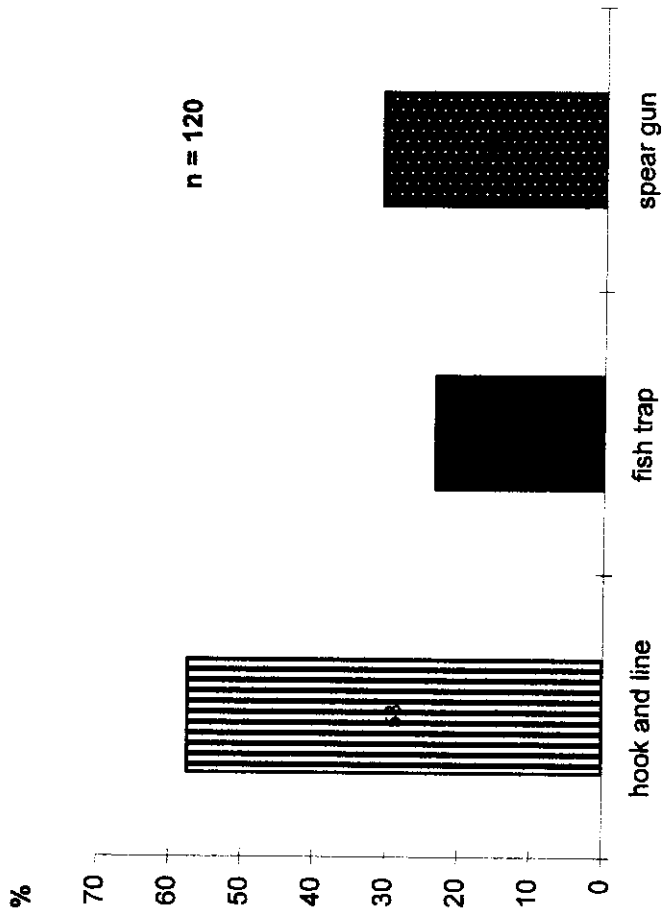


Figure 3. Fishing gears used by fishermen in Parque Nacional del Este.

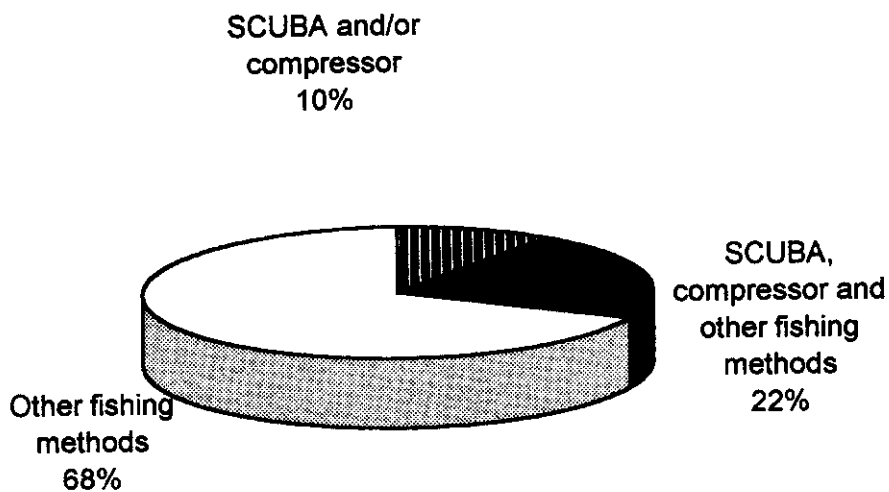


Figure 4. Use of SCUBA and compressor by fishermen in Parque Nacional del Este.

