

# **The Use of Fish Traps in Puerto Rico: Current Practice, Long-term Changes, and Fishers' Perceptions**

MICHELLE T. SCHÄRER<sup>1</sup>, MARTHA C. PRADA<sup>1</sup>, RICHARD S. APPELDOORN<sup>1</sup>, RON HILL<sup>2</sup>, PETE SHERIDAN<sup>2</sup>,  
and MANUEL VALDÉS-PIZZINI<sup>3</sup>

*<sup>1</sup>Department of Marine Science  
University of Puerto Rico  
Mayagüez, Puerto Rico 00681*

*<sup>2</sup>National Marine Fisheries Service, NOAA  
Galveston, Texas 77551 USA*

*<sup>3</sup>Center of Applied Social Research  
University of Puerto Rico  
Mayagüez, Puerto Rico 00681*

## **ABSTRACT**

Traps are used extensively by artisanal fishers in the Caribbean for catching fishes and crustaceans in diverse habitats. An interdisciplinary study incorporating fisher knowledge and quantitative field surveys was employed to study current trap fishing practices in Puerto Rico in order to provide up to date information to managers and researchers. Here, we report on trap fishing methods today and fishers' perception of current trends and some problems affecting the resource of Puerto Rico. Forty-seven trap fishers representing 5 regions (North, South, East, West, and Islands) were interviewed on site about gear construction, effort, habitat preferences and fishers' perceptions of the main problems in the fishery and their possible solutions. Materials used in fish trap construction have been changing, over time; however, the main routine for setting traps remains generally the same with some localized variations. Despite its traditional dominance, more than half of fishers have reduced their number of traps; therefore individual effort seems to be declining. Coral reefs were not reported as a preferred fish trap location, but rather areas adjacent to reefs (sand, seagrass, hard-bottom, and algal habitats) are targeted. The main problems reported by fishers in Puerto Rico are trap loss and habitat degradation, problems that correspond to increasing coastal development. Additionally, conflicts among users have promoted the use of unbuoyed traps, which in turn may lead to an increase in ghost fishing impacts. Ghost traps are known to continue fishing long after they are lost and may be causing undetermined effects on fishing grounds. Suggestions to alleviate some problems include enforcement of environmental regulations and zoning schemes.

**KEY WORDS:** Fish traps, Artisanal fishery, Puerto Rico

## **La Pesca de Nasas en Puerto Rico: Situación Actual, Cambios a Largo Plazo y la Percepción de los Pescadores**

Las nasas son utilizadas en la mayoría de las islas del Caribe para la captura de peces y crustáceos en diversos hábitats, por lo que tienen un impacto sobre la dinámica natural del hábitat y de las poblaciones pescadas. En un enfoque interdisciplinario describimos la metodología de la pesca de nasas actual en Puerto Rico y la percepción de los pescadores sobre los cambios y problemas en la pesquería. Cuarenta y siete pescadores de 5 regiones (norte, sur, este, oeste e islas) fueron entrevistados in situ. El propósito de la encuesta era describir el método de construcción de las nasas, el tipo de esfuerzo, preferencias de hábitat y la percepción de los pescadores sobre los principales problemas de la pesquería y sus posibles soluciones. Los resultados indican que el material utilizado en las nasas ha cambiado aunque la manera en que se utilizan se ha mantenido igual con algunas variaciones por localidad. A pesar de ser el arte de pesca tradicional de Puerto Rico, más de la mitad de los dueños de nasas han reducido el número de trampas, y por ende, el esfuerzo. Los arrecifes de coral no son la localidad preferida para pescar con nasas, pero si las áreas adyacentes a éstos (rastreales, yerbazales, fondos de algas y gorgonios). Los mayores problemas que afectan a los pescadores de nasas en Puerto Rico son: el robo de artes de pesca, la pérdida de boyas y la degradación ambiental, entre otros. Estos problemas están correlacionados al aumento en el esfuerzo pesquero por parte de los buzos, el aumento en el número de embarcaciones recreativas en áreas pesqueras y el desarrollo costero. El aumento desregulado de embarcaciones en las áreas de pesca ha causado el uso de nasas 'ahogadas' (sin boyas), lo que ha provocado un aumento en la pérdida del arte. Las nasas perdidas tienen un efecto en los hábitats y debe considerarse en las regulaciones de manejo de pesquerías. Algunas sugerencias para aliviar estos problemas incluyen vigilancia en el mar y zonificación de aguas costeras.

