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Reefs of an uninhabited Caribbean island: fishes, benthic habitat, and opportunities to discern reef fishery impact

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Abstract

Navassa Island is a tiny, (5 km^2) uninhabited US protectorate located between Jamaica and Haiti. It is part of the Caribbean Islands National Wildlife Refuge, under the jurisdiction of the US Fish and Wildlife Service. We conducted a quantitative assessment of Navassa's coral reef fishes and benthic habitat, in order to assist with the development of conservation plan for the island. The shallow reefs of Navassa ($<$23m) have high live coral cover (range 20–26.1%), high degree of architectural complexity (rugosity index range 1.4–1.9), and moderate abundance of the keystone grazing urchin, *Diadema antillarum*, at all sites (mean 2.9 ± 0.9 per 30 m^2). Despite its remoteness, an unregulated, artisanal fishery (primarily using traps and hook and line) carried out by Haitians is the primary mode of human impact on Navassa reefs. Even so, reef fish communities exhibit high density (range 97–140 fish per 60 m^2) and retain representation by large snapper, grouper and herbivores, which are mostly lacking in nearby Caribbean locations with high fishing pressure. Thus, Navassa reefs appear to be trophically intact with fish populations relatively "unexploited," presenting a conservation challenge and a research opportunity. The regulation and conservation of the fishery will be difficult, due to the international nature of the situation. However, given the apparently small impact that artisanal fisheries have yet had on its reef communities, Navassa presents a possibly unique opportunity to study the ecological functioning of a relatively trophically intact Caribbean reef, and represents a strong imperative for conservation, monitoring, and research. © 2002 Elsevier Science Ltd. All rights reserved.

Keywords: Navassa; Artisanal fisheries; Coral reefs

1. *Introduction*

The tiny island of Navassa is a US protectorate under jurisdiction of the US Fish and Wildlife Service. The island measures approximately 5 km^2 and is currently uninhabited. The cliffs that surround the island extend straight down into the ocean, to a shelf ranging from 22–25 m depth, and are composed of sand and rubble with patch-reef type habitats disbursed throughout. Hence, the topography of Navassa Island reefs does not conform to the typical zonation described for Caribbean reefs (Goreau 1959; Goreau and Goreau, 1973), with protected near shore back reef and sea grass communities, reef crests and fore-reef habitats. In fact, seagrass and mangrove habitats are essentially absent, and this absence likely has strong influence on the reef fish communities of Navassa. Also, most of the shallow reef surface is vertical, with horizontal reef surfaces largely confined to a small shelf area at the Northwest Point (11–14 m), to indentations along or at the base of the wall, and on pinnacles, apparently formed as segments of the wall broke off (i.e. the pinnacles appeared to be geologically based, not accreted biogenic structures). Local human impacts are limited to artisanal fishing undertaken by Haitians who travel to Navassa in small boats, and thus this fishery is unregulated except by remoteness.

An expedition to Navassa in March 2000, the third sponsored by the Ocean Conservancy (formerly the Center for Marine Conservation), sought to provide a quantitative assessment of the coral reef communities

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around Navassa, (both fishes and benthic components) which will be critical to coral reef conservation and fishery management. A previous expedition to Navassa (August–September 1999) documented the biodiversity of the island, producing taxonomic lists for many groups including marine fishes, marine algae, terrestrial plants, reptiles and insects. Thus, the objectives of the current study were first to quantify reef fish abundance, biomass, size structure and assemblage composition, as well as habitat characteristics, including benthic community structure and rugosity. The second objective was to examine the influence of the artisanal fishery on Navassa coral reefs.

