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U.S. Caribbean Fish Trap Fishery Costs and Earnings Study

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EXECUTIVE SUMMARY

This study describes the socio-economic characteristics of the U.S. Caribbean trap fishery that encompasses the Commonwealth of Puerto Rico and Territory of the U.S. Virgin Islands. In-person interviews were administered to one hundred randomly selected trap fishermen, constituting nearly 25% of the estimated population. The sample was stratified by geographic area and trap tier. The number of traps owned or fished to qualify for a given tier varied by island. In Puerto Rico, tier I consisted of fishermen who had between 1-40 fish traps, tier II was made up of fishermen who possessed between 41 and 100 fish traps, and tier III consisted of fishermen who held in excess of 100 fish traps. In St. Thomas and St. John, tier I was composed of fishermen who held between 1 and 50 fish traps, tier II consisted of fishermen who had between 51-150 fish traps and tier III was made up of fishermen who had in excess of 150 fish traps. Lastly, in St. Croix, tier I was made up of fishermen who had less than 20 fish traps and tier II consisted of fishermen who had 20 or more fish traps.

The survey elicited information on household demographics, annual catch and revenue, trap usage, capital investment on vessels and equipment, fixed and variable costs, behavioral response to a hypothetical trap reduction program and the spatial distribution of traps. The study found that 79% of the sampled population was 40 years or older. The typical Crucian trap fisherman was older than their Puerto Rican and St. Thomian and St. Johnian counterparts. Crucian fishermen's average age was 57 years whereas Puerto Rican fishermen's average age was 51 years, and St. Thomian and St. Johnian fishermen's average age was 48 years. As a group, St. Thomian and St. Johnian fishermen had 25 years of fishing experience, and Puerto Rican and Crucian fishermen had 30, and 29 years, respectively.

Overall, 90% of the households had at least one dependent. The average number of dependents across islands was even, ranging between 2.8 in the district of St. Thomas and St. John and 3.4 in the district of St. Croix. The percentage utilization of catch for personal or family use was relatively low. Regionally, percentage use of catch for

personal or family uses ranged from 2.5% in St. Croix to 3.8% in the St. Thomas and St. John. About 47% of the respondents had a high school degree.

The majority of the respondents were highly dependent on commercial fishing for their household income. In St. Croix, commercial fishing made up 83% of the fishermen's total household income, whereas in St. Thomas and St. John and Puerto Rico it contributed 74% and 68%, respectively. The contribution of fish traps to commercial fishing income ranged from 51% in the lowest trap tier in St. Thomas and St. John to 99% in the highest trap tier in St. Croix. On an island basis, the contribution of fish traps to fishing income was 75% in St. Croix, 61% in St. Thomas and St. John, and 59% in Puerto Rico.

The value of fully rigged vessels ranged from $400 to $250,000. Over half of the fleet was worth $10,000 or less. The St. Thomas and St. John fleet reported the highest mean value, averaging $58,518. The Crucian and Puerto Rican fleets were considerably less valuable, averaging $19,831 and $8,652, respectively. The length of the vessels ranged from 14 to 40 feet. Fifty-nine percent of the sampled vessels were at least 23 feet in length. The average length of the St. Thomas and St. John fleet was 28 feet, whereas the fleets based in St. Croix and Puerto Rico averaged 21 feet. The engine's propulsion ranged from 8 to 400 horsepower (hp). The mean engine power was 208 hp in St. Thomas and St. John, 108 hp in St. Croix, and 77 hp in Puerto Rico.

Mechanical trap haulers and depth recorders were the most commonly used on-board equipment. About 55% of the sampled population reported owning mechanical trap haulers. In St. Thomas and St. John, 100% of the respondents had trap haulers compared to 52% in Puerto Rico and 20% in St. Croix. Forty-seven percent of the fishermen surveyed stated having depth recorders. Depth recorders were most common in the St. Thomas and St. John fleet (80%) and least common in the Puerto Rican fleet (37%). The limited presence of emergency position indication radio beacons (EPIRBS) and radar was the norm among the fish trap fleet. Only 8% of the respondents had EPIRBS and only 1% had radar.

Interviewees stated that they fished between 1 and 350 fish traps. Puerto Rican respondents fished on average 39 fish traps, in contrast to St. Thomian and St. Johnian and Crucian respondents, who fished 94 and 27 fish traps, respectively. On average, Puerto Rican respondents fished 11 lobster traps, and St. Thomian and St. Johnian respondents fished 46 lobster traps. None of the Crucian respondents fished lobster traps.

The number of fish traps built or purchased ranged between 0 and 175, and the number of lobster traps built or bought ranged between 0 and 200. Puerto Rican fishermen on average built or purchased 30 fish traps and 14 lobster traps, and St. Thomian and St. Johnian fishermen built or bought 30 fish traps and 11 lobster traps. Crucian fishermen built or bought 25 fish traps and no lobster traps. As a group, fish trap average life ranged between 1.3 and 5 years, and lobster traps lasted slightly longer, between 1.5 and 6 years.

The study found that the chevron or arrowhead style was the most common trap design. Puerto Rican fishermen owned an average of 20 arrowhead traps. St. Thomian and St. Johnian and Crucian fishermen owned an average of 44 and 15 arrowhead fish traps, respectively. The second most popular trap design was the square trap style. Puerto Rican fishermen had an average of 9 square traps, whereas St. Thomian and St. Johnian fishermen had 33 traps and Crucian fishermen had 2 traps. Antillean Z (or S) -traps, rectangular and star traps were also used. Although Z (or S) -traps are considered the most productive trap design, fishermen prefer the smaller-sized arrowhead and square traps because they are easier and less expensive to build, and larger numbers of them can be safely deployed. The cost of a fish trap, complete with rope and buoys, varied significantly due to the wide range of construction materials utilized. On average, arrowhead traps commanded $94 in Puerto Rico, $251 in St. Thomas and St. John, and $119 in St. Croix.

The number of trips per week ranged between 1 and 6. However, 72% of the respondents mentioned that they took two trips per week. On average, Puerto Rican fishermen took 2.1 trips per week, St. Thomian and St. Johnian fishermen took 1.4 trips per week, and

Crucian fishermen took 2.5 trips per week. Most fishing trips started at dawn and finished early in the afternoon. Over 82% of the trips lasted 8 hours or less.

On average, Puerto Rican fishermen hauled 27 fish traps per trip whereas St. Thomian and St. Johnian fishermen and Crucian fishermen hauled 68 and 26 fish traps per trip, respectively. The number of traps per string and soak time varied considerably across islands. In St. Croix, 84% of the respondents had a single trap per line, whereas in St. Thomas and St. John only 10% of the respondents had a single trap per line. Approximately, 43% of Puerto Rican fishermen used a single trap line. St. Thomian and St. Johnian fishermen soaked their traps for 6.9 days while Puerto Rican and Crucian fishermen soaked their traps for 5.7 and 3.6 days, respectively.

The heterogeneity of the industry was also evidenced by the various economic surpluses generated. The survey illustrated that higher gross revenues did not necessarily translate into higher net revenues. Our analysis also showed that, on average, vessels in the trap fishery were able to cover their cash outlays, resulting in positive vessel income (i.e., financial profits). In Puerto Rico, annual financial profits ranged from $4,760 in the lowest trap tier to $32,467 in the highest tier, whereas in St. Thomas and St. John annual financial profits ranged from $3,744 in the lowest tier to $13,652 in the highest tier. In St. Croix, annual financial profits ranged between $9,229 and $15,781. The survey also showed that economic profits varied significantly across tiers. Economic profits measure residual income after deducting the remuneration required to keep the various factors of production in their existing employment. In Puerto Rico, annual economic profits ranged from ($9,339) in the lowest trap tier to $ 8,711 in the highest trap tier. In St. Thomas and St. John, annual economic profits ranged from ($7,920) in the highest tier to ($18,486) in the second highest tier. In St. Croix, annual economic profits ranged between ($7,453) to $10,674.

The presence of positive financial profits and negative economic profits suggests that higher economic returns could be earned from a societal perspective by redirecting some of these scarce capital and human resources elsewhere in the economy. Furthermore, the

presence of negative economic earnings is evidence that the fishery is overcapitalized and that steps need to be taken to ensure the long-run economic viability of the industry. The presence of positive financial returns provides managers with a window of opportunity to adopt policies that will strengthen the biological and economic performance of the fishery while minimizing any adverse impacts on local fishing communities. Finally, the document concludes by detailing how the costs and earnings information could be used to develop economic models that evaluate management proposals.

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This study is part of the Southeast Fisheries Science Center's social science research agenda to improve our knowledge and understanding of U.S. Caribbean fisheries, fishermen and fishing communities.

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INTRODUCTION

The fish trap fishery is one of the most valuable fisheries in the U.S. Caribbean. In Puerto Rico, this fishery accounts for approximately 22 percent of the landings and 24 percent of the revenue. Spiny lobster and snappers account for over 60 percent of the revenue derived from fish traps. In the U.S. Virgin Islands, fish traps are responsible for approximately 37 percent of the landings and revenue. Spiny lobster and triggerfish alone account for 48 percent of the revenues derived from fish traps.

Fish traps are commonly used in coral reef and related habitats, where they target a variety of species including spiny lobsters, deep-water snappers, shallow-water snappers, grunts, and groupers. During the last decade, the impact of traps on coral reefs has been the focus of considerable debate. A number of organizations, including environmental groups, have expressed concern over the physical damage caused by the setting and hauling of traps (Sheridan *et al*, 2003). Early research indicated that 40% of the traps off St. Thomas were placed over hard corals resulting in an estimated annual loss of 100 m^2 of hard coral (Quandt, 1999). Healthy reefs can yield up to 35 metric tons of fish per square kilometer annually (Russ, 1991). However, on-going research suggests that about 20% of the traps are placed on hard coral in the U.S. Virgin Islands (Sheridan *et al*, 2003). More recently, Garrison *et al* (2004) found that in St. John fishermen preferentially set traps in algal plains.

In addition to habitat damage, the non-selective nature of fish traps is another source of concern. Fish traps catch a variety of overexploited reef fish species. Reef-fish species, particularly groupers, are vulnerable to overfishing because of their life history characteristics, which include slow growth, delayed reproduction, and sedentary behavior. For example, Nassau and Goliath groupers remain overexploited, despite commercial harvest bans since the early 1990's. Because of the widespread use of traps by small-scale fishermen, addressing the anthropogenic impacts of habitat-gear interactions not only requires biological assessments but also socioeconomic assessments.

In anticipation of the need to evaluate the effects of proposed trap regulations on fishermen and their communities, we conducted a costs and earnings study. The primary objective of the study was to collect socio-economic information on the U.S. Caribbean fish trap fishery to support the management and conservation efforts of the Caribbean Fishery Management Council (CMFC). The draft Amendment to the Fishery Management Plans (FMPs) of the U.S. Caribbean to Address Required Provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) is considering, among other alternatives, either reducing the number of existing fish traps and/or phasing out their use over a five to ten year horizon. Socio-economic assessments are vital to evaluate the potential impacts of trap regulations on fishermen and fishing communities.

The paucity of socio-economic data has been a significant hurdle in evaluation of regulatory proposals. Most of the existing economic information is limited to dockside value data. In Puerto Rico, price data are collected from voluntary trip ticket catch reports.[1] In the U.S. Virgin Islands, price information is reported annually. Holt and Uwate (2004) recently compiled a time series of U.S. Virgin Islands prices from the mid 1970's to present. There have been two other costs and earnings studies, which were limited in geographic scope and are now outdated (see, Kahn, 1948; Olsen *et al*, 1982). Unfortunately, this dated research is inadequate to support current management actions and meet the requirements put forth by MSA. Nevertheless, a positive development in the last few years has been censuses of fishermen by local fisheries agencies. These censuses have gathered demographic and capital investment (i.e., vessel and equipment) information (see, Matos-Caraballo *et al*, 2003; Kojis, 2004).

This study describes the salient socio-economic characteristics of the U.S. Caribbean fish trap fishery, which encompasses the Commonwealth of Puerto Rico and Territory of the U.S. Virgin Islands (i.e., St. Thomas, St. John, and St. Croix). To protect respondents' confidentiality we only present group averages, frequency distributions, and other summary statistics. The survey inquired about household demographics, annual catch and revenue, fishing practices, capital investment on vessels and equipment, fixed and

[1] The new Puerto Rican fisheries law makes the reporting of landings mandatory.

variable costs, behavioral response to a hypothetical trap reduction program and the spatial distribution of traps. In addition to providing summary statistics, we discuss how future research will use this data to develop models that evaluate the economic performance of various regulatory proposals such as a trap reduction program.

MATERIALS AND METHODS

Survey Development and Administration

The Southeast Fisheries Science Center (SEFSC) commissioned the development of the fish trap cost and earnings study. The study was to complement other federal, state, and local research efforts examining gear and habitat interactions (see, Sheridan *et al*, 2003). The SEFSC also began collecting socio-economic and cultural information to identify fishing communities and describe their level of engagement and dependence on local fisheries.

In September 2001, the SEFSC contracted with Thomas J. Murray and Associates, Inc. (M&A) to develop and conduct the costs and earnings data collection. The study commenced in November 2001 with a meeting between SEFSC and M&A social scientists. The meeting served to outline the logistics of the project and the content of the questionnaire. M&A in collaboration with the SEFSC social scientists designed the survey instrument. A number of steps were taken to develop the survey. Initially, M&A organized two meetings to introduce the objectives of the study, identify main issues affecting the trap fishery, and solicit feedback on the initial set of proposed questions. Federal, commonwealth/territory, and local agency representatives, academic experts, and commercial trap fishermen attended the San Juan (Puerto Rico) and St. Thomas (U.S. Virgin Islands) meetings held in January 2002. The comments received during these meetings were incorporated into the initial questionnaire. Subsequently, the questionnaire was tested with fishermen who volunteered to assist with the study. The meetings and questionnaire testing took place in January-February 2002.

Following a number of exchanges, M&A and SEFSC social scientists agreed on the revised questionnaire, and proceeded with the Paper Reduction Act (PRA) clearance process. A notice was published in the *Federal Register* on Tuesday, November 20, 2001 (Vol. 66, No. 224, pp. 58120-58121) soliciting public comments regarding the data collection process. The Office of Management and Budget (OMB) received the survey instrument and accompanying materials in July 2002. OMB approved the data collection in December 2002.

Due to the timing of the approval, M&A social scientists delayed final testing of the questionnaire until April 2003. During this time, SEFSC social scientists developed a sampling frame and research protocol. The protocol stated that enumerators were to contact each fisherman in order from a randomized list, and that fishermen were only to be removed from the list if they a) refused to participate, b) were not available due to illness or death, or c) could not be reached within 8 separate attempts.

Between April and September of 2003, contractors conducted one hundred interviews in Puerto Rico and U.S. Virgin Islands. In December 2003, the SEFSC received a database and an interim final report. The report described the development of the questionnaire, field training and questionnaire implementation, and the database structure design and transfer. SEFSC received the final report and database in March 2004.

Survey instrument

The survey instrument had nine sections (Appendix A). The first section asked for background demographic information on the fishermen and their households. It specifically elicited information on the age, number of dependents, years of formal education, years of commercial fishing experience, primary landing, or access site, percentage of income derived from commercial fishing, and participation and revenue generated from non-fishing activities. Section two inquired about dockside revenue by main species and gear types. The third section elicited information on fishing practices and trap usage, including the number of traps fished last season, number of traps built last

season, average trap's life span, average number of trips taken per week, number of traps pulled per trip, duration of fishing trip, soak time, etc.

Section four collected variable cost information, including fuel, oil, ice, bait, supplies, and labor. Section five inquired about fishermen's annual distribution of effort among fisheries and their participation on non-fishing activities. The sixth section collected capital investment on vessel and equipment. This section gathered information on the vessel size and age, hull type, engine horsepower, number and type of traps as well as the value of the vessel, traps, and other miscellaneous equipment.

The seventh section requested information on fixed costs, which include docking fees, vessel mortgage payments, vessel insurance payments, and vessel and equipment maintenance and repair expenditures. The eighth section sought information on fishermen's business motivations and reasons for certain fishing practices (e.g., factors that affect trap usage, reasons for not fishing the ideal number of traps) as well as likely behavioral response to a hypothetical reduction in the number of traps fished (e.g., changes in soak time, gear and area switching, etc.). Lastly, we asked fishermen to describe the spatial distribution of their traps.

Sampling Design

The absence federal licenses in the U.S. Caribbean required the use of the 2002 Puerto Rican fishermen census and U.S. Virgin Islands license registration databases to establish a sampling frame.[2] The sampling frame identified 324 fish trap fishermen in Puerto Rico and 97 fish trap fishermen in U.S. Virgin Islands (Table 1). The Puerto Rican fishermen census database provided the number of fish traps owned whereas the U.S. Virgin Islands license registration database provided the number of fish traps fished. The number of fish traps owned in U.S. Virgin Islands was not available at the time of the survey. However, it recently became available after the completion of the 2003 U.S. Virgin Islands

2 The only exception is the HMS permit, which is required for those vessels harvesting tunas, swordfish and sharks in the Atlantic Ocean, including Gulf of Mexico and Caribbean waters.

fishermen census (Kojis, 2004). Both the Puerto Rico and U.S. Virgin Islands databases supplied useful auxiliary information such as fishermen names and addresses.

In developing the sampling frame, we favored the 2002 Puerto Rican fishermen census over the Puerto Rican license registration because Puerto Rico's Department of Natural and Environmental Resources (DNER) until recently did not require fishermen to obtain a license to operate in Commonwealth waters. While most fishermen had them because the Commonwealth government provides a number of incentives such as discounted boat registration fees, there was concern that the list contained a large (but unspecified) number of recreational fishermen seeking these incentives. Also, because the 2002 Puerto Rican fishermen census benefited from the extensive involvement of local port samplers, it was felt that the census best identified genuine commercial fishermen.[3] In addition, since the Puerto Rican license registration database did not differentiate between commercial and recreational fishermen, it was impossible to assess whether this database provided a representative sample of commercial fishermen population. Finally, only the 2002 Puerto Rico fishermen census database was available electronically. In the case of the U.S. Virgin Islands, we only had the licensing database, which contained the number of traps fished. At the time of the study, U.S. Virgin Islands' Department of Planning and Natural Resources (DPNR) was in the process of conducting their 2003 fisher census, which has since been completed (Kojis 2004). DPNR requires fishing licenses to operate in territorial waters. In 2001, U.S. Virgin Islands implemented a moratorium on the issuance of new commercial fishing permits.

The sampling design required a stratified random sample of 100 fish trap fishermen. The number of traps owned (or fished) was used to stratify the sample. The sampling designed called for a voluntary, in-person interview of 60 fishermen in Puerto Rico, 20 fishermen in St. Thomas and St. John, and 20 fishermen in St. Croix. For each geographic area, the sampling plan divided fishermen into two or three strata (or tiers) to reflect the scale of operation, defined by the number of traps owned or fished, from which a random sample was drawn.

3 Matos-Caraballo (2003) provides a summary of the 2002 Puerto Rican fishermen census.

The number of traps owned or fished to qualify for a given tier varied by island. In Puerto Rico, tier I consisted of fishermen who owned between 1-40 fish traps, tier II was made up of fishermen who possessed between 41 and 100 fish traps, and tier III consisted of fishermen who held in excess of 100 fish traps. In St. Thomas and St. John, tier I was composed of fishermen who held between 1 and 50 fish traps, tier II consisted of fishermen who had between 51-150 fish traps and tier III was made up of fishermen who had in excess of 150 fish traps. Lastly, in St. Croix, tier I was made up of fishermen who had less than 19 fish traps and tier II consisted of fishermen who had in excess of 20 fish traps (Table 1).

The rationale for the stratification was to capture the fleet's heterogeneity (i.e., small, medium, and large-scale operators) and to minimize the possibility of inadvertently marginalizing or excluding components of the fleet. Thus, the stratification tended to disproportionately sample medium and large-scale operators. In addition, the stratification made the survey more cost effective and convenient to administer. Scale of operation tiers were determined in consultation with local fisheries experts.

To meet the requirements of the sampling protocol, interviewers contacted selected fishermen from a randomized list that recorded fisherman's name, address, and phone number. Surveyors were also instructed to select a replacement if fishermen a) refused to participate, b) were not available due to illness, death, or travel, and c) could not be contacted after eight separate attempts. When the number of willing participants prevented the contractors from meeting the stratum goal, interviewers completed additional interviews in another stratum. This allowed the contractors to meet the one hundred interviews required under the contract. This situation occurred twice, as surveyors conducted two additional interviews in the second tier stratum for Puerto Rico and three extra interviews in the second tier stratum for St. Thomas and St. John (Table 1).

Table 1: Survey universe, sample size, and number of responses by tier

Area	Tier (number of fish traps)	Population (number of fishermen)	Target number of interviews	Number of completed interviews	Number of contacts
Puerto Rico	1-40	258	30	30	57
	41-100	53	20	22	31
	≥101	13	10	8	13
Puerto Rico Total		***324***	***60***	***60***	***101***
St. Thomas and St. John	1-50	19	8	5	19
	51-150	20	7	10	17
	≥151	13	5	5	9
St. Croix	1-19	31	13	13	30
	≥20	14	7	7	12
U.S.V.I. Total		***97***	***40***	***40***	***88***
Grand Total		**421**	**100**	**100**	**188**

Notwithstanding considerable effort and resources devoted to this endeavor, the raw (or un-adjusted) response rate was 53.2%. We calculated this rate by dividing the total number of completed interviews by the total number of people contacted (Table 1).

Table 2 shows the reasons for non-response. Fifty-two fishermen were unreachable and 18 fishermen refused to participate. This accounted for 59.1% and 20.5% of the non-response rate, respectively. If we ignore those fishermen who were unreachable, and those who no longer fished with traps (i.e., no longer qualified); then, the effective (or adjusted) response rate increased to 80.6%.

Table 2: Reasons for declining to participate in the survey

	Puerto Rico	St. Thomas and St. John	St. Croix	Total
Population	324	52	45	421
Planned sample	60	20	20	100
Number of contacts	101	45	42	188
Number of non-respondents	41	25	22	88
Reasons for non-response				
Unreachable	25	13	14	52
No longer qualified	10	2	0	12
Refused	3	8	7	18
Other	3	2	1	6

RESULTS

This section describes the main results of the fish trap costs and earnings survey. For presentation ease, we summarize the survey questions in themes rather than sequentially. We present eight broad themes that discuss various socio-economic aspects of the U.S. Caribbean fish trap fishery. The thematic format allows us to synthesize salient socio-economic information to characterize the U.S. Caribbean fish trap fleet and it also allows us to integrate diverse economic information to develop various economic and financial performance measures. The summary statistics are presented by tiers (i.e., number of traps owned or fished). Low tier numbers correspond to small-sized operations whereas

large tier numbers correspond to medium or larger-sized operations (Table 1). The tabulated numbers for each tier are sample means. The numbers in parenthesis are standard errors of the mean.

Demographic profile

The first theme describes fisherman's age, educational background, number of dependents, fishing experience, household's dependence on fishing income, personal consumption of catch, and employment in non-fishing occupations. This demographic theme summarizes survey questions 1 through 9 (Appendix A).

The age of the sampled population ranged from 23 to 84 years. On average, Crucian fishermen were older than Puerto Rican and St. Thomian and St. Johnian fishermen. St. Croix fishermen's average age was 57 years whereas Puerto Rican fishermen's average age was 51 years, and St. Thomian and St. Johnian fishermen's average age was 48 years (Table 3). With the exception of St. Thomas and St. John fishermen, the larger the number of traps owned (or fished), the older the fisher. Frequency analysis showed that there were 4 respondents in the 20 to 29 age group, 17 respondents in the 30 to 39 age group, 20 respondents in the 40 to 49 age group, and 27 respondents in the 50 to 59 age group. Twenty respondents were in the 60 to 69 age group, 9 respondents in the 70 to 79 age group, and 3 respondents in the 80 to 89 age group (Table 4).

