Does Trap Fishing Impact Coral Reef Ecosystems? An Update

P. SHERIDAN[1], R. HILL[2], G. MATTHEWS[2], R. APPELDOORN[3], B. KOJIS[4], and T. MATTHEWS[5]

[1] *NOAA Fisheries, Southeast Fisheries Science Center*
3500 Delwood Beach Road
Panama City, Florida 32408 USA

[2] *NOAA Fisheries, Southeast Fisheries Science Center*
4700 Avenue U
Galveston Texas 77551 USA

[3] *Department of Marine Sciences, University of Puerto Rico*
Mayagüez, Puerto Rico 00681-9013 USA

[4] *Virgin Islands Department of Planning and Natural Resources*
Division of Fish and Wildlife
6291 Estate Nazareth 101
St. Thomas, Virgin Islands 00802-1104 USA

[5] *Florida Fish and Wildlife Conservation Commission*
Marine Research Institute
2796 Overseas Hwy, Suite 119
Marathon, Florida 33050 USA

ABSTRACT

Trap fishing for fishes and lobster is common near coral reefs in the Caribbean, but little is known about the effects of these stationary gears on targeted habitats. We are in the middle of a multi-year project (2001-2005) in the U. S. Virgin Islands, Puerto Rico, and the Florida Keys that includes:

i) Mapping the distribution of traps relative to bottom habitat types via geographical information systems (GIS),
ii) Quantifying trap densities by predicted versus actual habitat type, and
iii) Quantifying damage to corals and other structure-providing organisms. We are examining seasonal and interannual variations in habitat use by trap fishers using both apparent trap distributions recorded via surface vessel surveys and actual trap distributions recorded by divers and underwater photography.

Preliminary findings suggest that traps were not distributed randomly (in proportion to habitat types available) and certain habitat types were targeted. However, a relatively small percentage (< 20 %) of the traps set in shallow water (< 30 m) actually contacted hard corals, gorgonians, or sponges. Damage occurred mainly to hard corals and was patchy, at a scale less than the total trap foot print. Almost half of the traps caused no apparent damage. There were seasonal shifts in trapping effort and habitats used.

KEY WORDS: Coral reef ecosystems, gear impacts, traps

Las Nasas de Peces y Langosta Impactan los Ecosistemas de Arrecifes de Coral?

La pesca de peces y langosta con trampas es común cerca de arrecifes coralinos en el Caribe, pero se sabe poco de los efectos de estas artes estacionarias en los hábitats sobre las que se desplegan. Estamos a mitad de un proyecto de varios años (2001-2005) en las Islas Vírgenes de los EE.UU., Puerto Rico y los Cayos de Florida que incluye:

i) Crear mapas de la distribución de las trampas en relación a los tipos de hábitat de fondo con sistemas de información geográficos (GIS),
ii) Quantificar las densidades de trampas mediante el tipo de hábitat predicho y el real, y
iii) Quantificar los daños a corales y otros organismos que proporcionan estructura. Estamos examinando variaciones estacionales e interanuales en la utilización de hábitats por parte de pescadores con trampas mediante el uso de distribuciones aparentes de trampas registradas por medio de prospecciones con embarcaciones desde la superficie y distribuciones reales de trampas registradas por buceadores y mediante fotografía submarina.

Los resultados preliminares sugieren que las trampas no estaban distribuidas aleatoriamente (en proporción al tipo de hábitat disponible) y que se seleccionaban ciertos tipos de hábitat. Sin embargo, un porcentaje relativamente pequeño (< 20 %) de las trampas desplegadas a baja profundidad (< 30 m) entraron en contacto con corales duros, gorgonias o esponjas. Los corales duros, principalmente, sostuvieron daños, aunque desiguales y a una escala menor que la impresión total dejada por la trampa. Casi la mitad de las trampas no causó ningún daño evidente. Se registraron cambios estacionales en el esfuerzo de las trampas y los hábitats utilizados.

PALABRAS CLAVES: Ecosistema de arrecife coralino, impactos de artes de pesca, trampas

INTRODUCTION

Trap fishing is common in coral ecosystem habitats under the jurisdiction of all three Federal fishery management councils in the southeastern United States and in adjacent state, territory, and commonwealth waters. Traps are used to capture spiny lobster *Panulirus argus* and stone crab *Menippe mercenaria* in Florida (Matthews and Williams 2000) and spiny lobster plus various reef fishes in Puerto Rico (Matos-Caraballo et al. In press) and the U. S. Virgin Islands (Garrison et al. 1998). Over 400,000 lobster traps were permitted for the 2002 - 2003 fishing season in Florida (which is conducting a trap reduction program), whereas approximately 13,100 traps are deployed in Puerto Rico (Matos-Caraballo et al. In press) and 8,500 traps are fished in the U. S. Virgin Islands. Fishing effort appears to be concentrated in certain areas of each coastline: the Middle Florida Keys; eastern, south-central, and south-western Puerto Rico; and southern St. Thomas and St. Croix (Sheridan et al. 2003, Schärer et al. 2003, Sheridan et al. 2004).

