Trap Fishing in the U. S. Virgin Islands: How and Where Effort is Exerted

PETER SHERIDAN[1], RONALD HILL[2], and BARBARA KOJIS[3]
[1] *NOAA Fisheries, Southeast Fisheries Science Center*
Panama City Laboratory
3500 Delwood Beach Road
Panama City, Florida 32408 USA
[2] *NOAA Fisheries, Southeast Fisheries Science Center*
Galveston Laboratory
4700 Avenue U
Galveston, Texas 77551-5997 USA
[3] *Virgin Islands Department of Planning and Natural Resources*
Division of Fish and Wildlife
6291 Estate Nazareth 101
St. Thomas Virgin Islands 00802-1104 USA

ABSTRACT

Trap fishing for fishes and lobsters is common in waters of the U. S. Virgin Islands and may affect coral ecosystem structure and function. We examined data on overall fishing patterns from trip reports by 103 fishermen during July 2000 - June 2001. Trip reports indicated fishermen preferred southwestern and northeastern St. Croix and southwestern and northwestern St. Thomas. Fishermen landed over 34,900 kg of spiny lobster and 193,000 kg of fish (primarily parrotfishes and triggerfishes) during the 12 month period. We subsequently interviewed 30 fishermen during November - December 2001 to obtain more detail on fishing gear, methods, and habitat types fished. Ten trap fishermen from St. Croix and 20 from St. Thomas (who also fished St. John) were surveyed. These fishermen operated 5,172 (60.8%) of the estimated 8,500 traps fished in the USVI. St. Croix fishermen concentrated off the south coast in relatively shallow waters (mean 17.7 m, maximum 30.5 m), while St. Thomas / St. John fishermen concentrated effort off southern St. Thomas in moderate to deep waters (mean 47.5 m, maximum 183 m). Fishermen moved traps regularly and seasonally, but unfortunately our survey did not capture the magnitude of distances moved. Trap construction was uniform in St. Thomas / St. John, whereas traps varied in size and were somewhat smaller in St. Croix. Individually buoyed traps were used off St. Croix, whereas trap lines (mean 13 traps per line, range 4-25 traps per line) were used off St. Thomas / St. John. Trap lines used buoyant rope that enabled off-bottom grappling. Fishing times were shorter off St. Croix than off St. Thomas / St. John (means 3.2 days vs. 7.2 days, respectively). Traps were most often deployed in vegetation (seagrass or algae), sand, or rubble habitats, but six fishermen targeted corals. These data are important for assessment of potential for trap damage to coral reef habitats.

KEY WORDS: Coral reef ecosystem, gear impacts, traps Pesca con trampas en Las Islas Virgenes de los E.E.U.U.

Pesca con Trampas en Las Islas Virgenes de los E.E.U.U.: Cómo y Donde Esfuerzo se Ejerce

La pesca de peces y langostas con trampas es práctica habitual en aguas de las Islas Vírgenes de los EE.UU. y puede afectar la estructura y funcionamiento de los arrecifes coralinos. Examinamos datos sobre patrones de pesca provenientes de informes de viaje de 103 pescadores durante el período julio 2000-junio 2001. Los informes de viaje indicaron que los pescadores prefieren el suroeste y noreste de St. Croix y el suroeste y noroeste de St. Thomas. Los pescadores desembarcaron más de 34,900 kg de langosta y 193,000 kg de pescado (principalmente peces loro y peces cochino) durante este período de 12 meses. Posteriormente entrevistamos a 30 pescadores durante los meses de noviembre a diciembre del 2001 para obtener más detalles sobre las artes de pesca, métodos y tipos de hábitat pescado. La muestra incluyó a 10 pescadores de trampas de St. Croix y 20 de St. Thomas (que también pescaban en St. John). Dichos pescadores operaron 5,172 (60.8%) de las 8,500 trampas que se estima son utilizadas para la pesca en las USVI. Los pescadores de St. Croix se concentraron en la costa sur en aguas relativamente someras (media 17.7 m, máximo 30.5 m) mientras que los pescadores de St. Thomas / St. John concentraron el esfuerzo en el sur de St. Thomas en aguas de profundidad mediana a alta (media 47.5 m, máximo 183 m). Los pescadores desplazaron las trampas regular y estacionalmente pero desafortunadamente nuestra prospección no capturó la magnitud de las distancias de dichos desplazamientos. La estructura de las trampas era uniforme en St. Thomas / St. John mientras que en St. Croix el tamaño de las trampas era variable y algo menor. En St. Croix se utilizaron trampas dotadas de boyas individuales mientras que en St. Thomas / St. John se utilizaron líneas con varias trampas (media de 13 trampas por línea, rango de 4-25 trampas por línea). Las líneas con trampas utilizan cuerda boyante que permite que las trampas no toquen el fondo. Los tiempos de pesca fueron menores en St. Croix que en St. Thomas / St. John (medias de 3,2 y 7,2 dias, respectivamente). Las trampas se colocaron más frecuentemente en hábitats con vegetación (plantas marinas o algas), arena o fragmentos de coral muerto, pero seis pescadores las desplegaron específicamente sobre corales. Estos datos son importantes para la evaluación de daños potenciales a hábitats de arrecifes coralinos debido al uso de trampas.