2. Methods

During the expedition to Navassa in March 2000, five sites along the West (lee) coast of the island were surveyed for reef fishes (Fig. 1). Quantitative benthic community structure and rugosity indices were measured at four of these sites. Depth of the survey sites ranged from

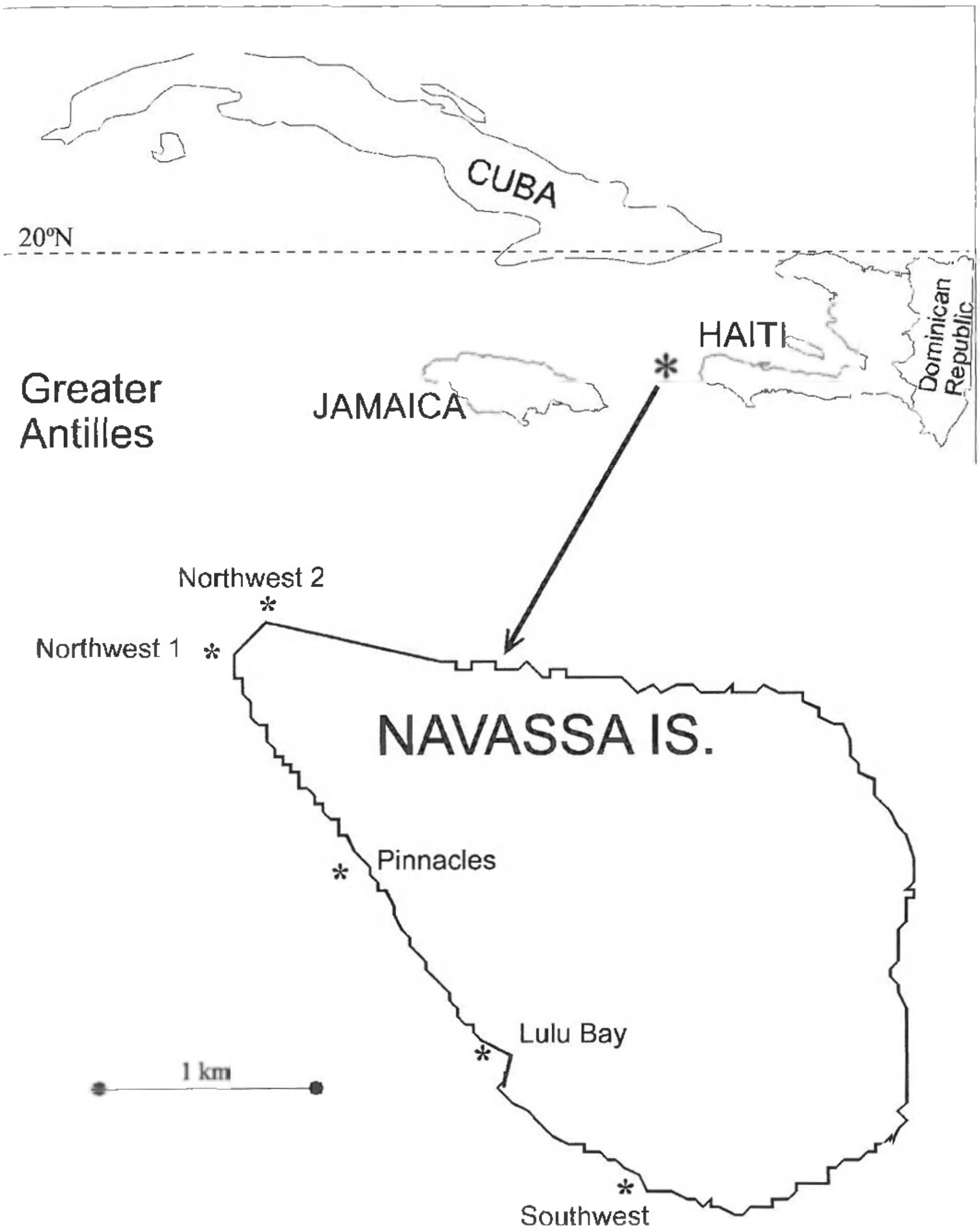

Fig. 1. Map of Navassa Island showing approximate location of study sites along the West coast.

9–11 m (Northwest sites) to 19 m (Pinnacles). Diving activities were precluded along the eastern coasts by heavy swell during the duration of the expedition.