**PALABRAS CLAVES:** Las nasas, situación actual, percepción

### **INTRODUCTION**

Throughout the twentieth century traps were the most important gear (Jarvis 1932, Abgrall 1975). Traps are reported as one of the most common fishing methods since the 19<sup>th</sup> century (Torres 1969), and are presently considered one of the dominant fishing methods in Puerto Rico, responsible for 22 % of the overall catch in 2001 (Matos-Caraballo pers. comm.). It is estimated that 15,481 traps were being used during 1995-1996, a 13 % increase from the 1988 report of the Puerto Rico Fishery Census (Matos-Caraballo 1997). Nonetheless, the number of traps used today seems to be declining and the average number of traps per fisher has decreased due to competition with trammel and gill nets, and the increasing number of divers (Griffith and Valdés-Pizzini 2002).

Given this historical pressure on reef-fish stocks, and the dynamics of habitats they depend on, it is necessary to understand the details of this fishing practice to be able to determine appropriate management actions. Interest in habitat effects by fishing gear has increased recently and the role of fish traps impacting essential fish habitats such as coral reefs needs to be understood. The purpose of this study was to investigate the current practices of artisanal trap fishers of Puerto Rico in order to better assess both the differences in fishing methods and analyze fishers' perspectives. By understanding the intricacies of this fishery within and between landing sites, the problems that fishers and managers confront are revealed. This information provides a basis for the development of an integrated management scheme in which the information provided by fishers may lead to their inclusion in future management decisions.

## METHODOLOGY

### Study Site

Research was conducted within the Puerto Rican archipelago, including the main island (18° N; 67° W) and two inhabited satellite islands, Vieques and Culebra located 19 and 40 km, respectively, to the east of Puerto Rico. Two interviewers visited 13 coastal sites in a stratified sampling scheme during spring of 2002. The study area was divided into five regions; North (Barceloneta, Vega Baja and Arecibo), South (Juana Diaz, Salinas and Guayama), East (Fajardo, Naguabo and Humacao), West (Lajas, North and South Cabo Rojo), and the islands (North and South Vieques and Culebra). Two municipalities, Cabo Rojo and Vieques were subdivided into North and South sites due to the great extent of the platform and the increased number of trap fishers in these regions. Lajas was grouped with the west region rather than south, due to its southwestern location.

### Methods

Verbal interviews were conducted on site with at least three trap fishers (if available) per site, usually at the dock or residence (Table 1). The survey instrument was composed of twenty-four items inquiring about the following issues: target species, fishing grounds, habitat and depth, seasonal trap movement, number of traps per fisher, trends in number of traps per fisher, trap construction materials, layout of traps, use of floats, habitat preferences, soak time, retrieval mechanism, methods to find lost traps, similarity of other fishers methods, and fishers' perceptions of the main problems in the fishery and their possible solutions. All responses were incorporated as given by the fishers.

Table 1. Number of interviews per site in five regions of Puerto Rico.

Region	Site	# Fishers
North	Arecibo	3
	Barceloneta	4
	Vega Baja	2
South	Juana Diaz	4
	Guayama	3
	Satinas	3
East	Ceiba	4
	Naguabo	3
	Humacao	3
West	N. Cabo Rojo	3
	S. Cabo Rojo	3
	Lajas	3
Isles	N. Vieques	3
	S. Vieques	4
	Culebra	2
5	15	47