The survey showed that the respondents were seasoned commercial fishermen. As a group, Puerto Rican and Crucian fishermen had 30, and 29 years of fishing experience, respectively. St. Thomian and St. Johnian fishermen had 25 years of fishing experience (Table 3). Commercial fishing experience varied considerably across tiers, except in Puerto Rico. In St. Croix, participation in the fishing industry ranged from 25 years in the lowest trap tier to 38 years in the highest trap tier.

Notwithstanding the prevalence of fish traps in the Caribbean, most respondents did not operate fish traps for their entire commercial fishing history. Fishermen from Puerto Rico, St. Croix, and St. Thomas and St. John had been fishing with fish traps for 23, 23, and 21 years, respectively. The majority of respondents had considerably less experience

with lobster traps than with fish traps. Puerto Rican fishermen experience with lobster traps ranged from 4 years (3rd tier) to 11 years (2nd tier), and St. Thomian and St. Johnian fishermen experience ranged from 0.6 years (1st tier) to 6 years (2nd tier). None of the Crucian fishermen interviewed operated lobster traps (Table 3).

Trap fishermen's formal education ranged between 1 to 16 years (Table 5). About 53 percent of the respondents did not complete high school (Table 3). As a group, St. Thomian and St. Johnian, Puerto Rican, and Crucian fishermen had 10, 10, and 9 years of formal education, respectively (Table 3).

The majority of the respondents were highly dependent on commercial fishing for their household income. In St. Croix, commercial fishing made up 83% of the fishermen's household income, whereas in St. Thomas and St. John and Puerto Rico, commercial fishing contributed 74% and 68% of the household income, respectively (Table 6).

The contribution of fish traps to commercial fishing income ranged from 51% in the lowest St. Thomas and St. John trap tier to 99% in the highest St. Croix trap tier. On an island basis, fish traps' contribution to fishing income was 75 % in St. Croix, 61% in St. Thomas and St. John, and 59% in Puerto Rico. In contrast, lobster traps' contribution to fishing income ranged from 0% in St. Croix to 14% in St. Thomas. In Puerto Rico, lobster traps' contribution to fishing income was 11% (Table 6).

The number of dependent household members ranged from 1 to 8, including the respondent. Overall, 90% of the households had at least one dependent. The average number of dependents across islands was constant, ranging between 2.8 in St. Thomas and St. John and 3.4 in St. Croix (Table 7).

Percentage utilization of catch for personal or family use was relatively low. Regionally, percentage use of catch for personal or family uses ranged from 2.5% in St. Croix to 3.8% in the St. Thomas and St. John. Notwithstanding the above, the lowest trap tier in St. Thomas and St. John exhibited a relatively high percentage for personal or family

consumption of catch (7.6%). U.S. Virgin Islands Territorial regulations require individuals who use pots and traps for personal consumption to obtain a commercial fishing permit (Table 6).

Respondents were hesitant to discuss their non-fishing occupations. Seventy-one of the respondents declined to answer this question. Of those who responded, the majority indicated that social security payments were their main source of alternative income. The survey also inquired about their earnings per day and number of days per year employed in non-commercial fishing jobs. Due to the low response rate, we do not report these results (Table 8).

Table 3: Demographic characteristics based on questions 1, 3, 4 and 5 *

Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Age of fish trap fisherman (years)	Puerto Rico	50.33 (2.84)	30	52.14 (2.33)	22	54.87 (1.63)	8	50.81 (2.3)	60
	St. Thomas & St. John	50.40 (4.94)	5	49.20 (1.91)	10	43.20 (3.42)	5	48.14 (2.13)	20
	St. Croix	55.07 (3.45)	13	62.57 (2.51)	7			57.41 (2.50)	20
Commercial fishing experience (years)	Puerto Rico	29.80 (2.79)	30	31.18 (2.35)	22	31.25 (2.48)	8	30.08 (2.26)	60
	St. Thomas & St. John	20.0 (4.11)	5	29.0 (2.03)	10	25.8 (4.01)	5	24.91 (1.96)	20
	St. Croix	24.61 (3.68)	13	38.29 (1.50)	7			28.87 (2.51)	20
Commercial fishing experience with fish traps (years)	Puerto Rico	22.33 (2.57)	30	28.09 (2.52)	22	27.12 (2.99)	8	23.47 (2.09)	60
	St. Thomas & St. John	20.0 (4.11)	5	26.3 (2.67)	10	23.6 (3.26)	5	23.32 (1.99)	20
	St. Croix	18.08 (3.41)	13	28.71 (4.03)	7			21.39 (2.67)	20
Commercial fishing experience with lobster traps (years)	Puerto Rico	6.2 (1.90)	30	11.54 (2.76)	22	3.75 (1.33)	8	6.98 (1.58)	60
	St. Thomas & St. John	0.60 (0.51)	5	5.89 (2.78)	9	5.6 (25)	5	3.80 (1.21)	19
	St. Croix	0 (0)	13	0 (0)	7			0 (0)	20
Formal education (years)	Puerto Rico	9.68 (0.656)	28	9.73 (0.56)	22	8.75 (0.97)	8	9.65 (0.52)	58
	St. Thomas & St. John	9.25 (1.37)	4	10.55 (0.54)	9	10.80 (0.94)	5	10.19 (0.56)	18
	St. Croix	8.08 (0.69)	12	10.66 (1.06)	6			8.85 (0.58)	18

* The tabulated numbers for each tier are sample means. The numbers in parenthesis are standard errors of the mean.

Table 4: Age distribution based on question 1

	Region			
Age	Puerto Rico	St Thomas and St John	St Croix	Frequency
10-19 years	0	0	0	0
20-29 years	4	0	0	4
30-39 years	10	4	3	17
40-49 years	12	6	2	20
50-59 years	14	9	4	27
60-69 years	13	1	6	20
70-79 years	4	0	5	9
80-89 years	3	0	0	3
Total	60	20	20	100

Table 5: Formal education distribution based on question 3

	Region				
Formal Education (years)	Puerto Rico	St Thomas and St John	St Croix	All Islands	Cumulative Percentage
1	1	0	0	1	1.06
2	0	0	0	0	1.06
3	2	0	1	3	4.26
4	5	0	0	5	9.57
5	3	0	2	5	14.89
6	2	2	3	7	22.34
7	4	3	2	9	31.91
8	4	0	0	4	36.17
9	4	1	1	6	42.55
10	3	0	2	5	47.87
11	3	1	1	5	53.19
12	21	10	5	36	91.49
13	1	1	0	2	93.62
14	1	0	0	1	94.68
15	1	0	0	1	95.74
16	3	0	1	4	100
Total	58	18	18	94	100
No response	2	2	2	6	

Table 6: Indexes of fishing dependence based on questions 2, 7, and 8

Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Percentage income derived from commercial fishing	Puerto Rico	64.0 (5.72)	28	88.81 (3.361)	21	78.12 (5.49)	8	68.73 (4.57)	57
	St. Thomas & St. John	49.0 (18.03)	5	85.5 (4.73)	10	93.0 (4.57)	5	74.04 (6.93)	20
	St. Croix	84.23 (5.55)	13	81.43 (7.78)	7			83.36 (4.53)	20
Percentage of commercial fishing income derived from fish trap fishing	Puerto Rico	56.14 (5.55)	28	68.75 (4.45)	20	84.37 (5.54)	8	59.37 (4.49)	56
	St. Thomas & St. John	50.75 (16.6)	4	61.0 (6.95)	10	73.0 (9.89)	5	61.00 (6.54)	19
	St. Croix	61.82 (8.84)	11	99.29 (0.51)	7			74.86 (5.77)	18
Percentage of commercial fishing income derived from lobster trap fishing	Puerto Rico	11.35 (3.9)	26	12.37 (3.77)	19	9.37 (2.9)	8	11.42 (3.15)	53
	St. Thomas & St. John	0 (0)	4	19.0 (7.26)	3	23.75 (11.48)		13.75 (4.12)	18
	St. Croix	0 (0)	13	0 (0)	7			0 (0)	20
Number of dependents (including self)	Puerto Rico	3.27 (2.51)	30	3.36 (0.30)	22	2.87 (0.36)	8	3.27 (0.21)	60
	St. Thomas & St. John	2.80 (0.63)	5	2.6 (0.34)	10	3.2 (0.46)	5	2.82 (0.29)	20
	St. Croix	3.46 (0.32)	13	3.14 (0.62)	7			3.36 (0.29)	20
Percentage of catch retained for personal or family use (%)	Puerto Rico	2.76 (0.77)	23	2.93 (0.55)	21	4.73 (1.65)	7	2.88 (0.60)	51
	St. Thomas & St. John	7.6 (2.98)	5	1.6 (0.41)	10	1.0 (0.32)	4	3.78 (1.16)	19
	St. Croix	2.17 (0.51)	12	3.14 (0.62)	7			2.49 (0.4)	19

Table 7: Distribution of dependent household members based on question 2

Number of dependent household member (including fisherman)	Region				
	Puerto Rico	St Thomas and St John	St Croix	All Islands	Cumulative percentage
1	4	4	2	10	10
2	24	7	7	38	48
3	8	1	2	11	59
4	9	5	3	17	76
5	10	3	5	18	94
6	3	0	0	3	97
7	1	0	0	1	98
8	1	0	1	2	100
Total	60	20	20	100	100

Table 8: Occupational multiplicity based on question 9

Region	Non-commercial fishing occupation	N	Region	Non-commercial fishing occupation	N	Region	Non-commercial fishing occupation	N
Puerto Rico			Saint Thomas and St John			Saint Croix		
	Businessman	1		Carpentry	1		Government	1
	Charter boat operator	1		Maintenance	1		Sailing instructor	1
	Electrician	1		Mechanic	1		Social security	4
	Fireman	1		Property rental	1			
	Fish importer	1		Sales	1			
	Government	2						
	Laboratory	2						
	Photographer	1						
	Factory worker (custard)	1						
	Social security	7						
Total		18			5			6
No Response		42			15			14

Vessel and equipment characteristics

This theme describes fishermen's capital investment. It summarizes information on the vessel's value, age, length, and hull construction. It also provides information on the engine's age, type and horsepower, and the presence of miscellaneous fishing and electronic equipment. This theme reviews questions 18 though 26a (Appendix A).

The value of fully rigged vessels ranged from $400 to $250,000 (Table 9). Fifty-one percent of the fleet was worth $10,000 or less. The St. Thomas and St. John fleet had the highest mean value, averaging $58,518. The Crucian and Puerto Rican fleets were of considerably less valuable averaging $19,831 and $8,652, respectively. Average capital investment value increased with trap usage (Table 10).

The length of the vessels ranged from 14 to 40 feet (Table 11). Fifty-nine percent of the vessels were at least 23 feet in length. As a group, the fleet based in St. Thomas and St. John had larger vessels averaging 28 feet (Table 10). The fleets based in St. Croix and Puerto Rico had an average length of 21 feet. While mean vessel size increased with the number of the traps owned, there was very little variation across tiers (i.e., less than five feet in difference among tiers within each group).

The age of the fleet varied between 2 and 60 years (Table 12). About 50 percent of the sampled fleet was at least 14 years old. Fishermen from St. Thomas and St. John had the relatively older vessels relative to their counterparts. The fleet's mean age was 18 years in St. Thomas and St. John, and 16 years in St. Croix and Puerto Rico (Table 10). With the exception of the Puerto Rico's trap tier II, the average vessel age increased with the number of traps owned.

The age of the engine varied between 1 to 27 years (Table 13). Fifty percent of the fleet had engines that were 5 years old or less. The mean engine age was 6.5 years in Puerto Rico, 8 years in St. Thomas and St. John, and 9 years in St. Croix (Table 10). With the exception Puerto Rico, where the average age of engines increased with the number of

traps owned, there was no trend between engine age and trap tier (Table 10). The number of years since the last major vessel overhaul ranged between 1 and 14 (Table 14). The number of years spanned since the last major engine renovation ranged between 0.5 and 14 years (Table 15).

Table 16 shows the fleet's engine propulsion ranged from 8 to 400 horsepower (hp). The average engine power was 208 hp in St. Thomas St. John, 108 hp in St. Croix, and 77 hp in Puerto Rico (Table 10).

Fiberglass hulled vessels were prevalent across the islands (Table 17). All of the vessels sampled in St. Thomas and St. John had fiberglass hulls compared to 95% of the vessels in St. Croix and 87% of the vessels in Puerto Rico. The few wooden hulled vessels corresponded to the lower trap tiers of Puerto Rico and St. Croix (Table 17).

Engine types varied across the islands. Outboard engines were more common in Puerto Rico and St. Croix whereas inboard engines were prevalent in St. Thomas and John. In St. Croix and Puerto Rico, outboard engines accounted for 85% and 80% of engines types used, respectively. Only 25% of the engines in St. Thomas and St. John were of the outboard type (Table 17).

Mechanical trap haulers and depth recorders were the most common on-board equipment used (Table 18). About 55% of the sampled population had mechanical trap haulers. In St. Thomas and St. John, all of the respondents reported owning haulers compared to 51.7% in Puerto Rico and 20% in St. Croix. Mechanical trap haulers were most prevalent in the higher trap tiers. Forty-seven percent of the fishermen surveyed stated having depth recorders. Depth recorders were most common in the St. Thomas and St. John fleet (80%) and least common in the Puerto Rican fleet (37%).

Thirty-seven percent of the sampled population had global positioning systems (GPS). Sixty-five percent of the vessels in St. Thomas and St. John were equipped with GPS

compared with 31.7% in Puerto Rico. About 25% of the Crucian fleet had GPS (Table 18).

The limited presence of emergency position indication radio beacons (EPIRBS) and radar was the norm among the fish trap fleet. Only eight percent of all respondents had EPIRBS and only one percent had radar. Thirty-five percent of the St. Thomas and St. John fleet had an EPIRB whereas five percent of the St. Croix fleet had an EPIRB. These results are consistent with Kojis (2004), who found that 9% of the U.S. Virgin Islands fleet had EPIRBs, and that the St. Thomian and St. Johnian fleet carried almost twice as many EPIRBs as the Crucian fleet. None of the Puerto Rican vessels sampled had an EPIRB. Only one fisherman in St. Croix had radar. None of the St. Thomian and St. Johnian and Puerto Rican vessels sampled had radar (Table 18). Kojis (2004) found that about 1.6 % of the U.S. Virgin Islands fleet had radars.

Table 9: Value of fully rigged vessel based on question 26a

Puerto Rico				St. Thomas and St. John				St. Croix			
Fully-rigged vessel value ($)	N	Cumulative Frequency	Cumulative Percentage	Fully-rigged vessel value ($)	N	Cumulative Frequency	Cumulative Percentage	Fully-rigged vessel value ($)	N	Cumulative Frequency	Cumulative Percentage
400	1	1	1.72	17,500	1	1	5.26	2,000	1	1	5.26
800	1	2	3.45	22,000	1	2	10.53	3,500	2	3	15.79
1,000	2	4	6.9	25,000	1	3	15.79	4,000	1	4	21.05
1,200	1	5	8.62	28,000	1	4	21.05	4,500	1	5	26.32
1,300	2	7	12.07	33,000	1	5	26.32	5,000	1	6	31.58
1,500	2	9	15.52	35,000	3	8	42.11	6,000	1	7	36.84
2,000	4	13	22.41	40,000	3	11	57.89	9,000	1	8	42.11
2,500	2	15	25.86	45,000	1	12	63.16	10,000	2	10	52.63
3,000	3	18	31.03	50,000	1	13	68.42	11,000	1	11	57.89
3,300	1	19	32.76	80,000	1	14	73.68	15,000	2	13	68.42
3,500	2	21	36.21	85,000	1	15	78.95	18,000	1	14	73.68
4,000	1	22	37.93	90,000	1	16	84.21	19,000	1	15	78.95
4,500	1	23	39.66	100,000	1	17	89.47	30,000	1	16	84.21
6,000	4	27	46.55	115,000	1	18	94.74	40,000	1	17	89.47
7,000	2	29	50	250,000	1	19	100	75,000	1	18	94.74
7,500	1	30	51.72					100,000	1	19	100
8,000	3	33	56.9								
8,250	1	34	58.62								
10,000	5	39	67.24								
12,000	3	42	72.41								
15,000	1	43	74.14								
20,000	3	46	79.31								
24,000	1	47	81.03								
25,000	2	49	84.48								
29,500	1	50	86.21								
30,000	4	54	93.1								
37,000	1	55	94.83								
42,000	1	56	96.55								
60,000	1	57	98.28								
150,000	1	58	100								
No response		2				1				1	

Table 10: Vessel characteristics based on questions 18, 19, 23, 24 and 26a

Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Fully rigged vessel value ($)	Puerto Rico	5,431.03 (1,053.08)	29	18,598 (2,516.72)	21	31,750 (10,752)	8	8,652.393 (1,033.95)	58
	St. Thomas & St. John	33,100 (3,550.68)	5	56,111 (7,456.77)	9	99,000 (31,657)	5	58,518 (8761.98)	19
	St. Croix	18,346 (4,276.15)	13	23,667 (10,908)	6			19,831 (4332.42)	19
Vessel length (ft)	Puerto Rico	19.8 (0.62)	30	24.5 (0.77)	22	24.75 (1.19)	8	20.77 (0.51)	60
	St. Thomas & St. John	26.0 (2.57)	5	27.7 (1.38)	10	31.0 (2.15)	5	27.90 (1.21)	20
	St. Croix	20.23 (0.87)	13	23.29 (2.07)	7			21.18 (0.88)	20
Vessel age (years)	Puerto Rico	15.97 (1.76)	30	18.54 (2.19)	22	15.25 (1.64)	8	16.36 (1.361)	60
	St. Thomas & St. John	16.4 (2.96)	5	17.7 (2.14)	10	21.2 (3.564)	5	18.1 (1.62)	20
	St. Croix	15.46 (2.05)	13	16.0 (3.52)	7			15.63 (1.787)	20
Engine age (years)	Puerto Rico	5.97 (1.15)	28	7.62 (1.10)	21	12.14 (1.6)	7	6.47 (0.93)	56
	St. Thomas & St. John	4.4 (2.71)	5	11.1 (1.68)	10	7.4 (2.41)	5	7.73 (1.32)	20
	St. Croix	9.79 (1.98)	12	7.07 (2.47)	7			8.9 (1.558)	19
Engine power (hp)	Puerto Rico	65.04 (12.12)	27	131.73 (14.87)	22	61.12 (125)	8	76.72 (9.80)	57
	St. Thomas & St. John	187.0 (33.95)	5	228.0 (12.04)	10	210.0 (5.55)	4	208.44 (13.99)	19
	St. Croix	98.69 (23.10)	13	129.29 (27.66)	7			108.21 (18.09)	20

Table 11: Vessel length distribution based on question 18

Puerto Rico				St. Thomas and St. John				St. Croix			
Vessel length (feet)	N	Cumulative Frequency	Cumulative Percentage	Vessel length (feet)	N	Cumulative Frequency	Cumulative Percentage	Vessel length (feet)	N	Cumulative Frequency	Cumulative Percentage
15	1	1	1.67	17	1	1	5	14	1	1	5
16	1	2	3.33	22	2	3	15	16	1	2	10
17	5	7	11.67	23	3	6	30	17	1	3	15
18	11	18	30	24	1	7	35	18	6	9	45
19	5	23	38.33	25	2	9	45	20	2	11	55
20	9	32	53.33	26	2	11	55	21	1	12	60
21	1	33	55	27	1	12	60	22	2	14	70
22	4	37	61.67	31	1	13	65	24	2	16	80
23	2	39	65	34	4	17	85	25	2	18	90
24	3	42	70	35	1	18	90	28	1	19	95
25	3	45	75	37	1	19	95	40	1	20	100
26	2	47	78.33	40	1	20	100				
27	1	48	80								
28	4	52	86.67								
29	1	53	88.33								
30	3	56	93.33								
31	1	57	95								
32	2	59	98.33								
35	1	60	100								

Table 12: Vessel age distribution based on question 19

Puerto Rico				St. Thomas and St. John				St. Croix			
Vessel age (years)	N	Cumulative Frequency	Cumulative Percentage	Vessel age (years)	N	Cumulative Frequency	Cumulative Percentage	Vessel age (years)	N	Cumulative Frequency	Cumulative Percentage
2	2	2	3.33	6	1	1	5	3	1	1	5
3	3	5	8.33	8	2	3	15	4	1	2	10
4	1	6	10	9	1	4	20	5	1	3	15
5	1	7	11.67	11	2	6	30	10	2	5	25
6	1	8	13.33	13	2	8	40	11	2	7	35
7	4	12	20	14	1	9	45	12	3	10	50
8	3	15	25	17	2	11	55	14	2	12	60
9	1	16	26.67	18	1	12	60	15	3	15	75
10	9	25	41.67	19	1	13	65	18	1	16	80
12	2	27	45	21	1	14	70	20	1	17	85
13	2	29	48.33	26	1	15	75	27	1	18	90
15	2	31	51.67	28	3	18	90	40	1	19	95
17	1	32	53.33	35	2	20	100	45	1	20	100
18	1	33	55								
19	4	37	61.67								
20	7	44	73.33								
22	1	45	75								
23	2	47	78.33								
24	1	48	80								
25	1	49	81.67								
26	1	50	83.33								
27	1	51	85								
30	3	54	90								
33	1	55	91.67								
35	2	57	95								
36	1	58	96.67								
40	1	59	98.33								
60	1	60	100								

Table 13: Engine age distribution based on question 23

Puerto Rico				St. Thomas and St. John				St. Croix			
Engine age (years)	N	Cumulative Frequency	Cumulative Percentage	Engine age (years)	N	Cumulative Frequency	Cumulative Percentage	Engine age (years)	N	Cumulative Frequency	Cumulative Percentage
1	12	12	21.43	1	3	3	15	1	5	5	26.32
2	6	18	32.14	2	3	6	30	3	4	9	47.37
3	6	24	42.86	3	2	8	40	4	1	10	52.63
4	5	29	51.79	4	1	9	45	7	1	11	57.89
5	1	30	53.57	5	1	10	50	8	2	13	68.42
6	1	31	55.36	6	1	11	55	14	1	14	73.68
7	1	32	57.14	8	1	12	60	17	1	15	78.95
8	1	33	58.93	9	1	13	65	21	2	17	89.47
9	2	35	62.5	14	2	15	75	24	1	18	94.74
10	5	40	71.43	16	1	16	80	27	1	19	100
11	1	41	73.21	17	1	17	85				
12	3	44	78.57	18	1	18	90				
13	3	47	83.93	19	1	19	95				
15	3	50	89.29	25	1	20	100				
17	1	51	91.07								
18	1	52	92.86								
20	1	53	94.64								
23	1	54	96.43								
25	2	56	100								
No response		4				0				1	

Table 14: Years since last major vessel renovation based on question 21

Puerto Rico				St. Thomas and St. John				St. Croix			
Vessel renovation (years)	Frequency	Cumulative Frequency	Cumulative Percentage	Vessel renovation (years)	Frequency	Cumulative Frequency	Cumulative Percentage	Vessel renovation (years)	Frequency	Cumulative Frequency	Cumulative Percentage
1	31	31	70.45	1	10	10	71.43	1	10	10	71.43
1.5	1	32	72.73	1.5	1	11	78.57	2	2	12	85.71
2	4	36	81.82	2	2	13	92.86	2.5	1	13	92.86
2.5	1	37	84.09	3	1	14	100	5	1	14	100
5	3	40	90.91					1	10	10	71.43
6	2	42	95.45					2	2	12	85.71
7	1	43	97.73					2.5	1	13	92.86
14	1	44	100					5	1	14	100
No response		16				6				6	

