



**Final Report**

**A pilot program to assess methods of collecting  
bycatch, discard, and biological data in the commercial  
fisheries of St. Thomas, U.S. Caribbean**

**A Cooperative Research Program Report Submitted to**

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by

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# 1 Introduction

NOAA Fisheries awarded a Cooperative Research Program (<http://www.grants.gov/search/search.do?mode=VIEW&oppId=9891>) grant to MRAG Americas to conduct a pilot program to deploy observers in St. Thomas fisheries. The purpose of this project is to assess the potential for obtaining information on bycatch, discards, and biological data from commercial fisheries off St. Thomas in the US Caribbean. The project focused on methods for obtaining information on composition and disposition of bycatch and discards at sea, opportunities for collecting biological data at sea, and the use of captain or crew for collecting data if space or safety on vessels does not allow observers.

For this project, MRAG Americas, Inc. (MRAG) and the Southeast Fisheries Science Center (SEFSC) teamed with the St. Thomas Fishermen's Association (STFA) to conduct a pilot observer program in the waters of St. Thomas (Figure 1). The results of the project could form the basis for planning a comprehensive observer program in the US Caribbean if management agencies should decide such a program is necessary. The project focused on gears typically used on the continental shelf platform of St. Thomas: fish traps, lobster traps, seine nets, and hook and line. Similar vessels are used for the four gear types (see adjacent photo).

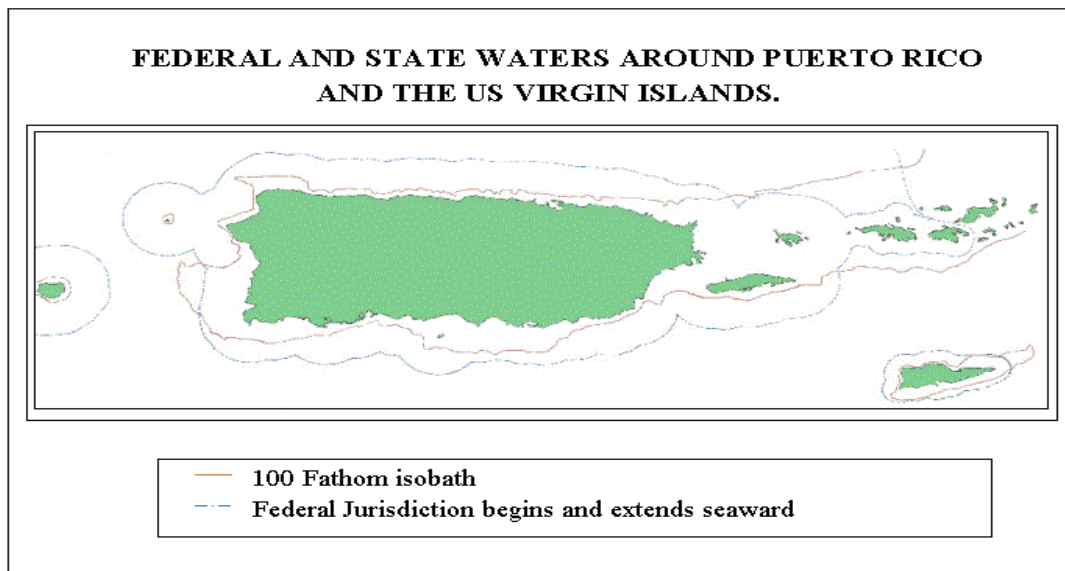


Figure 1. Federal and State waters around Puerto Rico and the U.S. Virgin Islands

The pilot project addressed two primary issues:

1. The feasibility associated with placing observers onboard commercial fishing vessels in the US Caribbean including:

- Financial, space, and safety considerations for placing observers on board
  - Limitations to data collection on board
  - Coordination and cooperation issues with fishers
2. Alternative methods of obtaining bycatch information other than to placing observers on board. Under the method being explored, selected fishers will return to port with the total catch for sampling of retained and discarded components (referred to as “captain samples”).

The project secondarily addressed the specific data to be obtained. The project is the first opportunity in St. Thomas to collect bycatch and related data on an individual trip level. The study provided an assessment of the magnitude of bycatch and discards for these fisheries. Problems of data bias could arise in the pilot project because placement of observers on vessels was voluntary and fishers may operate differently when they have an observer on board.

This project is a companion study to a similar project conducted on St. Croix (Trumble et al. 2006). The fishers and fisheries of St. Croix and St. Thomas exhibit substantially different characteristics (Barbara Kojis, Former Director, USVI Division of Fish and Wildlife, pers. comm.). While fishers commonly use gill and trammel nets in St. Croix, St. Thomas fishers rarely use these nets, but do use seine nets that encircle rather than gill the fish. St. Thomas fishers together use over 10,000 traps, while St. Croix fishers use around 1,600. About 4,000 plastic lobster traps used around St. Thomas are not used at St. Croix. The insular shelf break occurs near 60 feet in depth off St. Croix, but near 100-130 feet depth off St. Thomas. These shelf break depths have substantial implications for discard survival, as the deeper shelf waters off St. Thomas suggest lower survival of any released fish. Perceptions of release survival may influence whether fishers release fish. St. Thomas/St. John fisheries are more coral reef-based than St. Croix. Even though fishing depth is deeper in St. Thomas/St. John, there are extensive deepwater coral reefs and gorgonian hard bottoms with scattered corals in the shelf waters of St. Thomas/St. John District. Far more St. Croix fishers fished deepwater snapper and probably grouper than St. Thomas/St. John fishers. St. Croix fishers also used nets more frequently than on St. Thomas/St. John. Traps were the most important gear used by commercial fishers on St. Thomas/St. John. Fish trap mesh size is larger on St. Thomas/St. John - minimum required size in territorial waters is 2" square on St. Thomas/St. John while on St. Croix it is 1.5" hexagonal. The larger size of the mesh used in traps on St. Thomas/St. John may result in fewer discards. Also, USVI wish to know if the slatted plastic lobster traps are catching fish as well and what the bycatch is of these traps. Fishers from the two areas also have cultural differences that may affect a future observer program.

In addition, this pilot project supplemented the port sampling activities of the USVI, DPNER, DFW by collecting biological samples. Significant reductions in funding of port sampling activities from traditional, funding sources (e.g., NOAA, NMFS, State Federal Cooperative Statistics Program and the Interjurisdictional Program) have significantly impacted the number of biological samples collected by DFW port samplers (see SEDAR 8 Yellowtail Snapper and Spiny Lobster RW Report 2005 and SEDAR 4 Deepwater Snapper Report, November 2004). Most port sampling has occurred on ST. Croix, and little to no port sampling has occurred on ST. Thomas in recent years.

Recently the SEDAR process documented that too-small sample sizes and lack of regular (ongoing) data collection needed to construct an adequate time-series of catch and abundance indices hindered the basic analyses conducted for the SEDAR 8 yellowtail snapper analyses (see [http://www.sefsc.noaa.gov/sedar/download/S8RW\\_FinalConsensus.pdf?id=DOCUMENT](http://www.sefsc.noaa.gov/sedar/download/S8RW_FinalConsensus.pdf?id=DOCUMENT), SEDAR 8 yellowtail snapper Consensus Report, June 2005). Supplemental data collections by this pilot project provides critical information needed for evaluation of the U.S. Caribbean fisheries resources.

## **2 Operations**

MRAG received notification of final approval for this project in July 2005. In July and early August, we finalized plans for implementation of the project. At the suggestion of Dr. Roger Uwate, we shifted the local oversight role from the US Virgin Islands Department of Fish and Wildlife (DFW) to the STFA. Dr. Olsen, executive director of STFA and former director of DFW, has the experience and contacts within the fisheries to perform these duties. In addition, involving the STFA enhanced the fisher involved aspects of the project. Dr. Uwate of DFW remained as a technical advisor until he left DFW near the end of the sampling period. We established September 1, 2005 as the target start date for observer operations.

Dr. Robert Trumble of MRAG and Ms. Nancie Cummings of the NMFS, SEFSC served as principle investigators of this project. Dr. David Olsen of STFA served as the observer supervisor on St. Thomas.