## RESULTS

### Target Species

Seventy-seven per cent of fishers targeted both reef fish and lobster, 13 % targeted finfish species alone and 10 % targeted only lobsters. The main target species include the Caribbean spiny lobster (*Panulirus argus*), groupers (*Epinephelus* spp.), shallow and deep-water snappers (*Lutjanus* spp.), trunk and box fish (*Lactophrys* spp.), grunts (*Haemulon* spp.), goatfishes (*Mulloidichthys* spp.), triggerfishes (*Balistes* spp.) and parrotfishes (*Sparisoma* spp. and *Scarus* spp.). Additionally spider crabs (*Mythrax spinosissimus*), octopus and conch (*Strombus gigas*) are occasionally captured in fish traps. Traps varied in size, shape and materials depending on the target species. Wooden pots ("cajones") are used mostly for lobster while wire mesh traps ("nasas") are used for fish and lobsters. Many fishers didn't identify a single target species due to the high species richness found in reef-fish communities.

### Fishing Grounds

Fishing grounds are located 1 to 40 km off shore depending on the extent of insular platform available and the fisher's boat or motor size. Traditional knowledge coupled with landmarks was the most common method used to locate fishing sites.

Only one fisher reported the use of GPS (Global Positioning System). Not all of a fisher's traps are located together; groups of traps may be several km apart and are tended on alternate days.

Traps are set from 9 to 181 m depth, with an average between 40 – 62 m. Mean depths at which traps are set vary in response to the characteristics of the insular platform. North coast fishers distribute traps in the deepest range (72-130 m), while southern fishers ranged between 40 and 51 m, the rest exploit slightly shallower depths ranging from 29-49 m.

Half the fishers interviewed moved traps in relation to a given season of the year. The main reasons given for moving traps seasonally were related to sea conditions, including weather related swells, hurricanes, currents and winds. The second most important reason was related to fish or lobster movements either during migrations or aggregations of target species.

### Habitat Utilization

Coral reefs were not reported as the preferred habitat for trap setting. However, fishers do target habitats associated with reefs (sand, seagrass, hard-bottom, and algal habitats). Overall, 38 % of fishers selected the "rastreal" as the preferred habitat. Rastreal is the local name given to a hard bottom of low to medium relief, which may be colonized by gorgonians, algae, sponges, and isolated coral colonies. Categories reported by the fishers include vegetation, sargassum, sand, rocks, and others depicted in Figure 1. At greater depths fishers are not able to determine a habitat and the category 'unknown' may be impacting habitats that are important for deeper water species.

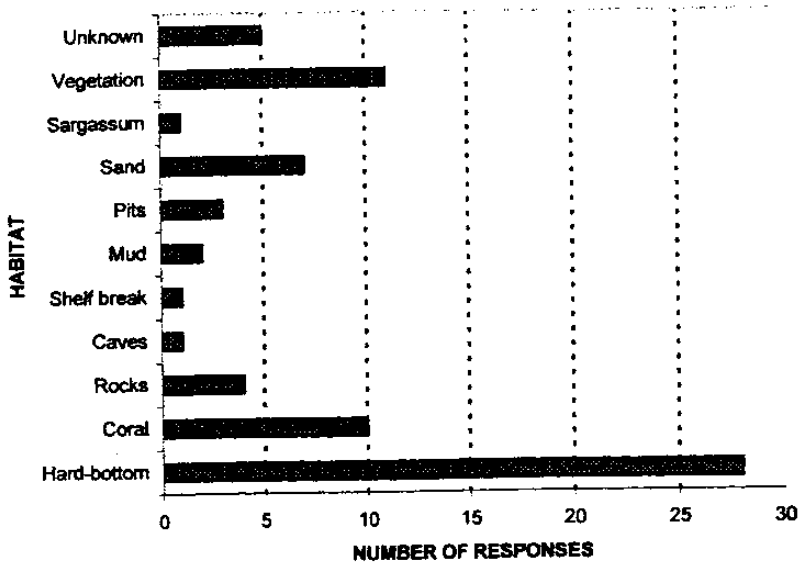


Figure 1. Preferred habitats for trap placement in Puerto Rico

### Number of traps

The number of traps and pots per fisher ranged from 10 to 300 and averaged 67 units overall, although regional variation was observed. On average fishers on the southern coast own the greatest number of traps (106), followed by westerners (77), islanders (69), easterners (58), and the northern fishers (26). Island wide, 55 % of fishers interviewed have experienced a decline in the total number of traps they own, 13 % have increased the number of traps and 30 % have maintained a constant number.