Table 15: Years since last major engine renovation based on question 21

Puerto Rico				St. Thomas and St. John				St. Croix			
Engine renovation (years)	Frequency	Cumulative Frequency	Cumulative Percentage	Engine renovation (years)	Frequency	Cumulative Frequency	Cumulative Percentage	Engine renovation (years)	Frequency	Cumulative Frequency	Cumulative Percentage
1	11	11	57.89	0.5	2	2	18.18	1	7	7	100
2	1	12	63.16	1	5	5	45.45				
3	1	13	68.42	2	3	8	72.73				
5	1	14	73.68	5	1	9	81.82				
6	2	16	84.21	9	1	10	90.91				
7	1	17	89.47	14	1	11	100				
8	2	19	100								
No response	41				9				13		

Table 16: Horsepower distribution based on question 24

Puerto Rico				St. Thomas and St. John				St. Croix			
Engine (HP)	Frequency	Cumulative Frequency	Cumulative Percentage	Engine (HP)	Frequency	Cumulative Frequency	Cumulative Percentage	Engine (HP)	Frequency	Cumulative Frequency	Cumulative Percentage
8	1	1	1.75	85	1	1	5.26	15	1	1	5
15	3	4	7.02	100	1	2	10.53	25	2	3	15
21	1	5	8.77	150	1	3	15.79	30	2	5	25
25	4	9	15.79	200	6	9	47.37	35	1	6	30
40	11	20	35.09	210	1	10	52.63	40	1	7	35
48	2	22	38.6	225	1	11	57.89	45	1	8	40
55	2	24	42.11	230	2	13	68.42	48	1	9	45
60	3	27	47.37	240	2	15	78.95	65	1	10	50
65	3	30	52.63	250	1	16	84.21	70	2	12	60
70	1	31	54.39	265	1	17	89.47	85	1	13	65
75	3	34	59.65	280	1	18	94.74	100	1	14	70
80	1	35	61.4	350	1	19	100	170	1	15	75
85	7	42	73.68					200	1	16	80
90	1	43	75.44					230	1	17	85
100	1	44	77.19					240	1	18	90
120	1	45	78.95					265	1	19	95
140	1	46	80.7					400	1	20	100
150	1	47	82.46								
168	1	48	84.21								
170	2	50	87.72								
210	1	51	89.47								
215	1	52	91.23								
240	2	54	94.74								
280	1	55	96.49								
285	1	56	98.25								
400	1	57	100								
No response	3				1				0		

Table 17: Number and percent of hull construction and engine types by stratum based on questions 20 and 22

Variable	Region		Tier I	Percentage	Tier II	Percentage	Tier III	Percentage	Tier Percentages
Hull construction	Puerto Rico	Fiberglass	23	76.67	21	95.45	8	100	86.67
		Wood	6	20	1	4.55	0	0	11.67
		Non- response	1	3.33	0	0	0	0	1.67
	St. Thomas and St. John	Fiberglass	5	100	10	100	5	100	100
		Wood	0	0	0	0	0	0	0
		Non response	0	0	0	0	0	0	0
	St. Croix	Fiberglass	12	92.31	7	100			95
		Wood	1	7.69	0	0			5
		No response	0	0	0	0			0
Engine type	Puerto Rico	Inboard	0	0	7	31.82	1	12.5	13.3
		Outboard	27	90	15	68.18	2	75	80.0
		Other	3	10	0	0	1	0	0
		Non-response					1	12.5	6.67
	St. Thomas and St. John	Inboard	3	60	8	80	4	80	75
		Outboard	2	40	2	20	1	20	25
		Other	0	0	0	0			0
		Non-response	0	0	0	0			0
	St. Croix	Inboard	0	0	1	14.3			5
		Outboard	13	100	4	57.14			85
		Other	0	0	1	14.3			5
		Non-response	0	0	1	14.3			5

Table 18: Number and percent of various fishing equipment by stratum based on question 25

Region	Equipment usage	Tier I	Percentage	Tier II	Percentage	Tier III	Percentage	Tier Percentages
Puerto Rico	Mechanical trap hauler	6	20	18	81.82	7	87.5	51.67
	Depth recorder	10	33.33	10	45.45	2	25	36.67
	GPS	8	26.67	8	36.36	3	37.5	31.67
	Radar	0	0	0	0	0	0	0
	EPIRB	0	0	0	0	0	0	0
	Other	2	6.67	0	0	0	0	3.33
St. Thomas and St. John	Mechanical trap hauler	5	100	10	100	5	100	100
	Depth recorder	3	60	9	90	4	80	80
	GPS	2	40	8	80	3	60	65
	Radar	0	0	0	0	0	0	0
	EPIRB	0	0	3	30	4	80	35
	Other	0	0	2	20	0	0	10
St. Croix	Mechanical trap hauler	1	7.69	3	42.86			20
	Depth recorder	5	38.46	4	57.14			45
	GPS	2	15.38	3	42.86			25
	Radar	0	0	1	14.29			5
	EPIRB	0	0	1	14.29			5
	Other	1	7.69	0	0			5

Trap characterization

Here we describe selected aspects of the trap gear. We present data on the number of fish and lobster traps fished built or purchased, and their average life time. We also discuss the manufacturing costs of various trap designs. This theme reviews survey questions 11 though 14, and 26b (Appendix A).

On average, Puerto Rican respondents fished 39 fish traps, whereas St. Thomian and St. Johnian and Crucian respondents fished 94 and 27 fish traps, respectively (Table 19). Puerto Rican respondents fished an average of 11 lobster traps and St. Thomian and St. Johnian respondents fished 46 lobster traps. None of the Crucian respondents fished lobster traps (Table 19). The maximum number fish traps reported was 350, whereas the maximum number of lobster traps reported was 460 (Tables 20, 21, 22, 23, and 24).[4]

The number of fish traps built or bought ranged between 0 and 175 (Table 25). Fifty-two percent of the sampled population built or purchased 25 fish traps or less. The number of lobster traps manufactured or purchased ranged between 0 and 200 (Table 26). Eighty percent of the fish trap fishermen interviewed did not build or buy any lobster traps in 2003. The survey showed that Puerto Rican fishermen built or bought 30 fish traps, St. Thomian and St. Johnian fishermen built or bought 30 fish traps, and Crucian fishermen built or bought 25 fish traps. On average, fishermen from Puerto Rico, St. Thomas and St. John and St. Croix manufactured or purchased 14, 11, and 0 lobster traps, respectively. As a group, the average life of fish traps ranged between 1.3 and 5 years, whereas the average life of lobster traps ranged between 1.5 and 6 years (Table 19). On average, the greatest number of traps that a vessel would normally carry was 8 traps for the Puerto Rican fleet, 11 traps for the St. Thomian and St. Johnian fleet, and 7 traps for the St. Crucian fleet (Table 19).

The most common trap design was chevron or arrowhead style (Figure 1). As a group, Puerto Rican fishermen owned 20 arrowhead traps. St. Thomian and St. Johnian and

[4] There were two fishermen, who owned traps but did not participate in this fishery in 2003.

Crucian fishermen had 44 and 15 arrowhead fish traps, respectively (Table 27). The second most popular type was square style (Figure 1). Puerto Rican fishermen had an average of 9 square traps whereas St. Thomian and St. Johnian fishermen had 33 traps and Crucian fishermen had 2 traps. Antillean Z (or S) traps, rectangular and star traps are also used (Figure 2). Although Z-traps are considered the most productive trap design, fishermen prefer the smaller-sized arrowhead and square traps because they are easier and less expensive to build and a larger number of them can be safely deployed.

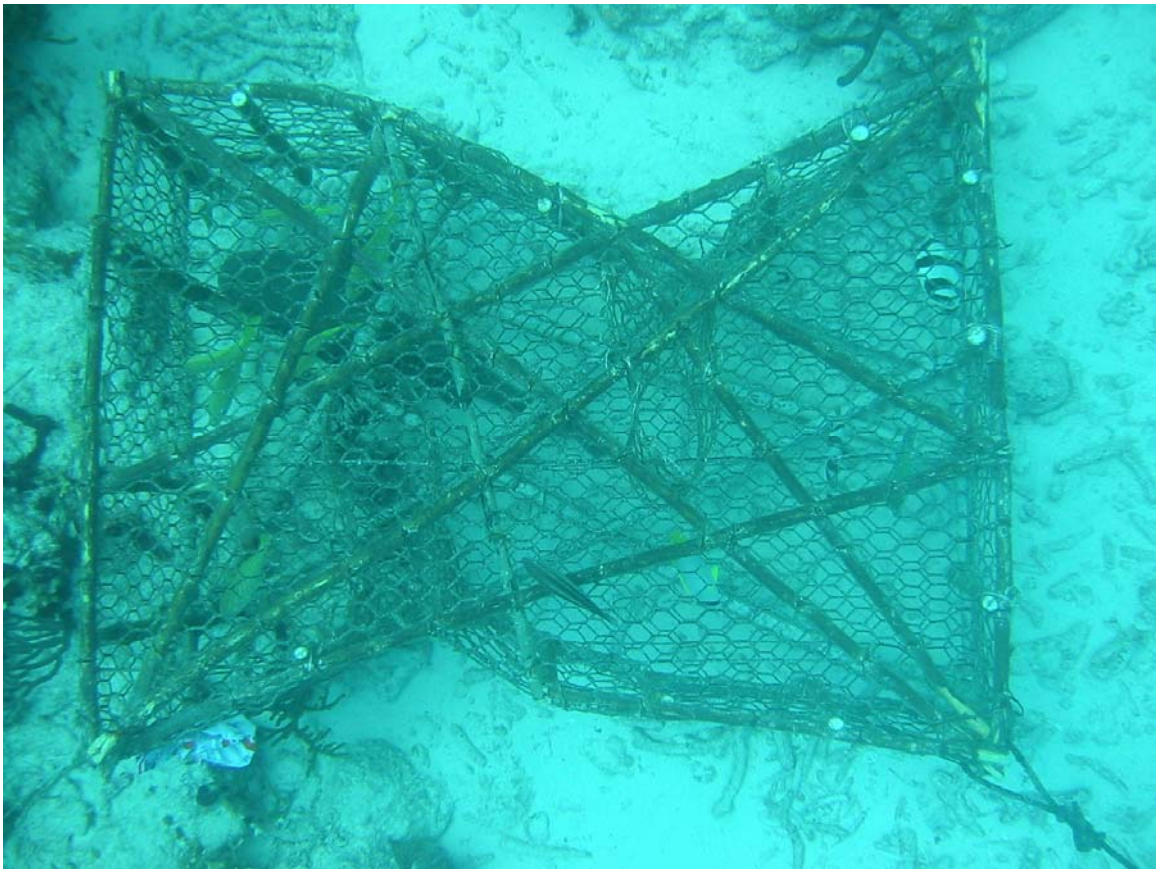
The cost of a fish trap complete with rope and buoys varied significantly. On average, arrowhead traps commanded $94 in Puerto Rico, $251 in St. Thomas and St. John, and $119 in St. Croix (Table 28). In contrast, square traps fetched $87 in Puerto Rico, $252 in St. Thomas and St. John and $93 in St. Croix (Table 28). Schärer *et al* (2004) report that the price of fish traps in Puerto Rico ranges between $100 and $150.

Regional cost and gear longevity differentials are related to the diversity of trap sizes and construction materials employed. Schärer *et al* (2004) report that the dimensions of fish traps in Puerto Rico range between 32 to 96 inches in length by 18 to 60 inches in width and 13 to 24 inches in height. Larger steel framed traps can reach 72 inches in length by 48 inches in width by 18 inches in height while smaller wooden traps can reach 36 inches in length by 36 inches in width by 16 inches in height. Lobster traps tend to be smaller (24 x 24 x 48 inches) and have pre-cut pine or spruce wooden slats. Constructions materials also vary appreciably. For instance, the trap frame can be made up of reinforced steel, wood, plastic, or some combination of these materials, whereas the trap mesh can be made up of chicken wire, galvanized wire or plastic coated wire (Schärer *et al,* 2002, Kojis, 2004). Galvanized wire lasts about a year whereas plastic coated wire lasts about two years (Schärer *et al,* 2002). It's noteworthy that many fishermen do not use buoys (i.e., set traps blindly) to protect themselves against trap theft and poaching and entanglement with propellers (Schärer *et al* 2002, Kojis, 2004).

Figure 1: Arrowhead and square fish traps

(Photo courtesy of Dr. J. Agar)

Figure 2: Z (or S) fish trap



(Photo courtesy of Dr. R. Hill)

Table 19: Trap usage characteristics by stratum based on questions 11, 12, 13 and 14

Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Number of fish traps fished last season	Puerto Rico	24.7 (2.41)	30	63.77 (5.35)	22	212.25 (21.66)	8	38.62 (2.28)	60
	St. Thomas & St. John	33 (6.31)	5	107.3 (8.15)	10	161 (5.02)	5	93.58 (4.09)	20
	St. Croix	20.23 (3.57)	13	42.14 (8.18)	7			27.05 (3.54)	20
Number of lobster traps fished last season	Puerto Rico	7.67 (2.51)	30	23.54 (5.95)	22	19.37 (5.93)	8	10.73 (2.24)	60
	St. Thomas & St. John	3 (2.58)	5	74.8 (33.1)	10	66 (31.92)	5	46.36 (15.05)	20
	St. Croix	0 (0)	13	0 (0)	7			0 (0)	20
Number of fish traps fished built or bought last season	Puerto Rico	24.43 (3.34)	30	45.73 (6.59)	22	71.25 (9.77)	8	29.79 (2.9)	60
	St. Thomas & St. John	12.2 (2.98)	5	31.1 (3.65)	10	53.2 (13.21)	5	29.72 (3.75)	20
	St. Croix	18.31 (3.83)	13	40.71 (9.143)	7			25.28 (3.88)	20
Number of lobster traps fished built or bought last season	Puerto Rico	10.3 (4.21)	30	31.409 (9.828)	22	14.37 (4.67)	8	13.92 (3.72)	60
	St. Thomas & St. John	0.8 (0.69)	5	13.5 (7.227)	10	23 (15.27)	5	11.23 (4.73)	20
	St. Croix	0 (0)	13	0 (0)	7			0 (0)	20
Maximum number of traps normally taken during a fishing trip	Puerto Rico	7.96 (0.96)	27	10 (0.73)	21	15.5 (3.36)	8	8.64 (0.78)	56
	St. Thomas & St. John	9.8 (2.93)	5	12. (1.58)	10	12.8 (0.76)	5	11.4 (1.24)	20
	St. Croix	7.38 (1.01)	13	5.71 (0.88)	7			6.86 (0.75)	20

Table 19 continued: Trap usage characteristics by stratum based on questions 11, 12, 13 and 14

Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Average life of fish traps	Puerto Rico	1.35	29	1.58	22	3.37	8	1.47	59
		(0.15)		(0.19)		(0.61)		(0.12)	
	St. Thomas & St.	5.17	3	4.85	10	4.8	5	4.92	18
	John	(1.27)		(0.51)		(0.72)		(0.45)	
	St. Croix	1.25	13	1.5	7			1.33	20
		(0.27)		(0.20)				(0.19)	
Average life of lobster traps	Puerto Rico	1.64	9	0.86	7	2.33	3	1.54	19
		(0.36)		(0.11)		(0.83)		(0.28)	
	St. Thomas & St.	-	-	6.33	3	5	1	5.93	4
	John			(1.31)		(.)		(0.91)	
	St. Croix	-	-	-	-			-	-

Table 20: Number of fish traps fished in Puerto Rico in 2003 based on question 11

No. of fish traps fished	Frequency	Cumulative Frequency	Cumulative Percentage
0	1	1	1.67
4	1	2	3.33
6	1	3	5
8	1	4	6.67
11	1	5	8.33
12	2	7	11.67
13	1	8	13.33
14	1	9	15
15	1	10	16.67
18	2	12	20
20	3	15	25
21	1	16	26.67
24	1	17	28.33
25	3	20	33.33
26	1	21	35
27	1	22	36.67
28	1	23	38.33
30	1	24	40
32	1	25	41.67
36	1	26	43.33
38	1	27	45
39	1	28	46.67
40	6	34	56.67
42	1	35	58.33
46	2	37	61.67
50	1	38	63.33
52	1	39	65
56	1	40	66.67
60	3	43	71.67
75	1	44	73.33
77	1	45	75
80	3	48	80
85	1	49	81.67
100	1	50	83.33
115	1	51	85
120	1	52	86.67
123	1	53	88.33
125	1	54	90
128	1	55	91.67
200	1	56	93.33
225	1	57	95
300	2	59	98.33
350	1	60	100

Table 21: Number of fish traps fished in St. Thomas and St. John in 2003 based on question 11

No. of fish traps fished	Frequency	Cumulative Frequency	Cumulative Percentage
10	1	1	5
30	2	3	15
40	1	4	20
46	1	5	25
55	1	6	30
63	1	7	35
80	1	8	40
84	1	9	45
117	1	10	50
120	1	11	55
130	1	12	60
139	1	13	65
144	1	14	70
150	3	17	85
160	2	19	95
185	1	20	100

Table 22: Number of fish traps fished in St. Croix in 2003 based on question 11

No. of fish traps fished	Frequency	Cumulative Frequency	Cumulative Percentage
0	1	1	5
8	1	2	10
9	1	3	15
10	1	4	20
12	1	5	25
14	3	8	40
15	2	10	50
20	1	11	55
25	2	13	65
28	1	14	70
30	1	15	75
50	1	16	80
54	1	17	85
55	1	18	90
60	1	19	95
100	1	20	100

Table 23: Number of lobster traps fished in Puerto Rico in 2003 based on question 11

No. of lobster traps fished	Frequency	Cumulative Frequency	Cumulative Percentage
0	40	40	66.67
4	1	41	68.33
12	1	42	70
15	1	43	71.67
18	1	44	73.33
27	1	45	75
30	1	46	76.67
32	2	48	80
38	2	50	83.33
40	2	52	86.67
45	1	53	88.33
50	1	54	90
60	2	56	93.33
70	1	57	95
77	1	58	96.67
100	1	59	98.33
115	1	60	100

Table 24: Number of lobster traps fished in St. Thomas and St. John in 2003 based on question 11

No. of lobster traps fished	Frequency	Cumulative Frequency	Cumulative Percentage
0	14	14	70
15	1	15	5
138	1	16	5
150	2	18	10
180	1	19	5
460	1	20	5

Table 25: Number of fish traps built or purchased in 2003 based on question 12

No. of fish traps built or purchased	Frequency	Cumulative Frequency	Cumulative Percentage
0	10	10	10
4	2	12	12
5	3	15	15
6	3	18	18
9	1	19	19
10	4	23	23
11	2	25	25
12	4	29	29
14	1	30	30
15	4	34	34
16	1	35	35
18	1	36	36
20	7	43	43
22	1	44	44
24	2	46	46
25	6	52	52
30	4	56	56
32	3	59	59
35	3	62	62
40	9	71	71
46	1	72	72
48	1	73	73
50	3	76	76
52	1	77	77
54	1	78	78
60	11	89	89
70	1	90	90
76	1	91	91
80	1	92	92
100	6	98	98
150	1	99	99
175	1	100	100

Table 26: Number of lobster traps built or purchased in 2003 based on question 12

No. of lobster traps built or purchased	Frequency	Cumulative Frequency	Cumulative Percentage
0	80	80	80
4	1	81	81
15	2	83	83
22	1	84	84
30	2	86	86
35	1	87	87
40	1	88	88
52	1	89	89
55	1	90	90
60	2	92	92
76	1	93	93
100	5	98	98
175	1	99	99
200	1	100	100

Table 27: Average number of traps by type and stratum based on question 26b

Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Arrowhead traps	Puerto Rico	12.53 (2.46)	30	21.5 (5.30)	22	150 (31.54)	8	19.52 (2.49)	60
	St. Thomas & St. John	14 (9.14)	5	36.8 (12.08)	10	97 (31.47)	5	43.52 (9.73)	20
	St. Croix	11.08 (3.33)	13	23.29 (6.65)	7			14.87 (3.09)	20
Square	Puerto Rico	6.97 (2.28)	30	17.09 (5.86)	22	7.50 (4.65)	8	8.64 (2.06)	60
	St. Thomas & St. John	19 (6.13)	5	26.7 (12.71)	10	64 (30.74)	5	33.21 (9.38)	20
	St. Croix	2.38 (1.02)	13	1.71 (1.21)	7			2.17 (0.8)	20
Antillean Z (or S) traps	Puerto Rico	0 (0)	30	16.59 (5.83)	22	0 (0)	8	2.71 (0.95)	60
	St. Thomas & St. John	0 (0)	5	0 (0)	10	0 (0)	5	0 (0)	20
	St. Croix	5.15 (3.24)	13	2.86 (2.02)	7			4.44 (2.32)	20
Rectangular	Puerto Rico	3.73 (2.12)	30	2.04 (1.36)	22	1.87 (1.16)	8	3.38 (1.70)	60
	St. Thomas & St. John	0 (0)	5	0 (0)	10	0 (0)	5	0 (0)	20
	St. Croix	0 (0)	13	0 (0)	7			0 (0)	20
Star	Puerto Rico	2.53 (1.46)	30	6.64 (3.17)	22	0 (0)	8	3.10 (1.27)	60
	St. Thomas & St. John	0 (0)	5	0 (0)	10	0 (0)	5	0 (0)	20
	St. Croix	0.54 (0.41)	13	0 (0)	7			0.37 (0.28)	20

Table 27 continued: Average number of traps by type and stratum based on question 26b

Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Other	Puerto Rico	0 (0)	30	0 (0)	22	40.37 (17.0)	8	1.62 (0.68)	60
	St. Thomas & St. John	0 (0)	5	39.8 (13.01)	10	0 (0)	5	15.31 (5.0)	20
	St. Croix	0.92 (0.70)	13	14.29 (10.10)	7			5.08 (3.18)	20

Table 28: Average cost of traps by type based on question 26b

Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Arrowhead traps	Puerto Rico	88.75 (13.78)	16	112.22 (9.67)	9	133.33 (14.82)	6	94.33 (11.32)	31
	St. Thomas & St. John	260 (34.34)	2	243.76 (23.25)	4	250 (22.64)	3	251.11 (15.64)	9
	St. Croix	123.57 (19.93)	7	108.75 (10.84)	4			118.77 (13.92)	11
Square	Puerto Rico	77.5 (12.9)	8	129.17 (21.19)	6	100 (0)	1	86.73 (11.06)	15
	St. Thomas & St. John	225 (22.57)	4	325 (53.03)	2	275 (19.61)	2	252.05 (17.05)	8
	St. Croix	100 (38.1)	3	70 (0)	1			93.44 (29.77)	4
Antillean Z (or S) traps	Puerto Rico	-		131.25 (31.59)	4	-		131.25 (31.59)	4
	St. Thomas & St. John	-		-		-		-	
	St. Croix	87.5 (9.52)	2	250 (0)	1			135.51 (6.71)	3
Rectangular	Puerto Rico	120 (16.73)	4	95 (19.12)	2	175 (0)	1	119.24 (14.27)	7
	St. Thomas & St. John	-		-		-		-	
	St. Croix	-		-				-	
Star	Puerto Rico	48.33 (12.82)	3	100 (0)	3	-		59.64 (10.2)	6
	St. Thomas & St. John	-		-		-		-	
	St. Croix	50 (0)	1	-				50 (0)	1

Table 28 continued: Average cost of traps by type and stratum based on question 26b

Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Other	Puerto Rico	-		-		52.5 (17.05)	2	52.5 (17.05)	2
	St. Thomas & St. John	-		268.75 (13.26)	4	-		268.75 (13.26)	4
	St. Croix	100 (0)	1	120 (0)	1			109.12 (0)	2

Fishing practices

This theme describes the main features of the fish trap operation. It provides information on the number of fish trap trips taken weekly, trip duration, number of traps hauled, number of traps per string, and soak time. This theme reviews survey question 15 (Appendix A).

The number of trips per week ranged between 1 and 6 (Table 29). Seventy two percent of the respondents mentioned that they took a maximum of 2 trips per week. Most fishing trips started at dawn and finished early in the afternoon. Over eighty-two percent of the trips lasted eight hours or less (Table 30).