2.1. *Reef fish populations*

Five sites were surveyed for coral reef fishes around Navassa Island: Northwest-1, Northwest-2, West Pinnacles, Lulu Bay and Southwest (Fig. 1), following the rapid assessment protocol of the Atlantic and Gulf Rapid Reef Assessment (AGRRA; Ginsburg et al., 1998). Briefly, fishes were counted in 30 m long, 2-m wide belt transects (60 m^2), using a 30-m transect tape and a 1 m T-bar to estimate transect width. Six to ten transects were placed haphazardly per site, and were located at least 5 m laterally away from the previous transect.

According to the AGRRA protocol, fishes from the following groups were surveyed during one pass along the transect: Epinepheline grouper, snapper, grunt, parrotfish, surgeonfish, triggerfish, angelfish, and butterflyfish. Additionally, the AGRRA protocol includes the survey of following five species: yellowtail damselfish (*Microspathodon chrysurus*), hogfish (*Lacholaimus maximus*), Spanish hogfish (*Bodianus rufus*), barracuda (*Sphyraena barracuda*) and bar jack (*Caranx ruber*). All fish sizes were estimated by comparison with the T-bar, which had 10-cm increments for scale, and were assigned to the following size categories: (<5 cm, 5–10, 11–20, 21–30, 31–40, >40 cm). When the diver reached the end of the transect line, the transect was re-swum in the opposite direction, and all other reef fish species (hereafter referred to as non-AGRRA fishes) were counted and sized, in order to establish a complete assessment of the Navassa reef fish assemblage.

2.2. *Benthic communities*

Benthic communities were quantified using a linear point-intercept method as described for the Rapid Assessment monitoring program in the Florida Keys National Marine Sanctuary (Miller et al., 2000). In conjunction with the quantitative sampling of fish communities, three to five of the fish transects were used to quantify benthic cover at all sites except Northwest-2 (Fig. 1). The transect tapes were placed by the diver sampling fishes without regard to coral occurrence. The organisms lying under points at 25-cm intervals along 25 m of each transect were recorded to quantify benthic community structure. The organisms or groups enumerated were scleractinian corals (to species level), hydrocorals (to species), octocorals (enumerated as branching or encrusting forms), sponges (as a group), crustose coralline algae (CCA, as a group), and upright macroalgae (to genus). One hundred points were recorded for each transect (0.25-m interval×25 m); thus the total number of point intersections tallied for a given organism on a given transect yielded an estimate of percent cover of the benthos. In a few cases where reef valleys yielded a large distance between the transect line and the bottom making identification of a single intercept point untenable, fewer than 100 points were recorded on a transect. In these cases, the number of points intercepting a given organism was divided by the total number of points recorded for that transect to estimate percent cover. Lastly, the number of *Diadema antillarum* sea urchins was counted and recorded within a 1-m wide swath along each transect. These tallies yielded an estimate of *Diadema* density (No. urchins per 30 m^2).

The last parameter quantified for each reef site was the rugosity index. Rugosity gives an indication of the topographic complexity of the reef, a characteristic important both for indicating habitat value (e.g. for fishes or mobile invertebrates), and as an indicator of reef metabolism and nutrient uptake (Atkinson, 1999). A 6-m long chain (3.5-cm links) was laid in a strait line to conform to the reef surface, and an additional measuring tape was used to measure the linear (flat) distance covered by the chain. The ratio of chain length to flat length gives the rugosity index (dimensionless). A perfectly flat surface would have a rugosity index of one, with larger numbers indicating rougher, more complex surfaces. Ten chain transects were measured at haphazard locations at each site except Pinnacles, where only four chain transects were quantified.

2.3. *Data analysis*

The mean density of all fish, including AGGRA and non-AGGRA species (per 60 m^2 transect) was calculated for all sites and transects combined (total density). Navassa fish biomass was estimated using the length-weight relationships for Caribbean reef fishes, generated by Bohnsack and Harper (1988). Lengths were first estimated by assigning each fish to the mid-point of its observed size category (e.g. 15 cm for the 11–20 cm size category). From the length data, crude estimates of biomass values were then calculated. Total mean biomass (g per 60 m^2) was calculated for all species where regression data were available. Species data were then combined and averaged to give an estimate of Navassa total fish biomass.