### Trap Characterization

Most fish traps in Puerto Rico are constructed by the fisher himself or a local trap builder. Trap framework is most commonly made with steel (60 %), followed by wood (34 %), and plastic (6 %), or combinations of these materials. Most traps are steel rebar (generally used for construction) that is cut and welded to the fishers' specifications. Traditionally red mangrove, *Rhizophora mangle*, wood was most common, although substitute woods are also used. Fishers must request a special permit to the Department of Natural and Environmental Resources to extract mangrove wood for fishing activities.

All shapes were reported (arrowhead, "Z", and square). Traps are usually covered by chicken wire or similar mesh ranging from 2.2 to 5 cm diameter, which may be bare wire (galvanized) or plastic covered wire ("engomado"). Many fishers reported the use of 5 cm hexagonal mesh. Federal regulations limit the minimum mesh size at 5 cm hexagonal or 3.75 cm square. Bare wire lasts approximately 1 year underwater and plastic covered wire lasts twice as long.

Trap dimensions range from 80 to 240 cm (mean=125 cm) length by 45 to 150 cm (mean = 103 cm) width and 32.5 to 60 cm (mean=43 cm) height. The most common iron rebar trap used in Puerto Rico measures 120 cm long by 90 cm wide and 45 cm high. Larger traps may reach 180 cm by 120 cm by 45 cm and are usually made of rebar. Smaller traps are often 90 cm by 90 cm by 40 cm and made of wood frames weighted with rocks. Plastic framed traps were reported on the East coast, and are made of food trays or sliced PVC pipes. Larger metal frame traps are used for deeper water while smaller wooden, metal, and plastic traps are used in shallower areas. Not all fishers bait their fish traps, although some reported leaving by-catch species inside the trap.

Lobster pots are usually smaller (60 x 60 x 120 cm) than fish traps and made of wooden slats of precut pine or spruce (imported from U.S.) placed in parallel and may contain wire mesh inside. Pots are weighted with cement or rocks to be kept upright while setting, and are generally baited with animal bones or hide. This gear is used by a few fishers of each region and is generally less abundant than fish traps.

### Trap Setting

Single trap layouts were reported by 53 % of fishers, where each trap is set with a single line and a series of buoys or floats below and at the surface. A total of 22

fishers (47 %) use series (strings) of 2 to 3 traps per line (range from 2 to 6, mean = 3.2). Of those, 68 % reported using buoys at both ends of each string, while the remaining 32 % do not use buoys, a method locally known as "ahogado" or drowned traps. Usually, 36-m to 99-m (equal to or greater than water depth) polypropylene lines connects the traps in series underwater.

Regional patterns can be observed between the use of single and series of traps. There is a predominant use of single traps on the West (100 %) and North (78 %) coasts, while most fishers on the South (70 %) and East (80 %) coast use series of traps. In the islands both methods were used extensively: 44 % single and 56 % in series. Three fishers from the South, three from the East and one from the islands reported the use of drowned traps in series.

### **Soak time**

Traps are tended at 2 to 9-day intervals (mean = 5). Soak time varies due to weather, target species (fish die quickly, lobster survive longer) or catch rate. It was reported that if the catch in that particular area or season were poor, they would extend soak time. The most common reason for extending the soak time beyond the average is the inability of the fisher to reach the trap due to unfavorable weather conditions.

### **Haul Mechanism**

Sixty-eight per cent of trap fishers reported the use of a winch or other mechanized apparatus to haul traps; otherwise it is done by hand. More than half of the fishers (68 %) reported small-scale trap movement after hauling. Traps are lifted vertically from the sea floor as the boat is positioned up current for retrieval. In the case of series of traps, each trap is hauled vertically and not dragged along the bottom. Fishers mentioned that it is counterproductive to drag a trap along the seafloor as it can get caught, damaged or lost if it catches onto coral or rock.