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

INTRODUCTION

Trap fishing occurs in coral ecosystems in both territorial waters (within 5.6 km or 3 nmi) and Federal waters (5.6 - 370 km or 3 - 200 nmi) of the coastline of the U. S. Virgin Islands (USVI). There are directed fisheries for

both spiny lobster *Panulirus argus* and various reef fishes (Garrison et al., 1998), as opposed to many other areas of the Caribbean where spiny lobster is an incidental catch for trap fishermen (Holthuis, 1991). There is concern that traps may have direct and indirect effects on coral ecosystem habitats and on structure and function of benthic communities (Jennings and Kaiser, 1998; Sheridan et al., 2005); however, actual damage to corals is thought to be minimal (Caribbean Fisheries Management Council, 1998).

The Virgin Islands Department of Planning and Natural Resources (VIDPNR) employs a monthly logbook system wherein licensed fishermen record a variety of data for each day during the year that catches are landed. These data are supplied to the national landings monitoring system of the U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA Fisheries). Such data might be useful in judging the potential for fishing gear impacts. However, the logbook data are limited to basic information such as area fished, numbers of traps fished, and landings. We felt that we needed to ask active fishermen specific questions on how and where they fished so that we could better understand fishing patterns and the potential for gear impacts to coral ecosystem habitats (Sheridan et al., 2003, 2005). Our objective was to define more accurately fishing gear and methods as well as fishing pressure by area and habitat type.

METHODS

VIDPNR and NOAA Fisheries catch statistics are made available for 12-month periods known as “fishing years” or “biological years”. When we initiated our study, the most recently completed data set for USVI was the period July 2000 - June 2001. We examined:

i) Number of uniquely identified fishermen (by code or vessel number),
ii) Dates each fisherman filed a trip report,
iii) Hours per trip spent working traps,
iv) Traps fished per trip,
v) Areas fished (Figure 1), and
vi) Landings per trip. Landings are recorded by common names such as parrotfishes or grunts.

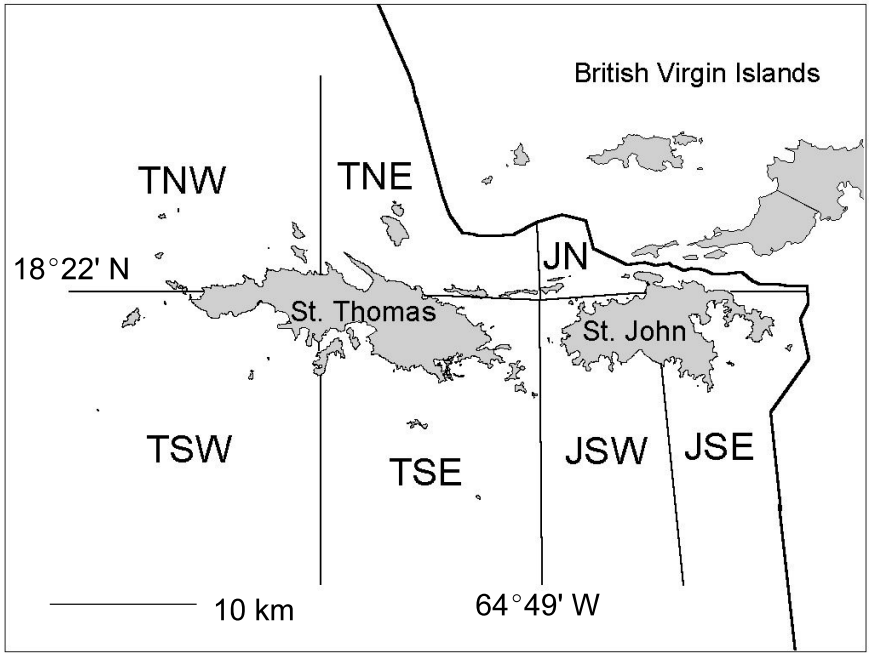
Following this assessment, we developed a series of questions that we thought would better represent how and where fishermen operated (Table 1). We wanted to know depths fished, trap dimensions, single traps versus trap lines, use of buoys, and gear used to set and haul traps or to locate lost traps.

