In-Situ Observations of Antillean Fish Trap Contents in Southwest Puerto Rico: Relating Catch to Habitat and Damage Potential

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ABSTRACT

The shelf-wide distribution of Antillean fish traps has been monitored in southwest Puerto Rico since 2002 to evaluate the benthic impacts of trap fishing within coralline habitats. Of 1438 traps documented in surface surveys to date, 161 traps were assessed by divers to quantify catch and trap-associated damage to sessile invertebrates; of these 39% were empty at the time of inspection. These data were used to assess trap catch (abundance, species composition) within habitats stratified by potential trap damage. Observed traps were predominantly arrowhead-style traps with 5-cm hexagonal vinyl-coated mesh composed either of wood (40%, n=65) or rebar frames (29%, n=46). Most traps inspected were found within colonized hardbottom habitats dominated by soft corals (63%, n=102) at intermediate depths (12-18 m). Fishes composed 78% of the total individuals caught (n=391), of which butterflyfishes, grunts, surgeonfishes, trunkfishes, and parrotfishes were most abundant. The banded butterflyfish, *Chaetodon striatus* (n=34), was the most frequently encountered fish species, whereas the foureye butterflyfish, *Chaetodon capistratus* (n=32), was the fish observed in the highest number of traps (n=17). Snappers and groupers composed only 7% of all observed fishes. The Caribbean spiny lobster, *Panulirus argus*, was the most numerous invertebrate (n=73, 85% of all invertebrates), the most numerous of any trapped organism (20% of the total), and was the most widely distributed (22% of all observed traps). The majority of trapped organisms (81%, n=316) was observed within colonized hardbottom and coral reef areas of moderate to high relief. Although sampled less frequently, contents observed in traps within less structured habitat types such as algal sand and mud consisted mostly of trunkfishes (19%, n=14) and grunts (15%, n=11). Within these habitats, *P. argus* was the most frequently observed species (32%, n=24), of which 58% were observed in algal sand habitat. Due to coincident presence of spiny lobster and a higher percentage of commercially valuable fish species within less complex habitats, the results suggest that fishers could prosper well by fishing traps only within areas of low structural complexity while lessening potential for gear damage of more complex habitat types.

KEY WORDS: Caribbean spiny lobster, fish trap, *Panulirus argus*, Puerto Rico, reef fishes, trap fishery

Observaciones In-Situ de Contenidos de Trampas de Pez Antillanos en el Suroeste de Puerto Rico: Relaciones entre Capturas, Habitat, y Potencial de Daño

La distribución de trampas de peces antillanos en el suroeste de Puerto Rico se monitoreo desde el año 2002 para evaluar los impactos bénticos de la pesca de trampas dentro de los habitats coralinos. De las 1438 trampas estudiadas hasta el momento, 161 trampas fueron observadas para cuantificar la captura y el daño asociado de las trampas a invertebrados sesiles; el 39% de estas trampas se encontraron vacías. Estos datos fueron utilizados para analizar la captura (abundancia, composición de especies) dentro de los habitats sujetos al daño potencial de las trampas. Las trampas observadas fueron predominantemente del tipo “arrowhead” (cabeza de flecha) con maya de vinil 5-cm. hexagonal sobre marcos de madera (40%, n=65) o varilla (29%, n=46). La mayoría de las trampas inspeccionadas se encontraron en habitats de fondo duro dominado por corales blandos (63%, n=102) a profundidades intermedias (12-18 m). Los peces representaron el 78% de la captura total de individuos (n=391), siendo los peces mariposa, cirujanos, roncos, y loros los mas abundantes. *Chaetodon striatus* (n=34), fue la especie de pez mas frecuente, mientras *Chaetodon capistratus* (n=32) fue el pez observado en el mayor numero de trampas (n=17). Los pargos y los meros representaron solo un 7% de los peces observados. La langosta espinosa del Caribe, *Panulirus argus*, fue el invertebrado mas frecuentemente observado (n=73, 85% de todos invertebrados), el organismo más numeroso en las trampas (20% de todos los individuos observados), y se encontró dentro del 22% de todas las trampas estudiadas. La mayoría de los individuos (81%, n=316) se observaron en fondos duros colonizados y áreas de arrecife de coral. Aunque estudiadas con menos frecuencia, las trampas en áreas de poca estructura (e.g. habitats de arena de alga y fango), contenían principalmente ostracidos (19%, n=14) y roncos (15%, n=11). Dentro de estos habitats, *P. argus* fue la especie mas frecuentemente observada (32%, n=24), con un 58% presente en arena de alga. Debido a la presencia coincidente de langosta espinosa, y al alto porcentaje de especies de peces de importancia comercial observados dentro de los habitats de poca estructura, estos resultados sugieren que los pescadores podrían prosperar si ubicaran las trampas solamente en áreas de baja complejidad estructural mientras disminuiendo potencial de daño de equipo pesquero en habitats más complejos.