### **Lost Gear**

Twenty-four per cent of fishers admitted they abandon traps not found. The most common way of searching for those missing traps is with a grapple hook (34 %), followed by diving (32 %) or circling ropes around the area that the trap was set. If waters are clear, occasionally they can see the line or trap from the surface and attempt to hook it.

### **Fishers' Perceptions**

The main problems reported by fishers in Puerto Rico are gear loss (due to theft or unintentional cutting of buoys), catch theft (surface or underwater), habitat degradation (habitat destruction, water pollution, sedimentation, eutrophication, etc.), overfishing and conflicts over space. The most common cause of the fisheries problems is attributed to trap loss, by intentional or unintentional means. Commercial and recreational divers remove the catch from the trap or cut the buoy line underwater. Another common problem is cutting of buoys by vessels (tugboats,

recreational, and commercial). Storms were reported as another cause of gear loss and strong currents may deflate or shrink buoys by submersion as these become fouled with epibiota. The economic costs of lost gear and the lack of government assistance were also mentioned as problems.

Environmental degradation of mangrove and seagrass habitats has reduced nursery habitats of inshore areas and this in turn has reduced catches in traps. Overfishing and illegal forms of fishing (undersized or gravid lobsters) were also mentioned as a problem. Other factors included the health issues affecting fishers, the lack of enforcement and overregulation applied to some local fishers. Additionally, the increased numbers of recreational vessels and trap loss or catch theft in fishing areas have promoted the use of unbuoyed traps.

Possible solutions to these problems were predominantly the improvement of management and enforcement actions. Some fishers suggested zoning schemes, such as designated fishing areas or marked vessel traffic lanes, to help alleviate these problems. A generalized increase in respect or awareness toward the fishers would help reduce trap loss, or perhaps government assistance would alleviate the economic hardship. Negative habitat effects of other activities (industrial, commercial, military, sewage, etc.) need to be addressed and fishers would like to see the enforcement of environmental laws and regulations.

## DISCUSSION

### Target Species

Overfishing may be influencing the catch composition in this fishery as many fishers are not targeting species rather than catching whatever is available. The catch of less "primera" (first class species such as groupers and snappers) and more "segunda" (second class fishes such as parrotfish, goatfish, triggerfish and grunts) is associated with changes in species composition in the Caribbean. More herbivorous fishes and other second-class species are being captured and marketed locally in response to these changes. Nassau grouper (*Epinephelus striatus*) were caught in all shallow habitats in fish traps 50 years ago, but are very rarely captured today (Oscar Lugo pers. comm.). A similar change in catch composition was observed in the USVI (Garrison et al. 1998).

### Fishing Grounds

Historically, fishing grounds were located in shallow inshore areas close to land. Modernization and government support allowed many fishers to exploit fishing grounds further offshore with the acquisition of motorboats (distance) and mechanized hauling equipment (depth). More recently, fishers have moved further offshore due to diminishing stocks and habitat degradation (pollution, sedimentation, eutrophication, sewer outfalls, etc.) in shallower coastal areas.

Fishing grounds and trap positions were found to vary in relation to catch or species aggregations by Jean-Baptiste (1999). Valdés-Pizzini et al. (1997) described



seasonal movements dictated by weather (hurricane season), searching for productive fishing grounds, and conflict avoidance at the southwestern coast of La Parguera. Both studies conclude that there is territoriality at sea, in which each fisher is utilizing a specific area that is avoided by others. Small-scale (<25 m) movement of traps seems to be associated to physical conditions such as wind and currents during tending. Swells, storms, and strong windy seasons may cause fishers to move traps closer to shore due to the difficulty of reaching deeper areas in small (<10 m) boats.