Mr. Mickey Aubain, a commercial, served as the primary observer during this project period. Mr. Tony McNeely served as backup observer. Dr. Olsen also provided observer coverage to supplement the coverage from Mr. Aubain and Mr. McNeely. Dr. Olsen and the observer conducted biological sampling of all observer samples. Ms. Ruth Gomez, DFW and Secretary of STFA, assisted Dr. Olsen with biological sampling. Both Ms. Gomez and Dr. Olsen have extensive experience with sampling the fish species found in the St. Croix fisheries. Ms. Gomez subsequently withdrew from the project.

### **2.1 Protocol development**

MRAG Americas developed a draft set of protocols for the St. Thomas observer project based on protocols from the St. Croix project, and routed the draft to Federal and Territorial partners. The protocol called for sampling catches in the same manner as suggested in the NMFS SEFSC Trip Interview Program (TIP see <http://www.sefsc.noaa.gov/tip.jsp>) sampling manual, for sampling of landings, and for recording catch and biological data using TIP forms. In addition to the TIP forms, the draft protocol contained forms for collecting data on survival of discarded bycatch, for recording protected species interactions, and confirming vessel participation in the observer project. Fishermen reported a variety of reasons for discarding fish:

- Risk of Ciguatera poisoning

- Too Small
- Unmarketable Species
- Too much in Market
- Used as Bait
- Dead
- w/Eggs (Lobster)

Following review of the draft protocol, a final version (Appendix) was prepared and distributed to all participants in the project. After beginning the observer work, complaints from fishers about bringing in large amounts of bycatch that would die led to a change in the protocol allowing fishers to systematically subsample the bycatch.

## **2.2 Equipment**

The DFW supplied port sampling equipment for use by observers during this project. The port sampling kit included a Chatillon metric pan scale (20 kg capacity X 50g), a one-meter measuring board, a caliper and a 1.5 m measuring tape. Coolers and plastic bags were provided for retained by-catch. Dr. Olsen received a complete kit that he provided to observers. The project supplied a safety kit that included a hand-held VHF radio to increase chances of successful communication in case of an emergency, a personal locator beacon to enhance likelihood of rescue in case of emergency, and a life jacket. The project provided observers with a digital camera to obtain a photographic record of sampled trips and bycatch. Ice was provided on request to fishers to maintain their catch fresh during biostatistical sampling.

## **2.3 Training**

Prior to the beginning of the observations, Dr. Trumble and Dr. Olsen discussed the objectives of the project and the sampling plan as outlined in the protocol and consulted on the training required for the observers. Safety issues were identified as a major training topic. Training focused on differences from the normal port sampling procedures and changes that would be necessary for this pilot observer project. Dr. Olsen and Ms. Gomez also provided training for observers to assure understanding and compliance with the observer protocol.

## **2.4 Outreach**

Once we shifted local management from DFW to STFA, we built on Dr. Olsen's close association with the fishers to inform them of the project and encourage their participation. Dr. Olsen discussed the project goals regularly at STFA membership meetings, and updated fishers on results of the project at the meetings. Prior to the start of the observer sampling, Dr. Trumble attended a STFA meeting to discuss the project and answer questions about the sampling procedure. Dr. Trumble visited the operations after observer sampling got well underway to observe the sampling and to discuss the project

with observers and fishers. As a result of these efforts, fishers had excellent access to information about the project, and a conduit for expressing concerns about the project.

### **3 Results from primary objectives**

The project schedule called for the project to begin in April 2005. However, final approval for the project occurred in July. Plans for implementing the project specified two months of preparation (July and August 2005) prior to the beginning of at-sea observing. During this period, Dr. Trumble and Dr. Olsen obtained necessary equipment, recruited and hired a primary observer, and Dr. Olsen conducted the training for Mr. Aubain just before the September 1 start of the project. Dr. Trumble attended a general membership meeting of the STFA in late August to discuss the pilot observer project with fishers. The project began observations in September.

The protocol called for roughly equal sampling of: hook and line; wire mesh pots/trap; plastic slatted pots/traps; and seine net. The program successfully engaged all gear types except seine nets from the beginning. After uniformly rejecting requests to participate in the program for most of the project duration, seine net fishers joined in the program during the last several months. The small size of vessels precluded placing observers on many of the vessels and all of the seine net vessels; however, many of the smaller vessels brought in captain samples. As a result, the project achieved only a portion of the observer trips anticipated but obtained additional captain samples to compensate.

The sampling protocol worked well although the relatively small initial catches took approximately two hours to measure. We projected a time requirement of up to 5 hours to process a large catch and anticipated strong fisher opposition to waiting that long for completion of the sample. Consequently, we decided to use a subsampling procedure for abundant species (more than 50 individuals) to measure every third fish and count and weigh the remainder in aggregate. This procedure is generally consistent with the TIP subsampling guidelines of measuring 20-30 fish of abundant species. The systematic subsampling assures collecting data through the entire sample and collection of the aggregate weight sample will allow the sample data to be easily raised to the total catch. The St. Thomas fishers generally showed good cooperation with the program. However, at the August STFA general meeting, fishermen expressed concern regarding why the study required killing the bycatch to measure them. Dr. Trumble and Dr. Olsen explained the need for biological data that can be processed only on shore. Each time one of the catches was sampled, fishermen watching the process repeated this concern. Once fishers placed large numbers of an individual bycatch species in the sampling cooler, they refused to retain additional individuals and released further catch. As a result, we changed the protocol to allow fishers to systematically subsample these catches. Fishers systematically sampled at different rates (generally one in three to one in five) depending on the size of the catch. Some species (for example the nurse shark shown here) were not returned at all. An effort was made to “debrief” the captains participating in the project to obtain an estimate of these fish which were not returned to shore and photographs are being taken where feasible. Bycatch not returned to shore was recorded by observers and by vessel operators for captain trips.

Of the 160 licensed fishers registered from St. Thomas, approximately 50 can be considered full time and active (David Olsen, STFA, pers. comm.). Of these, we obtained data from 21 fishers who represented approximately 42% of full time and 13% of total permits. The project obtained samples from 2 seine net fishers, 8 fish trap fishers, 5 lobster trap fishers, and 9 hook and line fishers. Several fishers fished more than one gear: two fished both net and trap and one fished net and hook and line. The relatively small proportion of participating fishers resulted in part because of refusals from many fishers contacted (see Section 3.1.3).

### **3.1 Feasibility of observer coverage**

#### **3.1.1 Space, safety, and financial considerations for placing observers on board**

As anticipated, the small size of most fishing vessels – generally less than 25 feet – in St. Thomas presented limited space for observers to conduct work at sea based on vessel size. Virgin Islands fishermen fish mainly from small boats averaging less than 25 feet in length. In the current study, the largest boat was 42 ft and the smallest 16. Average vessel sizes employed in the sample by the various fisheries are shown in Table 1.

Table 1. Average vessel size.

| Fishing Method  | Boat Length (ft) |
|-----------------|------------------|
| Fish Traps      | 24.9             |
| Lobster Traps   | 31.2             |
| Hand Line       | 22.5             |
| Seine Net       | 17.6             |
| Long Line       | 32.0             |
| Average for All | 24.7             |

Gear type and at-sea conditions affected the effective space available for observers. Rough seas typical of St. Thomas waters, especially during winter months, increased the difficulties of observers to make observations. Of the gears sampled, space was the biggest issue for trap fishing trips (see adjacent photo). For boats less than 25 feet in length, space was further restricted when traps were hauled by hand (which requires two crew). The space required for handling traps left little room for observers to collect samples or observe fishing activities, which compromised the ability of observers to adequately collect complete bycatch data. Observers had problems obtaining all data from vessels using traps. Observers on trap vessels often had to make visual estimates of numbers and species caught in the traps.



The observer protocol called for observers to board only vessels that had passed safety inspections by the US Coast Guard or USVI authorities. The Coast Guard regularly boarded fishing vessels from St. Thomas and checked that the vessels met at-sea safety standards. In spite of the small size of the vessels, observers felt safe on board all vessels sampled. All observers had the final choice whether to ride along on any vessel. The project provided all observers with a life jacket, personal locator beacon, and a hand-held VHF radio to enhance personal safety.

Due to the small vessel size and open-ocean sea conditions, observers experienced harsh conditions on board nearly all trips, which points to a need for experience at-sea. Observers must understand and accept harsh conditions and an often stressful working environment. Observers get beaten by high speed transits in rough seas in small vessels, often wind/sea conditions causing onboard balance problems. Observers face uncomfortable and severe exposure to sun, wind, rain, and seawater. Loose fishing gear and the general state of vessel condition may expose observers to increased risk of injury. However, observers did not report any data lost as a result of the conditions at sea.