The densities of certain groups (grouper, large grouper, parrotfish, snapper) were calculated for comparison with other Caribbean locations. The grouper category contains AGGRA Ephinepheline serranids, while the large grouper category contains the same species minus grasby (*Ephinephelus cruentatus*) and coney (*Ephinephelus fulvus*). Finally, the total mean density for all species and for selected species was split into fish size categories for comparison.

3. Results

3.1. *Reef fish populations*

Mean reef fish density for Navassa was 119.1±6.8 fish per 60 m^2 (Mean±1 Standard Error; $n=42$ transects), while mean biomass was 13,718.9±1595.0 g per 60 m^2 (Fig. 2a). Mean densities for Navassa for certain economically and ecologically important fish groups were compared to published values from other Caribbean areas for rough illustration (Fig. 2b), however census methods are not equivalent in all cases. Navassa shows high densities of grouper, averaging 1.6±0.2 fish per 60 m^2, and especially large grouper, averaging 0.3±0.1 fish per 60 m^2 compared to other Caribbean sites. Parrotfish densities for Navassa averaged 5.0±0.5 fish per 60 m^2, and are intermediate between those reported for sites in the Florida Keys, where parrotfishes are not targeted for harvest, and for unfished sites in Saba. Indeed, the family Scaridae comprised 28% of total fish biomass at Navassa, more than any other fish family. Mean snapper densities of 0.9±0.3 fish per 60 m^2 are of intermediate abundance for Navassa compared to other published Caribbean sites.

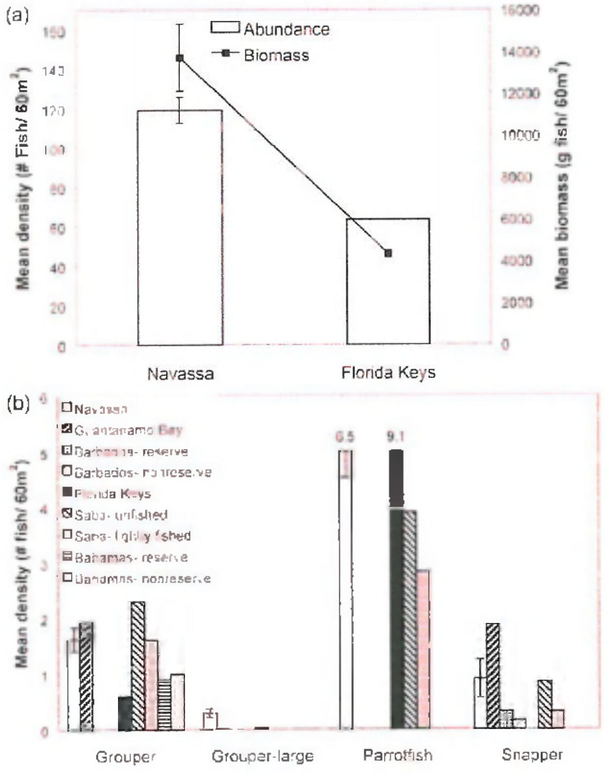

Fig. 2. (a) Mean fish density (No. fish per 60-m^2 transect) and mean fish biomass (g fish per 60 m^2 transect) for all Navassa Island transects ($n=42$) compared to data from the Florida Keys (Bohnsack et al., 1999). The Florida Keys data use a visual plot census method which yields a conservative estimate of areal density, and is only included for a rough comparison. Values are means±1 standard error for Navassa data. (b) Fish mean density for selected species in Navassa Island ($n=42$) compared to other Caribbean locations: Guantanamo Bay (Sedaghatkish and Roca, eds., 1999), Barbados (Chapman and Kramer, 1999), Florida Keys (Sluka et al., 1994, 1996); Saba (Roberts, 1995), Bahamas (Sluka et al., 1996). The Grouper category only includes Epinepheline serranids, while the Large Grouper category includes the same species, minus grasby and coney. Values are means±1 standard error for Navassa data. Means that were too large for the scale are indicated by the number above the bar.