Interviews were conducted during November-December 2001 with 10 fishermen from St. Croix and 20 fishermen from St. Thomas (few fishermen are based in St. John). VIDPNR visited landing sites and interviewed commercial fishermen who were most likely to respond. VIDPNR estimated that there were 30-40 full time trap fishermen each in St. Thomas / St. John and St. Croix. In St. Thomas, 20 of 22 fishermen who were asked to participate subsequently agreed to answer the questionnaire. In St. Croix, all 10 fishermen who were asked answered the questionnaire. With 30 interviews, we thus estimated 37.5-50% coverage of all commercial fishermen.

If a fisherman operated in more than one area, then the total number of traps fished was split equally among all areas fished. Answers supplied as ranges (e.g., depth range fished, traps per line, length of line between traps, or soak time) were converted to midpoints. Island-related differences in fishing characteristics were assessed with a t-test using STATISTICA (StatSoft, Inc., Tulsa, OK).

Table 1. U. S. Virgin Islands trap fishing survey, November-December 2001. Phrases in parentheses were used by interviewers to elicit specific responses.

1. Location (St. Thomas / St. John, or St. Croix), Survey Number, and Date
2. What are the target species? (Lobster, fishes in general, or name specific fishes)
3. Where are traps set? (Indicate VIDPNR area codes, e.g. TNW or C-5; refer to logbook map)
4. What depths are traps fished? (Indicate depth or depth range and units, e.g. ft, m, or fm)
5. Are there differences in location by season? (Yes / no) Why? (Weather, fish movement, etc.)
6. How many traps do you own? How many traps are fished? (in the water at one time)
7. Has the number of traps changed over time? If Yes, is the number increasing or decreasing?
8. How are traps constructed? (Material, mesh size, length x width x height in or cm)
9. Are traps fished as single traps? (Yes / no) If single, do all traps have buoys? (Yes / no)
10. Are traps fished as trap lines? (Yes / no) If lines, do you buoy both ends, one end, or neither?
11. If lines, how many traps per line? If lines, how long is the line between traps? (Ft or m)
12. If lines, is a floating line used between traps? (Yes / no)
13. Can you tell what type of habitat you are setting your traps in? (Yes / no)
14. If yes, what habitat is targeted? (Coral reef, sand, seagrass, rubble, etc.)
15. What is the soak time for your traps? (Days)
16. How does this change with season or target fish? (e.g., longer in fall, shorter for snapper)
17. Do you use a winch or pot hauler? (Yes / no)
18. Are traps usually hauled and re-set in place or are they moved regularly? (Describe)
19. What do you do if floats are missing or traps are lost? (e.g., use grapple, dive)
20. Do others fish in the same manner as you? (Yes / no)
21. If no, how are they different? How have they changed over time?