The St. Thomas pilot observer project had two key financial aspects: financial impacts on vessels of carrying an observer, and compensation to the observer team (observers, observer supervisor, and biological sampler).

Fishers, especially those using traps, experienced inconvenience and trip delays from having observers on board. Observers slowed down operations and thereby increased the length of trips. If trap fishers find no retainable fish in a trap, the trap often goes back to the sea with any catch left in as bait. Therefore, taking out bycatch for the observer is time consuming; the extent of this issue varies by fisher. In addition, removal of bycatch used traditionally as bait, could potentially impact subsequent catch rate success and impact fisher profit, short term. Compensation to fishers of \$150 per observer trip

partially offset the inconvenience. Fishers who participated by bringing in fish otherwise discarded (captain samples) were compensated \$150 for the extra time and effort required and the potential loss of profits from loss of bycatch used normally as bait.

Observer pay of \$200 per observer day is roughly comparable to pay rates of observer programs managed by NMFS. Recent solicitations for observer programs in the Northeast and Pacific Islands Regions specified minimum observer pay of \$13.21 per hour plus overtime consistent with the Fair Labor Standards Act, which converts to around \$180 per day base rate. The short-term and irregular observer activities justified payments above a base rate. Observers found the payment adequate for the work performed. However, many St. Thomas fishers do not fish long hours, often completing a fishing day in less than eight hours. Under a long-term observer program, payment for actual hours rather than a daily rate could reduce costs for the program.

Dr. Olsen participated in all biological sampling. Ideally, a trained biological sampling team, rather than the observer supervisor, would have performed this task. However, the request by DFW to transfer responsibility to STFA required personnel other than from DFW. Dr. Olsen's experience allowed observers without previous biological sampling experience to assist with the biological sampling. When available, qualified and trained biological samplers are an asset to this type of research project and should be used.

### **3.1.2 Limitations to data collection**

The small size of vessels, limited space on board, and often rough sea conditions prevented observers from processing samples on board. This added substantially to the time observers spent, as they must perform all sampling on shore after completion of the fishing trip. Sampling on shore may have enhanced data quality as a second sampler was available for processing the catch and a stable sampling table made measurements and recording easier. Sampling on shore resulted in a tradeoff of additional confidence in data quality at the cost of delaying the process to some degree.

However, several issues may lead to questions of representativeness of the data.

- Representativeness of samples to total St. Thomas fishery: The St. Thomas fleet has less than 10 larger vessels (longer than 30 feet) that can comfortably carry observers. The active fleet consists of approximately 50 vessels, with about 160 licenses issued. These larger vessels primarily use fish and lobster traps. The larger size gives these vessels more flexibility of operation, so they may fish in a different manner than small boats. The observer team obtained agreement from 8 different fishers, or about 16% of the full time fishers, to participate in the observer program. We experienced many refusals, and focused on the most fishers who tended to cooperate best. Therefore, observer samples may not adequately represent the entire commercial fishery of St. Croix. The project distributed the observer trips nearly equally among the fish trap, lobster trap and hand-line gear types. Due to the small vessels size no observers were on the seine net trips. The and captain trips nearly equally among the fish trap, lobster trap and hand-line gears. The number of fishers participating was also nearly equal across the gears the trap and line fishing gears. Only two seine net fishermen participated.

- Discard numbers: Some lobster fishers may have altered their harvest behavior in the presence of observers (e.g. shorts or berried females could have been discarded, which might otherwise have been harvested in the absence of an observer). Observers noted no violation of fishing regulations, other than two lobsters measured on shore at 1 mm below the legal size.
- Excluded fishery: We did not obtain any samples of conch fishing trips by commercial fishers.

Discard mortality not determined: The project had a secondary objective to see if observers could collect viability data for discards. Observers could not consistently ascertain the condition of discarded fish because of the working conditions onboard the small fishing vessels. The protocol called for a multi-stage set of viability conditions; observers determined that, at best, they could estimate condition as “viable” or “not viable.” Observers and fishers did collect viability data, but the project team considered these unreliable. Observers and fishers characterized nearly all discards as “viable” but no information exist to confirm if such fish actually survive. Fishers often left many organisms (treated in the data as discards) in the trap as bait; this bait may survive multiple hauls but will ultimately die if not released. For fish trap catch, estimating mortality/vitality is seriously confounded by fate of discards once they are tossed over the side due to predation by birds (especially frigate birds) or fish (especially barracuda) although fishermen report that most of the discards successfully return to the bottom. Only 2.2% of the discards were reported as not surviving. Seabirds often follow trap boats to feed on discards. Fishermen feel that since the fish trap mesh size was increased to 2 inches, with a consequent reduction in discards, that the number of Frigate birds has decreased. They attribute this to a reduction in food resources from discarded fish.

- Multiple gear fishing trips: Even within a gear category/method, fisher behavior or species preference can dramatically alter the composition of catch. This is most common for trap vessels that may use a combination of fish and lobster traps, or may use hook and line gear during trap soaks. We categorized each trip by the dominant gear used for that trip.

### **3.1.3 Coordination and cooperation issues with fishers**

A subset of about 42% of the 50 full time fishers allowed observers on fishing vessels or agreed to bring in captain samples. The majority of fishers refused to cooperate with the pilot observer program. The success we achieved for the project derived from the rapport of the observer team with the fisher community. The rapport allowed the observer team to impart information with a credibility that could not likely have happened with a less well known and respected team, even if otherwise well experienced.

Fishers expressed two major reasons for not participating. First, fishers did not want observers from the fishing community to ride along because of concerns that the observer could pass on or personally use information gained from the fisher. Second, fishers were generally reluctant to slow or alter harvest operations so that observers could complete their work. This was especially the case for trap fishers, who experience the most

disruption to operations among the fishery types. Other fishers did not want to alter fishing or marketing operations to carry observers or wait for sample processing by observers. Others just did not want anyone else on board. On only two occasions did a fisher initially agree to participate in an observer or captain trip, and then cancel without calling back, leaving the observer waiting. No organized opposition to the observer project developed among fishers, although several individuals did object to the project.

Fishers who did cooperate with the program developed a strong buy-in to the program and demonstrated a feeling of ownership that surprised the project team. These fishers argued in support of the program with fishers who did not wish to participate, and several individuals who supported the program did not normally participate in such activities in the past. The supporting fishers expressed a desire to use real data as a basis for management decisions, and felt that the data could help them advocate for management decisions. The STFA played a large role in developing and maintaining support for the observer program. The STFA updated members regularly at membership meeting with progress reports and preliminary data analyses. The STFA also received feedback from fishers that led to alterations in the protocol, particularly the decision to allow retention of a subset of discards that occurred in large numbers to minimize mortality and the decision to subsample weights during biosampling to reduce processing time.

### ***3.2 Alternatives to putting an observer onboard***

This project tested captain samples as an alternative to placing observers on board fishing vessels. This was necessary in particular to sample vessels that were deemed too small to carry an observer. The captains who participated agreed to bring fish they would have otherwise discarded into port for sampling by the observer team. Some analysts and managers could have concerns that fishers may not bring in total catch, and may discard catch to deliberately bias the bycatch data. However, the observer team did not detect any evidence, from talking with fishers and during sampling of catch, that fishers had biased the sample. Some gear types are more appropriate and less likely for bias as targets of captain samples. For example, fishers haul seine nets into a vessel without sorting at sea, which makes the entire catch available for sampling on shore as fishers sort retained catch from catch to be discarded in port. Deepwater snapper fisheries catch relatively few non-target species, which makes bringing in discards a minor activity. However, bringing in trap bycatch requires more effort from captains than for other fisheries, and offers an easy opportunity to bias data by discarding species that could cause management concern or by leaving bycatch in the trap as bait.

This project did not test other possible alternatives to observers. We considered but did not test the following methods.

- The bycatch information recorded on USVI, DFW Commercial Catch Report (CCR) forms could also be used. However this dataset has yet to be analyzed. Issues with ability of fishers to recall discards, major difficulty and reluctance that some fishers have in filling out forms, and possible intentional bias may reduce the accuracy of these data. In addition, the tendency of some fishers to combine catch over several trips could introduce additional concerns in analysis of fisher

reported bycatch/discard. However, the support from fishers for the observer collection project may enhance the accuracy of the CCR data, as a number of fishers have expressed interest in maintaining the catch reporting from the pilot observer project.