### Habitat Utilization

Fishers are exploiting coral reef associated habitats, although the reef itself is not targeted in most cases. Fishers seem to be targeting low relief hard bottom habitats where the trap will attract and not compete with the vertical relief of coral patches or rocks. Some fishers explained that traps set on coral are not very effective as the fish have other refuges available and will not enter the trap. They also do not want to risk entangling in rocky coral habitats where gear can be damaged or lost. Jean-Baptiste (1999) identified sandy algal plains as the most frequently exploited habitat in La Parguera, Puerto Rico. A study by Appeldoorn et al. (2000) demonstrated that most of the traps are on reef associated habitats, but not coral, and those considered in coral reef habitat were on sand 30 % of the time. Comparably, over half of the traps surveyed by SCUBA in St. John USVI were set in algal plain or gorgonian hard bottom habitats (Garrison et al. 1998). Scaling effects are very important in the determinations of habitat utilization by fish traps.

### Number of Traps

A century ago a single fisher utilized 6-12 traps per boat (Wilcox, 1900) and that was enough for significant catches. In 1930, Jarvis (1932) estimated a total of 4,239 traps and more recent estimates lie above 11,000. Despite the historical increase in the number of traps per fisher, this survey indicates declining trends in which many fishers have reduced the number of traps owned or are retiring completely from the fishery. This result is supported by data from the Puerto Rico commercial fishery statistics program (Matos-Caraballo pers. comm.).

Trap loss seems to be the principal reason for the decline in number of traps, and those that reported an increase in the number of traps are trying to compensate for gear loss to maintain a constant number of traps. Increase in costs (between \$100 and \$150) of traps has also influenced the reduction in numbers of traps per fisher.

### Trap Characterization

Caribbean arrowhead is the most common form used in Puerto Rico historically (Abgrall 1975). In the past most fish traps were constructed of mangrove (*Rhizophora mangle*) wood, with organic fibers (palm, cane, calabash) woven to construct mesh and ropes and bamboo used as floats (Wilcox 1900). Galvanized wire or plastic covered chicken (hexagonal) wire was in common use by the 1960s (Suarez-Caabro 1969). Modern traps are required by federal regulation to have a

biodegradable panel that releases catch of lost traps, but not all fishers comply with this regulation. They believe that larger fish, corrosion, and impact with rocks due to swells will open the trap and few fish will be killed. In the past this was less significant due to the organic nature of trap materials that decomposed quickly underwater. The use of synthetic materials may increase the ghost fishing effect of lost gear.

Metal traps are heavier and seem less susceptible to movement on the bottom than wooden or plastic traps. Lighter wood or plastic traps have a greater potential to cause benthic habitat damage (collision, abrasion) due to swells in shallow areas. Pots seem to be more vulnerable to sea swells than traps, perhaps due to the smaller size and lighter construction materials. These could potentially cause more habitat damage in shallower areas subject to swells and currents.

### Trap Setting

Historically, series of traps were set in clear, shallow habitats where they could be located visually and retrieved with grapple hooks. The main reason for not using buoys on trap series today is due to theft. Deteriorating water quality in coastal regions of Puerto Rico makes finding unbuoyed traps more difficult. To locate unbuoyed series of traps, fishers drag a small grapple hook on the seafloor at slow speeds until it catches on the trap line that usually floats a bit from the surface. In order to do this, they prefer areas with little or no bottom relief where the grapple can become entangled.

### Soak time

Soak times today (5 days) are generally longer than historical reports (1 day), although this varies depending on the target species. Presumably, the effects of overfishing have increased the soak time for traps as many fishers reported that if capture rates are low, they extend soak time. During mutton snapper (*Lutjanus analis*) aggregation season, they will check traps more frequently as these fish die quickly. Climatic events will extend soak time in some cases due to dangerous seas for the small (<10 m) open craft vessels trap fishers use in Puerto Rico.

### Haul Mechanism

Presently, most fishers are assisted by a mechanized winch to haul traps to the surface. With this equipment fishers have been able to exploit deeper regions of the platform (Abgrall 1974) and a larger number of traps per fishing unit (boat, fisher and crew). Nonetheless a few still haul traps by hand and are prone to show associated health conditions such as hernia and back problems.