The size distribution of Navassa reef fishes is shown in Fig. 3. The greatest abundance of all species of fish combined was found in the 6–10 cm category. Navassa snapper sizes were particularly large, with 92.1% of snappers possessing lengths greater than 40 cm. Grouper and parrotfishes were also relatively large, with 14.7% and 22.5%, respectively, possessing lengths greater than 40 cm. Rough comparisons of Navassa fish sizes with published studies from other areas of the Caribbean are given in Table 1.

Interestingly, certain common reef fish species were absent from the survey data. No members of the grunt family (Haemulidae) were observed, nor were labrids such as hogfish (*Lachnolaimus maximus*) or slipperydick wrasse (*Halichoeres bivittatus*). Other species, such as a very large (>1 m) jewfish (*Epinephelus itajara*), were observed but not recorded during the transect swims.

Casual interviews with two groups of Haitian fishers indicated that overall fishing effort was relatively minimal. We observed only 1–4 small (~20-feet) boats, with 3–5 fishers per boat during the 10-day survey period. Fishers said they only fished for 8–10 days at a time before returning to Haiti, where fishes were either consumed for subsistence or sold. We observed only fishing by either hand line, or traps further offshore of the reef. In the underwater surveys, we saw no evidence of more destructive fishing practices such as blast fishing, which are common in certain areas of the Pacific. The catch did include several species that were not observed during the underwater transect surveys including, queen

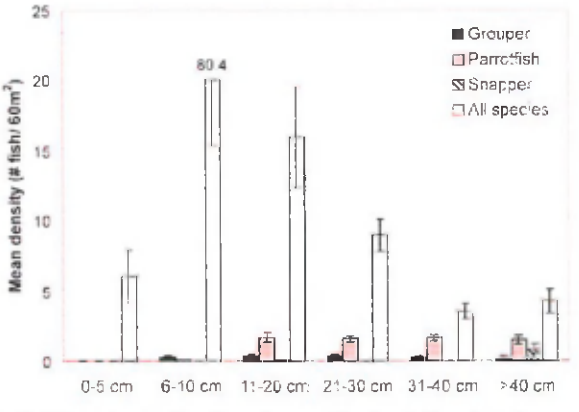

Fig. 3. Mean density for all species combined and for selected groups, by fish size categories for all Navassa Island transects ($n=42$). The Grouper category only includes Epinepheline serranids. Values are means±1 standard error. Means that were too large for the scale are indicated by the number above the bar.

Table 1

Comparison of recent Caribbean coral reef fish data intended to provide a rough benchmark comparison of Navassa populations, since the methods for fish surveys vary widely

	Navassa Current study (5 lightly fished sites)	Caribbean Hodgson (1999) (49 Reefcheck sites)	Florida Keys Sluka et al. (1994) Schmitt (1997)	Jamaica Koslow et al. (1988) (heavily/moderately fished)
Grouper	0% sites, grouper (>30 cm) = 0 fish/100 m^2	65% sites, grouper (>30 cm) = 0 fish/100 m^2	7% of sites, grouper (>35 cm) = 0 fish/100 m^2	# "large" grouper = 0 on 27 dives/ = 1 on 24 dives (50 m long transects)
	20% sites, grouper (>30 cm) <0.5 fish/100 m^2	22% sites, grouper (>30 cm) <0.5 fish/100 m^2	93% of sites, grouper (>35 cm) <0.5 fish/100 m^2	
	80% sites, grouper (>30 cm) ≥0.5 fish/100 m^2			
Parrotfish	0% sites 0 fish/100 m^2	4% sites 0 fish/100 m^2	Range: 7–22 fish/100 m^2	"large" parrotfish, except *Sparisoma viride* = 0–0.3 per dive
	0% sites, 0–2 fish/100 m^2	28% sites, 0–2 fish/100 m^2		
	20% sites, 2–5 fish/100 m^2	37% sites, 2–5 fish/100 m^2		
	80% sites, >5 fish/100 m^2	31% sites, >5 fish/100 m^2		
Snapper	40% sites, 0 fish/100 m^2	20% sites = 0 fish/100 m		
	0% sites <1 fish/100 m^2	27% sites <1 fish/100 m^2		
	60% ≥1 fish/100 m^2			

trigger (*Balistes vetula*), Nassau grouper (*Epinephelus striatus*), smooth dogfish (*Mustelis canis*), blackjack (*Caranx lugubris*), and a red snapper species.