- Vessel monitoring systems (VMS) can be used to track fisher movements. However, VMS does not provide data on catch and discards. VMS cannot confirm when or if fishers actually fish. VMS could support observer activities but cannot substitute for direct observations and biological measurements provided by at-sea observers. The small size of vessels leaves little room for installation of EM gear.
- Closed circuit television cameras and other electronic monitoring (EM) can provide useful information about fishing activities and catch. However, EM cannot obtain biological data. The small size of vessels leaves little room for installation of EM gear. Costs of EM are generally less than observer coverage but still high relative to vessel revenues.
- For some gears, a bycatch study could be conducted from a non-fishing vessel with a commercial fisherman accompanying. For example, to study trap bycatch, the fisher could visit his traps in a research vessel with a research team hauling traps at a pace controlled by study objectives. This would enable better info on vitality criteria using aquaria and also allow divers to record the fate of discards (eaten by birds or predatory fish). The expense of such charter-vessel research would limit the observations to relatively few vessels.

## 4 Data analysis

The voluntary participation in the pilot observer project means that we could not distribute observer coverage over the fleet with a randomized or stratified procedure to obtain representative coverage of the St. Thomas fishing fleet. Refusal to participate by some segments of the fleet precluded sampling of these vessels. Other vessels too small to carry observers are included in the sampling only to the extent that fishers participated through the captain samples. Therefore, use of the data must occur with caution.

Fishers often used more than one gear during a fishing trip. For example, when gear needed to soak before retrieval, fishers might fish with hook and line or by diving. For the analyses that follow, we assigned each trip to a single gear that we determined best represented that trip.

No biological samples from St. Thomas, other than those from this project, were collected during the period of the pilot observer project. Therefore, analysts preparing scientific support documents for management purposes of reef fish fisheries for St. Thomas must either use these data or have no data for the period. Analysts and managers must ascertain the appropriateness of these data for the purpose intended, and determine whether the samples sufficiently represent the fishing activities of St. Thomas fishing fleet.

### 4.1 Comparison of observer trips and captain samples

The current study attempted to assess the feasibility of placing observers on local fishing boats (Observer Trips) as compared to having fishermen return the by catch to shore where it could be measured (Captain's Trips). Because of the small vessel size, it was difficult to place observers on the boats. The distribution of Observer Trips and Captain's trips is shown in Table 2.

Table 2. Distribution of Captain's and Observer's trips among the various fishing methods.

| Fishing Method | Captain's Trips | Observer's Trips | Total |
|----------------|-----------------|------------------|-------|
| Fish Traps     | 16              | 10               | 26    |
| Lobster Traps  | 6               | 9                | 15    |
| Hand Line      | 11              | 9                | 20    |
| Seine Net      | 10              | 0                | 10    |
| Long Line      | 2               | 0                | 2     |
|                | 45              | 28               | 73    |

There appears to be close agreement between the by catches returned during Captain's trips and the observer's trips. This is shown in Figure 2 where the percent of each species in the total by catch is plotted for both Captain's and Observer's trips. The percentage abundance in the two samples was non-significant when tested by a t-test. The resulting Correlation was significant and  $p < 0.01\%$  ( $df=36$ ) which we interpret to indicate that the two methods provide similar results.

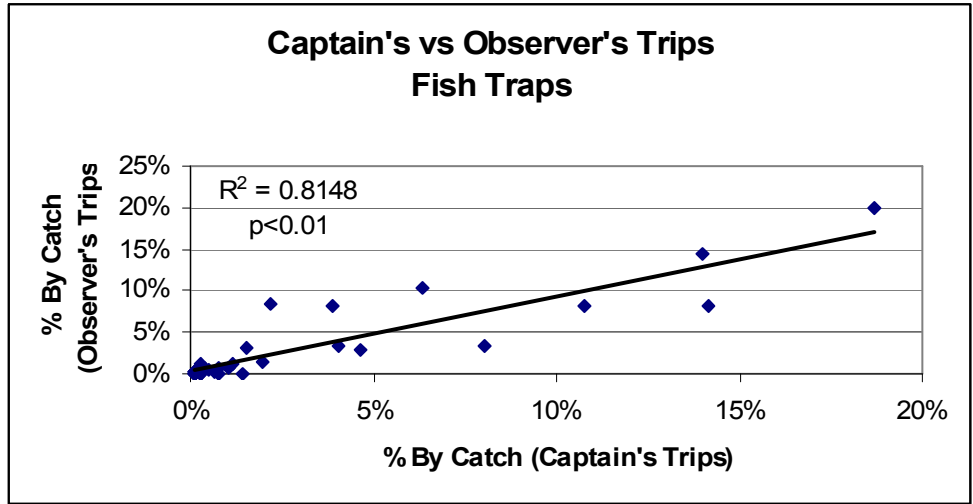


Figure 2. Percent species abundance of bycatch for Captain's trips and Observer Trips.

Captain's trips and Observer trips were also highly correlated ( $R^2=0.96$ ) for the lobster trips although the dominance by lobster by catch created much of this correlation. These data lead to a conclusion that both captain's and observer's trips provided similar results.

## 4.2 Trip Characteristics

### 4.2.1 Soak Time

Over 3400 fish and lobster traps were hauled during the study. The average soak time for these traps is shown in Table 3.

Table 3 Soak time for fish and lobster traps.

| <b>Soak Time for Fish and Lobster Traps (Days)</b> |         |            |     |     |         |
|--|---------|------------|-----|-----|---------|
| Gear   | # Trips | Total Gear | Min | Max | Average |
| Fish Traps   | 26      | 1875       | 6   | 21  | 9.6     |
| Lobster Traps                                      | 15      | 1554       | 7   | 14  | 8.5     |

### 4.2.2 Fishing Depths

For most of the trips, fishermen provided a range of depths over which they fished. Maximum and minimum values were calculated for these trips and average figures were calculated by combining the mid-points of this range with trip values where fishermen only provided a single depth value (Table 4). With the exception of a single trip that reported 60 feet as the start of the depth range, all of the fish and lobster trips started deeper than 70 feet. Traps were set as deep as 210 feet but the average for both fish and lobster traps was around 110 feet.

Table 4 Characteristics of sampled trips.

| <b>Characteristics of Sampled Fishing Trips</b> |         |     |      |         |  |
|---|---------|-----|------|---------|--|
| <b>Fishing Depths (Feet)</b>                    |         |     |      |         |  |
| Gear  | # Trips | Min | Max  | Average |  |
| Fish Traps                                      | 26      | 60  | 175  | 110.0   |  |
| Lobster Traps                                   | 15      | 80  | 210  | 106.0   |  |
| Hand Line                                       | 20      | 60  | 150  | 100.4   |  |
| Seine Net                                       | 10      | 15  | 30   | 22.5    |  |
| Long Line                                       | 2       | 80  | 1200 | 643.8   |  |
| <b>Crew</b>                                     |         |     |      |         |  |
| Gear  | # Trips | Min | Max  | Average |  |
| Fish Traps                                      | 26      | 1   | 2    | 1.7     |  |
| Lobster Traps                                   | 15      | 1   | 3    | 2.1     |  |
| Hand Line                                       | 20      | 1   | 6    | 2.3     |  |
| Seine Net                                       | 10      | 1   | 3    | 2.3     |  |
| Long Line                                       | 2       | 2   | 2    | 2.0     |  |
| <b>Fishing Hours</b>                            |         |     |      |         |  |
| Gear  | # Trips | Min | Max  | Average |  |
| Fish Traps                                      | 26      | 3   | 12   | 5.6     |  |
| Lobster Traps                                   | 15      | 2   | 11   | 6.3     |  |
| Hand Line                                       | 20      | 2.5 | 10   | 4.8     |  |
| Seine Net                                       | 10      | 4   | 4.75 | 4.4     |  |
| Long Line                                       | 2       | 4.5 | 6.5  | 5.5     |  |

### 4.2.3 Crew size

The average crew size for all techniques averaged around two persons including the captain (Table 4).