### Lost gear

The use of grappling hooks for gear recovery potentially damages benthic habitat as this action may dislodge smaller colonies of coral, octocoral, sponge, vegetation etc., which are important components of essential fish habitat. Gorgonian and vegetation hard bottom habitats may be impacted although the scars produced

by this mechanism are shallower and thinner than boating scars, for example. The effects of grappling hooks pulled by fishers should be assessed in diverse habitats in order to quantify the relative damage by trying to recover lost traps.

### **Fishers' Perceptions**

The perceptions reported in this study appear to be a constant concern of local fishers, as reported in other studies (Griffith and Valdés-Pizzini 2002). Habitat damage by industrial pollution, sewage discharge, and military practices are considered a threat to trap fishing. These activities are reportedly affecting coastal habitats and have contributed to the decline of fish stocks (Martínez and Valdés-Pizzini 1997). The stealing of other fisher's trap contents is not new to fishing in the Caribbean. Leaving gear unattended has been a cause for the conflict since colonial times (Torres 1969). More recently traps have buoy lines intentionally cut and may be tended underwater by divers with the aid of SCUBA. In some cases, fishers will retrieve empty traps with doors wide open. In some cases this has promoted the use of plastic ties on trap doors so that the fisher will know if their traps were tampered with. This may increase the 'ghost' fishing effect if the biodegradable panel is sealed shut. Ghost traps are known to continue fishing long after they are lost (Bullimore et al. 2001) and may be causing significant impacts that needs to be considered.

In relation to the main problem of trap and catch loss there is much enforcement required at sea. Local agencies are not equipped to provide this enforcement and co-management by fishers associations may be a solution to these problems. In some cases, fishers have taken the matter into their own hands, which has lead to violent and destructive actions.

Loss of gear caused by propellers cutting lines is very common in Puerto Rico. Increasing numbers of recreational and industrial vessels have been a problem since the 1970s (Abgrall 1974). In the past it was the southern and eastern coasts that were more affected by industrial development and increased maritime traffic (thermoelectric plants, oil refineries, military practices, etc.). Today trap fishers from all regions of the island are losing buoys due to increased commercial (ferries, freight, tugs) and recreational (charters, private, diving) maritime traffic. This conflict may also cause increased 'ghost' fishing in specific areas. Some suggestions to alleviate these problems include enforcement at sea and zoning schemes.

An increasingly common problem affecting natural resources island wide is the decreasing quality of the marine environment. The destruction of benthic habitats and water pollution are considered serious threats to the fishery. Mangroves are removed and wetlands filled to construct industrial, commercial and residential projects that respond to increasing populations of the islands. Damage to marine habitats includes dredging, sewage outfalls, chemical spills, military activities, and groundings among others. Many nursery and essential habitats critical for species in the marine ecosystem have been eliminated and fishers claim for environmental justice. Most fishers believe that large polluters should be regulated and enforced or fined in proportion to the damage they have caused to the environment. Several fishers recommended that results of water quality monitoring in estuarine and coastal

areas should be made available to the public on a timely basis in order for environmental justice to be achieved.

### CONCLUSIONS

The main impact on habitats by this gear is related to the abundance and distribution of traps, although the frequency of hauling seems to be lower than in the past. Even though coral reefs are not preferred by fishers, isolated coral colonies and other benthic organisms may be impacted by traps in hard-bottom habitats, although these are usually dominated by gorgonians which absorb the greatest impact (pers. obs.). The ghost fishing effect will impact the populations of benthic organisms and higher consideration should be given to this impact in fishery management plans.

Current practices are affected by a number of anthropogenic factors that impact the natural resources that support the activity. This is supported by a panel of experts assessing human uses in coral reefs (Valdés-Pizzini 2002). Conflicting uses of coastal areas, environmental degradation, and diminishing resources may be causing a short-term decline in the trap fishery of Puerto Rico, after a steadily increasing historical trend.