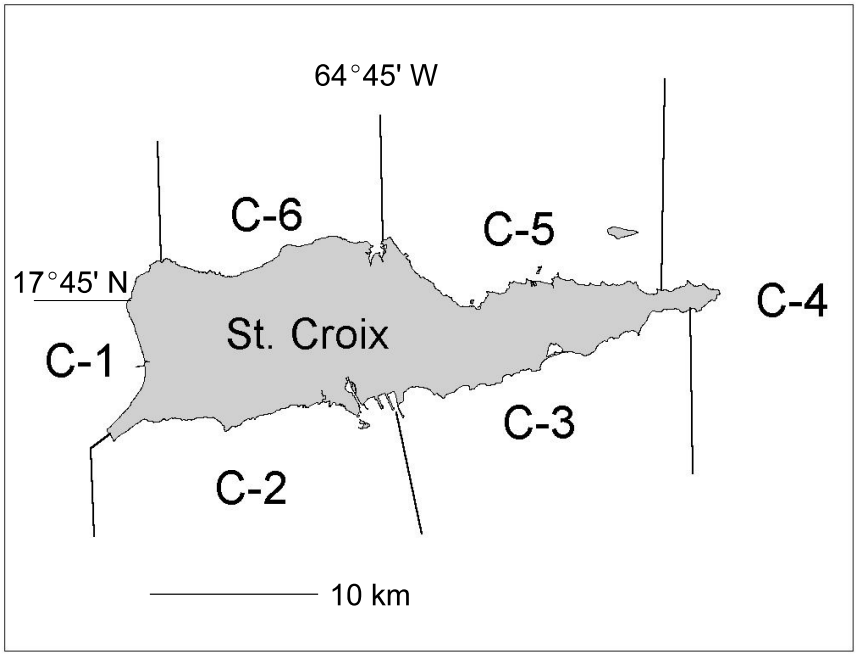


Figure 1. Fishing area codes for the U. S. Virgin Islands.

RESULTS

VIDPNR / NOAA Fisheries catch statistics

Data were summarized from 4,866 trip reports (Table 2). A total of 97 fishermen was identified by unique code numbers in the data set, but only 74 were considered full time. Ten of 41 fishermen from St. Croix and 13 of 56 fishermen from St. Thomas completed ≤ 24 trips per year (or ≤ 2 trips per month) and generally had fewer than 10 traps, thus we consider them to have been either part time, just starting, or quitting the fishery. We believe that approximately 8,500 traps are fished (1,500 around St. Croix and 7,000 around St. Thomas; VIDPNR, unpublished data). However, the maximum number of traps in the water during the reporting period was 4,853 (766 from St. Croix and 4,087 from St. Thomas), based on a total of the maximum number of traps reportedly fished by each fisherman. These data suggest that fishermen did not employ all of their traps all the time. Even though each group of fishermen took similar numbers of trips (Table 2), St. Croix fishermen worked significantly fewer traps and spent significantly less time on the water working their traps than did St. Thomas fishermen. Traps were most often fished off southwestern and northeastern St. Croix and western St. Thomas (Table 3, Figure 1).

During the period July 2000 - June 2001, biomass of fish landed in St. Thomas was highest during February but only fell below 80% of the maximum during April (Figure 2). Landings of fish in St. Croix were also relatively steady from month to month, with highest landings in August-September and <80% of the September maximum only in November and May. Lobster landings were distinctly seasonal, with highest landings in St. Thomas during November-June and in St. Croix during December-April and relatively low landings (35-60% of maxima) in other months (Figure 2). Annual landings for the period included over 34,900 kg of spiny lobster and over 193,000 kg of fish. Seven families of fishes comprised over 90% of the landings from each area (Table 2). St. Croix landings were dominated by parrotfishes then by surgeonfishes, snappers, and grunts, whereas St. Thomas landings were dominated by triggerfishes then by parrotfishes, snappers, and groupers.

Fisherman interviews

Assessment of interviews revealed some commonalities and many differences among fishermen from each island (see following sections). Within each island group, all fishermen agreed that others used similar techniques and gear and that fishing methods had not changed recently, although several fishermen thought the number of traps was increasing.

Target organisms

Nineteen fishermen captured fishes and lobsters, 10 fishermen caught fish only, and one fisherman from St. Thomas caught lobster only. Most St. Croix fishermen (seven of 10) captured fish only, while three of 20 St. Thomas fishermen captured fish only.

Table 2. Island-related differences in trap fishing effort (compared by t-tests) and catch composition (not tested) as estimated from trip reports by USVI trap fishermen during July 2000 - June 2001 (NOAA Fisheries, Miami, FL, unpublished data). St. Croix = 41 fishermen, 2280 trips. St. Thomas (includes St. John) = 56 fishermen, 2586 trips. t-test df = 95 (annual data not tested).