### 4.2.4 Trip Length

Trip length varied significantly and ranged from 2-3 hours to 11-12 hours (Table 4). For the trap boats, the longer trips were associated with larger scale operations which hauled upwards of 150 traps and fished areas along the north drop off and to the west beyond Savanna Islands.

## 4.3 Species Make up of Catch and Bycatch Combined

### 4.3.1 Retained Landings

Table 5 includes all landings that the fishers would have retained for the 73 catches sampled, in the absence of the observer program. A total of 89 species and 6871 individuals were included in the “retained” catch. Thirteen species made up 80% of these landings.

Table 5. Total of retained landings, exclusive of bycatch.

| Species in Landings             | TIP Code | Number | % of Total |
|---------------------------------|----------|--------|------------|
| <i>Ocyurus chrysurus</i>        | 140      | 1500   | 21.83%     |
| <i>Panulirus argus</i>          | 919      | 868    | 12.63%     |
| <i>Caranx crysos</i>            | 117      | 483    | 7.03%      |
| <i>Balistes vetula</i>          | 253      | 469    | 6.83%      |
| <i>Epinephelus guttatus</i>     | 88       | 338    | 4.92%      |
| <i>Haemulon plumieri</i>        | 155      | 320    | 4.66%      |
| <i>Acanthurus coeruleus</i>     | 652      | 266    | 3.87%      |
| <i>Holocentrus rufus</i>        | 625      | 398    | 5.79%      |
| <i>Acanthurus chirurgus</i>     | 651      | 230    | 3.35%      |
| <i>Calamus pennatula</i>        | 165      | 222    | 3.23%      |
| <i>Caranx ruber</i>             | 115      | 149    | 2.17%      |
| <i>Haemulon sciurus</i>         | 156      | 148    | 2.15%      |
| <i>Haemulon melanurum</i>       | 506      | 130    | 1.89%      |
| <i>Lutjanus synagris</i>        | 136      | 120    | 1.75%      |
| <i>Lactophrys quadricornis</i>  | 700      | 97     | 1.41%      |
| <i>Sparisoma rubripinne</i>     | 679      | 82     | 1.19%      |
| <i>Epinephelus fulvus</i>       | 80       | 74     | 1.08%      |
| <i>Lactophrys polygonius</i>    | 701      | 69     | 1.00%      |
| <i>Lutjanus analis</i>          | 134      | 68     | 0.99%      |
| <i>Pomacanthus arcuatus</i>     | 576      | 67     | 0.98%      |
| <i>Euthynnus alletteratus</i>   | 230      | 65     | 0.95%      |
| <i>Sparisoma viride</i>         | 196      | 63     | 0.92%      |
| <i>Scyllarides aequinoctia.</i> | 918      | 58     | 0.84%      |

| Species in Landings                | TIP Code | Number | % of Total |
|------------------------------------|----------|--------|------------|
| <i>Tylosurus crocodilus</i>        | 58       | 58     | 0.84%      |
| <i>Sparisoma chrysopterum</i>      | 675      | 54     | 0.79%      |
| <i>Lactophrys bicaudalis</i>       | 702      | 38     | 0.55%      |
| <i>Selar crumenophthalmus</i>      | 120      | 36     | 0.52%      |
| <i>Calamus bajonado</i>            | 166      | 28     | 0.41%      |
| <i>Aluterus schoepfi</i>           | 725      | 26     | 0.38%      |
| <i>Cantherhines pullus</i>         | 255      | 25     | 0.36%      |
| <i>Etelis oculatus</i>             | 143      | 25     | 0.36%      |
| <i>Rhomboplites aurorubens</i>     | 142      | 25     | 0.36%      |
| <i>Holacanthus ciliaris</i>        | 184      | 22     | 0.32%      |
| <i>Lactophrys trigonus</i>         | 257      | 22     | 0.32%      |
| Crab, marine                       | 906      | 17     | 0.25%      |
| <i>Epinephelus cruentatus</i>      | 82       | 17     | 0.25%      |
| <i>Priacanthus arenatus</i>        | 98       | 16     | 0.23%      |
| <i>Lutjanus buccanella</i>         | 138      | 14     | 0.20%      |
| <i>Scomberomorus cavalla</i>       | 233      | 10     | 0.15%      |
| <i>Scomberomorus regalis</i>       | 234      | 10     | 0.15%      |
| <i>Mycteroperca interstitialis</i> | 752      | 10     | 0.15%      |
| <i>Lactophrys triqueter</i>        | 703      | 9      | 0.13%      |
| <i>Lutjanus vivanus</i>            | 139      | 8      | 0.12%      |
| <i>Mycteroperca venenosa</i>       | 91       | 8      | 0.12%      |
| <i>Haemulon parrai</i>             | 501      | 7      | 0.10%      |
| <i>Lachnolaimus maximus</i>        | 189      | 7      | 0.10%      |
| <i>Acanthurus bahianus</i>         | 218      | 5      | 0.07%      |
| <i>Anisotremus surinamensis</i>    | 162      | 5      | 0.07%      |
| <i>Elagatis bipinnulata</i>        | 124      | 5      | 0.07%      |
| <i>Haemulon striatum</i>           | 507      | 5      | 0.07%      |
| <i>Pomacanthus paru</i>            | 577      | 5      | 0.07%      |
| <i>Scarus coeruleus</i>            | 195      | 5      | 0.07%      |
| <i>Sparisoma aurofrenatum</i>      | 677      | 5      | 0.07%      |
| <i>Haemulon flavolineatum</i>      | 157      | 4      | 0.06%      |
| <i>Scarus vetula</i>               | 678      | 4      | 0.06%      |
| <i>Epinephelus morio</i>           | 87       | 3      | 0.04%      |
| <i>Negaprion brevirostris</i>      | 12       | 3      | 0.04%      |
| <i>Sphyræna picudilla</i>          | 205      | 3      | 0.04%      |
| <i>Bodianus rufus</i>              | 190      | 2      | 0.03%      |
| <i>Caranx latus</i>                | 118      | 2      | 0.03%      |
| <i>Carcharhinus limbatus</i>       | 403      | 2      | 0.03%      |
| <i>Epinephelus adscensionis</i>    | 90       | 2      | 0.03%      |

| Species in Landings               | TIP Code     | Number | % of Total |
|-----------------------------------|--------------|--------|------------|
| <i>Epinephelus mystacinus</i>     | 86           | 2      | 0.03%      |
| <i>Haemulon album</i>             | 153          | 2      | 0.03%      |
| <i>Haemulon aurolineatum</i>      | 159          | 2      | 0.03%      |
| <i>Haemulon carbonarium</i>       | 500          | 2      | 0.03%      |
| <i>Kyphosus sectatrix</i>         | 179          | 2      | 0.03%      |
| <i>Remora remora</i>              | 590          | 2      | 0.03%      |
| <i>Scarus taeniopterus</i>        | 678          | 2      | 0.03%      |
| <i>Ablennes hians</i>             | 59           | 1      | 0.01%      |
| <i>African lobster</i>            |              | 1      | 0.01%      |
| <i>Anisotremus virginicus</i>     | 501          | 1      | 0.01%      |
| <i>Canthidermis sufflamen</i>     | 252          | 1      | 0.01%      |
| <i>Caranx crysos shark bite</i>   | 117          | 1      | 0.01%      |
| <i>Carcharhinus leucas</i>        | 870802050200 | 1      | 0.01%      |
| <i>Carcharhinus perezii</i>       | 400          | 1      | 0.01%      |
| <i>Chaetodipterus faber</i>       | 183          | 1      | 0.01%      |
| <i>Galeocerdo cuvier</i>          | 10           | 1      | 0.01%      |
| <i>Haemulon bonariense</i>        | 502          | 1      | 0.01%      |
| <i>Haemulon chrysargyreum</i>     | 158          | 1      | 0.01%      |
| <i>Holacanthus tricolor</i>       | 577          | 1      | 0.01%      |
| <i>Lutjanus mahogoni</i>          | 137          | 1      | 0.01%      |
| <i>Majidae</i>                    | 618701000000 | 1      | 0.01%      |
| <i>Mulloidichthys martinicus</i>  | 176          | 1      | 0.01%      |
| <i>Pristipomoides aquilonaris</i> | 883536070100 | 1      | 0.01%      |
| <i>Rhizoprionodon porosus</i>     | 8708020303   | 1      | 0.01%      |
| <i>Sphyraena barracuda</i>        | 203          | 1      | 0.01%      |
| <i>Thunnus atlanticus</i>         | 228          | 1      | 0.01%      |
| <i>Trachinotus falcatus</i>       | 125          | 1      | 0.01%      |
| <i>Trachinotus goodei</i>         | 126          | 1      | 0.01%      |
| # Species                         | 89           | 6871   |            |

### 4.3.2 Total Bycatch

Bycatch represents the fish in the catch that fishers would have discarded. These consist of all fish measured at the dock, fish that fishers reported but discarded at sea, and species that fishers “sub-sampled” at sea.