3.2. Benthic communities

Mean live scleractinian coral cover at the four sampled sites was 22.6±1.3% (±1 S.E.; range 20–26%; $n=4$ sites; Fig. 4). Other major space occupiers were sponges, averaging 17.3±4.1% (7–27%) and upright macroalgae, averaging 21.6±2.2% (16–26%, primarily *Halimeda* spp. and brown fleshy algae such as *Dictyota* and *Lobophora* spp). The highest sponge cover (as well as the highest coral cover and rugosity) was measured at Pinnacles, while the highest macroalgal abundance was at Northwest point, the site with the greatest expanse of horizontal reef area. Comparative values for other well-studies Caribbean reefs (Discovery Bay, Jamaica and the Florida Keys) are displayed in Fig. 4 for illustration.

Mean abundance of *Diadema antillarum* urchins was 2.9±0.8 (1 S.E.) urchins per 30 m^2 ($n=14$ transects). Rugosity of the reefs at Navassa was extremely high, averaging 1.6±0.1 (range 1.4–1.90, $n=5$ sites).

4. Discussion

The purpose of the current study was to collect baseline data on the status of Navassa coral reefs and to determine whether artisanal fishers from Haiti were impacting the reef community. This included surveying Navassa coral reef fish populations, estimating fishing effort, and characterizing benthic community structure.

4.1. Benthic/habitat status

The underwater landscape around Navassa is spectacular, largely owing to the predominance of vertical reef surfaces. Indeed at some sites, it was difficult to find enough horizontal space to place the desired 10 transects. Interestingly, the site with extensive horizontal reef area (Northwest Point) also had the highest cover of brown algae, which can compete and displace corals. Overall, the "health" of shallow water reefs in Navassa appears quite good as indicated by this quantitative survey (i.e. high coral to macroalgal ratio (Fig. 4) and moderate densities of grazing urchins), as well as other qualitative observations including low incidence of coral disease or other active mortality, vigorous populations of *Acropora palmata* (designated as a Candidate species under the US Endangered Species Act by NMFS in 1999), and an abundance of small recruits of many scleractinian species.

The predominance of vertical reef surfaces also contributes to the high topographic complexity of these reefs. It appeared that the high rugosity values observed at the Navassa survey sites result partially from underlying geology and partly from the complex benthic

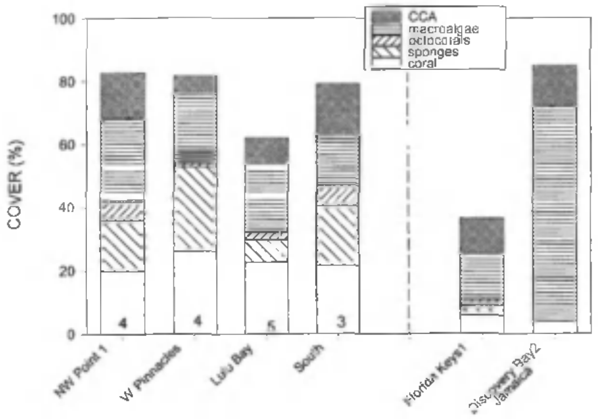

Fig. 4. Benthic community composition for four sites at Navassa (left portion of graph) and, for comparison, other Caribbean sites, depicted as mean percent cover of dominant benthic groups: corals indicates scleractinian corals only; macroalgal group is composed primarily of *Dictyota* spp., *Halimeda* spp. and *Lobophora variegata*; CCA represents crustose coralline algae, a bottom type that indicates high levels of grazing and is advantageous for coral settlement. The number of transects sampled at each site is given in the bars. (1) Data averaged from five outer bank reef sites in Biscayne National Park, northern Florida Keys (Miller et al., Unpublished data). (2) Data from long-term study site at Discovery Bay (Aronson and Precht, 2000); cover by sponges was not reported in this study.

community growing upon it. Reefs with high rugosity yield a high potential for reef metabolism and nutrient uptake as well as high value as fish habitat. While rugosity index data is not commonly collected in reef rapid assessments, Atkinson (1999) argues that it should be because it allows inferences regarding the nutrient uptake and, hence, reef metabolism. Szmant (1997) suggested that topographic complexity is a vital determinant of a reef's capacity to metabolize nutrient input without undergoing a "phase shift" to macroalgal dominance.