There is concern that traps may be a widespread source of damage to coral habitats, particularly hard corals (Hamilton 2000, ReefGuardian International website www.reefguardian.org). The U. S. Caribbean Fishery Management Council, however, postulated that traps were fished away from corals in order to avoid gear loss (Caribbean Fishery Management Council 1998).

Traps may impact coralline habitat types during setting or hauling, while fishing, during storms, or if lost. When set or hauled, traps may physically damage hard and soft corals, sponges, seagrasses, and macroalgae. While in place, traps may flatten structural components of corals as well as plants, leading to injury and reduced growth or death. If traps are set in strings or lines, the connecting lines may abrade or shear structures surrounding them. Grapples used for retrieval of traps or trap lines potentially add another source of damage. Storms may cause damage by dragging traps and trap lines over the bottom. Lost traps could cause continuous habitat damage until they degrade.

Few studies have been conducted to assess the potential for trap-induced injuries to coralline habitats. Lobster traps placed on turtlegrass *Thalassia testudinum* or manateegrass *Syringodium filiforme* in Florida caused decreased cover (Ault et al. 1997) or shoot densities (Uhrin et al. 2003) of seagrasses within four weeks. Test plots had recovered within four months after trap removal except under traps left in place six weeks or six months (Uhrin et al. 2003). A variety of reports has indicated that fish and lobster traps are indeed deployed in coral and hard bottom habitats, although these are not the habitat types preferred by fishers (Valdéz-Pizzini et al. 1997, Jean-Baptiste 1999, Quandt 1999, Appeldoorn et al. 2000, and Garrison et al. Unpublished manuscript). However, surveys of fishers in Puerto Rico and the U. S. Virgin Islands indicated that some trap fishers actually targeted coral habitats (Schärer et al. In press, Sheridan et al. In press). Three studies have attempted to quantify damage to coralline habitats from trap fishing. Both Quandt (1999) in the U. S. Virgin Islands and Appeldoorn et al. (2000) in Puerto Rico found the actual areas of damage to corals, sponges, and gorgonians was low (2-5 %), but the proportions of colonies damaged was high (up to 50 %). Eno et al. (2001) noted that lobster and crab traps in Great Britain bent and uprooted sea pens, bent but did not damage sea fans, and damaged some hard coral colonies. Recent research by Cumming (2002) indicated that even relatively small tissue injuries (< 30 cm^2) could lead to shrinkage or death of Indo-Pacific acroporid and pocilloporid corals after 3-5 months.

Our goal is to compare and contrast the distribution and potential habitat effects of trap fishing in the Florida Keys, Puerto Rico, and the U.S. Virgin Islands. Habitat information is available for each area to depths of 20 m (National Ocean Service 2002). Trap fishing, however, often exceeds those depths and there is a need for evaluation of habitat types affected by deeper water fishing. Our objectives are:

i) To review the known distributions of fishing effort and habitats,
ii) To develop methods for rapid, large scale surveys of the distribution of traps and potential for habitat damage in both shallow and deep waters, and

iii) To document gear effects on habitat types, and
iv) To suggest less destructive fishing methods, if needed. Here we present an update of information gathered from each location to date.

FLORIDA KEYS

The area under investigation encompasses the Atlantic coastal waters of the Florida Keys from the shoreline to the last visible trap buoy offshore, which may reach depths of 60 - 80 m. Traps are surveyed by small boat transects along randomly chosen longitude lines. Transects across no-fishing areas are relocated to the nearest 1-minute longitude line that does not include an area closed to fishing. Transects are 0.25 minutes wide, which at this latitude (24° N) is approximately 488 m and allows observers to view the entire width of the transect. The length of each transect varies depending on the location of the last visible buoy but averages 9400 m. Twenty 0.25 minute-wide transects have been completed (10 in the Middle Keys and 5 each in the Upper and Lower Keys).

All observations of traps and associated habitats were made with a Global Positioning System (GPS) receiver, depth recorder, and a submersible video camera. Traps without attached buoys were occasionally visible from the surface and were recorded but, without buoys, could not be identified as lobster or stone crab traps.