At the beginning of the study, fishermen objected to “killing” all of the bycatch returned to shore that would have been discarded at sea. An accommodation was reached whereby fishers would systematically subsample a fixed percentage of abundant species and the record the sampling ratio. These consist of all fish measured at the dock as well as fish which were reported but not landed and species which were “sub-sampled” by the fishermen (Table 6). Of the 25 fish trap trips, sub sampling was employed on 12.

Table 6. Subsampled catch.

| Trip# | Species                     | TIP | Ratio | Returned to Shore | Adjusted Landings <sup>1</sup> |
|-------|-----------------------------|-----|-------|-------------------|--------------------------------|
| 011   | <i>Lutjanus apodus</i>      | 137 | 4     | 4                 | 16                             |
| 011   | <i>Ostraciidae</i>          | 256 | 4     | 18                | 72                             |
| 013   | <i>Ostraciidae</i>          | 256 | 4     | 4                 | 16                             |
| 013   | <i>Acanthurus coeruleus</i> | 652 | 3     | 13                | 39                             |
| 017   | <i>Ostraciidae</i>          | 256 | 3     | 23                | 69                             |
| 017   | <i>Lutjanus apodus</i>      | 135 | 4     | 5                 | 20                             |
| 017   | <i>Acanthurus coeruleus</i> | 652 | 4     | 2                 | 8                              |
| 018   | <i>Ostraciidae</i>          | 256 | 5     | 20                | 100                            |
| 019   | <i>Ostraciidae</i>          | 256 | 4     | 52                | 208                            |
| 020   | <i>Ostraciidae</i>          | 256 | 10    | 12                | 120                            |
| 023   | <i>Ostraciidae</i>          | 256 | 4     | 23                | 92                             |
| 024   | <i>Acanthurus coeruleus</i> | 652 | 4     | 9                 | 36                             |
| 024   | <i>Ostraciidae</i>          | 256 | 4     | 19                | 76                             |
| 036   | <i>Diodon holacanthus</i>   | 820 | 2     | 4                 | 8                              |
| 036   | <i>Calamus pennatula</i>    | 165 | 4     | 1                 | 4                              |
| 036   | <i>Balistes vetula</i>      | 253 | 3     | 4                 | 12                             |
| 036   | <i>Acanthurus coeruleus</i> | 652 | 4     | 8                 | 32                             |
| 041   | <i>Ostraciidae</i>          | 256 | 4     | 15                | 60                             |
| 041   | <i>Acanthurus coeruleus</i> | 652 | 4     | 23                | 92                             |
| 051   | <i>Diodon holacanthus</i>   | 820 | 5     | 2                 | 10                             |
| 069   | <i>Ostraciidae</i>          | 256 | 4     | 29                | 116                            |

As can be seen from Table 6, the bulk of the “sub-sampled” fish were box fish belonging to the family Ostraciidae. Virgin Islands fishermen do not distinguish between a number of these species so an assumption was made that the box fish that were sub sampled had the same distribution as those that were sampled. In addition to the “sub sampled” fish, an additional 256 box fish were seen but not identified to species during observer trips.

An assumption was made that species mix of these boxfish was the same as that of the measured sample which is shown in Table 7. The adjusted number of discards must be added to the number of discards to obtain estimates of total discards.

<sup>1</sup> To be added to landed bycatch. Total shown in Table 11.

Table 7. Species composition of Ostraciidae samples.

| Shell Fish                     | TIP # | # Sampled | %   | Adjusted for Sub Sampling |
|--------------------------------|-------|-----------|-----|---------------------------|
| <i>Lactophrys poligonius</i>   | 703   | 273       | 36% | 421                       |
| <i>Lactophrys triqueter</i>    | 703   | 160       | 21% | 247                       |
| <i>Lactophrys quadricornis</i> | 700   | 147       | 19% | 227                       |
| <i>Lactophrys bicaudalis</i>   | 704   | 108       | 14% | 167                       |
| <i>Lactophrys trigonus</i>     | 704   | 80        | 10% | 123                       |
| Total                          |       | 768       |     | 1185                      |

### 4.3.3 Finfish by catch

Risk of Ciguatera affected nearly 14% of the finfish by catch. 78% of the by catch was discarded because the fish were smaller than market size. Of these 56% of the total by catch were either small box fish (Ostraciidae) or surgeon fish (Acanthuridae). Virgin Islands consumers eat a wide variety of species. A total of 89 species were found in the landed catch (Table 9). Thus, it not unexpected that only 9% of the by catch was made up by unacceptable species. Finally, fishermen had said that when the market was filled with a particular species, they discarded those fish at sea. None of the current sample was discarded for that reason. Use of bycatch for bait is an insignificant element of the by catch.

Table 9. Species composition and reasons for discard of by catch.

| Species                          | TIP | Number |
|----------------------------------|-----|--------|
| <b>Risk of Ciguatera</b>         |     |        |
| <i>Caranx latus</i>              | 118 | 8      |
| <i>Caranx lugubris</i>           | 119 | 2      |
| <i>Caranx ruber</i>              | 115 | 21     |
| <i>Gymnothorax moringa</i>       | 442 | 1      |
| <i>Lutjanus apodus</i>           | 135 | 118    |
| <i>Lutjanus buccanella</i>       | 138 | 3      |
| <i>Lutjanus griseus</i>          | 132 | 26     |
| <i>Lutjanus jocu</i>             | 133 | 10     |
| <i>Lutjanus mahogoni</i>         | 137 | 6      |
| <i>Mulloidichthys martinicus</i> | 176 | 7      |
| <i>Priacanthus arenatus</i>      | 98  | 1      |
| <i>Pseudupeneus maculatus</i>    | 175 | 2      |
| <i>Scomberomorus regalis</i>     | 234 | 5      |
| <i>Seriola rivoliana</i>         | 111 | 1      |

|  |            |                        |
|--|------------|------------------------|
| <i>Sphyræna barracuda</i>                    | 203        | 12                     |
| <b>Risk of Ciguatera, Used to Bait Traps</b> |            |                        |
| <i>Lutjanus apodus</i>                       | 135        | 3                      |
| <i>Lutjanus jocu</i>                         | 133        | 2                      |
| <i>Lutjanus mahogoni</i>                     | 137        | 3                      |
| <i>Priacanthus arenatus</i>                  | 98         | 4                      |
| <b>Total</b>                                 |            | <b>235<br/>(13.6%)</b> |
| Smaller Than Market Size                     |            |                        |
| <i>Acanthurus bahianus</i>                   | 218        | 2                      |
| <i>Acanthurus chirurgus</i>                  | 651        | 82                     |
| <i>Acanthurus coeruleus</i>                  | 652        | 201                    |
| <i>Balistes vetula</i>                       | 251        | 52                     |
| <i>Calamus pennatula</i>                     | 165        | 38                     |
| <i>Caranx hippos</i>                         | 601        | 1                      |
| <i>Caranx ruber</i>                          | 115        | 4                      |
| <i>Crab, marine</i>                          | 930        | 1                      |
| <i>Epinephelus adscensionis</i>              | 90         | 1                      |
| <i>Epinephelus cruentatus</i>                | 82         | 28                     |
| <i>Epinephelus fulvus</i>                    | 80         | 2                      |
| <i>Epinephelus guttatus</i>                  | 88         | 6                      |
| <i>Gerres cinereus</i>                       | 148        | 1                      |
| <i>Haemulon aurolineatum</i>                 | 159        | 2                      |
| <i>Haemulon flavolineatum</i>                | 157        | 2                      |
| <i>Haemulon melanurum</i>                    | 506        | 2                      |
| <i>Holacanthus ciliaris</i>                  | 184        | 2                      |
| <i>Holacanthus tricolor</i>                  | 575        | 5                      |
| <i>Holocentrus marianus</i>                  | 8810080105 | 3                      |
| <i>Holocentrus rufus</i>                     | 625        | 32                     |
| <i>Lactophrys bicaudalis</i>                 | 702        | 117                    |
| <i>Lactophrys poligonius</i>                 | 701        | 273                    |
| <i>Lactophrys quadricornis</i>               | 700        | 149                    |
| <i>Lactophrys trigonus</i>                   | 704        | 81                     |
| <i>Lactophrys triqueter</i>                  | 258        | 41                     |
| <i>Lactophrys triqueter</i>                  | 701        | 100                    |
| <i>Lactophrys triqueter</i>                  | 703        | 33                     |
| <i>Lutjanus apodus</i>                       | 135        | 1                      |
| <i>Lutjanus synagris</i>                     | 136        | 3                      |
| <i>Ocyurus chrysurus</i>                     | 140        | 37                     |
| <i>Ostraciidae</i>                           | 256        | 32                     |
| <i>Pomacanthus arcuatus</i>                  | 576        | 2                      |