The survey results indicated that fish populations appear relatively unexploited, since overall fish density, biomass and size were relatively rich compared to other areas of the Caribbean (Fig. 2b; Table 1). For example, fish density and biomass in Navassa was 2–3 times greater than in the Florida Keys (Fig. 2a; Bohnsack et al., 1999). Maximal Navassa fish density values were also 1.5 times greater than maximal values for Haitian reef fish populations (Ferry and Kohler, 1987).

In addition, density and size were greater for selected species, including grouper and parrotfishes. Large, commercially important grouper species (excluding smaller species such as coney and grasby) had an approximately 3.5 times greater density in Navassa than in the Guantanamo Bay, Cuba marine reserve (Sedaghatkish and Roca, 1999). Densities for total grouper (including coney and grasby) were 2.8 times greater in Navassa than in the Florida Keys (Sluka et al., 1994) and similar to those found in Guantanamo Bay, in lightly fished areas of Saba Island (Roberts, 1995), and in a no-take reserve in the central Bahamas (Sluka et al., 1994). Larger species, such as tiger grouper (*Mycteroperca tigris*) were also seen in Navassa, while none were found in Guantanamo Bay or Barbados (Chapman and Kramer, 1999), and were rare in the Florida Keys. Grouper size was also relatively larger, in comparison to Reefcheck data from 1997, where 65% of the Caribbean sites reported no grouper greater than 30 cm (Hodgson, 1999). Parrotfish densities were similar to values for unfished areas of Saba (Roberts, 1995) and areas such as the Florida Keys where parrotfish are not a targeted stock (Schmitt, 1997). In Navassa, 80% of sites had parrotfish densities over five fish per 100 m^2 while only 31% of sites across the Caribbean reported densities this high (Hodgson, 1999). Snapper densities were similar in Navassa to those in Saba. In contrast, Navassa snapper densities were 50% less than in Barbados and were substantially less than in Guantanamo Bay. Conservative density estimates for certain species, such as yellowtail snapper (*Ocyurus chrysurus*) were six times greater in the Florida Keys than in Navassa, however snapper were much smaller in the Keys, with mean sizes ranging from 15–20 cm (Bohnsack et al., 1999).

The lack of species such as grunts and certain wrasses may be due to the lack of seagrass habitats around Navassa, which are usually required for juveniles of these species. Alternatively, grunts are also common forage for larger predators, such as grouper, so that the greater abundance of predatory fishes could be impacting the abundance of smaller species. Although these species were not apparent in the transect survey data, they were collected using rotenone during the 1999 expedition to Navassa (Collette et al., 1999).

4.2. Conservation implications and future research needs:

Intensely exploited reef fish populations are characterized by decreased catch rates, decreased abundance of large predatory fishes and total reef fishes, decreased individual size, and decreased species richness (e.g. Munro, 1983; Russ and Alcala, 1989). The present study showed that density and size of large predatory fishes and the density of reef fishes in general compare favorably with lightly fished reefs throughout the Caribbean. No data are available on catch rates in Navassa. While various fish taxa (e.g. grunts) were not observed in Navassa, this depression in species richness is explained by natural habitat limitation (i.e. lack of seagrass and mangrove habitat). Thus, we conclude that despite ongoing artisanal fishing activity on Navassa reefs, the impact of harvest on the reef fish assemblage appears minimal.