Trap locations were plotted against habitat maps derived from aerial photography (National Ocean Service 2002) to make initial determinations of trap distribution by apparent habitat type. Habitat types used in the classification of photographs were grouped into major categories: corals, other invertebrates (sponges and gorgonians), seagrass, macroalgae, bare substrate (sand, mud, rubble), and unknown (could not be identified due to poor water clarity). We also employed the videocamera to verify actual habitat type if possible.

Habitat damage to reef-building corals, sponges, and gorgonians was assessed at a subset of the traps located in high or low relief coral. Other habitat types will be included in future assessments. Assessments were done by divers prior to moving the trap. The area under each trap was marked for long-term monitoring by driving nails into nonliving substrate near the corners of the trap and attaching brightly colored polyurethane flagging tape to the nails. A small subsurface buoy was deployed near each trap to assist in relocating the site once the trap was removed. Each site was revisited soon after the trap was removed to assess any additional habitat impact resulting from trap retrieval and one month later to assess recovery of any damaged marine life.

All benthic fauna within each quadrat was examined for signs of damage. Any habitat impacts within 5 m of the center of the quadrat were also photographed and documented. Percent damage was recorded two ways. First, for each habitat type, each 10 cm^2 grid with damage was counted and that count was divided by the number of grids of that habitat type and converted to a percent. This damage quantification method allowed a coarse but easily quantifiable measure of percent damage. Second, the area of the individual incidences of damage was measured by overlaying a transparent acrylic sheet with 1-cm squares over the damaged area and counting the number of squares containing the damage. For vertically oriented gorgonians and branching sponges, damage was measured linearly along each branch of the organism. This second damage quantification method allowed for an accurate measure of the amount of damaged caused per trap. Next, the benthic fauna within a 5 m radius of the trap site was examined for further damage that may have been caused by movement of the trap. Any damage observed was measured using the 1 cm grid and the organisms were photographed and recorded.

Estimates of damage were limited to the loss of living tissue or fragmentation. For hard corals in general, damage was defined as locations where the trap removed coral tissue and the white color and texture of the skeleton was visible. Areas of discoloration, where tissue was still visible, were noted but not recorded as injuries. Damage to gorgonians was defined as any area where the axial skeleton was visible. Damage to sponges was defined as any area where the trap caused an abrasion or laceration.

Transects were completed in March and April 2002, representing the end of the lobster fishing season, and during August 2002 to January 2003, representing the distribution of traps at the beginning of the lobster fishing season. A total of 3,940 traps was found in 9,137 ha surveyed. Approximately 82 % of all traps were lobster traps, 15 % were stone crab traps, and 3 % had no identifier buoys. Mapped habitat types within the area surveyed included seagrass (48 % of the total area), coral (9 %), sponge / gorgonian (1 %), bare substrate (1 %), and unidentified (48 %). Trap locations in the mapped area included seagrass (38 % of the total area), coral (6 %), sponge / gorgonian (1 %), bare substrate (2 %), and unidentified (54 %). These comparisons indicate that traps are less likely to be found over coral and seagrass than would be expected from the habitat maps. However, use of the videocamera permitted resolution of the large area that could not be identified from aerial photographs. Actual habitat distribution of traps then became seagrass (61 % of the total area), coral (9 %), sponge / gorgonian (1 %), bare substrate (18 %), and macroalgae (11 %). It is interesting to note that in the Florida Keys, at least, relatively few traps are found on coral habitats.

Detailed habitat characterizations and damage assessments for 14 of the traps found in coral habitat indicated that a small percentage of the habitat in this area was living and that an even smaller percentage was coral. The amount of coral under traps (3.3 % of the area) was less than that in adjacent control quadrats (5.8 % of the area).

Habitat damage was only occasionally observed under or near traps and the limited observations made to date not allow for quantification of trap impacts. Instead, we provide a description of the observed trap impacts in 4 quadrats where coral damage was observed. One trap was not actively fished and had been moved into a low relief coral habitat during a storm. This trap came to rest adjacent to a large coral colony and on three small colonies. All three small coral colonies exhibited scrapes of less than 10 cm^2. Two of the quadrats had small coral scrapes (both confined to one grid each) adjacent to the trap deployment site. One of these scrapes occurred coincident with trap deployment and the second occurred coincident with trap retrieval. The fourth quadrat included an injury to an 80 cm diameter coral colony that was

displaced. This trap was not actively fished and was presumably lost when a storm moved the trap into a low relief coral area. Subsequent surveys to assess the recovery of these injuries were not possible because of low visibility water and the loss of the subsurface markers. There was one incidence of damage to a *Palythoa* sp. colony (a non-reef forming coral) which had recovered by the next survey 18 days later.