|                                       |     |                          |
|---------------------------------------|-----|--------------------------|
| <i>Pomacanthus paru</i>               | 575 | 8                        |
| <i>Priacanthus arenatus</i>           | 98  | 1                        |
| <i>Scyllarides aequinoctialis</i>     | 918 | 1                        |
| <b>Total</b>                          |     | <b>1,346<br/>(77.6%)</b> |
| <b>Non Marketable Species</b>         |     |                          |
| <i>Aluterus monoceros</i>             | 730 | 2                        |
| <i>Aluterus schoepfi</i>              | 725 | 7                        |
| <i>Aluterus scriptus</i>              | 726 | 11                       |
| <i>Bothus lunatus</i>                 | 249 | 1                        |
| <i>Cantherhines macrocerus</i>        | 727 | 11                       |
| <i>Cantherhines pullus</i>            | 255 | 3                        |
| <i>Caranx crysos half fish</i>        | 117 | 2                        |
| <i>Chaetodon striatus</i>             | 561 | 14                       |
| <i>Chilomycterus antillarum</i>       | 822 | 2                        |
| <i>Crab,marine</i>                    | 930 | 2                        |
| <i>Diodon holacanthus</i>             | 820 | 77                       |
| <i>Echeneus naucratis</i>             | 108 | 2                        |
| <i>Equetus lanceolatus</i>            | 172 | 1                        |
| <i>Eupomacentrus fuscus</i>           |     | 1                        |
| <i>Ocyurus chrysurus (shark bite)</i> | 140 | 1                        |
| <i>Pomacentridae</i>                  | 185 | 1                        |
| <i>Scorpaena plumieri</i>             | 244 | 12                       |
| <i>Serranus tabacarius</i>            | 92  | 1                        |
| <b>Total</b>                          |     | <b>151<br/>(8.7%)</b>    |
| <b>Too Much in Market</b>             |     |                          |
|                                       |     | <b>0</b>                 |
| <b>Used as Bait</b>                   |     |                          |
| <i>Crab,marine</i>                    | 906 | 1                        |
| <i>Haemulon aurolineatum</i>          | 159 | 1                        |
| <b>Total</b>                          |     | <b>2<br/>(0.1%)</b>      |

#### 4.3.4 Lobster by catch

There were only two undersize individuals and no female lobsters with eggs in the in the entire sample of landed lobster, indicating a near perfect compliance with size limit requirements. Nearly 68% of the lobster by catch were undersize lobsters and 32% were lobsters with eggs. Almost all of the by catch is returned to the sea bed in the traps. These traps have straight openings approximately 35 cm square. Lobsters can easily exit a trap should they so desire.

Table 10. Reasons for discard of spiny lobster by catch.

| <b>Species</b>                                  | <b>TIP</b> | <b>Number</b> | <b>% of Total</b> |
|---|------------|---------------|-------------------|
| <b>Spiny Lobsters</b><br><i>Panulirus argus</i> | 901        |               |                   |
| Smaller than Legal Size                         |            | 312           | 67.5%             |
| Smaller than Legal Size, With Eggs              |            | 11            | 2.4%              |
| With Eggs                                       |            | 139           | 30.1%             |
| <i>Scyllarides aequinoctia</i> .                | 918        | 1             |                   |

#### 4.3.5 Total of all by catch samples

The sum of bycatch sampled on shore, and bycatch recorded and discarded at sea, and the bycatch systematically subsampled at sea by fishers equals the total bycatch (Table 11).

Table 11. Summary of all by catch samples combined for all methods.

| By Catch Species               | TIP | # Observed on Shore | % of Total | Including Not Returned to Shore | Including Sub Sampled and Not Returned | Combined % of Total |
|--------------------------------|-----|---------------------|------------|---------------------------------|--|---------------------|
| <i>Panulirus argus</i>         | 901 | 395                 | 17.56%     | 25                              | 420                                    | 11.85%              |
| <i>Lactophrys polygonius</i>   | 703 | 273                 | 12.14%     | 2                               | 696                                    | 19.65%              |
| Ostraciidae                    | 256 | 256                 | 11.38%     | 6                               |  | 0.00%               |
| <i>Acanthurus coeruleus</i>    | 224 | 169                 | 7.51%      | 5                               | 377                                    | 10.64%              |
| <i>Lactophrys triqueter</i>    | 703 | 160                 | 7.11%      |                                 | 407                                    | 11.48%              |
| <i>Lactophrys quadricornis</i> | 700 | 147                 | 6.54%      | 6                               | 380                                    | 10.72%              |
| <i>Lutjanus apodus</i>         | 137 | 123                 | 5.47%      |                                 | 159                                    | 4.49%               |
| <i>Lactophrys bicaudalis</i>   | 704 | 108                 | 4.80%      | 2                               | 277                                    | 7.81%               |
| <i>Lactophrys trigonus</i>     | 704 | 80                  | 3.56%      |                                 | 203                                    | 5.74%               |
| <i>Diodon holacanthus</i>      | 820 | 73                  | 3.25%      | 10                              | 101                                    | 2.85%               |
| <i>Acanthurus chirurgus</i>    | 651 | 64                  | 2.85%      | 3                               | 67                                     | 1.89%               |
| <i>Balistes vetula</i>         | 253 | 52                  | 2.31%      | 3                               | 67                                     | 1.89%               |
| <i>Calamus pennatula</i>       | 165 | 28                  | 1.24%      |                                 | 28                                     | 0.79%               |
| <i>Epinephelus cruentatus</i>  | 82  | 28                  | 1.24%      |                                 | 28                                     | 0.79%               |
| <i>Ocyurus chrysurus</i>       | 140 | 26                  | 1.16%      | 2                               | 28                                     | 0.79%               |
| <i>Caranx ruber</i>            | 115 | 25                  | 1.11%      | 1                               | 26                                     | 0.73%               |