	St. Croix	St. Thomas	P
Mean (range) dates with trip reports	55 (1-167)	48 (1-169)	0.190
Mean (range) hours / trip	4.3 (1-12)	6.4 (1-16)	<0.001
Mean (range) traps fished / trip	16 (1-81)	53 (1-237)	<0.001
Annual spiny lobster landings (kg)	1,857	33,066	
Annual fish landings (kg)	58,973	134,551	
Fish catch composition (% weight)			
Parrotfishes	38.6	13.9	
Surgeonfishes	15.5	10.9	
Snappers	14.4	13.9	
Grunts	14.4	10.9	
Triggerfishes	8.1	24.4	
Groupers	2.8	12.9	
Porgies	1.9	6.9	
Other	4.3	6.2	

Table 3. Comparison of catch statistics common to both trip reports (St. Croix = 41 fishermen and 2,280 trips; St. Thomas = 56 fishermen and 2,586 trips) and to interviews (St. Croix = 10, St. Thomas = 20). See Figure 1 for location of fishing areas.

Statistic		Trip reports	Interviews
Fishermen landing (%)	Fish + lobster	47.9	63.3
	Fish only	51.1	33.3
	Lobster only	1.0	3.4
St. Croix fishing areas (%)	C-1	< 0.1	0.0
	C-2	32.0	29.3
	C-3	18.4	32.3
	C-4	12.2	23.1
	C-5	37.4	15.2
	C-6	< 0.1	0.0
St. Thomas fishing areas (%)	TNW	29.8	6.4
	TSW	32.5	38.1
	TSE	15.2	27.0
	TNE	4.1	2.2
	JN	0.2	0.8
	JSW	5.2	10.5
	JSE	10.5	11.6
	BVI	2.5	3.4
Mean number of traps	St. Croix	16	32
	St. Thomas	53	231

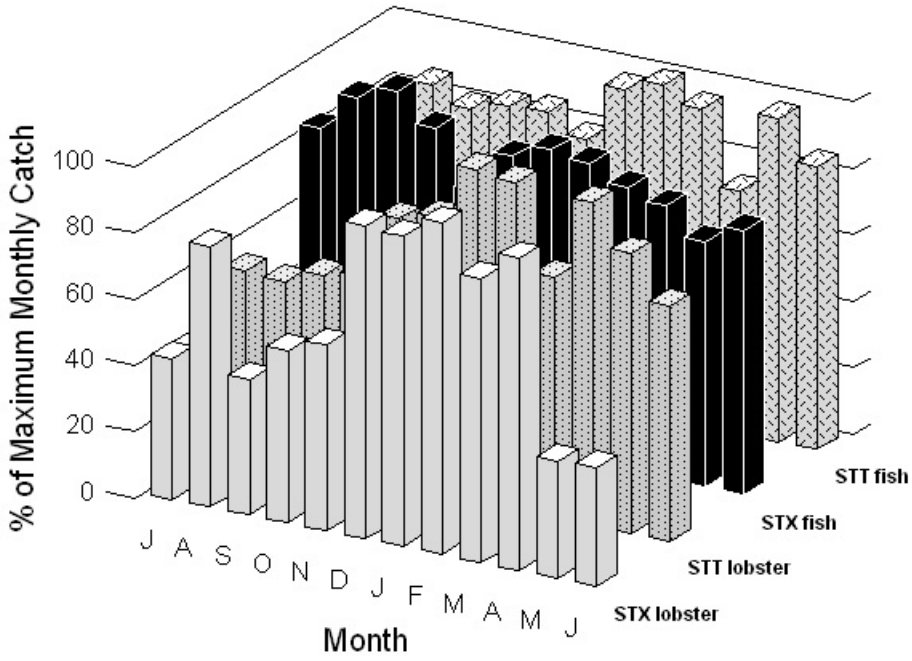


Figure 2. U. S. Virgin Islands trap landings during July 2000 - June 2001 by island group (STT = St. Thomas / St. John, STX = St. Croix). Monthly maxima: STT fish = 14,035 kg, Feb; STX fish = 6,215 kg, Sep; STT lobster = 3,616 kg, Jan; STX lobster = 230 kg, Feb. Data from NOAA Fisheries, Miami, FL.