PALABRAS CLAVES: Langosta espinosa del Caribe, *Panulirus argus*, peces de arrecife, pesquería de trampa, Puerto Rico, trampa de pez

INTRODUCTION

Antillean fish traps are commonly used in Caribbean artisanal fisheries (Munro *et al.* 1971, Munro 1983). Composed mainly of wood or steel-rebar frames with galvanized wire mesh, they are highly effective at capturing reef fishes and Caribbean spiny lobster (*Panulirus argus*) within coralline habitats (Dammann 1980**,** Stevenson and Stuart-Sharkey 1980, Garrison *et al.* 1998). When placed in habitats with little or no structure within coral reef ecosystems, traps attract many species that migrate away from reefs into these lower relief areas during feeding periods (Wolff *et al.* 1999). Presumably, traps offer structure and refuge (Hixon and Beets 1989) that is otherwise lacking. Studies have shown catch-per-unit-effort to be higher for traps placed within less structurally complex areas (Wolff *et al.* 1999, Robichaud *et al.* 2000). However, as traps are a non-selective passive gear that may be deployed in large quantities (Stevenson 1978; Beliaeff *et al.* 1992, Collazo and Calderon 1988), their continued use has likely contributed to the overfished status of Caribbean waters (Munro 1983, Appeldoorn *et al.* 1987, Robichaud *et al.* 1999). Recent needs for improved habitat conservation have raised questions regarding their role in coral reef habitat degradation via direct destruction of sessile benthic flora and fauna during placement, fishing, and hauling (Quandt 1999, Appeldoorn *et al.* 2000, Eno *et al.* 2001, Sheridan *et al.* 2003, 2005, and Uhrin *et al.* 2005).

In Puerto Rico, trap catches make up 21% of total landings, while contributing 24% of the total commercial value of the Puerto Rican fishery (Matos-Caraballo 2004). During 2002, approximately 13,100 traps were fished in Puerto Rico (Matos-Caraballo *et al.* 2005), representing a 15% decrease from a previous survey in 1996 (Matos-Caraballo 2000). Trap use, and percent contribution of trap catches to landings, have fallen from previously dominant values (Collazo and Calderon 1988, Matos-Caraballo 2004), as a result of decreases in catch value overriding construction and recovery expenses; high numbers of stolen traps; and incidents of poaching by divers (Griffith and Valdez-Pizzini 2002, Scharer *et al.* 2004, Matos-Caraballo *et al.* 2005). Trap catches historically dominated by first-class fish species such as snappers, groupers, trunkfishes, and grunts (Stevenson and Stuart-Sharkey 1980), have been replaced by second- and third-class herbivores (e.g. parrotfishes, surgeonfishes), while landings for *P. argus* have declined over time (Matos-Caraballo 2004). Despite these shifts, traps remain a commonly used gear in local fisheries (Appeldoorn *et al.* 2000)

Trap use has been significant along the southwest platform of Puerto Rico (Matos-Caraballo 2000), where 966 traps were reported to be used in the Municipality of Lajas during 1995 - 1996. Recently, decreases in the numbers of observed buoyed traps (Marshak, unpublished data) have been noted within this area. Within the barrio of La Parguera, investigations have provided insight into the distribution of the trap fishery along the southwest coast (Valdez-Pizzini *et al.* 1997, Jean-Baptiste 1999); damage from traps to benthic habitats (Appeldoorn *et al.* 2000, Sheridan *et al.* 2003, 2005); and fishing trends (Scharer *et al* 2004). Appeldoorn *et al.* (2000) also recorded observed trap contents during *in situ* observations of trap habitat placement. Investigations into components of trap performance within particular areas of La Parguera have been performed as well (Recksiek *et al.* 1991, Acosta *et al.* 1994). Most previous *in situ* observations of traps in the Caribbean have focused upon experimental trapping (Munro *et al.* 1971, High and Ellis 1973, Munro 1974, Luckhurst and Ward 1985), however Garrison *et al.* (1998, 2004) observed contents of fishers' traps during the early 1990's. Although these observations represented only a snapshot of trap activity, and could not be interpreted as final catch, they served as a good indicator of the species targeted within different habitats subject to trap fishing.