Fishermen from St. Thomas and St. John took fewer but longer trips than their Puerto Rican and Crucian counterparts. As a group, St. Thomian and St. Johnian fishermen took 1.4 trips per week while Puerto Rican fishermen took 2.1 trips per week, and Crucian fishermen took 2.5 trips per week (Table 31). Fishermen from St. Thomas and St. John fished an average of nine hours per trip whereas fishermen from Puerto Rico and St. Croix fished for 6 hours (Table 31). The number of traps hauled also varied. Table 31 shows that St. Thomian and St. Johnian fishermen hauled 68 fish traps per trip, while Puerto Rican and Crucian fishermen hauled 27 and 26 fish traps per trip, respectively.

St. Thomian and St. Johnian fishermen soaked their fish traps for seven days while Puerto Rican and Crucian fishermen soaked their fish traps for six and four days, respectively (Table 31). Schärer *et al* (2004) note that the mean soak time for Puerto Rican fish traps was five days. The number of traps per string varied considerably across islands. In St. Croix, 84 percent of the respondents had a single trap per line (Table 34). In St. Thomas and St. John, only 10 percent of the respondents had a single trap per line (Table 33). About fifty-five percent of the St. Thomian and St. Johnian fish trap fleet had at least 10 traps per string. Over forty-three percent of the Puerto Rican respondents used one trap per string (Table 32). These results are consistent with earlier findings by Schärer *et al* (2004) who report that 53% of the Puerto Rican fishermen use single trap layouts.

Table 29: Number of fishing trips per week based on question 15

No. weekly fishing trips	Frequency	Cumulative Frequency	Cumulative Percentage
1	24	24	28.24
1.5	1	25	29.41
2	36	61	71.76
3	17	78	91.76
3.5	2	80	94.12
4	1	81	95.29
5	3	84	98.82
6	1	85	100
No response	15		

Table 30: Duration of fishing trip based on question 15

Trip duration (hrs)	Frequency	Cumulative Frequency	Cumulative Percentage
2	2	2	2.35
2.5	1	3	3.53
3	4	7	8.24
3.5	4	11	12.94
4	9	20	23.53
4.5	1	21	24.71
5	6	27	31.76
5.5	3	30	35.29
6	15	45	52.94
6.5	2	47	55.29
7	9	56	65.88
7.5	1	57	67.06
8	13	70	82.35
9	3	73	85.88
10	3	76	89.41
10.5	1	77	90.59
11	2	79	92.94
11.5	1	80	94.12
12	3	83	97.65
16	1	84	98.82
30	1	85	100
No response	15		

Table 31: Fishing trip characteristics based on question 15

Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Number of weekly trips	Puerto Rico	2.07 (0.18)	25	2.46 (0.21)	14	2.28 (0.11)	7	2.13 (0.15)	46
	St. Thomas & St. John	1.0 (0)	5	1.3 (0.15)	10	2.2 (0.16)	5	1.41 (0.07)	20
	St. Croix	2.46 (0.31)	12	2.71 (0.33)	7			2.54 (0.23)	19
Trip duration (hours)	Puerto Rico	5.36 (0.31)	25	6.78 (0.42)	14	7.14 (0.51)	7	5.62 (0.26)	46
	St. Thomas & St. John	6.5 (1.30)	5	11.6 (1.47)	10	9.1 (0.95)	5	9.11 (0.78)	20
	St. Croix	4.96 (0.4)	12	6.78 (1.16)	7			5.55 (0.47)	
Number of traps hauled per trip	Puerto Rico	23.08 (2.44)	25	38.71 (3.51)	14	69.43 (4.19)	7	27.13 (2.08)	46
	St. Thomas & St. John	33.0 (6.31)	5	87.4 (8.3)	10	89.6 (9.61)	5	68.07 (4.61)	20
	St. Croix	21.92 (3.62)	12	33.43 (6.46)	7			25.7 (3.23)	19
Soak time (days)	Puerto Rico	4.68 (0.59)	25	4.32 (0.43)	14	6.71 (0.92)	7	5.73 (0.92)	47
	St. Thomas & St. John	7.0 (0)	5	6.9 (0.32)	10	6.6 (0.31)	5	6.86 (0.15)	20
	St. Croix	3.5 (0.48)	12	3.71 (0.71)	7			3.57 (0.40)	19
Number of traps per line	Puerto Rico	2.0 (0.31)	25	2.96 (0.55)	14	3.0 (0.83)	7	2.171 (0.27)	46
	St. Thomas & St. John	3.6 (1.45)	5	11.9 (1.13)	10	11.2 (1.3)	5	8.7 (0.76)	20
	St. Croix	1.83 (0.57)	12	1.28 (0.20)	7			1.65 (0.39)	19

Table 32: Number of fish traps per line in Puerto Rico based on question 15

No. fish traps per string	Frequency	Cumulative Frequency	Cumulative Percentage
1	20	20	43.48
2	16	36	78.26
3	2	38	82.61
3.5	1	39	84.78
5	2	41	89.13
6	2	43	93.48
8	1	44	95.65
10	1	45	97.83
11	1	46	100

Table 33: Number of fish traps per line in St. Thomas and St. John based on question 15

No. fish traps per string	Frequency	Cumulative Frequency	Cumulative Percentage
1	2	2	10
2	1	3	15
4	3	6	30
5	1	7	35
8	1	8	40
10	1	9	45
12	5	14	70
14	1	15	75
15	3	18	90
16	1	19	95
19	1	20	100

Table 34: Number of fish traps per line in St. Croix based on question 15

No. fish traps per string	Frequency	Cumulative Frequency	Cumulative Percentage
1	16	16	84.21
2	1	17	89.47
3	1	18	94.74
10	1	19	100

Economic and financial performance measures of the fleet.

This theme explains the development and interpretation of various socio-economic performance indicators and summarizes revenue and expenditure information collected in survey questions 16, 17, 27, and 28 (Appendix A).

The estimation of economic and financial surpluses requires distinguishing between economic and financial benefits (Figure 3). Conceptually, economic benefits measure the value of fishing to society in terms of economic cost of the resources used. On the other hand, financial benefits measure net revenue derived from fishing. For the purposes of this report, the amount of net revenue captures the return to the vessel owner's labor and capital investment. These indicators impart different perspectives on the health of the fishery. For instance, if Fishery Management Councils are concerned about how management proposals may impact the stability and well-being of fishing communities, they may want to use financial measures to examine short-run changes to vessel owner and crew income (Pascoe *et al*, 1996; Whitmarsh *et al*, 2000). Conversely, if Councils wish to advance the economic performance of their fisheries by reducing over-capacity, they may want to use economic performance measures to decide how to best allocate limited public funds among competing vessel and gear buy-back options.

Economic and financial performance measures differ in the way they define costs (and consequently profits).[5] Financial accounting views costs as cash outlays (explicit costs) whereas economic accounting views costs as the remuneration required to keep inputs in their present employment. Alternatively, economic costs are the payments that inputs would obtain in the next best alternative. In efficient markets, market prices should reflect the economic (opportunity) cost of inputs. Financial and economic profits are simply the difference between gross revenue and costs as defined above.

Cost structure.

[5] Total revenue or total gross value of production is the same for both indicators.

There are two types of cost: variable and fixed. Variable costs are those expenses incurred during the operation of the vessel. These vary with the level of harvesting activity. Variable costs can be further categorized into running expenses, which include fuel, lubricants, bait, ice, food, and supplies, and into crew labor expenses. Typically, crew wages are paid as a share of the trip's revenue after deducting operating expenses. Crew compensation excludes returns to owner-operator labor.

Fuel and bait were the largest running expenses (Table 35). On average, fishermen from St. Thomas and St. John spent $54 on fuel per trip, whereas fishermen from St. Croix and Puerto Rico spent $21 and $12, respectively. With the exception of the St. Thomas and St. John top tiers, fuel expenses increased with the number of traps operated. Since these two tiers had the same proportion of inboard (80%) and outboard (20%) engines (Table 17), we reason that the higher average fuel expenditures for tier II can be partially explained by the higher average horsepower found in tier II vessels. Table 10 shows that for the St. Thomas and St. John fleet, tier II vessels had an average horsepower of 228, whereas tier III vessels had an average horsepower of 210. Running costs per trip ranged between $24 and $98.

Fuel expenses accounted for 54.8% of the running costs in St. Thomas and St. John, 48.3% in Puerto Rico and 45.6% in St. Croix (Figure 4). Bait expenses were responsible for 22.6% of the running costs in St. Thomas and St. John, 22.5% in St. Croix and 14.2% in Puerto Rico. Grocery costs varied between 10.8% and 20% of the running costs (Figure 4).

Fixed costs are those expenses incurred regardless of whether the vessel operates or stays idle. They are independent of the level of fishing activity. Fixed costs include mooring fees, hull, engine, and fishing gear maintenance and repair expenses, fishing permit and vessel registration fees, vessel and gear mortgage payments, and insurance payments. Maintenance expenses account for the largest share of the fixed costs (Table 36). Over fifty percent of the total fixed costs in St. Thomas and St. John, and St. Croix were due to vessel and gear maintenance (other than fish traps) whereas in Puerto Rico they

accounted for 35.2% of such costs (Figure 5). Fish trap maintenance costs were the highest in Puerto Rico where they accounted for 52.2% of the fixed costs. Fish trap maintenance was responsible for 28.3% of the fixed costs in St. Croix, and for 15.3% of the fixed costs in St. Thomas and St. John. The low mooring expenses in Puerto Rico reflect the fact that the majority of the vessels are moored at makeshift piers, or at piers belonging to fish cooperatives (*villas pesqueras*) or coastal communities. Fishermen receive discounted mooring fees if they belong to a fish cooperative. A modest number of small-sized vessels (*yolas*) are either tied to mangrove roots or beached and tied to a permanent structure on the shoreline. In Puerto Rico, fish cooperatives also provide fish storage and marketing services. The miscellaneous category records fish cooperative fees. The low docking expenses in St. Croix reflect the fact that a majority of vessel owners trailer their vessels from their homes to the access ramps. In Puerto Rico, mostly line fishermen in the northwest and north coast trailer their vessels.

Performance measures

We estimated four performance measures to gauge the economic health of the trap fishery (Figure 3). The first performance measure calculated was simply the annual gross revenues. The average St. Thomian and St. Johnian and Crucian fisherman annual gross revenue was $39,018 and $33,317, respectively (Table 38). The average Puerto Rican fisherman annual gross revenue was $15,306. Annual gross revenues generally doubled with increasing tier size. For instance, the lowest St. Thomas and St. John tier reported gross revenues of $17,600, the middle tier reported gross revenues of $34,092, and the highest tier report gross revenues of $77,900 (Table 38).

The second performance measure estimated was the difference between annual gross revenues and running costs (i.e., all variable costs, excluding labor costs). The average St. Thomian and St. Johnian fisherman net revenue was estimated at $31,592, whereas the average Crucian and Puerto Rican fisherman net revenue was estimated at $29,874 and $11,499, respectively (Table 38). Similar to the annual gross revenue case, net revenues almost doubled with increased tier size.

Finally, we estimated financial and economic profits. Financial profit measures the vessel's income after deducting annual running, crew and fixed costs from the vessels annual gross revenue (Figure 3). Financial profit (or boat income) captures the return to the vessel owner including return to own labor and capital invested (Pascoe *et al*, 1996). In contrast, economic profits measure the value of fishing to society in terms of resource costs of the activity, excluding redistributive payments such as interest and taxes (Pascoe *et al*, 1996). Economic profits were measured as the difference between annual gross revenue and the sum of running and fixed costs, cost of capital as used in the fishery, crew's and captain's opportunity cost, and economic depreciation (Figure 3). Unlike economic profits, financial indicators measure viability in terms of commercial profitability (Pascoe *et al*, 1996).

Before discussing the financial and economic profit estimates, it is useful to review the treatment of various expenses. In the absence of well-functioning markets, market prices may not always capture the full opportunity cost of factors of production. Thus, special attention must be given when estimating factor costs, particularly labor and capital costs (Holland, 2002). The economic treatment of non-wage labor can be complicated because share system payments may exceed the actual (yet unknown) opportunity cost of labor. In other words, the vessel captains and crew may receive payments in excess of what is needed to keep them employed in the fishery, which would provide distorted labor cost estimates (Waters, Rhodes, and Wiggers, 2001). Another complication is labor 'stickiness', which means that labor continues to be employed even though its remuneration does not cover its opportunity cost. Kinship based institutions, deep-seated community ties, and strong occupational attachment have been shown to be important determinants of labor stickiness (Terkla *et al*, 1988; Griffith and Valdés-Pizzini, 2002). In addition, fishermen who get paid on share system assist vessel owners repairing the vessel and gear. This assistance is not remunerated since is part of an understood system of obligations to the boat owner. They are part of a set of cultural values of mutual help. Due to the absence of records on the amount of time spent on these maintenance activities, we cannot obtain an accurate picture of the opportunity cost of labor. Lastly, we did not estimate fishermen's satisfaction bonus, which refer to the non-pecuniary

benefits fishermen obtain from participating in fishing activities. Anderson (1980) discusses the policy implications of ignoring the benefits derived from fisherman's satisfaction bonus.

In this analysis, we assumed that the opportunity cost of crew was the wage the individual could have earned working as a construction laborer. Matos-Caraballo (2003) observes that declining fish stocks have forced many Puerto Ricans from the fishery sector towards construction and agricultural sectors. In some instances, these fishermen have taken factory or landscaping jobs in the continental U.S. The Bureau of Labor Statistics reports that construction workers earned $6.40/hour in Puerto Rico, and $9.20/hr in the U.S. Virgin Islands. We also assumed that the vessel captain opportunity cost would be the remuneration obtained as charter captain. In addition, we assumed that charter boat captain could earn about $20 per hour in Puerto Rico and $25 per hour in the U.S. Virgin Islands. When estimating financial labor costs, we either calculated crew's remuneration based on share system (i.e., number of crew plus a share for the captain and vessel) or used the stated fixed wage rate, if available. Fishermen report that some large operators pay on trap hauled basis rather than a share system. Under this alternative contractual agreement, crew receives between $1 and $1.50 per trap hauled. Crews paid under this alternative agreement do not assist vessel owners with maintenance chores.

Like other factors of production, the appropriate economic accounting of capital investments requires knowledge of the value of the asset in the next best alternative. The non-malleability of capital investments brings about economic accounting difficulties. Vessels and fishing equipment cannot be easily modified or altered to participate in other sectors of the economy, other than into another fishery (Agar and Sutinen, 2004). In limited entry regimes, the opportunity cost of capital can be extremely low and even zero if capital lacks the appropriate permits to participate in alternative fisheries (Pascoe *et al*, 1992). Drawing on Grafton (1992), we estimated the opportunity cost of capital (more properly the rental price of capital, m) by assuming a straight line depreciation given by (ε). Mathematically,

$$m = v[\varepsilon + r]$$

We broadly defined asset value (v) as the value of a fully rigged vessel. Because we lacked information of the life expectancy of the various components of the "asset" (i.e. hull, engine, electronics), we assumed a life expectancy of 15 years (ε=1/15). The opportunity cost of money (r) was set at 7%.

We estimated the economic profit that the vessel owner would have received without debt. Interest paid on borrowed capital is ignored since the payment reflects ownership of an asset. In other words, the lender is part-owner of the vessel (i.e., asset) and the interest paid is the return on that investment rather than a true economic cost (Boncoeur *et al*, 2000). We also disregarded taxes when estimating economic costs since they are transfer payments. They are mechanism by which governments collect income from one sector of the economy and pass them on to another sector. Thus, taxes do not capture the value of scarce resources (Hundloe, 2002). Last, we weighed the fixed costs by the percentage of fishing revenue derived from fish traps because many vessels use multiple gears. Otherwise, fish traps would be "overpaying" their share of the fixed costs.

Table 38 shows that on average the annual return to the vessel owner's labor and capital investment (i.e., financial profit) varied between $4,760 and $32,467. Financial profits tended to increase as the tier increased. In general, Crucian fishermen were the most profitable, averaging $11,816, compared with $8,885 from St. Thomian and St. Johnian fishermen and $6,780 from Puerto Rican fishermen.

Table 38 shows that on average annual economic profits varied between $(18,486) and $10,674. As a group, Crucian fishermen made $(952) in economic profits compared to $(13,204) from St. Thomian and St. Johnian fishermen. As group, Puerto Rican fishermen generated $(8,807) in annual economic profits. Only the highest Crucian tier and the highest Puerto Rican tier generated positive economic profits.

The presence of positive financial profits suggests that revenues exceed the boat owner's cash outlays (i.e., commercially profitable). In contrast, the presence of negative economic profits indicates that from society's perspective the true costs of the factors of

production exceed the revenue generated by the fleet. The presence of conflicting performance measures lies in the treatment of costs. Only economic performance measures take into account the opportunity cost of capital and labor. The opportunity cost of an action is the forgone revenue for not undertaking the next best alternative.

Figure 3: Taxonomy of economic and financial performance measures

GROSS REVENUE

Running costs	**NET REVENUE**

Running costs	**Fixed Costs**	**Crew payments**	**Interest payments**	**FINANCIAL/VESSEL OWNER PROFIT**

Running costs	**Fixed Costs**	**Capital, crew and captain's labor opportunity cost**	**Economic depreciation**	**ECONOMIC PROFIT**

(Adapted from Whitmarsh *et al*, 2000)

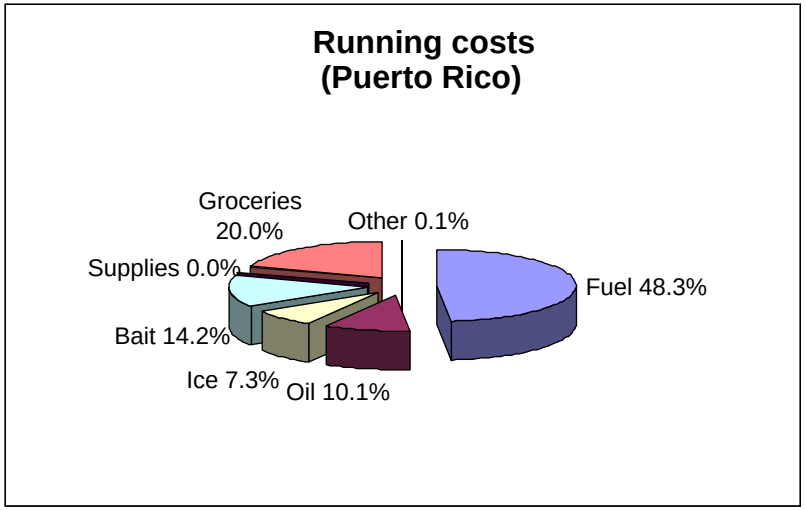
Table 35: Average variable costs by stratum based on question 16

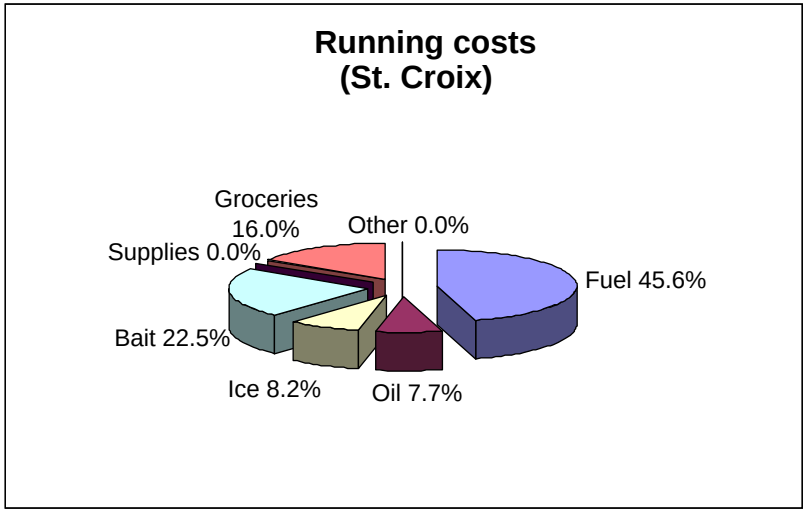
Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Fuel ($)	Puerto Rico	11.07 (2.18)	29	13 (2.17)	22	16.12 (3.37)	8	11.61 (1.77)	59
	St. Thomas & St. John	47.2 (2.40)	5	60.5 (4.61)	10	53.8 (8.47)	5	53.96 (2.9)	20
	St. Croix	15.38 (1.83)	13	31.86 (8.69)	7			20.51 (2.98)	20
Oil ($)	Puerto Rico	2.46 (0.29)	29	2.34 (0.42)	22	1.81 (0.28)	8	2.41 (0.24)	59
	St. Thomas & St. John	3.6 (0.84)	5	4.4 (0.68)	10	3.8 (0.63)	5	3.96 (0.43)	20
	St. Croix	2.5 (0.41)	13	5.57 (1.51)	7			3.45 (0.55)	20
Ice ($)	Puerto Rico	1.81 (0.5)	29	1.25 (0.44)	22	2.84 (0.87)	8	1.76 (0.40)	59
	St. Thomas & St. John	5.8 (4.0)	5	6.2 (1.39)	10	9 (2.60)	5	6.75 (1.68)	20
	St. Croix	3.81 (0.7)	13	3.43 (1.14)	7			3.69 (0.6)	20
Bait ($)	Puerto Rico	2.49 (1.1)	29	6.09 (2.30)		10 (6.20)	8	3.40 (0.98)	59
	St. Thomas & St. John	10.4 (5.30)	5	19.5 (4.42)	10	44 (12.30)	5	22.3 (4.01)	20
	St. Croix	3.69 (1.25)	13	24.29 (9.24)	7			10.1 (3)	20
Supplies ($)	Puerto Rico	0 (0)	29	0 (0)	22	0 (0)	8	0 (0)	59
	St. Thomas & St. John	2 (1.72)	5	0.5 (0.35)	10	0 (0)	5	0.92 (0.64)	20
	St. Croix	0 (0)	13	0 (0)	7			0 (0)	20

Table 35 continued: Average variable costs by stratum based on question 16

Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Food/groceries ($)	Puerto Rico	5 (0.78)	29	4.09 (0.67)	22	4.12 (0.82)	8	4.81 (0.63)	59
	St. Thomas & St. John	7 (2.57)	5	11.9 (2.05)	10	14 (2.88)	5	10.63 (1.42)	20
	St. Croix	7.35 (1.17)	13	6.86 (2.45)	7			7.19 (1.11)	20
Other costs ($)	Puerto Rico	0 (0)	29	0 (0)	22	0.37 (0.23)	8	0.01 (0.01)	59
	St. Thomas & St. John	0 (0)	5	0 (0)	10	0 (0)	5	0 (0)	20
	St. Croix	0 (0)	13	0 (0)	7			0 (0)	20