Fishing locations

Fishermen did not cross between island groups (St. Croix is 60 km south of St. Thomas / St. John). Interviewed St. Croix fishermen operated 322 traps, approximately 21% of the estimated 1,500 traps fished from that island. St. Croix fishermen placed the largest numbers of traps in areas C-3 and C-2 on the south coast (Table 3), indicating approximately 62% of the total St. Croix effort was expended there. Fewer traps were placed in areas C-4 and C-5 on the east and northeast coasts, and none of the interviewed fishermen placed traps in areas C-1 or C-6 on the west and northwest coasts. The latter trend was borne out by the July 2000 - June 2001 trip reports which indicated only four of 2,280 trips were to areas C-1 or C-6. Shallow shelf waters are relatively narrow in these two areas relative to areas C-2 through C-5. All fishermen operated in either one or two areas. St. Croix fishermen reported mean fishing depths of 17.7 m (range 7.3-30.5 m), but nine of 10 fishermen reported minimum and maximum depths were the same.

Interviewed St. Thomas fishermen operated 4,610 traps, approximately 66% of the estimated 7,000 traps fished from that island. St. Thomas fishermen placed the largest numbers of traps in areas TSW and TSE on the southwest and southeast coast of St. Thomas (Table 3), indicating approximately 65% of the total effort was expended there. Moderate numbers of traps were placed in areas JSE and JSW south of St. John and in TNW northwest of St. Thomas. Lowest trap numbers were in areas TNE and JN (Table 3), corresponding to northeast St. Thomas and northern St. John. It is unknown why TNE receives low effort, but JN encompasses Virgin Islands National Park where fishing is restricted. One fisherman reported deploying 160 traps exclusively near Tobago in the British Virgin Islands (north of TNE). Although the modal number of areas fished was two, seven fishermen reported operating in three or four areas and one fisherman operated in six areas. St. Thomas fishermen reported mean fishing depths of 47.5 m (range 18.3-183 m). Only seven fishermen reported a narrow (3 m) depth range fished, whereas most of the other fishermen reported depth range variations exceeding 9 m. Two fishermen reported extreme depth ranges of 27-97 m and 55-183 m.

Almost all fishermen (27 of 30) reported that they moved their traps on a seasonal basis. However, our survey questions were not detailed enough to capture the nature of these moves so we do not know if moves involved changing depths, changing fishing areas, or both. Movement of target species, weather, or both were most often cited (23 of 30 responses) as reasons for moving traps. Three fishermen cited tides in combination with species movements and weather. One fisherman said he moved traps only when he switched target species.

Fishing gear

Fishermen interviewed on St. Croix operated fewer traps (mean 32, range 16-100) than did fishermen from St. Thomas (mean 231, range 38-600) (Table 3). Most St. Croix fishermen (eight of 10) indicated that they had decreased the number of traps fished recently (switching to gillnets), whereas many fishermen from St. Thomas (14 of 20) said their trap counts were stable.

All fishermen said their traps were made of wire or wire and iron rebar, and three fishermen said they also included either wood or plastic in fabrication. Trap specifications were quite variable in St. Croix. Mesh size averaged 4.6 cm with a mode of 3.8 cm and a range of 3.8-6.4 cm. Trap length averaged 147 cm, with a mode of 152 cm and a range of 122-183 cm. Trap widths were mostly 122 cm, but one fisherman each reported traps of either 91 cm or 117 cm. Traps were all 46 cm high. All St. Thomas fishermen used the same size traps: 5 cm mesh, 122 cm length, 122 cm width, and 46 cm height. While trap length and width are not currently regulated, mesh sizes in USVI waters are restricted to 3.8 cm in St. Croix, to 5 cm in St. Thomas, and to 3.8 cm in Federal waters around all islands. In addition, all traps must have escape panels with biodegradable fasteners, must be inspected by VIDPNR, and must carry numerical identification tags.