Since 2002, the shelf-wide distribution of trap fishing has been monitored off La Parguera, Puerto Rico to further evaluate the benthic impacts of trap fishing within coralline habitats (Sheridan *et al.* 2003, 2005). Two major criticisms of traps are their non-selectivity (Munro *et al.* 1971, Stevenson and Stuart-Sharkey 1980) and their role in habitat degradation (Hamilton 2000). This paper addresses the issue of non-selectivity and how it is affected by the habitat fished. Observations of trap contents within habitats of high relief (hard coral reef), medium relief (hardbottom colonized by soft corals), and low relief (algal sand, seagrass, or non-vegetated sand and mud) are summarized and compared. The range of high to low relief corresponds with an expected high to low potential for long-term damage or death of impacted invertebrates and plants (Appeldoorn *et al.* 2000, Eno *et al.* 2001, Sheridan *et al.* 2005, Uhrin *et al.* 2005).

METHODS AND MATERIALS

Along the insular platform of La Parguera, Puerto Rico (17º52.000' N, 67º0.000' W to 17º58.000' N, 67º8.000' W), trap distribution was seasonally monitored 3-4 times per year during 2002 - 2006. Following the methods of Sheridan *et al.* (2003), boat transects 0.25 minutes longitude wide were run from random starting points near shore to the edge of the insular platform throughout the offshore coral reef ecosystems of La Parguera. All trap buoys identified within a transect were marked with a hand-held Global Positioning System (GPS), and depth and buoy type were recorded (we assumed traps were directly beneath buoys unless a very long tether was detected). Benthic habitats were recorded based on overlays of side-scan sonar maps, *in situ* sampling, or expert knowledge. A subset of traps was selected for diver assessments, ensuring that all habitat types were represented during the sampling. Logistics dictated that areas of high trap effort or high potential habitat damage be sampled in order to gain an adequate sample. Traps were frequently found grouped, and generally 2-4 selected traps per trap cluster were inspected using SCUBA. As traps were frequently spaced at large distances from each other, dives were often focused upon trap pairs that were separated by no more than 100 meters. At least 10 traps were assessed per sampling season.

Divers recorded observed habitat within and outside of a 5 m radius of the trap from a standardized list of habitat types. Percent cover and density of all observed sessile invertebrates and flora adjacent to and beneath the trap were quantified to the lowest identifiable taxon using a 1 m^2 quadrat, although these data will not be discussed herein. Trap construction (frame materials, mesh dimension, and type) and configuration (arrowhead, Z-trap, and square box) as well as numbers of species and individuals of fishes and mobile invertebrates within each trap were recorded. However, actual soak time and final catch for all traps observed were unknown. Data for all surface-observed trap buoys and diver-inspected traps were entered into a Geographic Information System (GIS) and overlaid on benthic habitat maps (Kendall e*t al.* 2001) using ArcGIS 9.0 Software.

RESULTS

Throughout the study, 1438 trap buoys were surveyed by boat. Most (40%) were encountered over colonized hardbottom dominated by octocorals (soft corals), although trap buoys were also frequently observed over algal sand (29%) and mud habitats (19%; Table 1). Most surveyed traps were in 12 - 18 m waters, a depth range characterized by colonized hardbottom habitat. However, a large component of traps was also found in the deeper algal plain (21 - 24 m) located in the western portion of the study area (Table 1).

A total of 161 traps were inspected by divers for construction, habitat, and contents (Table 1). Diver-inspected traps were predominantly arrowhead-style traps composed of 5-cm hexagonal vinyl-coated wire mesh and either wood (40%) or steel-rebar (29%) frames. Most inspected traps (63%) were in colonized hardbottom habitats at 12 - 18 m depths (Figure 1). Although fewer traps were examined in other habitats, their frequency of observation was similar in proportion to their relative abundance in all surveyed traps.