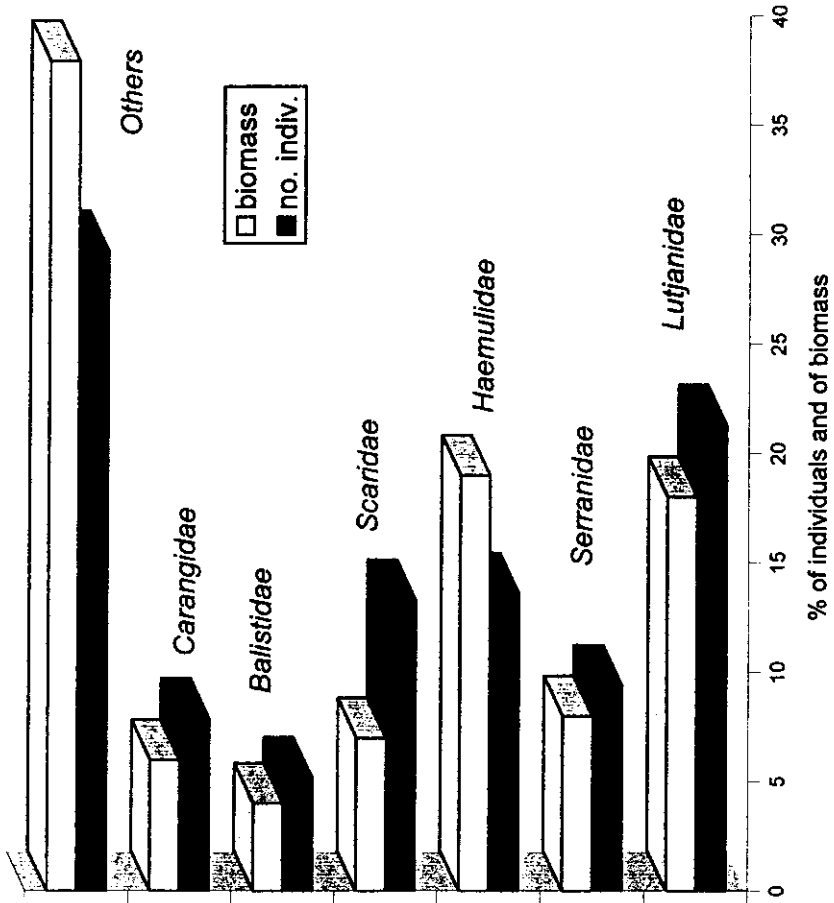


Figure 5. Composition of finfish landings by family in Parque Nacional del Este.

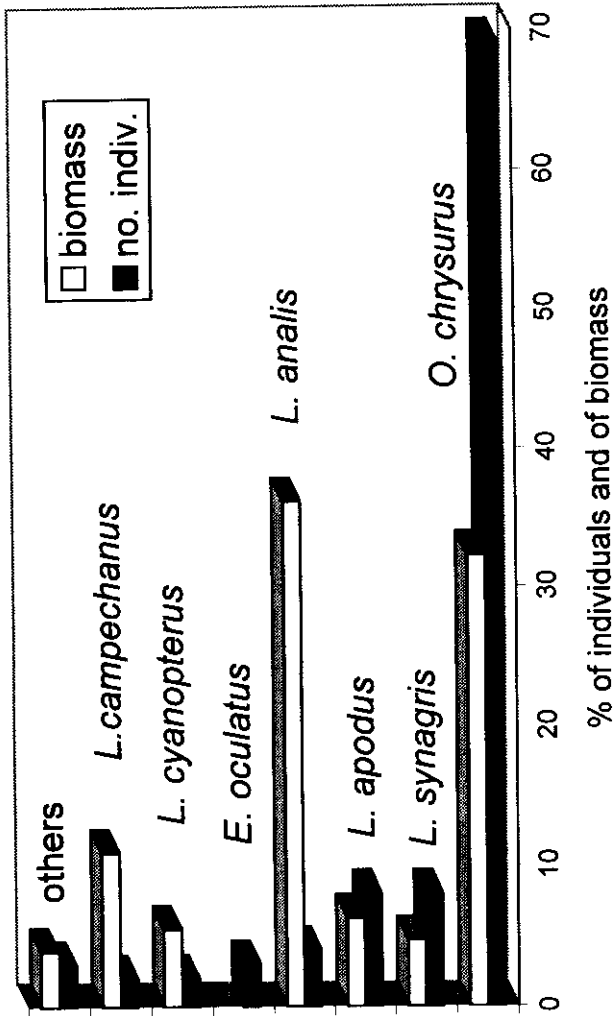


Figure 6. Abundance and biomass of snapper landings in Parque Nacional del Este.