Nine of 10 St. Croix fishermen used single traps, each with a single buoy attached. The lone St. Croix fisherman who used trap lines only fished two

traps per line, with 45 m of line between traps and both ends buoyed. All of these fishermen set and hauled traps by hand. Conversely, 19 of 20 St. Thomas fishermen used trap lines and mechanized pot haulers, with the remaining individual fishing both single traps and trap lines. Fifteen of these fishermen used buoys on each end of the trap lines, one used a single buoy, three fishermen did not use buoys, and one did not respond. Buoy lines can be used for trap retrieval. Buoys are not required, but if used they must employ color codes assigned by VIDPNR for identification. Trap lines held an average of 13 traps (range 4-25) with average 76 m of line between successive traps. All fishermen who used trap lines employed buoyant line to aid in trap retrieval (by grapple).

Soak times were significantly shorter in St. Croix (mean 3.2 d, range 2-7 d) than in St. Thomas (mean 7.2 d, range 3.5-10.5 d; $t = -6.27$, $p < 0.01$). Six of 10 St. Croix fishermen said their soak times did not change seasonally, whereas 14 of 20 St. Thomas fishermen changed their soak times seasonally (for example, longer in colder water) or with target species (for example, shorter with heavier types of bait). Longer soak times among St. Thomas fishermen were likely related to fishing in deeper waters, operating more traps, and using trap lines.

Traps are usually moved during the fishing operation, as 19 fishermen responded that they moved traps "regularly" and five stated they moved traps short distances or occasionally. Unfortunately, our questions were not structured to reveal whether fishermen using trap lines hauled all traps aboard the boat then moved relatively large distances or just moved traps relatively short distances while working trap lines. It is unlikely that traps are moved large distances if catch rates in a given area are acceptable. However, only five fishermen (four from St. Croix) stated that they hauled and replaced their traps in the same areas.

When fishermen returned to their trap sites and could not locate buoys (i.e., buoys were missing or submerged), eight fishermen (all from St. Croix) stated that they would dive to locate and retrieve missing traps, whereas 21 fishermen (19 from St. Thomas) used grappling hooks to retrieve missing gear. One fisherman did not state how he retrieved missing traps. Grappling was primarily off-bottom (20 of 21 grapple users) and is used to snag buoyant trap lines. Only one fisherman used on-bottom grappling techniques, even though he stated that he used only two traps per line, buoyant trap lines, and two buoys.

Habitats fished

All fishermen claimed to be familiar with the habitat types they were targeting. Given the depths fished, good visual placement was likely off St. Croix where mean fishing depths were 17.7 m. However, St. Thomas fishermen worked significantly deeper waters (mean 47.5 m, $t = -4.60$, $p < 0.01$; range 18.3-183 m) that were often in excess of accurate bottom visibility. Most fishermen (22 of 30) said they fished in more that one habitat type, most often stating that they deployed traps in seagrass (23 responses), sand (19), and coral rubble (12). No one reported fishing in algae, even though both seagrass and algae are common to USVI, so we suspect that fishermen consider both

types of plants as the same habitat. Seagrasses are found closer to shore in relatively shallow water (to 20 m), while algal plains are found further from shore and in deeper waters (National Ocean Service, 2002). Six of 30 fishermen (all from St. Croix) claimed to be operating in coral reefs, but they represented 142 of the 322 (44%) traps surveyed in St. Croix.

Comparison of data sets

There was some overlap in types of data that were collected for this study. The trip report data set consisted of every report filed by fishermen for the period July 2000 - June 2001. Our interviews basically asked 30 fishermen to summarize their typical (annual) habits, and the interviews were conducted in November-December 2001. Therefore, some divergence in results was expected due to both large scale versus small scale data sets as well as to timing of data. Indeed, there were obvious differences along with some similarities (Table 3). For example, about half of the trip reports indicated landing fish only, whereas only one third of the interviews indicated that they fished for fish only. Interviews were more likely to be accurate for target groups, since trip reports do not distinguish between successful and unsuccessful trips (i.e., reporting zero catch of lobsters does not mean lobsters were not targeted along with fish). Trip reports indicated more activity in fishing areas C-5 and TNW whereas interviews indicated that C-2 and TSE were more important; however, we note that both data sets indicated areas C-3 and TSW as prime fishing locations. In this case, trip reports are likely a better index of actual fishing area pressure. Mean numbers of traps employed by fishermen differed greatly between data sets, but this could be due to capture of daily versus annual use patterns. Again, trip reports were likely to be a more accurate indicator of where fishing pressure is applied. Interviews provided many types of information not available from trip reports such as trap construction and fishing depths.