Table 1. Numbers of surface-surveyed and diver-inspected traps and mean (+SE) numbers of individuals and species per inspected trap of observed fishes and invertebrates by habitat and depth class off La Parguera, Puerto Rico, 2002-2006.

			Fishes per trap		Invertebrates per trap	
Habitat	**Surveyed Traps**	**Inspected Traps**	**Individuals**	**Species**	**Individuals**	**Species**
Hard Coral	73	15	1.07 (0.34)	0.87 (0.27)	0.47 (0.24)	0.33 (0.16)
Soft Coral	578	102	2.44 (0.39)	1.28 (0.16)	0.43 (0.11)	0.21 (0.04)
Algal Sand	414	22	0.77 (0.34)	0.59 (0.20)	0.73 (0.23)	0.41 (0.13)
Mud	278	12	1.50 (0.56)	0.83 (0.27)	0.25 (0.13)	0.25 (0.13)
Sand	59	7	0.43 (0.30)	0.43 (0.30)	1.86 (0.99)	0.71 (0.36)
Seagrass	36	3	1.00 (1.00)	1.00 (1.00)	0.67 (0.67)	0.33 (0.33)
All Habitats	**1438**	**161**	1.90 (0.26)	1.07 (0.11)	0.53 (0.09)	0.27 (0.04)
Depth (m)						
0 - 3	6	0	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3 - 6	4	1	18.00 (------)	6.00 (------)	0.00 (0.00)	0.00 (0.00)
6 - 9	2	0	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
9 - 12	38	8	4.13 (1.83)	2.13 (0.67)	0.38 (0.26)	0.38 (0.67)
12 - 15	204	29	2.34 (0.68)	1.41 (0.33)	0.83 (0.28)	0.34 (0.33)
15 - 18	434	75	1.68 (0.34)	0.95 (0.14)	0.40 (0.13)	0.21 (0.14)
18 - 21	275	25	1.64 (0.48)	1.04 (0.25)	0.40 (0.25)	0.24 (0.25)
21 - 24	165	14	1.36 (0.64)	0.79 (0.30)	0.71 (0.32)	0.29 (0.30)
24 - 27	243	8	0.13 (0.13)	0.13 (0.13)	1.00 (0.33)	0.63 (0.13)
27 - 30	54	1	0.00 (------)	0.00 (------)	0.00 (------)	0.00 (------)
>30	13	0	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)