Figure 4: Running costs percentages by stratum





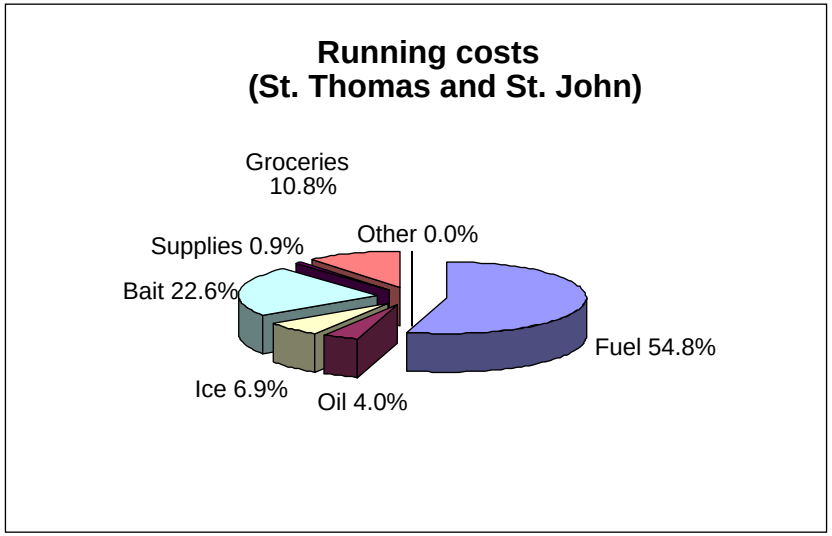


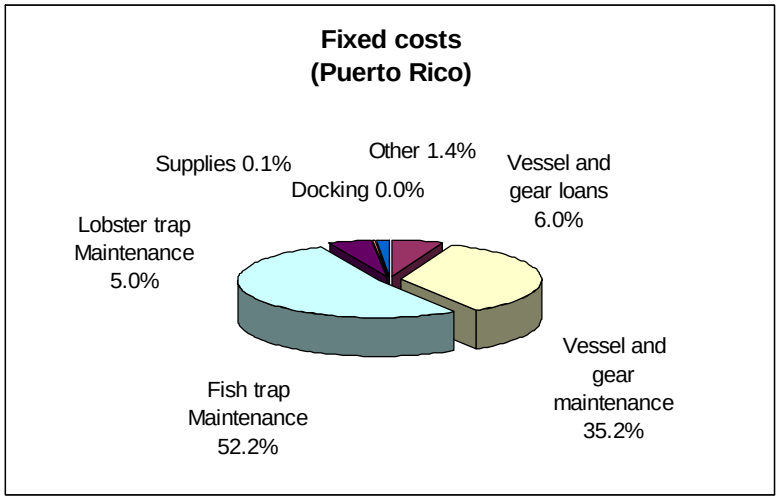
Table 36: Fixed costs by stratum based on questions 27 and 28

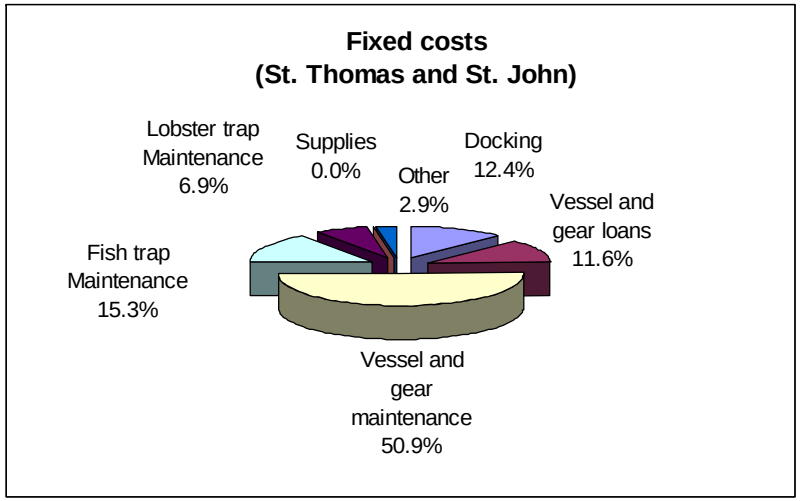
Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Docking fees ($)	Puerto Rico	0 (0)	30	0 (0)	22	0 (0)	8	0 (0)	60
	St. Thomas & St. John	480 (412.03)	5	1,020 (400.25)	10	3,240 (514.74)	5	1,377.7 (250.84)	20
	St. Croix	0 (0)	13	39.28 (27.78)	7			12.22 (8.64)	20
Loan payments on vessel(s) and gear ($)	Puerto Rico	52.8 (49.64)	30	592.36 (223.25)	22	252 (156.28)	8	149.05 (54.18)	60
	St. Thomas & St. John	780 (669.55)	5	2,614.8 (1342.49)	10	0 (0)	5	1,290.69 (571.37)	20
	St. Croix	0 (0)	13	0 (0)	7			0 (0)	20
Maintenance and repairs on vessel(s) and gear ($)	Puerto Rico	716.67 (152.32)	30	1,520.45 (278.97)	22	1,506.25 (276.38)	8	879.83 (130.07)	60
	St. Thomas & St. John	7,700 (3506.83)	5	4,510 (808.32)	10	4,400 (1521.13)	5	5,648.08 (1372.26)	20
	St. Croix	2,253.85 (733.86)	13	1,885.71 (530.59)	7			2,139.32 (531.82)	20
Maintenance and repairs of fish traps ($)	Puerto Rico	1,045.5 (619.85)	30	1,704.09 (177.02)	22	4,777.5 (996.29)	8	1,302.97 (496.04)	60
	St. Thomas & St. John	952 (283.02)	5	1,550 (444.35)	10	3,000 (822.75)	5	1,694 (286.72)	20
	St. Croix	1,150 (309.37)	13	1,275.71 (574.86)	7			1,189.11 (278.22)	20
Maintenance and repairs of lobster traps ($)	Puerto Rico	11.67 (9.47)	30	543.18 (177.70)	22	687.5 (274.72)	8	125.73 (31.99)	60
	St. Thomas & St. John	120 (103)	5	550 (226.38)	10	2,060 (1,557.83)	5	770.38 (400.84)	20
	St. Croix	0 (0)	13	0 (0)	7			0 (0)	20

Table 36 continued: Fixed costs by stratum based on questions 27 and 28

Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Supplies ($)	Puerto Rico	2 (1.88)	30	9.54 (4.22)	22	12.5 (7.75)	8	3.65 (1.68)	60
	St. Thomas & St. John	0 (0)	5	0 (0)	10	0 (0)	5	0 (0)	20
	St. Croix	1,250 (348.02)	13	0 (0)	7			861.11 (239.74)	20
Other ($)	Puerto Rico	0 (0)	30	208.18 (139.19)	22	31.5 (12.75)	8	35.32 (22.77)	60
	St. Thomas & St. John	0 (0)	5	60 (42.43)	10	1,200 (941.36)	5	323.07 (235.90)	20
	St. Croix	0 (0)	13	0.71 (0.51)	7			0.22 (0.16)	20

Figure 5: Fixed costs percentages by stratum





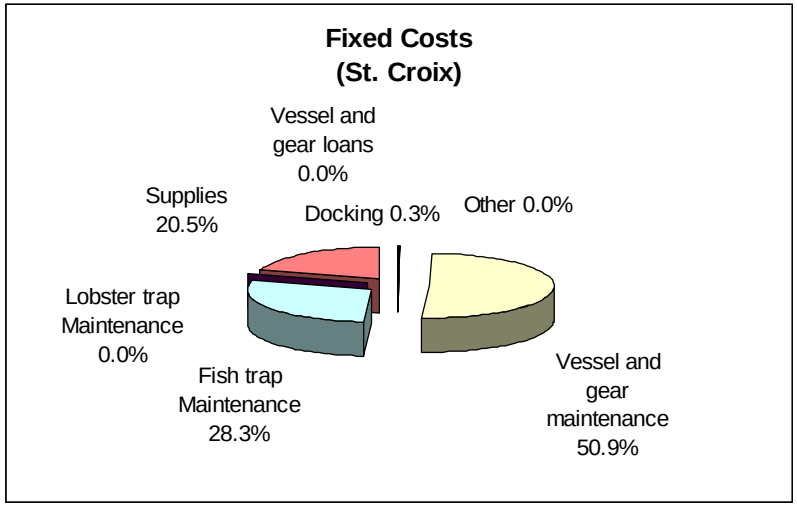


Table 37: Annual financial costs by stratum

Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Annual gross revenue ($)	Puerto Rico	11,198 (1929.74)	29	27,837 (3,271.4)	19	54,940 (6,810.32)	7	15,306 (1,663.53)	55
	St. Thomas & St. John	17,600 (4,637.24)	5	34,092 (6469.31)	10	77,900 (10,645)	5	39,018 (4,017.98)	20
	St. Croix	24,340 (6,130.38)	11	50,136 (12,466)	7			33,317 (5,898.84)	18
Annual running costs ($)	Puerto Rico	3,173.88 (704.11)	25	5,696.79 (1,049.57)	14	4,282.57 (1,051.98)	7	3,549.51 (599.48)	46
	St. Thomas & St. John	3,952 (361.53)	5	6,520.8 (610.67)	10	13,894 (2,164.61)	5	7,425.6 (604.53)	20
	St. Croix	4,888.32 (787.51)	12	7,216.86 (938.33)	7			5,653.29 (612.09)	19
Annual crew payments ($)	Puerto Rico	2,607.88 (619.06)	24	6,326.07 (1,108.44)	12	9,641.74 (2,216.13)	6	3,326.36 (544.73)	42
	St. Thomas & St. John	3,959.47 (1,710.15)	5	11,413 (2,298.34)	10	41,427 (12,226)	5	16,193 (3,242.53)	20
	St. Croix	10,127 (4,409.26)	11	24,017 (11,441)	7			14,961 (4,910.84)	18
Annual fixed costs ($)	Puerto Rico	1,775.83 (654.95)	30	3,985.45 (437.85)	22	7,015.25 (1,150.07)	8	2,347.51 (528.45)	60
	St. Thomas & St. John	9,252 (3,868.49)	5	7,690 (1,166.06)	10	13,900 (2,250.05)	5	9,813.23 (1,586.03)	20
	St. Croix	4,653.85 (1,081.14)	13	3,201.43 (1,067.47)	7			4,201.98 (815.48)	20
Annual interest payments ($)	Puerto Rico	52.8 (49.63)	30	592.36 (223.25)	22	252 (156.28)	8	149.054 (54.18)	60
	St. Thomas & St. John	780 (669.55)	5	2,614.8 (1342.49)	10	0 (0)	5	1,290.69 (571.37)	20
	St. Croix	0 (0)	13	0 (0)	7			0 (0)	20

Table 38: Financial and economic performance measures

Variable	Region	Tier I	N	Tier II	N	Tier III	N	All	N
Annual gross revenue ($)	Puerto Rico	11,198 (1929.74)	29	27,837 (3,271.4)	19	54,940 (6,810.32)	7	15,306 (1,663.53)	55
	St. Thomas & St. John	17,600 (4,637.24)	5	34,092 (6469.31)	10	77,900 (10,645)	5	39,018 (4,017.98)	20
	St. Croix	24,340 (6,130.38)	11	50,136 (12,466)	7			33,317 (5,898.84)	18
Annual net revenue ($)	Puerto Rico	8,618.62 (1,896.03)	24	20,350 (2,896.86)	12	46,235 (7,309.15)	6	11,499 (1,658.77)	42
	St. Thomas & St. John	13,648 (4,711.02)	5	27,571 (6,251.47)	10	64,006 (10,120)	5	31,592 (3,891.62)	20
	St. Croix	22,216 (6,379.51)	10	42,919 (11,960)	7			29,874 (5,977.46)	17
Annual financial profits ($)	Puerto Rico	4,760.62 (1,262.83)	23	11,931 (2,556.35)	12	32,467 (7,732.34)	6	6,779.63 (1,146.84)	41
	St. Thomas & St. John	3,744.17 (4,769.77)	4	9,694.3 (4,745)	10	13,652 (4,496.9)	5	8,885.25 (2,758.62)	19
	St. Croix	9,229.02 (3,602.69)	9	15,781 (3,712.61)	7			11,816 (2,627.23)	16
Annual economic profit ($)	Puerto Rico	-9,339.26 (2,178.41)	21	-11,905 (3,910.45)	10	8,711.44 (5,520.27)	6	-8,806.75 (1,903.12)	37
	St. Thomas & St. John	-10,891 (5,391.60)	3	-18,486 (6,475.49)	9	-7,920.39 (11,881)	5	-13,204 (4,788.43)	17
	St. Croix	-7,453.38 (7,916.82)	9	10,674 (13,922)	6			-952.51 (7,120.99)	15

Business objectives and fishing capacity utilization

Here we describe trap fisherman's business motivations and fishing capacity usage and constraints. This theme covers survey questions 29 through 34 (Appendix A).

Forty percent of the Puerto Rican fishermen indicated revenue maximization as their major business objective whereas forty-five percent of the St. Thomian and St. Johnian fishermen and forty percent of the Crucian fishermen cited profit maximization (Table 39).

On average, Puerto Rican fishermen required fewer crew than their U.S. Virgin Islands counterparts. Over 46 percent of the Puerto Rican respondents mentioned that they could fish alone compared to 20 percent of the St. Thomian and St. Johnian respondents and 35 percent of the Crucian respondents (Table 40). Eighty percent of the St. Thomian and St. Johnian fishermen and 65% of the Crucian fishermen mentioned that they needed a minimum of one crew member to operate the vessel compared to 42% of the Puerto Rican fishermen. Table 40 shows the distribution of minimum crew size needed by stratum.

The survey also inquired about the number of crew normally taken during a typical trip (Table 41). Seventy-five percent of the USVI respondents stated that they hired one crew member. Seventy percent of Puerto Rican fishermen indicated that they take one crew. Table 41 shows the distribution of regular crew usage by stratum.

Respondents mentioned that the maximum number of fish traps that they had ever fished ranged between 4 and 1,200 traps. In Puerto Rico, the number of traps used ranged from 4 to 500 (Table 42), and in St. Thomas and St. John they ranged from 12 to 1,200 (Table 43). In St. Croix the number of traps fished ranged from 12 to 300 (Table 44). Table 45 shows the distribution of the maximum number of fish traps fished by stratum.

When asked about the maximum possible number of fishable traps, Puerto Rican fishermen indicated a range between 4 and 500 traps, whereas St. Thomian and St. Johnian fishermen offered a range between 50 and 1,200 traps (Tables 46 and 47). Crucian fishermen maximum number of fishable traps ranged between 5 and 300 (Table 48). Table 49 shows the distribution of maximum number of fishable traps by stratum.

The survey also inquired about the main reasons for not fishing the maximum number of possible traps (Table 50). In all islands, the other category predominated followed by high operating costs. Among the most common constraints cited were trap theft, time limitations, trap loses caused from recent hurricanes (particularly Hugo in 1989, Marilyn in 1995, and Georges in 1998), bad weather, and vessel and gear limitations (figures 6 and 7).

Table 39: Stated business objective by stratum based on question 29

Region	Business objective	Tier I	Percentage	Tier II	Percentage	Tier III	Percentage	Tier Percentages
Puerto Rico	Maximize profits	8	26.67	6	27.27	3	37.5	28.33
	Minimize costs	8	26.67	5	22.73	3	37.5	26.67
	Maximize revenue	12	40	10	45.45	2	25	40
	Other	2	6.67	1	4.55	0	0	5
	N/A							
St. Thomas and St. John	Maximize profits	1	20	6	60	2	40	45
	Minimize costs	1	20	1	10	0	0	10
	Maximize revenue	3	60	1	10	3	60	35
	Other	0	0	2	20	0	0	10
	N/A							
St. Croix	Maximize profits	6	46.15	2	28.57			40
	Minimize costs	0	0	1	14.29			5
	Maximize revenue	4	30.77	1	14.29			25
	Other	3	23.08	1	14.29			20
	N/A			2	28.57			20

Table 40: Minimum number of crewmembers based on question 30

Region	Minimum crew size	Tier I	Frequency	Tier II	Frequency	Tier III	Frequency	Tier Percentages
Puerto Rico	0	14	46.67	10	45.45	4	50.0	46.67
	1	15	50	7	31.82	3	37.5	41.67
	2	1	3.33	5	22.73	1	12.5	11.67
St. Thomas and St John	0	1	20	3	30	0	0	20
	1	4	80	7	70	5	100	80
	2	0	0	0	0	0	0	0
St. Croix	0	5	38.46	2	28.57			35
	1	8	61.54	5	71.43			65
	2	0	0	0	0			0

Table 41: Normal number of crewmembers based on question 31

Region	Normal crew size	Tier I	Frequency	Tier II	Frequency	Tier III	Frequency	Tier Percentages
Puerto Rico	0	6	20	2	9.1	1	12.5	15
	1	23	76.67	13	59.1	6	75	70
	2	1	3.33	7	31.8	1	12.5	15
St. Thomas and St John	0	1	20	1	10	0	0	10
	1	4	80	7	70	4	80	75
	2	0	0	2	20	1	20	15
St. Croix	0	1	7.7	1	14.3			10
	1	9	69.2	6	85.7			75
	2	3	23.1	0	0			15

Table 42: Maximum number of traps fished in Puerto Rico based on question 32

Maximum number of traps	Frequency	Cumulative percentage
4	1	1.69
11	1	3.39
15	1	5.08
20	3	10.17
30	2	13.56
32	3	18.64
36	1	20.34
40	3	25.42
42	1	27.12
45	1	28.81
50	5	37.29
60	8	50.85
74	1	52.54
80	2	55.93
96	1	57.63
100	2	61.02
110	2	64.41
115	1	66.1
120	6	76.27
140	1	77.97
150	1	79.66
164	1	81.36
200	2	84.75
236	1	86.44
240	1	88.14
250	1	89.83
300	2	93.22
325	1	94.92
360	1	96.61
400	1	98.31
500	1	100

Table 43: Maximum number of traps fished in St. Thomas and St. John based on question 32

Maximum number of traps	Frequency	Cumulative percentage
12	1	5
55	1	10
59	1	15
115	1	20
120	1	25
125	1	30
140	1	35
144	1	40
150	1	45
160	2	55
175	1	60
185	1	65
300	2	75
330	1	80
400	1	85
500	1	90
600	1	95
1200	1	100

Table 44: Maximum number of traps fished in St. Croix based on question 32

Maximum number of traps	Frequency	Cumulative percentage
12	1	5
13	1	10
14	1	15
16	1	20
20	1	25
21	1	30
23	1	35
24	1	40
25	1	50
28	1	55
45	1	60
50	1	70
56	1	75
58	1	80
60	1	85
75	1	90
90	1	95
300	1	100

Table 45: Maximum number of traps fished by stratum based on question 32

Maximum number of traps fished	Puerto Rico			St. Thomas and St. John			St. Croix	
	Tier I	Tier II	Tier III	Tier I	Tier II	Tier III	Tier I	Tier II
1-19	3			1			3	1
20-39	9						5	2
40-59	8	2		1	1		4	1
60-79	6	3					1	1
80-99	1	2						1
100-119	1	4		1				
120-139	1	4	1		2			
140-159		2		1	2			
160-179		1		1	1	1		
180-199						1		
200-219		1	1					
220-239			1					
240-259		2						
260-279								
280-299								
300-349		1	2		2	1		1
350-399			1					
400-449			1		1			
450-499								
500-599			1			1		
600-699						1		
700-799								
800-899								
900-999								
1000-1099								
1100-1199								
1200-1299					1			
N/A	1							

Table 46: Maximum number of fishable traps in Puerto Rico based on question 33

Maximum number of traps	Frequency	Cumulative percentage
4	1	1.67
20	4	8.33
30	3	13.33
32	1	15
40	2	18.33
45	1	20
50	5	28.33
60	4	35
75	1	36.67
80	6	46.67
90	1	48.33
96	1	50
100	5	58.33
110	1	60
123	1	61.67
200	1	63.33
300	4	70
360	1	71.67
400	2	75
500	4	81.67
N/A	11	100

Table 47: Maximum number of fishable traps in St. Thomas and St. John based on question 33

Maximum number of traps	Frequency	Cumulative percentage
50	1	5
75	1	10
100	2	20
125	1	25
150	1	30
160	1	35
200	1	40
275	1	45
300	3	60
400	1	65
480	1	70
600	1	75
700	2	85
1200	1	90
N/A	2	100

Table 48: Maximum number of fishable traps in St. Croix based on question 33

Maximum number of traps	Frequency	Cumulative percentage
5	1	5
12	1	10
14	1	15
16	1	20
21	1	25
25	2	35
30	2	45
40	1	50
50	4	70
56	1	75
75	2	85
100	1	90
125	1	95
300	1	100

Table 49: Maximum number of fishable traps by stratum based on question 33

Maximum number of fishable traps	Puerto Rico			St. Thomas and St. John			St. Croix	
	Tier I	Tier II	Tier III	Tier I	Tier II	Tier III	Tier I	Tier II
1-19	1						3	1
20-39	8						2	3
40-59	7	1		1			5	1
60-79	4	1		1			2	
80-99	4	4						
100-119	2	4		1	1		1	
120-139			1		1			1
140-159					1			
160-179						1		
180-199								
200-219			1		1			
220-239								
240-259								
260-279					1			
280-299								
300-349		3	1		2	1		1
350-399			1					
400-449			2		1			
450-499						1		
500-599		2	2					
600-699						1		
700-799				1		1		
800-899								
900-999								
1000-1099								
1100-1199								
1200-1299					1			
No response	4	7		1	1			

Table 50: Production constrains based on question 34

Region	Production constrains	Tier I	Tier II	Tier III	All tiers
Puerto Rico	High operating costs	8	5	0	13
	Labor shortage	0	1	0	1
	Low fish abundance	5	2	0	7
	Market limitations	0	0	0	0
	Other	22	15	7	44
St. Thomas and St. John	High operating costs	2	2	1	5
	Labor shortage	2	1	0	3
	Low fish abundance	1	0	0	1
	Market limitations	1	1	0	1
	Other	3	6	3	12
St. Croix	High operating costs	3	0		3
	Labor shortage	0	0		0
	Low fish abundance	0	0		0
	Market limitations	0	1		1
	Other	10	7		17

Figure 6: Other reasons why Puerto Rican fishermen do not fish at maximum capacity

Puerto Rico tier I:

1. Theft
2. Thieves
3. Time consuming.
4. Health reasons
5. Platform
6. Thieves
7. Thieves
8. Thieves
9. Age and engine is no good
10. Has 8 traps and does not catch any fish

Puerto Rico tier II:

1. Limited amount of time
2. Thieves
3. Lack of materials
4. I am old
5. I also dive. Time limitation.
6. Building capacity since hurricane George
7. Too many traps to tend
8. I do not have a good engine and there is no government assistance
9. Regulations, other work and diving, used to be work before mangrove restrictions
10. Limited fishing grounds, too many fishermen in Vieques
11. Lack of sufficient fishing grounds
12. Building capacity since hurricane George hit
13. Bad weather and theft of traps
14. Economic condition does not allow me

Puerto Rico tier III:

1. Age
2. Thieves and theft
3. Thieves
4. More trips would be too much
5. Trap fishing is hard work. Cannot work any harder
6. Is not comfortable to fish with traps and is not worthwhile kill yourself doing it.
7. Lack of time

Figure 7: Other reasons why USVI fishermen do not fish at maximum capacity

St. Thomas and St. John Tier I:

1. Hurricanes killed me. Hugo, Marilyn
2. Not young anymore
3. Other obligations. More work in construction since Marilyn

St. Thomas and St. John Tier II:

1. Time consuming
2. Hurricanes, labor price. Previously worked harder but it was too much work. He had 1200 traps before Hugo, then 800 after Marilyn. Now he has 84 fish traps and 460 lobster traps.
3. Hard to maintain.
4. Too much poaching
5. Long way to go, time consuming
6. Time consuming. Not enough time to do the work.

St. Thomas and St. John tier 3:

1. Conservation ethic
2. Hurricanes devastated traps=> fearful of further losses
3. Time consuming.

St. Croix Tier I:

1. Weather/hurricanes
2. Don't want to do more than can handle
3. Traps cannot support the livelihood of fishermen. Nets can support it. The enemies are thieves and damage caused by boats.
4. The enemy
5. Robbing
6. Gear loss and tankers
7. Fear that will steal traps
8. They have closed too many areas. We need to go further out. Buck Island is closed, Lang bank is closed, Barracuda Bank.

St. Croix tier II:

1. Size of boat and no mechanic hauler
2. Sometimes pull out traps due to weather. Do not have time to look for materials.
3. Area is small.
4. Pulling traps without mechanical hauler is too hard.
5. Supply and demand is steady.

Behavioral response to a trap reduction program

This theme investigates how fishermen would react to a hypothetical reduction in the number of traps fished. Specifically, we are interested in understanding how fishermen would attempt to mitigate pecuniary losses caused by this hypothetical reduction. For example, would they use unregulated inputs more extensively (e.g., decrease soak time of the remaining traps, increase number of trips, etc)? Or would they switch to other gears and/or areas, or target different species?