Coral reefs are complex communities, and strong interactions such as those between herbivorous fishes and benthic algae (Hay, 1991) are important in maintaining biodiversity. It has been argued that overfishing of Caribbean coral reefs, in conjunction with basin-wide die-off of the herbivorous sea urchin *Diadema antillarum* in the early 1980s has been responsible for "phase shifts" of these reef communities from coral-dominated to macroalgal-dominated systems (Hughes, 1994; Hughes et al., 1999). Indeed, fleshy seaweed abundance in heavily fished areas such as Jamaica have been consistently over 60% cover since 1985 (Hughes, 1994), with the exception of areas where *Diadema* have rebounded (to densities of 1.25 per 1 m^2) and reduced macroalgal cover (to $\sim 15\%$) in the past 2 years (Aronson and Prect, 2000). Macroalgal cover at the four sites quantified in Navassa ranged from ~ 16–26% (Fig. 4) with mean *Diadema* density of 0.1 per 1 m^2. Additional anecdotal observations such as an unusually high incidence of arm regeneration in brittle star collections (Hendler, personal communication) suggest that overall predation regimes are relatively intense at Navassa. These results corroborate our fish survey data showing that Navassa assemblages contain abundant large predators and herbivores. Meanwhile, we recognize that the undisturbed state of Navassa reef trophic webs is relative, as wide-scale trophic disruption of Caribbean reefs by functional removal of mega-fauna such as turtles may be ubiquitous and very old (Jackson, 1997). That is, what appears to us as favorable coral and algal cover may still represent some degree of degradation from Navassa's true pristine state.

Our direct observations of fishing effort also indicate relatively low impact, with only 1–4 small boats fishing in an extremely crude estimate of 5–8 km^2 of fishable area. Thus, effort is estimated to be 5–8 times less than the heavily exploited northern shore of Jamaica (Hughes, 1994). However, anecdotal observations from the three Ocean Conservancy-sponsored cruises suggest that the capacity of the Haitian fishery may be increasing rapidly, since the earlier expeditions observed only sail powered boats, while the current expedition observed outboard motors on all the Haitian fishing vessels present (Anonymous, 2000). However, due to the prohibitive price of gasoline, these motors are currently used for transport around the island, not to and from Haiti.

This current state of reef communities at Navassa represents both a conservation challenge and a research opportunity. The artisanal fishery activity at Navassa is currently unregulated and unquantified. Careful monitoring of the fish populations and the fishery and the application of fishery management will be required in order to avoid over-exploitation, especially if fishing effort escalates by Haitian fishers. Given the current socioeconomic conditions in Haiti and the likely trend for increased technology and sophistication of fishing methods, it seems likely that pressure could escalate rapidly unless management programs are enforced. Limiting entry into the fishery by only licensing current Haitian fishers and using the US Coast Guard from Guantanamo Bay, Cuba for enforcement is one option. Though the international nature of the situation will make implementation difficult, the application of strict conservation and fishery management (of which fishery effort and catch monitoring is an important component) must be a high priority to maintain the current status of Navassa reefs.

This unique status of Navassa reefs also represents an important research opportunity. It is rarely possible to quantify the direct and indirect impacts of fishing on the structure and function of Caribbean reef communities, when we have so little opportunity to study reef community function in systems that are not grossly disturbed by human harvest. Navassa appears to present such an opportunity, via comparative studies of appropriate aspects of reef community function including population dynamics of important reef components (corals, macroalgae, grazing urchins, and fishes) and various functional processes (productivity, nutrient cycling, recruitment) with other Caribbean reef areas.

In the most pessimistic case, if the conservation measures described above are not successfully implemented, fishing effort and catch may increase rapidly at Navassa to the point where adverse impacts on the reef ecosystem occur. This scenario (starting from a point of minimal fishery impact but with rapid fishery escalation over time), though tragic, could provide some benefit, but only if research and monitoring is begun ahead of time. Continued quantification of baseline reef status and processes at Navassa and the examination of trends if fishing effort increases may identify threshold levels of fishing effort or harvest where reef communities are adversely impacted, in the absence of other local anthropogenic stressors. While the habitat peculiarities of Navassa (abundance of vertical structure, lack of mangroves and seagrasses) dictate care in generalization of results to other areas, temporal changes in the Navassa reef community may lend insights on fishery impact that are not available elsewhere, a nugget of information which could greatly improve coral reef management and its effectiveness.

These important monitoring and research activities at Navassa are not currently underway nor are they under concrete plan for the near future. Given the possibility of future escalations in the fishery, this opportunity may soon be lost.

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