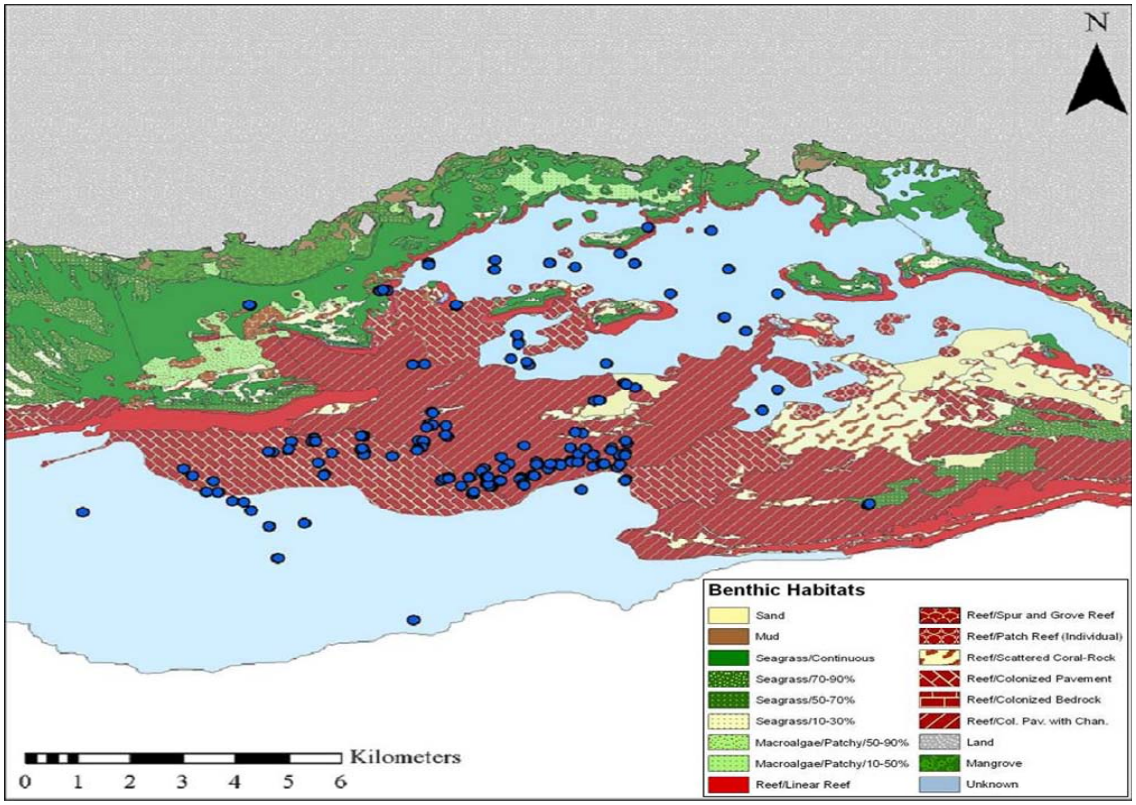

Figure 1. Map of all diver-inspected traps along the insular platform of La Parguera, Puerto Rico, 2002-2006

Only 61% of inspected traps contained mobile organisms at the time of observation. Of the total number of organisms observed in traps (n = 391), fishes represented 78% and comprised 44 species. Butterflyfishes (Chaetodontidae, 3 spp), grunts (Haemulidae, 6 spp), surgeonfishes (Acanthuridae, 3 spp), trunkfishes (Ostraciidae, 5 spp), and parrotfishes (Scaridae, 5 spp) were the most frequently observed families. Banded butterflyfish, *Chaetodon striatus* (n = 34), foureye butterflyfish, *Chaetodon capistratus* (n = 32), white grunt, *Haemulon plumieri* (n = 27), and ocean surgeonfish, *Acanthurus bahianus* (n = 20) were the most frequently observed fish species. Out of all traps observed, *C. capistratus* was found in 11% (n = 17), making it the fish species observed in the highest number of traps. Snappers and groupers composed only 7% of all observed fishes, of which the schoolmaster, *Lutjanus apodus* (n = 11), was most frequent. Four species of invertebrates comprised 22% of all organisms observed in traps. Caribbean spiny lobster, *P. argus,* was the most numerous of all invertebrates (85%, n = 73), the most numeous of all trapped organisms (20%), and the most frequently observed organism (22% of all inspected traps).

Mean number of fishes per inspected trap (Table 1) was highest within colonized hardbottom (2.44 +/- 0.39 SE), mud (1.50 +/- 0.56 SE), and hard coral (1.07 +/- 0.34 SE) habitats, with mean number of fish species per inspected trap highest within colonized hardbottom habitat (1.28 +/- 0.16 SE). Mean number of invertebrates per inspected trap was highest within sand (1.86 +/- 0.99 SE) and algal sand (0.73 +/- 0.23 SE) habitats, while mean number of invertebrate species per inspected trap was highest within sand habitat (0.71 +/- 0.36 SE). Throughout the insular platform, mean number of fishes per inspected trap was highest within shallow to moderate depths, with highest incidence within one inspected trap (18 individuals; 3-6 m depth), and higher incidence within 9 - 12 m (4.13 +/- 1.83 SE) and 12 - 15 m (2.34 +/- 0.68 SE) depths. Similar trends were observed for mean number of fish species per depth range. Mean number of invertebrates per inspected trap was highest within the 24 - 27 m (1.00 +/- 0.33 SE), 12 - 15 m (0.83 +/- 0.28 SE), and 21 - 24 m (0.71 +/- 0.32 SE) depth ranges, with mean number of invertebrate species highest within deeper platform regions (0.63 +/- 0.13 SE; 24 - 27 m).