The suggestion given by some fishers of zoning coastal areas may be useful in two manners:

- i) Zoning at sea could reduce gear loss by avoiding vessel traffic in fishing areas and *vice versa*, and
- ii) Establishing fishing or non-fishing zone concepts among users in Puerto Rico. The designation of management areas could incorporate marine protected areas in the zoning schemes that could benefit the fishery.

### ACKNOWLEDGEMENTS

Our appreciation to all the fishers that collaborated with this effort and the P. R. Fisheries Statistics Program.

### LITERATURE CITED

- Abgrall, J.F. 1975. A Cost Production Analysis of Trap and Hand-line Fishing in Puerto Rico. *Contribuciones Agropecuarias y Pesqueras*. Departamento de Agricultura 7. 68 pp.
- Appeldoorn R.S., M. Nemeth, J. Vasslides, and M. Scharer. 2000. The Effect of Fish Traps on Benthic Habitats Off La Parguera, Puerto Rico. Report to the Caribbean Fishery Management Council. Hato Rey, Puerto Rico.
- Bullimore, B.A., M.J. Kaiser, S.E. Gilbert, and K.M. Lock. 2001. A study of catches in a fleet of "ghost-fishing" pots. *Fisheries Bulletin* 99:247 - 253.

- Garrison, V.H., C.S. Rogers, and J. Beets. 1998. Of reef fishes, overfishing and *in situ* observations of fish traps in St. John, U.S. Virgin Islands. *Revista de Biología Tropical*, 46 (Supl. 5):41-59.
- Griffith, D. and M. Valdés-Pizzini. 2002. *Fishers at Work, Workers at Sea: A Puerto Rican Journey Through Labor and Refuge*. Temple University Press, Philadelphia, Pennsylvania USA. 265 pp.
- Jarvis, N.D. 1932. *The Fisheries of Porto Rico*. U.S. Department of Commerce #13. U.S. Government Printing Office, Washington, D.C. 45 pp.
- Jean-Baptiste, N. 1999. *Distribución especial de las nasas y sus relaciones con la topografía, las agregaciones de peces y capturas estacionales*. M.S. Thesis, University of Puerto Rico, Mayagüez, Puerto Rico. 107 pp.
- Matos-Caraballo, D. and Z. Torres-Rosado. 1988. *Technical Report: Censo Comprensivo de Pesquería Comercial de Puerto Rico*. ELA Vol. 1 No. 3.
- Martínez, J., and M. Valdés-Pizzini. 1997. "Culture, Rationality, and Development: Historical Constructions and 'Distortions' of Conservation Efforts in the Fisheries of Southwestern Puerto Rico." *Proceedings of the Gulf and Caribbean Fisheries Institute* 49:86-94.
- Matos-Caraballo, D. 1997. *Puerto Rico Fishery Census, 1995-1996 Saltonstall-Kennedy Project*. Final Report to NMFS, NOAA 21pp.
- Suarez-Caabro, J.A. 1969. *Puerto Rico's Commercial Marine Fisheries*. U.S. Department of Interior. Fish and Wildlife Service #866.
- Torres, Bibiano. 1969. *La Pesca en Puerto Rico en los Primeros Años del Siglo XIX*. *Revista del Instituto de Cultura Puertorriqueña*, Año XII, Num. 43: 18-21.
- Valdés-Pizzini, M. 2002. *Report on Human Uses Impacting Coral Reefs and the Identification of Potential Monitoring Activities*. Sea Grant Report, Mayagüez, Puerto Rico. 20 pp.
- Valdés-Pizzini, M., J.M. Posada, K. Grove, and M. Rosado. 1997. *Mapping Fishing Grounds Using Global positioning System (GPS) Technology*. *Proceedings of the Gulf and Caribbean Fisheries Institute* 49:125-139.
- Wilcox, W.A. 1900. *Notes on the Foreign Fishery Trade and Local Fisheries*. U.S. Commission of Fish and Fisheries, Washington Government Printing Office part XXV.