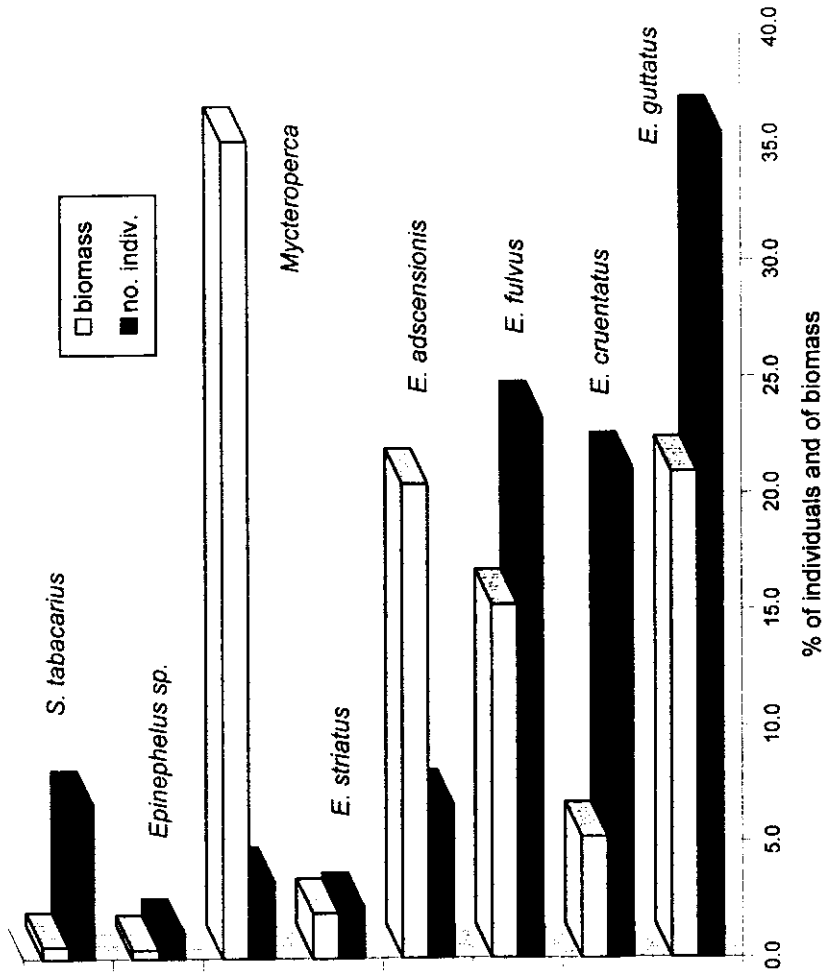


Figure 7. Abundance and biomass of grouper landings in Parque Nacional del Este.

DISCUSSION

Fish species richness in the study area is similar to that recorded for other areas in the Caribbean. Yet, as in many other locations, the reef fish assemblages appear to be significantly altered by intense fishing (Bohnsack, 1982; Koslow *et al.*, 1988). In Parque Nacional del Este, the composition of groupers is now dominated by small size species. This pattern is reflected in the data both from visual surveys and the catch composition by fishermen. The increase in relative abundance of small and non-targeted species has been documented in several other coastal areas (Koslow *et al.*, 1988; Claro, 1991; Chiappone *et al.*, this proceeding) and potentially indicates a second-order effect of intense fishing, mediated by changes in competition and/or predation.

Both types of surveys utilized in this study (visual surveys and interviews) demonstrate that the Nassau grouper population is heavily depleted and commercially extinct in the study area. This is also the case of other larger grouper species. No *Mycteroperca* species were recorded in the visual surveys, and only a handful of specimens appeared in the sampled landings.

As is the case for groupers, the catch composition of snappers closely resembled relative abundance patterns from the visual surveys. The absence of mutton (*Lutjanus analis*) and gray (*L. griseus*) snappers in the reefs west of the park is notable, and corresponds with their low proportion in the catches. Yellowtail snapper (*Ocyurus chrysurus*) appears to be the most common snapper species in the coastal habitats of the park and accounts for most of the catch of this important commercial fish family. The mutton snappers appearing in the landings were captured at depths greater than 30 m.

Predatory reef fishes play a prominent role in the structuring of reef fish communities. The intense fishing of species may have a significant deleterious effect on the structure and function of coastal ecosystems. Furthermore, the life history characteristics of many species (longevity, delayed reproduction, aggregated spawning) may make them particularly vulnerable to fishing. Claro (1991) documented the increase of a low-value grunt species (mostly tomtate, *Haemulon aurolineatum*) in patch reefs, artificial reefs and mangrove fish assemblages in the Gulf of Batabanó, Cuba, due to the overfishing of the historically dominant lane snapper (*Lutjanus synagris*). He postulated that the population of lane snapper did not recover after the implementation of fisheries regulations (limited quota, minimum size, closed season) because the juvenile stages of margate (*H. aurolineatum*) out-competed juvenile lane snappers for food and space, thereby affecting its recruitment. These second-order effects seem to be difficult to reverse and have an unpredictable impact on reef fish assemblages and coastal fisheries. Although similar data are not available for Parque Nacional del Este, the recovery potential of the park's resources may face similar challenges.