PUERTO RICO

Survey methods in Puerto Rico generally followed those described above for Florida, except videocameras were not used at each site. Instead, divers assessed a larger number of traps to verify habitat type and to quantify damage, if any. No long-term sites have yet been established to monitor recovery at trap sites with damage to corals or invertebrates. In addition, transects were restricted to southwest Puerto Rico but have been conducted several times during 2002 - 2003 to determine seasonal shifts in trap locations and habitat use. Finally, some transects were run along latitude lines. Future activities will expand transects and diver observations coast-wide.

A total of 488 fish and lobster traps was found in 2,575 ha surveyed. Mapped habitat types within the area surveyed were dominated by coral (46 % of the total area), followed by seagrass (3 %), bare substrate (2 %), and macroalgae (1 %), and included a large unidentified component (48 %). The distribution of trap locations followed these proportions almost exactly: coral (48 %), seagrass (3 %), bare substrate (2 %), macroalgae (< 1 %), and unidentified (47 %). Diver surveys do not indicate any deviation from these proportions, so the large area that was not identifiable through areal photography seems to resemble habitat proportions already identified. Damage estimates are not yet available from the diver surveys. The available data indicate that traps are distributed according to habitat availability. Because corals make up a large proportion of the available habitat, it is likely that damage to corals in Puerto Rico is more common than in Florida. However, this observation must be tempered by the limited geographic extent of the surveys to date.

US VIRGIN ISLANDS

Survey methods in the U. S. Virgin Islands generally followed those described above for Puerto Rico. To date, longitudinal transects have been found to be uninformative, in that traps with visible buoys tend to be concentrated in relatively shallow waters whereas traps deployed in deeper waters typically have submerged buoys (fishers mark locations by GPS, return to these sites, and use grappling hooks to retrieve trap lines; Sheridan et al. In press). Transects consist of 400 m wide tracks that are run parallel to the coast, or between landmarks such as islands or points of land, and are recorded continuously using GPS. Transects have been conducted several times during 2002-2003 to determine seasonal shifts in trap locations and habitat use.

A total of 527 traps was found in 3,200 ha surveyed. Mapped habitat types within the area surveyed were dominated by coral (42 % of the total area), followed by seagrass (8 %), macroalgae (7 %), bare substrate (1 %), and sponge / gorgonian (1 %), and included a large unidentified component (42 %). The distribution of trap locations was somewhat different from those proportions: coral (54 %), seagrass (11 %), macroalgae (5 %), bare substrate (1 %), sponge / gorgonian (0 %), and unidentified (30 %). Diver surveys present a third picture: coral (14 %), seagrass (13 %), macroalgae (11 %), bare substrate (32 %), and sponge / gorgonian (29 %). The unidentified acreage from aerial photography seems to have been resolved into major increases in bare substrates and smaller increases in seagrass and macroalgal habitats. In addition, the high coral cover in mapped estimates is split into a large sponge / gorgonian component. Damage estimates have been made at 182 traps using diver surveys. The available data indicate that traps cause damage at about 50 % of all traps visited. Instances of damage (scrapes, breakage) were most prevalent among gorgonians and sponges (90 instances), followed by corals (25 instances). Few instances of matted or discolored macroalgae or seagrass were recorded. As yet, no long-term monitoring sites have been established to monitor fate or recovery of organisms.

FUTURE ACTIVITIES

We are still in the process of conducting this study. At all locations, we anticipate continued seasonal and inter-annual estimation of the variation in trap placement, damage, and recovery rates. In Florida, we need to expand coverage of surface transects and to increase diver surveys of traps. In Puerto Rico, we will expand surface transects coast-wide and add long-term monitoring sites. In the U. S. Virgin Islands, we need to develop methods for dealing with traps and trap lines that are not visible at the surface. Finally, at all locations we will implement traps surveys using a remotely operated vehicle (ROV) in order to be able to survey traps that are fished at depths exceeding those accessible to divers. We will test ROV surveys against diver surveys to ensure calibration.

ACKNOWLEDGMENTS

This project was funded by the NOAA Coral Reef Initiative. We thank the many staff members, divers, and students at our respective agencies for field and laboratory assistance. The translated abstract was provided by E. Cortés.