Although fishes in general were more frequently observed within colonized hardbottom areas (81%, n=316), they were dominated by second- and third-class herbivores (butterflyfishes, surgeonfishes, parrotfishes; Figure 2). However, grunts and trunkfishes were also encountered in moderate abundance. Only 5% (n = 16) of all fishes observed were within hard coral reef habitat, of which parrotfishes (n = 6) and butterflyfishes (n = 4) were most frequently encountered. Fishes observed in traps set within low relief algal sand and mud habitats, although lower in number, were predominantly trunkfishes (34%, n = 14) and grunts (27%, n = 11). Relative abundance of grunts and trunkfishes was higher in habitats of lower relief when compared to other habitat types. In less structured habitats, *P. argus* was the most frequently observed entrapped species (32%, n = 24) and individuals were more frequently encountered in algal sand (58%) than mud (8%). The majority of all lobsters (60%) were observed in traps within colonized hardbottom, while only 6.8% (n = 5) were found in coral reef habitat.

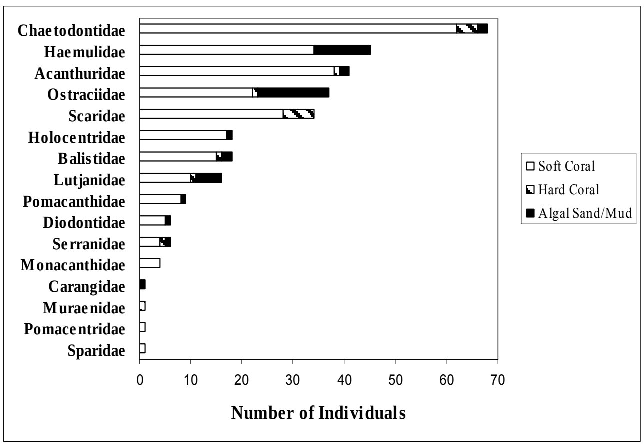

Figure 2. Fish families observed within traps in high relief (hard coral), medium relief (soft coral), and low relief (algal sand or mud) habitat types.

DISCUSSION

The majority of traps surveyed by boat and inspected by divers were found within colonized hardbottom habitats of intermediate depth (12 - 18 meters). A large number of traps were also surveyed within deeper algal sand. The greater depths of traps in algal sand often limited effective dive observations during sampling days. Valdez-Pizzini *et al.* (1997) and Jean-Baptiste (1999) have identified the deeper algal sand habitats along the western part of La Parguera as areas of significant trapping activity.

Appeldoorn *et al.* (2000) recorded most traps in sand habitats, but they found 44% of all traps observed within reef or colonized hardbottom habitats. Jean-Baptiste (1999) identified 43.4% (n = 181) of all surveyed traps within "consolidated carbonate", or reef and hardbottom, while Schärer *et al.* (2004) found that interviewed trap fishermen listed this habitat as the most preferred. Similarly, our study found 45% of all surveyed traps to be within colonized hardbottom dominated by soft coral or reef, reinforcing the continued importance of this habitat to the La Parguera trap fishery. Within our study, only 29% of all observed traps were surveyed in algal sand. According to Jean-Baptiste (1999), algal sand is the most frequently targeted habitat along the southwest coast. Appeldoorn *et al.* (2000) surveyed only 9% of traps within algal sand. However, the range of the sampling areas of these previous studies were either wider (Valdez-Pizzini *et al.* 1997, Jean-Baptiste 1999) or narrower (Appeldoorn *et al.* 2000) than our sampling range. Regardless, significant trap effort along the deeper algal plain has continued. Mapped distributions of diver-inspected traps mirrored those distributions of all three previous studies, with traps most frequently located in deeper areas beyond inshore and mid-shelf emergent reefs at increased westward concentrations.

Although traps were historically fished within shallow nearshore areas, movement offshore and away from reefs has been observed as a result of lower numbers of commercially valuable species and habitat degradation (Scharer *et al.* 2004). Similar movements into deeper habitats of lower topographic relief have been observed in the U.S. Virgin Islands, where traps were most frequently found in deeper algal sand areas and offshore octocoral hardbottom (Garrison *et al.* 1998, 2004). These shifts were correlated with the same factors listed for the Puerto Rican fishery.