DISCUSSION

This report provided a detailed description of trap fishing operations in USVI waters. The primary fishing grounds are southern and northeastern St. Croix and southern and western St. Thomas and St. John. St. Croix fisherman work relatively shallow waters, using single traps of varying sizes and construction materials retrieved by hand. St. Thomas fisherman work moderately deep waters, using strings of traps of uniform size and construction retrieved mechanically. Fishermen either dive (St. Croix) or use off-bottom grapples (St. Thomas) to retrieve lost gear. Traps are moved regularly either during fishing operations or in response to weather or target species availability. However, our survey was not designed well enough to get details on these movements such as changes in depth or area. Fishermen most often place traps in vegetated, sand, or rubble habitats, but some St. Croix fishermen report targeting coral habitat. Thus, there is potential for gear impacts to coral habitat in the USVI.

In Puerto Rico, a survey of 47 fishermen from all coastal regions also indicated that coral reefs were not the preferred habitat for trap setting (Schärer

et al., 2004). Overall, 60 % of Puerto Rican fishermen selected hardbottom areas, particularly the "rastreal", as the preferred fishing 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. However, 10 Puerto Rican fishermen did indicate that corals are a targeted habitat.

The effects of trap fishing on bottom habitats are largely unstudied, particularly for coral reefs and reef-associated habitats. Jennings and Kaiser (1998) concluded that static gear such as traps are unlikely to have the widespread habitat impacts of mobile gear such as trawls, although effects may be detected where effort is concentrated or in bottom types supporting long-lived fauna such as corals. Mixed impacts have been reported from lobster and crab traps in European waters: bent and uprooted sea pens, bent but otherwise undamaged sea fans, and living material scraped from hard coral colonies (Eno et al., 2001). Although many of those organisms were not damaged or killed outright, Jennings and Kaiser (1998) postulated that both frequency and intensity of contact may affect coral survival. The Caribbean Fishery Management Council (1998) indicated the potential for damage to coral from traps was slight since "setting traps in coral areas increases the chance of losing traps" and thus traps were likely fished away from corals. However, there are reports beyond our survey that traps are placed in USVI and Puerto Rico corals (Garrison et al., 1998; Quandt, 1999; Schärer et al. 2004) and that traps can damage corals (Quandt, 1999; Appeldoorn et al., 2000). Movement of traps during haul-back or storms may also induce damage (Jennings and Kaiser, 1998). Potential for damage during haul-back in USVI has been lessened by the use of buoyant trap lines which facilitate off-bottom grappling for trap retrieval. However, if currents are strong or trap line reset is delayed while fishing, then traps and lines may be dragged across the bottom. There remains a need to assess the extent and duration of damage to corals from trap fishing and to begin working with fishermen to reduce the potential for habitat disruption.

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LITERATURE CITED

Appeldoorn, R.S., M. Nemeth, J. Vasslides, and M. Schärer. [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, Mayagüez, PR.Unpubl. MS. 33 p.

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. Volume I*. Caribbean Fishery Management Council, San Juan, Puerto Rico. 173 p.

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. *Revista de Biologia Tropical* **46** (Suppl. 5):41-59.

Holthuis, L. B. 1991. *FAO species catalogue. Volume 13. Marine lobsters of the world. An annotated and illustrated catalogue of species of interest to fisheries known to date*. FAO Fisheries Synopsis No. 125, Volume 13. United Nations Food and Agriculture Organization, Rome. 292 p.

Jennings, S., and M. J. Kaiser. 1998. The effects of fishing on marine ecosystems. *Advances in Marine Biology* **34**:201-352.

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

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

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, 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.

Sheridan, P., R. Hill, G. Matthews, R. Appeldoorn, B. Kojis, and T. Matthews. 2005. Does trap fishing impact coral reef ecosystems? An update. *Proceedings of the Gulf and Caribbean Fisheries Institute* **56**:511-520.