LITERATURE CITED

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. Department of Marine Sciences, University of Puerto Rico, Mayaguez, PR. 33 pp. Unpubl. MS.

Ault, J., J. Serafy, D. DiResta, and J. Dandelski. [1997]. Impacts of commercial fishing on key habitats within Biscayne National Park. Report to the National Park Service. University of Miami, Rosenstiel School of Marine

and Atmospheric Sciences, Miami, FL, Cooperative Agreement No. CA-5250-6-9018. 80 pp. Unpubl. MS.

Caribbean Fishery Management Council. 1998. Essential fish habitat (EFH) generic amendment to the fishery management plans (FMPs) of the U. S. Caribbean including a draft environmental assessment. Vol. I. Caribbean Fishery Management Council, San Juan, Puerto Rico. 173 pp. plus appendices.

Cumming, R.L. 2002. Tissue injury predicts colony decline in reef-building corals. *Marine Ecology Progress Series* **242**:131-141.

Eno, N.C., D.S. MacDonald, J. A.M. Kinnear, S.C. Amos, C.J. Chapman, R. A. Clark, F.S.P.D. Bunker, and C. Munro. [2001]. Effects of crustacean traps on benthic fauna. *ICES Journal of Marine Science* **58**(1):11-20.

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. *Rev. Biol. Trop.* **46** (5):41-59.

Garrison, V.H., C.S. Rogers, J. Beets, and A.M. Friedlander. St. John, U. S. Virgin Islands trap fishery: the habitats targeted and the fishes trapped. U. S. Geological Survey, St. Petersburg, FL. Unpubl. MS.

Hamilton, A.N., Jr. [2000]. Gear impacts on essential fish habitat in the southeastern region. U. S. Department of Commerce, NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center, Mississippi Laboratories, Pascagoula Facility, Pascagoula, MS. 41 pp. Unpubl. MS.

Jean-Baptiste, N. [1999]. Distribución espacial de las nasas y sus relaciones con la topografia, las agragaciones de peces y capturas estacionales. M.S. Thesis, University of Puerto Rico, Mayaguez, PR. 107 pp.

Matos-Caraballo, D., M. Cartagena-Haddock, and N. Peña-Alvarado. 2005. Comprehensive census of the marine commercial fishery of Puerto Rico 2002. *Proceedings of the Gulf and Caribbean Fisheries Institute* **56**:97-110.

Matthews, T.R. and T. Williams. 2000. Effect of regulations on harvest in Florida's spiny lobster fishery. *Proceedings of the Gulf and Caribbean Fisheries Institute* **51**:119-127.

National Ocean Service. 2002. Benthic habitats of Florida, Puerto Rico, and the U. S. Virgin Islands. NOAA National Ocean Service. National Center for Coastal Ocean Science, Biogeography Program, 1305 East West Highway, Silver Spring, MD (available on CD from http:// biogeo.nos.noaa.gov/projects/mapping).

Quandt, A. [1999]. Assessment of fish trap damage on coral reefs around St. Thomas, USVI. University of the Virgin Islands, St. Thomas, USVI. 11 pp. Unpubl. MS.

Schärer, M.T., M.C. Prada, R.S. Appeldoorn, R. Hill, P. Sheridan, and M. Valdés-Pizzini. 2004 The use of fish traps in Puerto Rico: current practice, long-term changes, and fishers' perceptions. *Proceedings of the Gulf and Caribbean Fisheries Institute* **55**:744-756.

Sheridan, P., R. Hill, and B. Kojis. [In press]. Trap fishing in the U. S. Virgin Islands: how and where effort is exerted. *Caribbean Journal of Science* **40**.

Sheridan, P., R. Hill, G. Matthews, and R. Appeldoorn. 2003. The effects of trap fishing in coralline habitats: What do we know? How do we learn more? *Proceedings of the Gulf and Caribbean Fisheries Institute* **54**:1-12.

Uhrin, A.V., M.S. Fonseca, and G.P. DiDomenico. [2003]. Effect of lobster traps on seagrass of the Florida Keys National Marine Sanctuary: damage assessment and evaluation of recovery. *Benthic Habitats and the Effects of Fishing,* American Fisheries Society Symposium. In press.

Valdéz-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**:125-138.

Proceedings of the

FIFTY – SIXTH ANNUAL

Gulf and Caribbean Fisheries Institute

ROADTOWN, TORTOLA
BRITISH VIRGIN ISLANDS

NOVEMBER 2003

Library of Congress Catalog Card Number
52-033783

Edited by:
R. LeRoy Creswell

FORT PIERCE, FLORIDA 2005