While landings from trap catches have decreased over time (Matos-Caraballo *et al.* 2005), reef fishes still make up the majority of trap landings as indicated by our study where fishes comprised 78% of all individuals observed in traps. However, the dominance of herbivores within coralline habitats, and paucity of snappers and groupers, suggests that incidence of first-class species within trap landings remains low (Matos-Caraballo *et al.* 2005). Studies have shown first-class species to be highly susceptible to overexploitation in trap fisheries (Wolff *et al.* 1999). Previous studies throughout the Caribbean have demonstrated a shift from historically higher catches of piscivores to increased catches of herbivores within traps set in coralline habitats (Ferry and Kohler 1987, Recksiek *et al.* 1991, Beliaeff *et al.* 1992, Acosta *et al.* 1994, Beets 1997, Garrison *et al.* 1998, 2004). This study strongly suggests that recovery of first-class fish species in southwest Puerto Rico still has yet to occur and that little change from previous observations has been made.

Data on fish abundance by habitat were similar to those of Garrison *et al.* (2004). Our data parallel their findings that some commercially important fish families (Haemulidae, Ostraciidae, Lutjanidae) are contributing notable catches in less structurally complex areas. However, increased observations within these habitats are warranted. Previous studies have demonstrated catch per unit effort in traps is negatively correlated with habitat complexity (Wolff *et al.* 1999, Robichaud *et al.* 2000). Decreases in commercial landings by traps for the most frequently observed invertebrate species and *P. argus*, have been observed in Puerto Rico (Matos-Caraballo *et al.* 2005). Although SCUBA and nets are now contributing higher proportions of landings than in previous years, Caribbean spiny lobster remains the most frequently captured single species within traps, mostly within colonized hardbottoms, but also within deeper algal plains. Appeldoorn *et al.* (2000) also reported spiny lobster as the most frequently observed species in traps.

For at least the past 40 years, trap fishing in La Parguera has consistently occurred within offshore habitats of lower complexity, primarily in colonized hardbottom and algal sand habitats. However, the potential for habitat damage from trap use in colonized hardbottom habitats is relatively high. Little topographic relief is available to protect sessile invertebrates from the weight of traps. Although these regions are interspersed with non-structured sand channels, variation in water clarity and unknown habitat delineations can result in traps being placed directly on structured habitat types. Fortunately, preliminary results (Marshak *et al.* Unpubl. data) seem to indicate that while most damage occurs to octocorals, they have been observed to heal readily (< 100 days) following simple abrasion damage from traps. As well, Uhrin *et al.* (2005) observed that lobster traps left for the typical 1-3 wk fishing period may have only short term effects but cause no long term damage or loss of seagrasses.

If traps cause habitat degradation and exacerbate detrimental population effects of intense fishing pressure on finfish and shellfish communities, the future for Caribbean fisheries could be bleak. However, if fishing effort could be effectively redirected to areas of low potential habitat damage, there may be benefits to both fishers and the ecosystem. Our data, together with those of Garrison *et al.* (2004), suggest that deployment of traps only in areas of very low damage potential could be lucrative for fishers. Catch per unit effort of first-class fishes and spiny lobster are higher when traps are placed away from structurally complex reefs, and our study found relatively high mean numbers of fishes and invertebrates per inspected trap within algal sand, mud, and sand habitats. Targeting of algal plains, mud, and sand would maintain reef structure. While hardbottom habitats offer areas of moderate structure where catches are favorable, the potential for damage is higher than in vegetated or non-structured habitats. Economic models may demonstrate that greatest economic benefit could be achieved by moving traps away from reefs and fishing less structurally complex habitats.

Our data show that fishers have already moved high proportions of their traps into these less complex areas. Recently observed decreases in trap densities within colonized hardbottom and algal plains throughout the period of our study (Marshak Unpubl. data) suggest that trap use in La Parguera is being phased out due to construction and recovery costs overriding catch value. Increased observations of buoyed gill nets within these habitats, and comments by fishermen (Marcos Rosado, University of Puerto Rico Department of Marine Sciences, personal communication) support this assertion. However, unregulated gill netting within these offshore habitats will impose even greater fishing pressure. Increased by-catch associated with higher use of less selective gear (Acosta 1994) could lead to further depletion of fish communities in La Parguera. A more favorable economic and ecological strategy would be to move traps away from reefs and to decrease fishing intensity in colonized hardbottoms. This would benefit fishers and the ecosystem through increased catch of higher-class species and minimized damage to the coral reef ecosystem. Such a strategy would be preferable to shifts to even less selective gear types.

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