This behavioral question was structured as a decision tree (see, question 35 in Appendix A). In the top level, respondents were initially asked 'If you were required to reduce your number of traps by $\underline{x}$ percentage how would you likely react?'. Respondents could state that they would either continue trap fishing or they would discontinue trap fishing. If they responded that they would continue trap fishing; then, they would be asked how would the reduction affect their trap usage (e.g., change soak time, number of trips, and/or areas fished)? Fishermen were offered three behavioral options: a) increase trap usage, b) decrease trap usage, and c) continue fishing as usual.

If respondents stated that they would stop trap fishing, they were asked whether they would continue commercial fishing. Two behavioral options followed this last question: d) cease fishing with traps but continue fishing commercially, and e) quit commercial fishing. Each of the five behavioral options (a, b, c, d, and e) contained follow up questions seeking more detail on switching gears, areas, and species, percentage of forgone revenue, alternative employment opportunities, etc. Each respondent was assigned a percentage reduction in the number of traps fished that was randomly determined prior to the interview. The random percent reduction ranged between 4 and 100 percent.

By and large, Puerto Rican fishermen stated that they would exit trap and/or commercial fishing when the trap percentage reductions reach upwards of 40% (Table 51). In the case of USVI fishermen, the interviews did not show a distinct percent reduction threshold on the exit trap fishing and/or commercial fishing options (Tables 52, and 53). Caution

should be exercised when interpreting the results in both the St. Thomas and St. John and the St. Croix cases given the relatively low number of observations in exit trap and/or commercial fishing categories.

For all three islands, the ’no change’ trap usage option elicited the most responses and had the greatest variability (Tables 51, 52 and 53). The ‘no change’ option for Puerto Rican fishermen showed the highest variability with percentage reductions ranging from 4 to 90% (Table 51). In addition, all three islands reported a relatively high degree of variability in the’ increasing trap usage’ option. Unlike Puerto Rican fishermen (particularly in tier I), none of the USVI fishermen stated that they would ‘reduce trap usage’ (Tables 51, 52 and 53).

Fishermen who stated that they would increase usage of their remaining traps noted that they would achieve this by increasing the number of trips and decreasing soak time (Table 54). The upper tiers of Puerto Rican and Crucian fishermen stated that they would likely move to new fishing grounds. When asked whether they would use other gears to offset lost revenues, Puerto Rican fishermen stated that they would use dive and net gears. In contrast, U.S. Virgin Islands fishermen favored hook and line and net gears (Table 54). Again, the reader should be careful when interpreting the results because of the relatively low number of observations.

As noted above, only Puerto Rican fishermen stated that they would decrease usage of their remaining traps given the random probabilities offered (Table 55). Table 55 shows that these fishermen would decrease the number of trips taken and increase soak time. Net fishing was mentioned as the main alternative gear.

The majority of the fishermen who mentioned that they would not change trap fishing practices in response to a hypothetical trap reduction, stated that they would not change species mix nor fishing grounds; however, they would adopt other gears. In Puerto Rico, fishermen showed a widespread support for hook and line gear, followed to a lesser

extent by net fishing and diving (Table 56) In contrast, U.S. Virgin Islands fishermen primarily favored the hook and line gear (Tables 57 and 58).

Fishermen who stated that the hypothetical trap reduction scenario would compel them to stop using traps noted that they would switch to other gears. In Puerto Rico, fishermen strongly favored hook and line gear, followed by net fishing and diving (Table 59). Puerto Rican fishermen's preference for these other gears parallels the historical transformation of the Puerto Rican fishing sector, which was characterized by a shift from fish traps to lines, nets, and diving (Valdés-Pizzini *et al*, 1992[6], Matos-Caraballo, 2000). In the U.S. Virgin Islands, fishermen noted that they would move into hook and line, net fishing and diving as well (Table 60). Tobias (2004) offers an interesting account of Crucian fishermen's transition from trap fishing to gill and trammel net fishing.

Fishermen who reported that the reduction would force them out of commercial fishing stated that they would have to rely on social security and welfare payments to make ends meet. In addition, fishermen mentioned construction and other land-based work as alternative sources of employment (Tables 61 and 62).

[6] Valdés-Pizzini, M., A. Acosta, M. Ruíz and D. Griffith, 1992. Assessment the Socio-Economic Impact of Fishery Management Options Upon Gillnet and Trammel Net Fishermen in Puerto Rico: An Interdisciplinary Approach (Anthropology and Fisheries Biology) for the Evaluation of Management Alternatives. Submitted to NOAA Fisheries. University of Puerto Rico, Mayagüez, Puerto Rico.

Table 51: Puerto Rican fishermen's response to hypothetical trap reductions based on question 35

Region		Percent reduction (%)	Increase usage of remaining traps	Decrease usage of remaining traps	No change in usage of remaining traps	No trap fishing	Quit fishing	Frequency
Puerto Rico	Tier 1	0-10	0	0	3	0	0	3
		11-20	0	0	1	0	0	1
		21-30	0	1	1	0	0	2
		31-40	0	0	1	0	0	1
		41-50	0	1	2	1	0	4
		51-60	0	1	4	1	0	6
		61-70	0	0	2	3	1	6
		71-80	0	0	0	1	1	2
		81-90	1	0	0	2	0	3
		91-100	0	0	0	2	0	2
		No response						0
	Tier 2	0-10	0	0	2	0	0	2
		11-20	0	0	2	0	0	2
		21-30	1	0	1	0	0	2
		31-40	1	0	0	0	0	1
		41-50	0	0	0	0	2	2
		51-60	1	0	1	1	0	3
		61-70	0	1	0	1	1	3
		71-80	0	0	1	1	0	2
		81-90	0	0	1	0	2	3
		91-100	0	0	0	1	1	2
		No response						0
	Tier 3	0-10	0	0	1	0	0	1
		11-20	-	-	-	-	-	-
		21-30	-	-	-	-	-	-
		31-40	1	0	0	0	0	1
		41-50	0	0	0	0	2	2
		51-60	-	-	-	-	-	-
		61-70	0	0	1	0	0	1
		71-80	-	-	-	-	-	-
		81-90	0	0	0	0	1	1
		91-100	0	0	0	1	1	2
		No response						2

Table 52: St. Thomian and St. Johnian fishermen's response to hypothetical trap reductions based on question 35

Region		Percent reduction (%)	Increase usage of remaining traps	Decrease usage of remaining traps	No change in usage of remaining traps	No trap fishing	Quit fishing	Frequency
St. Thomas and St. John	Tier 1	0-10	-	-	-	-	-	
		11-20	0	0	1	0	0	1
		21-30	-	-	-	-	-	
		31-40	0	0	0	1	0	1
		41-50	0	0	2	0	0	2
		51-60	-	-	-	-	-	
		61-70	-	-	-	-	-	
		71-80	-	-	-	-	-	
		81-90	0	0	1	0	0	1
		91-100	-	-	-	-	-	
	Tier 2	0-10	0	0	1	0	1	2
		11-20	-	-	-	-	-	
		21-30	-	-	-	-	-	
		31-40	1	0	0	0	0	1
		41-50	1	0	1	0	0	2
		51-60	-	-	-	-	-	
		61-70	0	0	1	0	1	2
		71-80	0	0	0	1	0	1
		81-90	-	-	-	-	-	
		91-100	0	0	0	0	2	2
	Tier 3	0-10	-	-	-	-	-	
		11-20	-	-	-	-	-	
		21-30	0	0	1	0	0	1
		31-40	-	-	-	-	-	
		41-50	-	-	-	-	-	
		51-60	1	0	1	0	0	2
		61-70	0	0	0	0	1	1
		71-80	-	-	-	-	-	
		81-90	-	-	-	-	-	
		91-100	0	0	0	0	1	1

Table 53: Crucian fishermen's response to hypothetical trap reductions based on question 35

Region		Percent reduction (%)	Increase usage of remaining traps	Decrease usage of remaining traps	No change in usage of remaining traps	No trap fishing	Quit fishing	Frequency
St. Croix	Tier 1	0-10	0	0	1	0	0	1
		11-20	0	0	1	0	0	1
		21-30	1	0	3	0	1	5
		31-40	-	-	-	-	-	-
		41-50	1	0	0	1	0	2
		51-60	0	0	0	1	0	1
		61-70	0	0	1	0	0	1
		71-80	0	0	1	0	0	1
		81-90	-	-	-	-	-	-
		91-100	-	-	-	-	-	-
		N/A						1
	Tier 2	0-10	0	0	2	0	0	2
		11-20	0	0	1	0	0	1
		21-30	-	-	-	-	-	
		31-40	-	-	-	-	-	
		41-50	1	0	0	0	0	1
		51-60	0	0	1	0	0	1
		61-70	-	-	-	-	-	
		71-80	-	-	-	-	-	
		81-90	0	0	0	1	0	1
		91-100	-	-	-	-	-	

Table 54: Anticipated impacts of the hypothetical trap reduction under the 'increase trap usage' option based on question 35

Region	Tier	Percent reduction	Annual trips before	Annual trips after	Soak before	Soak after	Annual net revenue reduction (%)	Different species	Different areas	Use other gear 1	Annual trips gear 1	Use other gear 2	Annual trips gear 2
Puerto Rico	I	85	150	200	2	1.5	80	N	N	Net fishing	150	-	-
	II	28	125	175	3	2	33	N	Y	Dive	200	-	-
		33	125	175	3	2	30	Y	Y	Dive	100	-	-
		57	100	150	3	2	0 (?)	Y	Y	-	-	-	-
	III	40	(104-156)	(104 - 156)	14	14	33	N	Y	-	-	-	-
St. Thomas and St. John	II	40	52	104	7	4	50	N	N	Hook and line	52	-	-
		50	104	208	10	-	90	N	N	-	-	-	-
	III	60	156	260	5	-	50	Y	Y	Net fishing	-	-	-
St. Croix	I	30	150	300	2	1	50	N	N	-	-	-	-
	I	45	100	159	3	2	85	Y	Y	Hook and line	200	-	-
	II	50	-	-	-	-	80	N	Y	-	-	-	-

Table 55: Anticipated impacts of the hypothetical trap reduction under the ‘decrease trap usage’ option based on question 35

Region	Tier	Percent reduction	Annual trips before	Annual trips after	Soak before	Soak after	Annual net revenue reduction (%)	Different species	Different areas	Use other gear 1	Annual trips gear 1	Use other gear 2	Annual trips gear 2
Puerto Rico	I	29	150	100	2	3	50	Y	Y	Net fishing	200	-	-
		44	52	-	7	-	-	-	-	-	-	-	-
		55	100	50	3.5	7	70	N	N	-	-	-	-
	II	65	156	-	3	-	-	Y	Y	Net fishing	250	-	-
St. Thomas and St. John	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Croix	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 56: Anticipated impacts of the hypothetical trap reduction under the ‘no change’ option in Puerto Rico based on question 35

Region	Tier	Percent reduction	Annual net revenue reduction (%)	Different species	Different areas	Use other gear 1	Annual trips gear 1	Use other gear 2	Annual trips gear 2
Puerto Rico	I	5	2	N	N	-	-	-	-
		5	50	N	N	Hook and line	250	-	-
		10	50	N	N	-	-	-	-
		13	40	Y	Y	Longline	150	-	-
		30	60	N	N	Net fishing	200	-	-
		31	30	-	Y	-	-	-	-
		46	30	-	Y	Net fishing	150	-	-
		49	-	N	N	-	-	-	-
		57	50	N	N	-	-	-	-
		58	95	N	N	Hook and line	50	-	-
		59	30	N	N	Hook and line	175	-	-
		60	80	N	N	Net fishing	350	-	-
		67	50	N	N	Hook and line	50	Net fishing	50
		67	10	N	N	Dive	100	Net fishing	100
	II	5	2	N	N	-	-	-	-
		7	0	N	N	-	-	-	-
		13	90	N	N	-	-	-	-
		15	-	Y	N	Hook and line	150	-	-
		28	15	N	Y	-	-	-	-
		55	50	N	N	Hook and line	100	-	-
		72	50	N	N	Dive	50	-	-
		81	80	Y	Y	Hook and line	200	-	-
	III	4	5	N	N	-	-	-	-
		65	50	N	N	-	-	-	-

Table 57: Anticipated impacts of the hypothetical trap reduction under the ‘no change’ option in St. Thomas and St. John based on question 35

Region	Tier	Percent reduction	Annual net revenue reduction (%)	Different species	Different areas	Use other gear 1	Annual trips gear 1	Use other gear 2	Annual trips gear 2
St. Thomas and St. John	I	50	30	Y	Y	Hook and line	160	-	-
		50	50	N	Y	-	-	-	-
	II	85	100	N	N	Hook and line	50	-	-
		5	4	N	N	Hook and line	20	-	-
		45	50	N	N	Hook and line	45	-	-
		65	80	N	N	-	-	-	-
	III	30	50	Y	Y	Hook and line	50	-	-
		60	60	Y	Y	-	-	-	-

Table 58: Anticipated impacts of the hypothetical trap reduction under the ‘no change’ option in St. Croix based on question 35

Region	Tier	Percent reduction	Annual net revenue reduction (%)	Different species	Different areas	Use other gear 1	Annual trips gear 1	Use other gear 2	Annual trips gear 2
St. Croix	I	5	0	N	N	-	-	-	-
		15	0	N	N	-	-	-	-
		25	-	Y	Y	Hook and line	150	-	-
		30	50	N	N	-	-	-	-
		30	30	N	N	-	-	-	-
		65	0	N	N	-	-	-	-
		75	25	Y	N	-	-	-	-
	II	5	2	N	N	-	-	-	-
		10	-	-	-	-	-	-	-
		20	0	N	N	-	-	-	-
		60	0	N	N	-	-	-	-
		60	80	Y	Y	Hook and line	250	-	-

Table 59: Anticipated impacts of the hypothetical trap reduction under the 'quit trap fishing' option in Puerto Rico based on question 35

Region	Tier	Percent reduction	Annual net revenue reduction (%)	Different gears	Annual trips with gear 1	Annual trips with gear 2	Annual trips with gear 3
Puerto Rico	I	49	0	Dive	350	-	-
		60	80	Net fishing	200	-	-
		61	90	Dive; Hook and line	200	350	-
		67	50	Hook and line	100	-	-
		70	0	Net fishing	200	-	-
		77	20	Hook and line	85	-	-
		84	95	Hook and line	250	-	-
		90	75	Longline	200	-	-
		96	20	Net fishing	250	-	-
		97	50	Hook and line	250	-	-
	II	53	80	Hook and line; Net fishing	200	200	-
		68	80	Dive	250	-	-
		71	75	Net fishing	300	-	-
		100	50	Dive; Hook and line	312	84	-
	III	92	75	Hook and line	150	-	-

Table 60: Anticipated impacts of the hypothetical trap reduction under the 'quit trap fishing' option in the U.S. Virgin Islands based on question 35

Region	Tier	Percent reduction	Annual net revenue reduction (%)	Different gears	Annual trips with gear 1	Annual trips with gear 2	Annual trips with gear 3
St. Thomas and St. John	I	35	40	Dive	104	-	-
	II	75	35	Net fishing	360	54	-
St. Croix	I	45	95	Hook and line	300	-	-
		60	10	Net fishing; Dive	100	100	-
	II	85	10	Hook and line	250	-	-

Table 61: Anticipated impacts of the hypothetical trap reduction under the ‘exit commercial fishing’ option in Puerto Rico based on question 35

Region	Tier	Percent reduction	Annual net revenue reduction (%)	Other employment
Puerto Rico	I	65	80	welfare
		73	95	retirement
	II	44	50	construction
		45	30	welfare
		67	-	land based work
		81	90	social security
		86	10	welfare
		94	20	construction
	III	43	82	social security
		50	67	social security
		85	60	land based work
		100	-	Welfare

Table 62: Anticipated impacts of the hypothetical trap reduction under the ‘exit commercial fishing’ option in U.S. Virgin Islands based on question 35

Region	Tier	Percent reduction	Annual net revenue reduction (%)	Other employment
St. Thomas and St. John	II	10	-	welfare
		70	-	welfare
		100	50	no idea
		100	75	welfare
	III	65	-	welfare
		95	50	construction
St. Croix	I	30	10	welfare

Trap fishing grounds

Last, we introduce three maps detailing the main fishing grounds and landings sites as reported by the interviewees (Figures 8, 9 and 10). These maps describe the extension of the fishing grounds rather than the trap concentration in various areas.

The Puerto Rican map shows that the trap fishing grounds tend to be more extensive in the southwest and northeast corners (Figure 8). The southwest corner is an area favorable to fishing because of its extensive and shallow continental shelf (Abgrall, 1974). The northeast corner is also conducive to good fishing because it has a large shelf and water depth never exceeds 40 fathoms. Few trap fishermen operate in the north coast because the continental shelf is short and deep. The 100 fathom line can be found within 2 miles from the coast. In addition, there are few sheltered areas to escape from the strong winds and currents prevalent in the area.

The U.S. Virgin Islands has two main fishing regions, the St. Thomas and St. John region and St. Croix region. The shelf around the St. Thomas and St. John region is extends 8 miles south of the islands and 20 miles north of the islands. The depth of water over most of the shelf is over 60 feet (Kojis, 2004). Figure 9 shows trap fishing grounds encircle both the islands of St. Thomas and St. John. According to Impact Assessment Inc. (2005)[7], fishing grounds south of St. Thomas are favored by fishermen because of their good bottom and because fishermen operating in northern waters relocate their traps to the south during the rough winter swells. The establishment of several closures (e.g., Red Hind Marine Conservation District and the Virgin Island Coral Reef National Monument south of St. John) has contributed to the over-crowding of southern waters.

[7] Impact Assessment Inc., 2005. Community Profiles and Socioeconomic Evaluation of Marine Conservation Districts: St. Thomas and St. John, U.S. Virgin Islands. Draft Report submitted to the Southeast Fisheries Science Center, NOAA Fisheries. Impact Assessment Inc., La Jolla, California.

In contrast to St. Thomas and St. John, the shelf around St. Croix is shallower (less than 60 feet) but considerably smaller. The majority of the Crucian shelf, except for Lang Bank east of St. Croix, lies within 3 nautical miles. On the northwest side of St. Croix, the shelf edge is only a hundred yards from shore (Kojis, 2004). Figure 10 shows that the main trap fishing grounds in St. Croix are found in the northeast and southwest corners. According to Valdés-Pizzini *et al* (2004)[8], productive waters are found along the south shore and north of Christiansted, Teague Bay, and Buck Island. These last two areas became recently protected.

[8] Valdés-Pizzini, M., K. Kitner, C. Garcia Quijano, 2004. The Predicament of the Cruzan Fisheries: A Rapid Assessment of the Socio-Economic Profiles of Fishing Communities in the Island of St. Croix, U.S. Virgin Islands. Draft submitted to the Southeast Fisheries Science Center, NOAA Fisheries. University of Puerto Rico, Mayagüez, Puerto Rico.