The information gathered on juvenile fish abundance by means of otter trawl surveys (León *et al.*, in press) suggests a lower species richness and abundance in nearby seagrass beds compared to other Caribbean areas (Weinstein and Heck, 1979). However, further studies specifically directed towards nearshore habitats will provide a better picture of the magnitude and pattern of fish recruitment in the southeastern coast of Hispaniola. This area has a fairly narrow shelf, and thus limited areas for juvenile recruitment and development. In addition, the geographic position of the area would likely make this region dependent to an unknown extent on the supply of fish larvae from up-current populations. Metcalf *et al.* (1973) recorded the occurrence of a complex current system in the Mona Passage, a 380-m deep channel between Hispaniola and Puerto Rico. Data obtained from drift bottles illustrated that currents flow from east to west, suggesting a resulting movement of the ocean surface waters from Puerto Rico to Hispaniola. The influence of this oceanographic pattern over fish larval dispersal is unknown, but may account for a possible connection between fish populations on both sides of the Mona Passage. The fish populations of southern Puerto Rico are known to be intensively fished (Appeldoorn and Lindeman, 1985). Therefore, the recovery potential of the southeastern Dominican Republic is likely to be impeded, perhaps even if stringent regulations (e.g., marine reserves) are put into effect to restore fisheries species (Russ *et al.*, 1996).

Sixty percent of the fishermen operating in Parque Nacional del Este target conch and lobster exclusively or together with finfish. However, a notable proportion of them (38%) exclusively target finfish. The data gathered during the creel surveys revealed that sizes of snappers and groupers from fishermen's catch are considerably greater than fisheries-independent surveys conducted in the western half of the park. Over 50% of the groupers and snappers from landings were greater than 30 cm. Most of the large fish come from depths greater than 20 m (the maximum depth of the reef surveyed), probably at the shelf drop-off, where fishermen concentrate their effort (roughly one-third fish up to a maximum depth greater than 30 m), partially using hookah as a fishing method.

Fisheries regulations in Dominican Republic (compiled by Ramírez, 1994) are limited and weak, and those referring to finfish fisheries are ambiguous and difficult to enforce. For example, Act Number 2099, established in 1984, bans fishing of spawning groupers, without any mention of season or location. Since there are no grouper spawning 'runs' or aggregations, and no data on reproductive seasons for the country. Therefore, it is difficult for fishermen to avoid catching spawners, and for managers to enforce such a regulation. Another example is Act Number 302-87 (1987) which bans the employment of nets, traps, and fishing gears 'that impede that young individuals avoid being captured or that lead to the death or mutilation of fishes with sizes shorter than those

established by the authorized agencies'.... However, there is no minimum size established for any fish species. In addition, specific regulations on minimum sizes and closed season alone will not be effective for protecting the fish community as a whole, a situation similar to many coastal areas (Russ, 1991). Unlike more sophisticated markets, Dominicans eat many different kinds (=species) of fish. The banning of grouper and snapper fishing is likely to result in the increased fishing of other species, even those with low economic value. This type of serial fishing will continue to affect the structure and function of the coastal ecosystem through potential changes in competition, predation, and herbivory (Hay, 1984; Claro, 1991; McClanahan *et al.*, 1994; McClanahan, 1995).

Fisheries constitute an important resource for coastal communities within and adjacent to Parque Nacional del Este. However, the marine area is not legally included in the park jurisdiction. A marine strip along the coast and out to the 1000-m depth contour should be included within the park jurisdiction. The depleted status of the fisheries populations, as well as the overall conditions of the coastal ecosystem, demand the implementation of urgent measures for the protection of marine resources. One important one is a zoning plan that includes no-take zones (marine reserves) combined with specific fisheries regulations (minimum sizes, closed seasons and fishing gears) for the rest of the park. This seems to be the only plausible plan for protecting the park marine ecosystem and for the restoration of the fish populations in the area (PDT, 1990; Roberts and Polunin, 1991; Bohnsack, 1994). Not only finfish resources but spiny lobster and queen conch will also benefit from this. The size, shape and placement of such no-take areas may be a subject of further analysis, however, the Canal de Catuano, a shallow area between mainland and Isla Saona seems to be a good candidate as it is a nursery ground for fish, lobster and queen conch. In addition, a strong outreach program and development of creative mechanisms to assist fishermen in their process of switching economic activity may contribute to reduce social costs of the implementation of such a conservation measure. Non-governmental organizations, academia, and international institutions may play an important role in assembling a coastal management plan that assures the protection of the natural resources of Parque Nacional del Este for present and future generations.

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