Figure 8: Trap fishing grounds in Puerto Rico

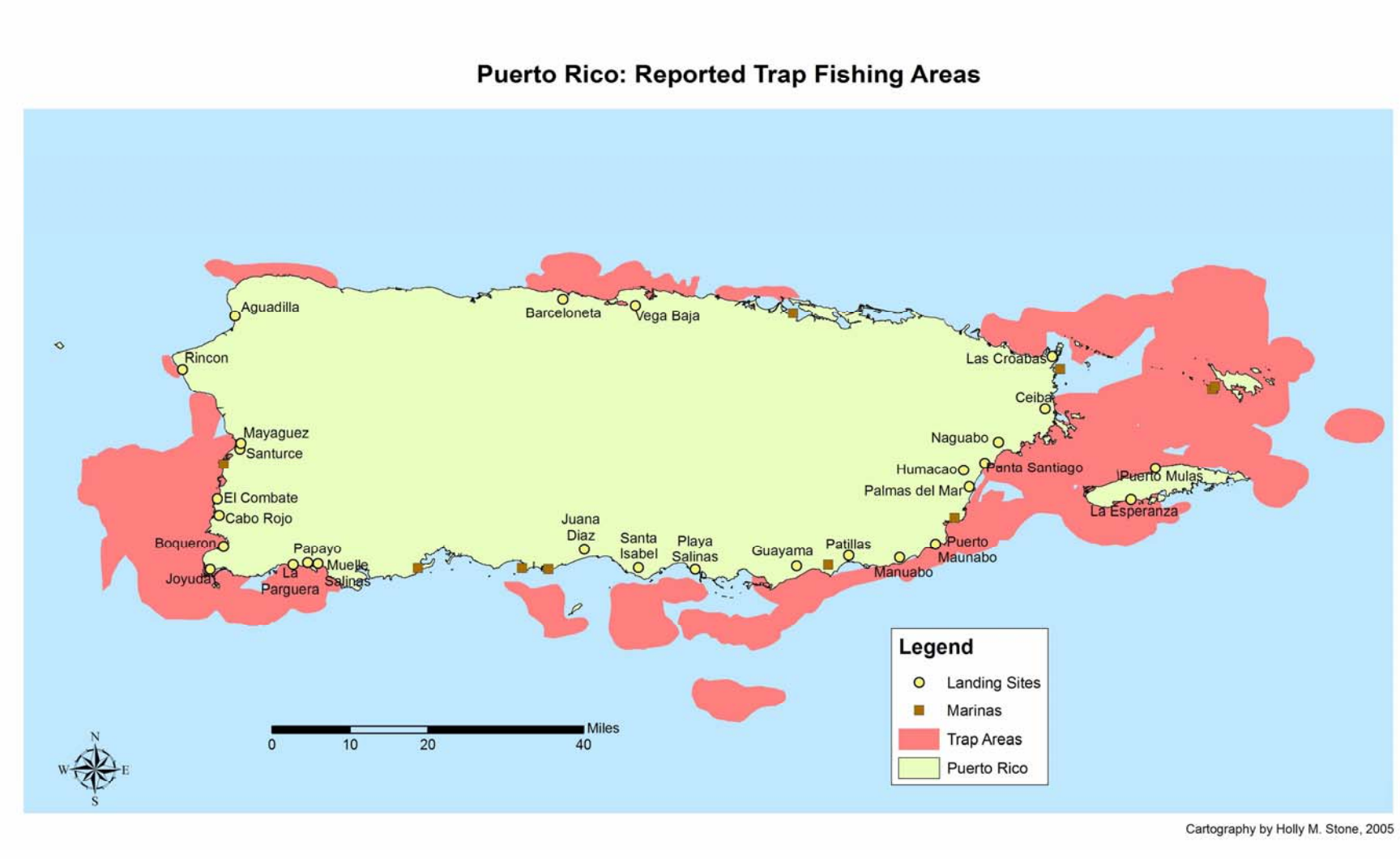


Figure 9: Trap fishing grounds in St. Thomas and St. John, U.S. Virgin Islands

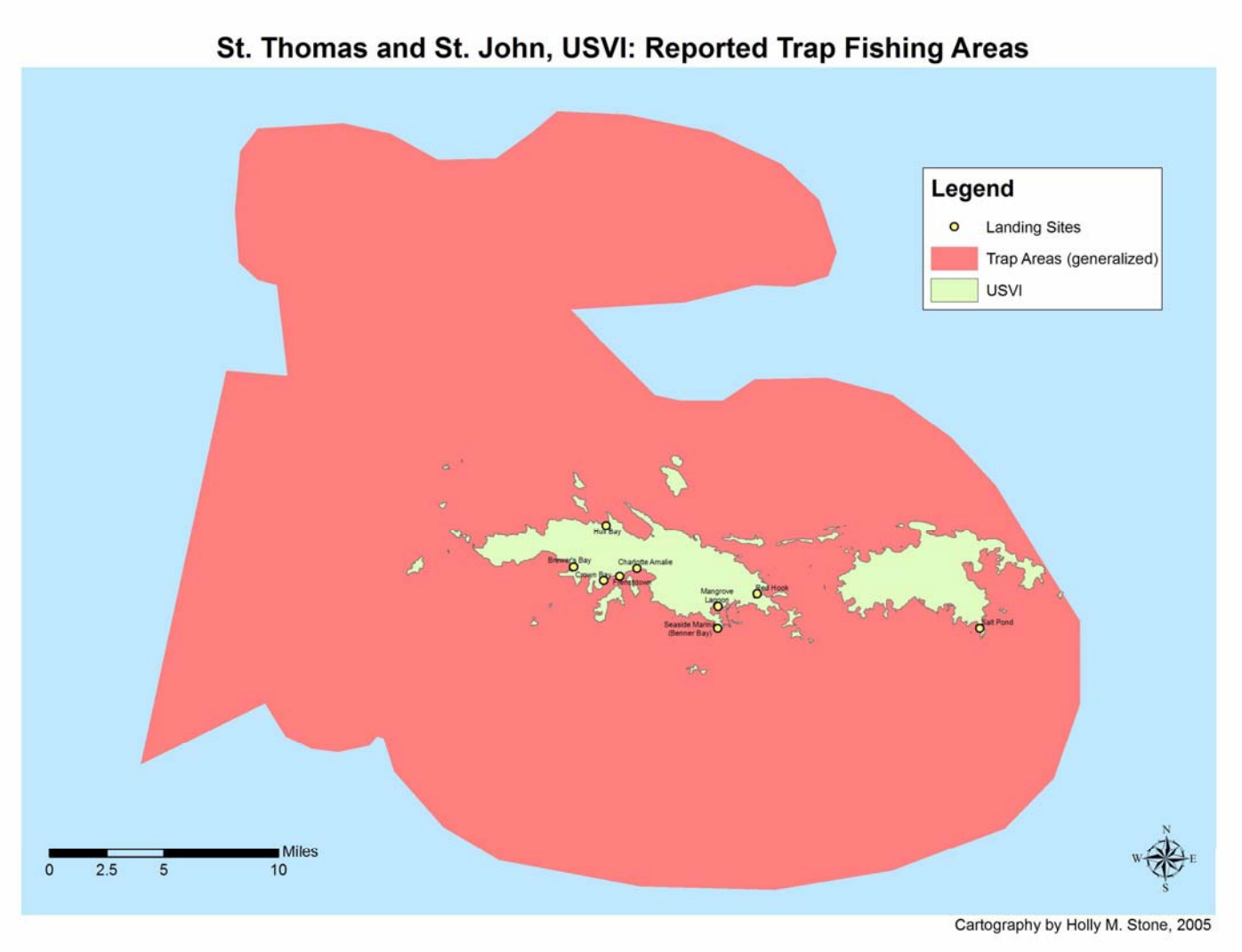
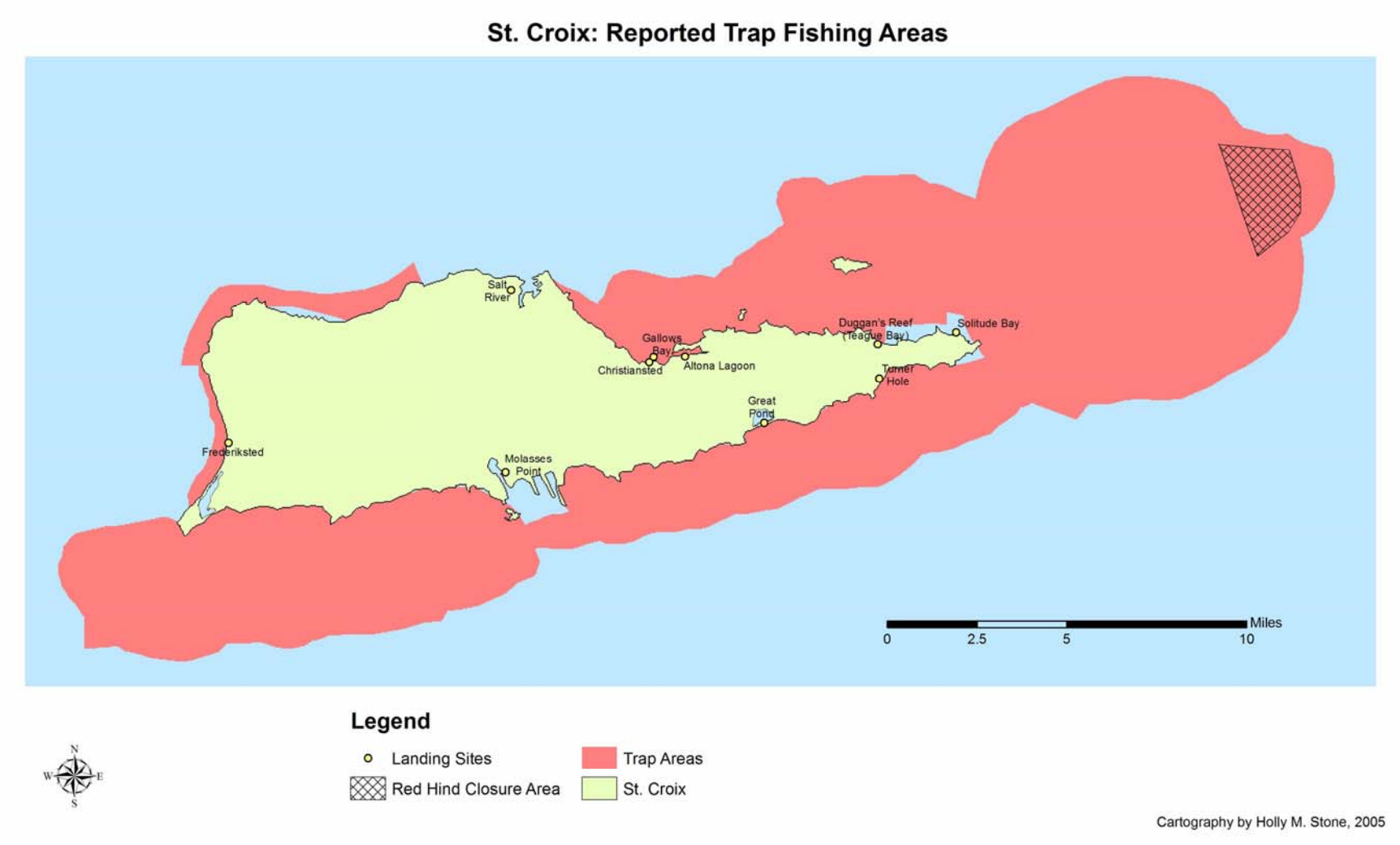


Figure 10: Trap fishing grounds in St. Croix, U.S. Virgin Islands



DISCUSSION

Historically, fish traps have been an important coastal fishing gear in the U.S. Caribbean. They are used extensively because they can be fished year round with minimal attention, which allows fishermen to pursue other activities. In addition, traps are easily and inexpensively built, require little skill to operate, and can be operated alone (Jarvis, 1932; Fiedler and Jarvis, 1932; Kahn, 1948; Swingle *et al*, 1970; Sylvester and Dammann, 1972).

Turn of the century accounts document that traps were the most important fishing gear in both Puerto Rico and U.S. Virgin Islands (Wilcox, 1904; Jarvis, 1932; Fiedler and Jarvis, 1932). In 1931, at the onset of the Great Depression, 1,403 Puerto Rican fishermen produced 3,080,000 pounds of fish valued at $207,085.[9] About 50% of the production was landed with traps, 20% with lines and the remaining 30% with nets and miscellaneous gear. There were about 4,239 traps in operation during this time (Jarvis, 1932). Pot fishing was more active between the months of June and January, the sugar cane industry off-season. In contrast, 405 U.S. Virgin Islands fishermen landed 616,000 pounds valued at $49,080 during the same period.[10] About 40% of the production was landed with traps, 30% with seines and the remaining 30% with lines and other hand gear. Fiedler and Jarvis (1932) estimated that there were approximately 1,600 traps in operation at the time. Unlike Puerto Rico, U.S. Virgin Islanders fished their pots year round.

In mid 1940's, Puerto Rican fish production yielded about 3,276,000 pounds valued at $458,640. Despite high seafood prices, production was constrained by the shortage of fishing equipment due to the war. Fish traps alone were responsible for 45 to 50% of the total catch. Kahn (1948) estimated that the number of fish traps was 3,812. No statistics are available for the U.S. Virgin Islands for the same period.

[9] Unless otherwise stated all values are nominal terms.
[10] Of the total, 127 fishermen lived in St. Thomas, 78 in St. John, and 200 in St. Croix (Fiedler and Jarvis, 1932). In terms of ethnicity, 314 fishermen were colored and 91 white.

In 1967, there were approximately 400 fishermen in U.S. Virgin Islands who produced about 1.5 million pounds of seafood valued at $782,000 (Swingle *et al*, 1970), yielding an increase of 150% in landings and 1,500% increase in ex-vessel value relative to 1930 figures. This swift increase in production and value was fueled by the rapid development of the hospitality industry and related business in the U.S. Virgin Islands. We estimated that were about 1,560 fish pots in operation, producing over 90% of the catch and dock-side value during this period.[11] Suárez-Caabro (1969) estimated that there were 7,614 traps operation in Puerto Rico during this time.

During the 1970's, innovations in the use of outboard motors, replacement of the wooden sloops for fiberglass boats, employment of iron rods in trap construction, availability of inexpensive chicken wire, and the use of winches for trap hauling swiftly increased the capacity and efficiency of the fishery.[12] In Puerto Rico alone, the number of traps increased from 8,191 to 26,170 between 1975 and 1982 (Suárez-Caabro and Abreu Volmar, 1976). Trap landings increased from 3,327,043 lbs to 3,859,538 lbs during this period (Suárez-Caabro and Abreu Volmar, 1976; CFMC, 2001; Matos-Caraballo, 2000). In U.S. Virgin Islands, trap construction also moved away from woven hoop vine and split bamboo to poultry wire (Olsen *et al*, 1978).

The availability of government credit and loan support programs for the purchase of vessels, engines, and fishing gear had a profound impact on the fishing sector (Abgrall, 1974; Valdés-Pizzini, 1985; Matos-Caraballo and Torres Rosado, 1989; Matos-Caraballo, 2000). Although, fish traps continued to be the most important gear, fishermen began adopting new fishing gears such as electric reel lines for the deep water snapper and grouper fishery, which occurred at shelf drop-offs and in nearby islands (Valdés-Pizzini,

[11] To derive these estimates we used Swingle *et al* (1970) table 2 which provides estimates of average number fish pots per person (7.3 fish pots/man), average yield per pot haul (16.3 pot hauls/week), yield per pot haul (7.8 lbs/pot haul) and average price of seafood of $ 0.5 per pound. In addition, we assumed that there were 120 full-time fishermen and 280 part-time fishermen. We also assumed that the production of three part-time fishermen was equal to one full-time fisherman. Kojis (2004) using the same estimates (but other assumptions) estimated that there were 3,296 trap in operation.

[12] Juhl and Suarez-Caabro (1973) report that trap fishing accounted for 52 percent of the Puerto Rican landings during the early 1970's.

1985). While fish trap fishermen were able to obtain larger vessels, high operating costs were responsible for these larger vessels moving into the deep water snapper and grouper fishery. Smaller vessels (*yolas*) equipped with winches continued to be used to haul traps (Valdés-Pizzini, 1985). In addition, the growing demand for queen conch by local restaurant markets stimulated the increase in scuba diving operations, which also targeted species traditionally caught in fish traps such as spiny lobster, snappers and groupers.

Intense competition, decreasing trap catches, alleged poaching and theft of traps by divers, as well as an increase in recreational boating (a key factor in the loss of traps) led local fishermen to initiate a trend in the late eighties and early nineties of increasing the use of trammel nets and gillnets, and to continue to explore possibilities of using lines for other fishes, including pelagic species such as dolphinfish and tunas (Matos-Caraballo, 2000; Griffith and Valdés-Pizzini, 2002). These changes contributed to the decline of the Puerto Rican fish trap fishery. The contribution of the fish pot gear to total landings has consistently decreased from 71.2% in 1982 (Collazo and Calderon, 1988), to 24% during the 1994-1997 (Matos-Caraballo, 2000), to 21% during 1998-2001 (Matos-Carballo, 2004). The 2002 census of Puerto Rican fishermen reported that there were 1,163 active commercial fishermen. The same study reported that the number of fish traps decreased from 11,213 in 1996 to 10,372 in 2002. Similarly, the number of lobster traps decreased from 3,615 to 2,774 during the same time period. Matos-Caraballo *et al* (2003) reports that fishermen stated that high harvesting costs, high numbers of stolen traps and lower productivity were the main reasons for the decline.

In contrast to the Puerto Rican experience, the development of USVI fisheries has been relatively slow because of the prevailing belief that fishery resources have been over-exploited for several decades (Olsen and LaPlace, 1981). In addition, the limited investment potential of local fishermen coupled with the minimal government assistance for improving vessels, equipment, methods, and handling techniques, forced technological advancements to move at a slow pace (Brownell, 1972; Brownell and Rainey, 1972; Olsen and LaPlace, 1981). However, there were research efforts geared at diversifying landings by introducing new harvesting techniques (e.g., lines) and

developing new fisheries (e.g., deep-water snapper and grouper and crab fisheries) (Olsen and Laplace, 1981). Attempts to develop the line deep-water snapper and grouper fisheries failed because fishermen believed that they needed larger fishing vessels and expensive fishing gear (Brownell and Rainey, 1972). Hill (1969) also notes that local fishermen have been reluctant to adopt new technologies.

> "*A perfect example of this was the purchasing of the first outboard motor by Monsieur Theodore Danet back in 1928. There was an immediate outburst among villagers, claiming that the boat would catch afire at sea and would be the cause for the loss of lives of many fishermen*".

During the late 1970's and 1980's, the growing demand for seafood by the local tourist industry led to the gradual displacement of traps in the U.S. Virgin Islands. Olsen *et al* (1982) report that in 1979 there were about 13,500 fish traps in operation. As in Puerto Rico, declining trap catches and returns and sustained trap losses due to hurricanes (e.g., Hugo, Luis, Marilyn, Bertha, Hortense, Georges, Lenny) forced many fishermen to switch from fish traps to other gears such as trammel and gillnets, particularly in St. Croix (Tobias, 2004). Today, 383 licensed commercial fishermen in the U.S. Virgin Islands use a variety of gears, including traps, lines, nets (e.g., gill and trammel nets) and scuba. Because of concerns over the detrimental impacts of nets, the USVI government is considering banning the use of trammel nets and gillnets. Kojis (2004) estimated that there were between 8,643 and 10,409 fish traps in USVI. Kojis (2004) also found that fish traps were more prevalent in St. Thomas and St. John than in St. Croix. Crucian fishermen relied more extensively on other gears such as gill and trammel nets, lines, and scuba. St. Croix has a significantly smaller shelf area compared to St. Thomas and St. John. Most of the shelf in St. Croix lies within 3 nautical miles from the shore.

This study provides a snapshot of the current socio-economic condition of the fishery. The survey results reveal several interesting shared traits as well as unique traits among industry participants. The demographic information suggests that the typical Crucian fishermen was older (57 years), had more commercial fishing experience (30 years), and

that their household income was more dependent on trap fishing than their St. Thomian and St. Johnian and Puerto Rican fellow fishermen. Crucian fishermen's higher dependence on fish traps was an unexpected result given Kojis' (2004) findings which suggested that Crucian fishermen tended to use a variety of fishing gears. St. Thomian and St. Johnian fishemen's income dependence on trap fishing was marginally higher than that found for Puerto Rican fishermen. Crucian fishermen's average fishing experience with fish traps (23 years) was only marginally higher than that of Puerto Rican and St. Thomian and St. Johnian fishermen. The level of formal education attainment, number of dependents and fishing for home consumption were relatively constant across the islands.

An interesting result of the survey is that in-aggregate, middle-aged individuals (48 to 57 years) made up a significant part of the fleet. Only four percent of the sampled population was 29 years or younger. The relatively high average age of the participants suggests that there is not a promising future in the trap fishery. If trap fishing was considered a lucrative occupation, then the younger generations would be drawn into this activity. Perusal of earlier studies suggests that fishermen's increasing average age is due to younger generations moving away from commercial fishing, especially trap fishing, rather than to difficulties in securing financing for vessels and fishing equipment. The earlier accounts of Kahn (1948) and Swingle *et al* (1970) also observed that fishing was not an attractive occupation for U.S. Caribbean youths. Kahn observed in the 1940's that low prices discouraged production and mobilized Puerto Rican fishermen into other more profitable occupations. Kahn's (1948) study reported that 24% of the Puerto Rican boat-owning fishermen were 29 years old or younger, 28% were between 30 and 40 years, and 48% were over 40 years.[13] The 2002 Puerto Rican fishermen census reported that the average age in the north, east, south and west coasts were 50, 49, 47, and 47 years, respectively. Assuming that Kahn's vessel owning population was normally distributed and mimicked overall fishermen population; then, the average fishermen age would have

[13] Kahn (1940) states that 48% of the vessel owning fishermen had 48 years. We believe that this 48 years figure was typo because the sum of the percentages is greater than 100%. Thus, we changed the figure from 48 to 40 years.

increased 7 to 10 years (i.e. from approximately 40 to 47-50 years depending on the coast).

In the U.S. Virgin Islands, the average age of fishermen using any gear type increased from 45 years in 1968 to 50.5 years in 2003 (Kojis, 2004). Hill (1969) estimated that the average fishermen age in the late 1960's was 42.5 years in St. Thomas, 46 in St. John and 47 in St. Croix. This study also showed that about 7% of the population of fish trap fishermen in the U.S. Virgin Islands was 30 years old or younger. However, U.S. Virgin Islands has had a moratorium since August 2001, which has prevented the entry of presumably younger fishermen. Although license transfers are not allowed, the Commissioner has approved the addition of relative's name to an individual license in the event that original license holder has either passed away or has been subject to a long-term illness.

The growing average age of trap fishermen can be partially understood by recognizing the role of economic development, immigration and technological change in the U.S. Caribbean. In the U.S. Virgin Islands, Swingle *et al* (1970) reported that during the late 1960's, the share of native USVI fishermen dropped from 100% to 56.5% because younger generations moved away from fishing into tourism related industries, local industrial enterprises, and government occupations.[14] These alternative occupations were less physically demanding and better remunerated. Foreigners from nearby islands likely took advantage of this opportunity created by the reduced local participation. Often, low skilled immigrants take occupations that locals consider low-paying or with little social status to boost their family income. Hill (1969) reported that many immigrant children, who became full-fledged Virgin Islanders, were reluctant to get involved in the fishing business. More recently, Kojis (2004) observed that in the proportion of USVI fishermen that were 'colored' fishermen decreased from 88% in 1930 to about 38.5% in 2004, and that the proportion of Hispanic fishermen grew from 0 to 33% (48.4% in St. Croix alone) during the same time period. A large percentage of these Hispanic fishermen that settled

[14] Swingle *et al* (1970) observe that 92.3% of St. John fishermen were native compared to 42.5% in St. Thomas because of reduced employment alternatives.

in St. Croix came from the island of Vieques in Puerto Rico. Ayala (2001), Ayala and Carro (2005), and Griffith and Valdés-Pizzini (2002) discuss the Puerto Rican (Vieques) migration to St. Croix.

Migration has also played a role in Puerto Rico. In the 1950's and 1960's, the Puerto Rico government promoted the massive migration of poor agricultural workers to the east coast of the continental United States. With the exception of Dominican nationals, few immigrants participate in the Puerto Rican fishing sector. A large number of Puerto Ricans migrated to the U.S. searching for increased employment opportunities and improved economic conditions.

Another factor influencing the structure of the trap fishery is that younger fishermen are being drawn into lucrative and physically strenuous gears, whereas older fishermen tend to adopt less physically demanding and less profitable gears. Recent studies have evidenced that younger fishermen drifted from trap fishing to net and diving due to the higher productivity of these latter fishing methods (Griffith and Valdés-Pizzini, 2002; Matos-Caraballo *et al*, 2003). The 2002 Puerto Rican Fishermen Census reports that between 1996 and 2002, the percentage of skin and scuba divers increased from 36% to 53% of the total number of fishermen. The census also documents that the number of fish traps declined from 11,213 to 10,372 and that the number of lobster traps declined from 3,268 to 2,774 during the same period (Matos-Caraballo *et al*, 2003).

Another contribution of this survey was the quantification of subsistence consumption. Coblentz (1997), drawing on his family consumption patterns, estimated that fishermen in the U.S. Virgin Islands consume approximately 148.2 lbs of seafood/person/yr. This estimate suggested that subsistence consumption alone was not sustainable, and has been a source of controversy which resulted in a series of exchanges in the journal of Conservation Biology (see, Jeffrey and Jennings, 1999; Cobletz, 1999). Our study showed that the contribution of fish traps to home consumption was moderate. Regionally, the percentage use of catch for personal or family uses ranged from 2.5% in St. Thomas and St. John to 3.8% in the St. Croix. We conservatively estimated that the

home consumption in U.S. Virgin Islands was about 37.8 lbs/person/year. In the calculation of this estimate, we assumed that landings were around 1,510,473 lbs, home consumption was 3%, and that 1,200 people lived in fishermen's household (400 fishermen times 3 dependents). An additional interesting trend is that the number of dependents declined between the late 1960's and early 2000's. The number of dependents decreased from 4.8 to 3.3 in St. Thomas, 3.3 to 2.8 in St. John, and 5.3 to 3.4 in St. Croix (Hill, 1969).

This survey also provided insight into the evolving trap fishing fleet and equipment composition. The value of fully-rigged vessels ranged between $400 and $250,000. Fifty-one percent of the fleet was worth $10,000 or less. The average value of a fully rigged vessel in Puerto Rico, St. Thomas and St. John and St. Croix was $8,652, $58,518, and $19,831, respectively. During the 1930s, the U.S. Virgin Islands fleet consisted of 147 rowboats, 28 sailboats, and a single motor boat. The majority of the vessels were made of wood. In St. Thomas, the most common boat (locally called canoe) ranged between 15 to 20 feet in length (Fiedler and Jarvis, 1932). Fiedler and Jarvis reported that the hulls of these boats were made of hollowed out logs brought from Santo Domingo, Dominican Republic. Logs also came from the French islands of Martinique and Guadalupe (Hill, 1969). The price of the gorged boat was about $15 whereas a finished boat was worth $40 (Hill, 1969). Sailboats were worth about $76. Swingle *et al* (1970) reported that the price of the fishing vessels ranged between $1,170 and $4,550, with an average value of $2,562. Olsen and LaPlace (1981) noted that with the exception of a small number of plywood-constructed vessels in St. Thomas, most of the fleet consisted of carved planked longboats whose construction techniques tended to be similar to those employed in the 18th century. Olsen and LaPlace (1981) also note that these vessels sold for $2,000-3,000. Outboard engines of up to 175 hp were used to power these vessels (Olsen and LaPlace, 1981). In Puerto Rico, Jarvis (1932) reported that the value of vessels propelled with oars and sails, the predominant vessel type in the Puerto Rican fleet during 1930's, ranged between $15 and $30. A decade later, Kahn (1946) estimated that the value of row, sail and motor boats was about $32, $243, and $2,450, respectively.[15]

[15] Kahn (1946) estimated that, at the time, there were 609 rowboats, 277 sailboats and 14 motor boats.

Our survey documented that the fish trap fleet was made up of vessels that ranged between 2 to 60 years in age and between 14 and 40 feet in length. The median age and size of the fleet was 14 years and 23 feet. The St. Thomian and St. Johnian fleet was made up of larger sized vessels (28 feet as opposed 21 feet in St. Croix and Puerto Rico) with almost twice the horsepower (208 hp) than their other island counterparts.

The majority of the St. Thomian and St. Johnian fleet also used in-board engines, in contrast to the Crucian and Puerto Rican fleets, which primarily used out-board engines. The characterization provided by this study suggests that fleet size and horsepower has been increasing over time. Swingle *et al* (1970) describe the USVI pot fleet as made up of vessels ranging between 14 and 20 feet. In contrast to our results, Sylvester and Dammann (1972) stated that the St. Croix vessels were somewhat larger than the St. Thomas and St. John fleet and tended to use in-board engines. Also, Sylvester and Dammann (1972) remarked that most fishermen hauled their pots by hand whereas our survey showed that all of St. Thomian and St. Johnian fishermen surveyed used mechanical trap haulers and 20% the Crucian fishermen interviewed used mechanical trap haulers. In the late 1960's engines averaged less than 20 hp in the U.S. Virgin Islands (Swingle *et al*, 1970).

This study also showed that the number of trips was fairly constant across islands. Fishermen from St. Thomas and St. John took 1.4 trips per week while fishermen from Puerto Rico took 2.1 trips per week, and fishermen from St. Croix took 2.5 trips per week. However, fishing practices differed across islands. For example, the average St. Thomian and St. Johnian fisherman took 9 hour fishing trips, set 9 traps per line, and hauled 68 traps per trip, compared to the typical Crucian fisherman who took 6 hour fishing trips, set 1-2 traps per line, and hauled 26 traps per trip. In the 1930's the average USVI vessel fished between 4 and 30 pots (Fiedler and Jarvis, 1932). Our study showed that Puerto Rican fishermen took 5-6 hour fishing trips, set 2 traps per line, and hauled 27 traps per trip.

The typical St. Thomian and St. Johnian fisherman fished 94 traps, whereas average Puerto Rican and Crucian fisherman fished 39 and 27 traps, respectively. Fiedler and Jarvis (1932) reported that USVI fishermen fished between 4 and 30 pots in the early 1930's. Kahn (1946) noted that during the 1940's Puerto Rican fishermen on average used about 15 fish pots, although some fishermen operated as many as 60 fish pots. Table 63 shows how trap costs have changed over time.

Table 63: Survey of trap costs over time

Region	Description	Nominal Dollars	Real Dollars (1982=100)	Reference
Puerto Rico	Small wooden traps with buoys and floats	2.5	22.32	Jarvis (1932)
	Small wooden traps with buoys and floats	5	44.64	Jarvis (1932)
	Wire traps with buoy lines and floats	6	53.57	Jarvis (1932)
	Medium sized pot	4	14.44	Kahn (1948)
	Wire traps (arrowhead) mangrove frame with galvanized chicken wire with buoy lines and floats. Lasts 12 months.	7.5	23.73	Feliciano (1958)
	Lobster wooden trap (cajón) with buoy lines and floats. Lasts 8 months.	3	9.50	Feliciano (1958)
	Arrowhead trap with buoy lines and floats	94	68.06	This study
USVI	Pot made of woven withes (mainly used in St. Thomas and St. John)	1.5	13.40	Fiedler and Jarvis (1932)
	Chicken wire pots (mainly used in St. Thomas and St. John)	3	26.78	Fiedler and Jarvis (1932)
	Drawn wire pots (mainly used in St. Croix)	4	35.71	Fiedler and Jarvis (1932)
	Drawn wire pots with buoy lines and floats (mainly used in St. Croix)	6	53.57	Fiedler and Jarvis (1932)
	Trap (St. Thomas and St. John)	80	82.65	Olsen and LaPlace (1981)
	Arrowhead trap with buoy lines and floats (St. Thomas and St. John)	251	181.75	This study
	Arrowhead trap with buoy lines and floats (St. Croix)	119	86.16	This study

Finally, we examined key performance indicators. The fleet's average gross revenues ranged between $11,200 and $77,900 (Table 38). Olsen *et al* (1982) reported that during the 1980's, trap fishermen average gross revenues ranged between $21,582 and $114,321 in St. Thomas and St. John, and between $11,313 to $43,141 in St. Croix.

We also assessed the financial and economic performance of the fleet. Our analysis showed that on average the trap fleet covered their cash outlays, resulting in positive vessel income (i.e., financial profits). As a group, financial profits ranged between $4,760 and $32,467 (Table 38). When we considered the full economic costs to society, which included cash expenditures and non-cash outlays such as the opportunity cost of capital and labor, we found that in some instances there were negative surpluses. Economic profits ranged between $(18,486) and $10,674 (Table 38). Only the top Crucian and Puerto Rican tiers made economic profits. Negative economic profits are indicative of resource rent dissipation and an overcapitalized fishery. Resource rent is the *in situ* value of the resource. Alternatively, resource rent is the return to the owner of the resource for the use of that resource. The presence of positive financial profits and negative economic profits suggests that while some vessel owners may be earning economic benefits, higher economic returns could be earned by reallocating some capital and labor to other sectors of the economy. In other words, from society's (economic) perspective, greater returns can be achieved by investing scarce capital and human resources elsewhere in the economy (Pascoe *et al*, 1996). Negative economic earnings corroborate that the future of the trap fishery is not promising unless steps are taken to ensure that the harvesting potential is commensurate with the reproductive potential of the resource. Furthermore, they provide additional insight into why trap fishermen and younger fishermen are adopting other gears.

CONCLUSIONS AND FUTURE DIRECTIONS

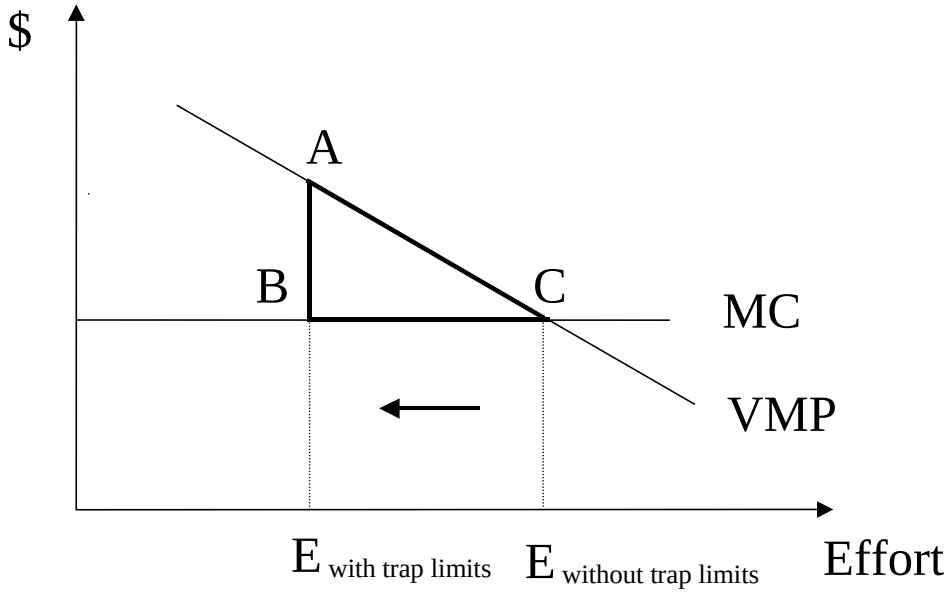
Resource and habitat degradation, marginalization, and poverty imperil the survival of small-scale fishing communities. Confronting these challenges demands policies that ensure that the harvesting potential is commensurate with the productivity of the resource and habitat. The present study contributes to management by describing the socio-economic condition of the U.S. Caribbean fish trap fleet. The study highlights the presence of a diverse fleet. The study found that an important segment of the small scale sector was highly dependent on this fishery. In some instances, trap fishing accounted for 50-80% of their household income. The diversity of the industry was also substantiated by the various economic surpluses generated, which showed high inter and intra island

variability. The survey illustrated that higher revenues did not necessarily translate into higher net economic returns. The presence of negative economic earnings indicates that steps need to be taken to ensure the long-run viability of the industry. The presence of positive financial returns provides managers with a window of opportunity to adopt policies that will strengthen the biological and economic performance of the fishery while minimizing any adverse impacts on fishing communities.

In addition to describing the socio-economic conditions of the fishery, the information collected can be used to develop economic models to evaluate management proposals. For example, if managers were interested in examining the socio-economic impacts of a trap reduction plan, several relationships such as value marginal product (VMP) and marginal cost (MC) could be estimated. Figure 11 presents the schematics of a stylized economic model that examines a potential reduction in the number of traps. The VMP is the gross revenue that is generated by adding one more trap into the fishery. As more traps are added into the fishery, the productivity per trap decreases. The MC is the expense of tending one more trap. The area underneath the VMP curve captures the total gross revenue and the area underneath the MC curve captures the total cost. The difference between these areas is the economic profit. If we assume that the fishery is operating under open access conditions, then the fleet would continue to set traps until the VMP is equal to the MC of tending them. If the Council decides to limit the number of traps from $E_{\text{w.o.traps limits}}$ to $E_{\text{with traps limits}}$, then the forgone net benefits would be given by the area ABC. The forgoing analysis assumes that the stock remains constant.

The development of bioeconomic models could further contribute to realize the full economic potential of the fishery. Bioeconomic models could assist not only in identifying socio-economic benchmarks, such as maximum economic yield and optimal yield, but could also help estimate harvesting paths that maximize social welfare. This study can also yield valuable information to investigate the socio-economic effects of other regulatory proposals such as gear and vessel buybacks, harvest quotas, and access limitations.

Figure 11: Economic impact of trap reduction proposal



PR/USVI FISH TRAP SURVEY INSTRUMENT

APPENDIX A: COSTS AND EARNINGS FISH TRAP STUDY

GENERAL INFORMATION

The following questions are asked about you and the primary vessel that you use for fishing.

NAME_____

1) What is your age? _____

2) How many family members do you support (including yourself)?
   Myself only 2 3 4 5 6 7 greater than 7

3) What is the last level of school you **completed**?
   Grades: 1 2 3 4 5 6 7 8 9 10 11 12 Other: _____

4) How many years have you been a commercial fisherman (include years as a helper)? _____

5) How many years have you fished commercially with:
   a) Fish traps? _____ years
   b) Lobster traps?_____ years

6) Which port do you consider to be your primary dock or access port?
   _____

7) What approximate percentage of your total household income is derived from:
   a) Commercial fishing _____ %
   b) Fishing with fish traps _____ %
   c) Fishing with lobster traps _____ %

8) What approximate percentage of your total catch do retain for personal or family use? _____ % lbs

9) What other paid employment do you have, if any, apart from commercial fishing, for example: construction, charter fishing, etc.?
   a) Job 1 _____ # days/yr. _____ $/day _____
   b) Job 2 _____ # days/yr. _____ $/day _____
   c) Job 3 _____ # days/yr. _____ $/day _____

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ANNUAL CATCH INFORMATION

10) Please use the following table to determine your total catch and revenue last season with each gear type.

Total Catch and Average Price per Pound, By Type of Gear

Species	**With Fish Traps**		**With Lobster Traps**		**With your Primary Other Gear (Please specify gear_____)**	
	Pounds Landed	***Average Price***	***Pounds Landed***	***Average Price***	***Pounds Landed***	***Average Price***
Lobster						
Potfish						
Other Reef Fish						
Pelagics (mackerel, dolphin)						
Other Species						

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PR/USVI FISH TRAP SURVEY INSTRUMENT

TRAP INFORMATION

11) How many traps did you fish last season?

a) Fish Traps _____

b) Lobster Traps _____

12) How many traps do you build/buy per year?

a) Fish Traps _____

b) Lobster Traps _____

13) How long do traps last on average?

a) Fish Traps _____yrs

b) Lobster Traps _____yrs

14) What is the greatest number of traps your boat can normally carry per trip? #_____traps

15) Please describe your fishing activities on a typical trip last year. (*Only complete the columns that correspond to the types of fishing trips that you take.*)

	Trips with Fish Traps only	**Trips with Lobster Traps only**	**Trips with both Fish and Lobster Traps**
Number of traps pulled per trip			Fish: Lobs:
How long does it take to pull those traps (hrs)			
Total duration of each trip (hrs)			
Number of trips fished per week			
Days between pulls for each trap (soak time)			Fish: Lobs:
Number of traps on each trap line			

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PR/USVI FISH TRAP SURVEY INSTRUMENT

TRIP COSTS

16) Please provide your best estimate of fishing costs, landings and revenues for a typical trip last year. *(Only complete the columns that correspond to the types of fishing trips that you take. You do not need to provide quantity information for the shaded areas)*

Trip Costs & Catch

Costs per Trip (*circle units below*)	**Trips with Fish Traps only**		**Trips with Lobster Traps only**		**Trips with both Fish and Lobster Traps**		**Trips with Primary Other Gear (Specify gear_____)**	
	Total Quantities per trip	***Total Dollars per trip***	***Total Quantities per trip***	***Total Dollars per trip***	***Total Quantities per trip***	***Total Dollars per trip***	***Total Quantities per trip***	***Total Dollars per trip***
Fuel (gallons / liters)								
Oil (quarts / liters)								
Ice (lbs. / kg.)								
Bait (lbs. / kg. / boxes)								
Supplies								
Food/groceries								
Other Costs								
Crew (excluding yourself)								
Total Costs								
Landings (lbs. / kg. and revenues per trip)								

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PR/USVI FISH TRAP SURVEY INSTRUMENT

FISHING EFFORT

17) Please indicate the approximate number of days worked last year in the following fishing activities and businesses unrelated to commercial fishing; Also include the primary species caught in each fishing activity. (*Only complete the rows that correspond to the types of fishing trips that you take.*)

Fishing Activity	**Number of trips or days (list total days per trip, if a multiple day trip)**	**List Primary Species Caught**
Trips with Fish Traps only		
Trips with Lobster Traps only		
Trips with both Fish and Lobster Traps		
Trips with primary other gear (specify) _____		
Non-fishery work		List jobs:

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PR/USVI FISH TRAP SURVEY INSTRUMENT

BOAT INFORMATION

18) What is the length of your vessel? _____ft / m

19) What is the age of your vessel? _____ years

20) What is your hull material? _____

21) When was the last major renovation done?

a) Vessel _____ b) Engine _____

22) What is your engine type? (*circle one*)

INBOARD OUTBOARD Other_____

23) What is the age of your engine? _____ years

24) What is the total horsepower of your engine? _____hp

25) Which of the following equipment do you have on your vessel? (*circle all that apply*)

TRAP PULLER (Manual / Hydraulic / Other)

DEPTH RECORDER

GPS RADAR EPIRB

Other equipment (nets, reel, etc.) _____

26) Please provide your BEST ESTIMATE of the market value for the following items used for commercial fishing last season.

a) #____vessel(s) and electronic equipment (fully rigged): $_____

b) Fish traps (complete with buoys,etc.):

i) Type_____ Number_____ $_____

ii) Type_____ Number_____ $_____

iii) Type_____ Number_____ $_____

c) Lobster traps (complete with buoys, etc):

i) Type_____ Number_____ $_____

ii) Type_____ Number_____ $_____

iii) Type_____ Number_____ $_____

d) Nets: Number_____ $_____

e) Longline: Number_____ $_____

f) Dive gear: $_____

g) Other gear_____ $_____

27) How much do you owe on loans for vessel & gear? $_____

PR/USVI FISH TRAP SURVEY INSTRUMENT

ANNUAL COSTS

28) Please provide your BEST ESTIMATE for the following annual cash expenses last calendar year:

a) Docking/security fees: $_____

b) Loan payments on vessel(s) and gear: $_____

c) Maintenance and repairs on vessel(s) & gear: $_____

d) Maintenance and repair on fish traps (wire, etc.) $_____

e) Maintenance and repair on lobster traps (wire, etc.) $_____

f) Helpers – approx. dollar amount you actually paid $_____

(*please indicate by checkmark how paid*)

___% share, ___wages, ___bonuses, ____some combination)

g) Other supplies $_____

h) Licenses $_____

i) Vessel Insurance $_____

j) P& I insurance (including crew): $_____

k) Other (for example trailer fee) $_____

PR/USVI FISH TRAP SURVEY INSTRUMENT

BUSINESS OBJECTIVES AND FISHING CAPACITY

29) During a year, what is your major business objective*? (Please indicate only ONE)*

Do you make decisions to maximize profit (revenue less costs)? _____

Do you make decisions to minimize costs? _____

Do you make decisions to maximize revenue? _____

If none of the above, what is your major objective? _____

_____

30) What is the minimum number of crew you need per trip?

0 1 2 3 4 5 greater than 5

31) How many crewmembers do you normally take on a trip?

0 1 2 3 4 5 greater than 5

32) What is the maximum number of traps that you have fished?
_____traps

33) What is the maximum number that you could fish? _____

34) If you do not typically fish the maximum number of traps, what are your reasons (*please select all that apply*)?

a) _____Higher gear and operating costs

b) _____Unavailability of labor

c) _____Insufficient fish abundance

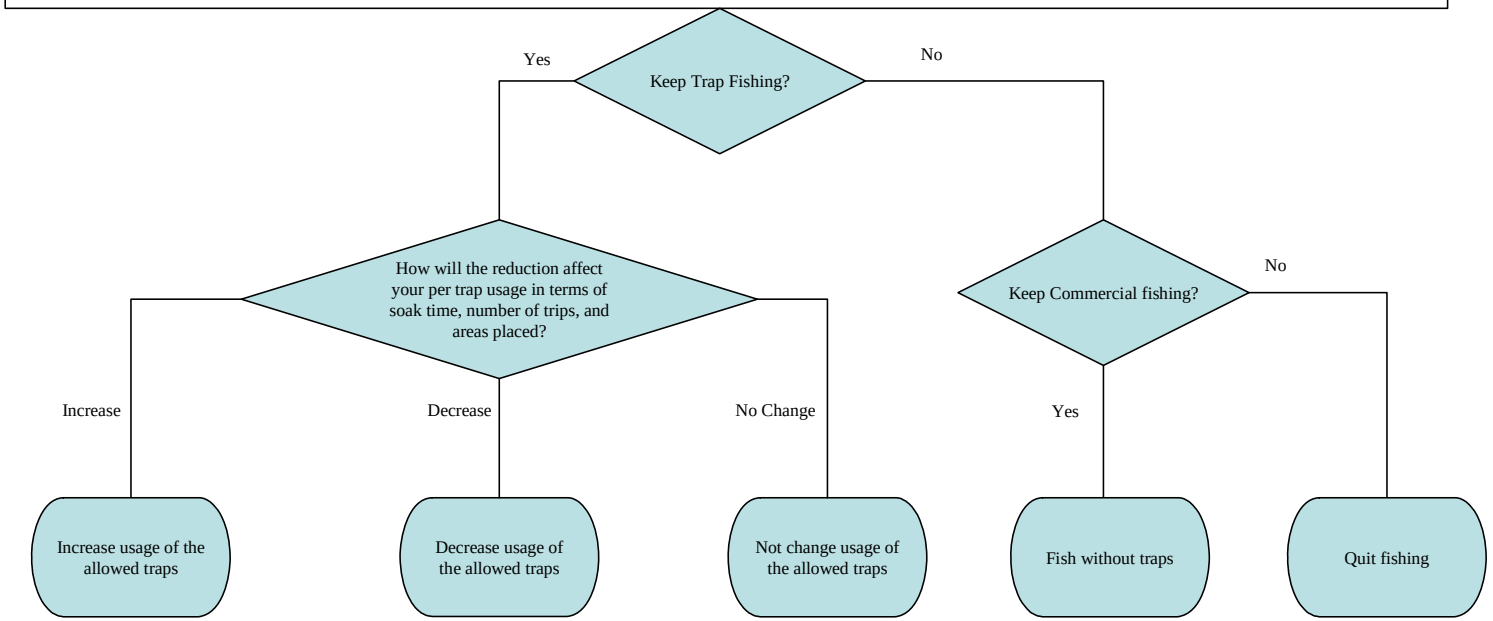
d) _____Market limitations

e) _____Other (_____)

PR/USVI FISH TRAP SURVEY INSTRUMENT

FISHERMAN CONTINGENT BEHAVIOUR

Q35: If you were required to reduce your number of traps by __% (may use fraction instead) how would you most likely react? Please circle path and answer follow up questions.



How will you accomplish this?
Go from ____ to _____ # trips/year
Go from ____ to _____ soak time (days)

By how much do you think your **annual net** revenues from trap fishing will change following the trap reduction?
_____**%**

Will target different species/areas (Y/N)
_____ species
_____ areas

Will you try to offset catch/revenue losses by using other gears? (Y/N)
If yes which gears.
Gear a:_____ # trips/year_____
Gear b:_____ # trips/year_____

How will you accomplish this?
Go from ____ to _____ # trips/year
Go from ____ to _____ soak time (days)

By how much do you think your **annual net** revenues from trap fishing will change following the trap reduction?
_____**%**

Will target different species/areas (Y/N)
_____ species
_____ areas

Will you try to offset catch/revenue losses by using other gears? (Y/N)
If yes which gears.
Gear a:_____ # trips/year_____
Gear b:_____ # trips/year_____

By how much do you think your **annual net** revenues from trap fishing will change following the trap reduction?
_____**%**

Will target different species/areas (Y/N)
_____ species
_____ areas

Will you try to offset catch/revenue losses by using other gears? (Y/N)
If yes which gears.
Gear a:_____ # trips/year_____
Gear b:_____ # trips/year_____

What other gear(s) would you use?
_____

How many trips per year would you take with
Gear a:_____
Gear b:_____
Gear c:_____

By how much do you think your **annual net** revenues from fishing will change?
_____%

What type of work will you seek?
_____
_____

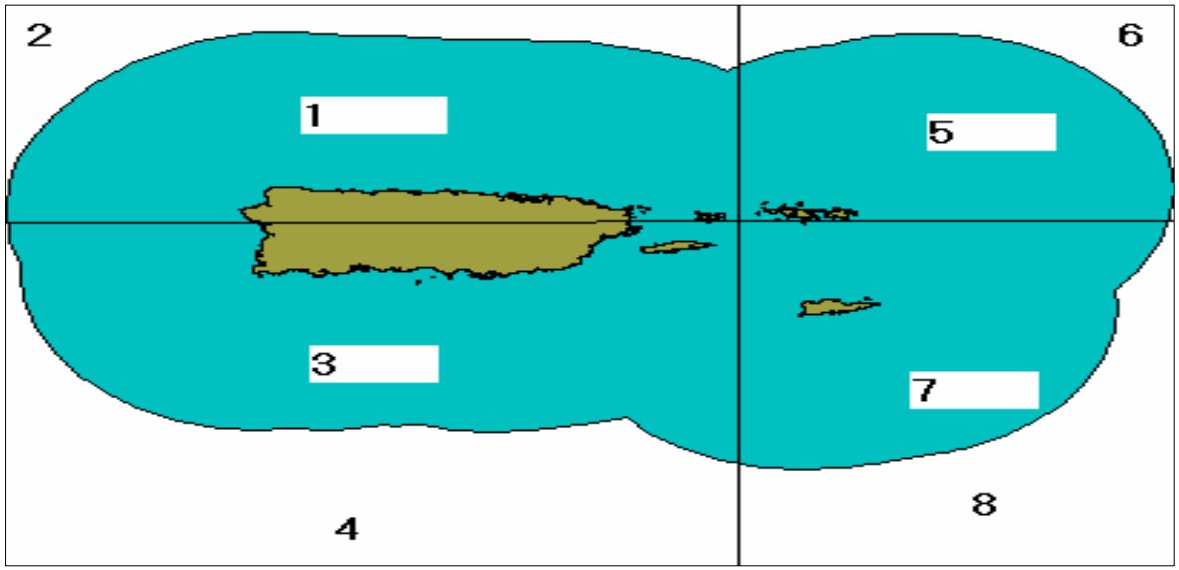
Do you expect to earn more or less than you earn before the trap reduction?

_____more%
_____less %

PR/USVI FISH TRAP SURVEY INSTRUMENT

FISHING GROUNDS MAP

36) Please use the map below to delineate the your (fish) trapping grounds. Note: A more detailed map was using during the mapping exercise.



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