| <b>By Catch Species</b>          | <b>TIP</b> | <b># Observed on Shore</b> | <b>% of Total</b> | <b>Including Not Returned to Shore</b> | <b>Including Sub Sampled and Not Returned</b> | <b>Combined % of Total</b> |
|----------------------------------|------------|----------------------------|-------------------|--|---|----------------------------|
| <i>Lutjanus griseus</i>          | 132        | 25                         | 1.11%             |  | 25  | 0.71%                      |
| <i>Holocentrus rufus</i>         | 625        | 21                         | 0.93%             | 3                                      | 24  | 0.68%                      |
| <i>Chaetodon striatus</i>        | 561        | 14                         | 0.62%             |  | 14  | 0.40%                      |
| <i>Scorpaena plumieri</i>        | 244        | 12                         | 0.53%             | 6                                      | 18  | 0.51%                      |
| <i>Sphyræna barracuda</i>        | 205        | 12                         | 0.53%             | 1                                      | 13  | 0.37%                      |
| <i>Aluterus scriptus</i>         | 728        | 11                         | 0.49%             | 1                                      | 12  | 0.34%                      |
| <i>Cantherhines macrocerus</i>   | 727        | 11                         | 0.49%             |  | 11  | 0.31%                      |
| <i>Lutjanus jocu</i>             | 133        | 11                         | 0.49%             | 3                                      | 14  | 0.40%                      |
| <i>Lutjanus mahogoni</i>         | 137        | 9                          | 0.40%             | 4                                      | 13  | 0.37%                      |
| <i>Caranx latus</i>              | 118        | 8                          | 0.36%             |  | 8   | 0.23%                      |
| <i>Haemulon aurolineatum</i>     | 159        | 8                          | 0.36%             |  | 8   | 0.23%                      |
| <i>Pomacanthus paru</i>          | 577        | 8                          | 0.36%             | 2                                      | 10  | 0.28%                      |
| <i>Aluterus schoepfi</i>         | 725        | 7                          | 0.31%             | 1                                      | 8   | 0.23%                      |
| <i>Mulloidichthys martinicus</i> | 176        | 7                          | 0.31%             |  | 7   | 0.20%                      |
| <i>Epinephelus guttatus</i>      | 88         | 6                          | 0.27%             |  | 6   | 0.17%                      |
| <i>Priacanthus arenatus</i>      | 98         | 6                          | 0.27%             | 1                                      | 7   | 0.20%                      |
| <i>Holacanthus tricolor</i>      | 577        | 5                          | 0.22%             |  | 5   | 0.14%                      |
| <i>Scomberomorus regalis</i>     | 234        | 5                          | 0.22%             |  | 5   | 0.14%                      |
| <i>Cantherhines pullus</i>       | 255        | 3                          | 0.13%             |  | 3   | 0.08%                      |
| <i>Holocentrus marianus</i>      | 8810080105 | 3                          | 0.13%             |  | 3   | 0.08%                      |
| <i>Lutjanus buccanella</i>       | 138        | 3                          | 0.13%             |  | 3   | 0.08%                      |

| <b>By Catch Species</b>               | <b>TIP</b> | <b># Observed on Shore</b> | <b>% of Total</b> | <b>Including Not Returned to Shore</b> | <b>Including Sub Sampled and Not Returned</b> | <b>Combined % of Total</b> |
|---------------------------------------|------------|----------------------------|-------------------|--|---|----------------------------|
| <i>Ocyurus chrysurus</i> (shark bite) | 140        | 3                          | 0.13%             |  | 3   | 0.08%                      |
| <i>Acanthurus bahianus</i>            | 218        | 2                          | 0.09%             |  | 2   | 0.06%                      |
| <i>Aluterus monoceros</i>             | 730        | 2                          | 0.09%             |  | 2   | 0.06%                      |
| <i>Caranx lugubris</i>                | 119        | 2                          | 0.09%             |  | 2   | 0.06%                      |
| <i>Chilomycterus antillarum</i>       | 822        | 2                          | 0.09%             |  | 2   | 0.06%                      |
| <i>Echeneis naucratis</i>             | 108        | 2                          | 0.09%             |  | 2   | 0.06%                      |
| <i>Epinephelus fulvus</i>             | 80         | 2                          | 0.09%             | 1                                      | 3   | 0.08%                      |
| <i>Haemulon aurolineatum</i>          | 159        | 2                          | 0.09%             |  | 2   | 0.06%                      |
| <i>Haemulon flavolineatum</i>         | 157        | 2                          | 0.09%             |  | 2   | 0.06%                      |
| <i>Holacanthus ciliaris</i>           | 184        | 2                          | 0.09%             |  | 2   | 0.06%                      |
| <i>Lutjanus synagris</i>              | 136        | 2                          | 0.09%             |  | 2   | 0.06%                      |
| <i>Pomacanthus arcuatus</i>           | 578        | 2                          | 0.09%             |  | 2   | 0.06%                      |
| <i>Pseudupeneus maculatus</i>         | 175        | 2                          | 0.09%             |  | 2   | 0.06%                      |
| <i>Scyllarides aequinoctia</i>        | 918        | 2                          | 0.09%             |  | 2   | 0.06%                      |
| <i>Bothus lunatus</i>                 | 249        | 1                          | 0.04%             | 1                                      | 2   | 0.06%                      |
| <i>Caranx crysos</i> half fish        | 117        | 1                          | 0.04%             |  | 1   | 0.03%                      |
| <i>Caranx hippos</i>                  | 601        | 1                          | 0.04%             |  | 1   | 0.03%                      |
| Crab,marine                           | 930        | 1                          | 0.04%             |  | 1   | 0.03%                      |
| <i>Epinephelus adscensionis</i>       | 90         | 1                          | 0.04%             |  | 1   | 0.03%                      |
| <i>Equetus lanceolatus</i>            | 172        | 1                          | 0.04%             | 1                                      | 2   | 0.06%                      |
| <i>Eupomacentrus fuscus</i>           | 185        | 1                          | 0.04%             |  | 1   | 0.03%                      |
| <i>Gerres cinereus</i>                | 148        | 1                          | 0.04%             |  | 1   | 0.03%                      |

| <b>By Catch Species</b>       | <b>TIP</b> | <b># Observed on Shore</b> | <b>% of Total</b> | <b>Including Not Returned to Shore</b> | <b>Including Sub Sampled and Not Returned</b> | <b>Combined % of Total</b> |
|-------------------------------|------------|----------------------------|-------------------|--|---|----------------------------|
| <i>Gymnothorax moringa</i>    | 442        | 1                          | 0.04%             |  | 1   | 0.03%                      |
| <i>Pomacentridae</i>          | 185        | 1                          | 0.04%             |  | 1   | 0.03%                      |
| <i>Seriola rivoliana</i>      | 111        | 1                          | 0.04%             |  | 1   | 0.03%                      |
| <i>Serranus tabacarius</i>    | 92         | 1                          | 0.04%             |  | 1   | 0.03%                      |
| <i>Gymnothorax funebris</i>   | 34         | 1                          | 0.04%             | 1                                      | 2   | 0.06%                      |
| <i>Ginglymostoma cirratum</i> | 5          | 1                          | 0.04%             | 5                                      | 6   | 0.17%                      |
| <i>Epinephelus stratus</i>    | 89         | 1                          | 0.04%             | 1                                      | 2   | 0.06%                      |
| <i>Lutjanus analis</i>        | 134        | 1                          | 0.04%             | 1                                      | 2   | 0.06%                      |
| <i>Megalops atlanticus</i>    | 25         | 1                          | 0.04%             | 3                                      | 4   | 0.11%                      |
| <i>Tylosauris crocodilus</i>  | 58         | 1                          | 0.04%             | 1                                      | 2   | 0.06%                      |
|                               |            | 2,249                      |                   | 102                                    | 3,543   |                            |

## 4.4 Results by Fishing Method

### 4.4.1 Fish Traps

Although the fish trap landings included 48 species, 10 species (topped by the Queen Triggerfish, *Balistes vetula* at 14.6%) made up 70% of the landings (Table 12).

Table 12. Landings from fish trap samples.

| Species                            | TIP | #   | % of Total |
|------------------------------------|-----|-----|------------|
| <i>Balistes vetula</i>             | 253 | 437 | 14.63%     |
| <i>Holocentrus rufus</i>           | 625 | 332 | 11.11%     |
| <i>Haemulon plumieri</i>           | 155 | 308 | 10.31%     |
| <i>Acanthurus coeruleus</i>        | 224 | 242 | 8.10%      |
| <i>Acanthurus chirurgus</i>        | 223 | 193 | 6.46%      |
| <i>Calamus pennatula</i>           | 167 | 193 | 6.46%      |
| <i>Epinephelus guttatus</i>        | 88  | 148 | 4.95%      |
| <i>Haemulon sciurus</i>            | 158 | 140 | 4.69%      |
| <i>Haemulon melanurum</i>          | 506 | 106 | 3.55%      |
| <i>Lutjanus synagris</i>           | 136 | 99  | 3.31%      |
| <i>Lactophrys quadricornis</i>     | 700 | 75  | 2.51%      |
| <i>Sparisoma rubripinne</i>        | 679 | 74  | 2.48%      |
| <i>Pomacanthus arcuatus</i>        | 578 | 63  | 2.11%      |
| <i>Lactophrys polygonius</i>       | 701 | 62  | 2.08%      |
| <i>Lutjanus analis</i>             | 134 | 60  | 2.01%      |
| <i>Epinephelus fulvus</i>          | 80  | 56  | 1.87%      |
| <i>Sparisoma viride</i>            | 676 | 52  | 1.74%      |
| <i>Panulirus argus</i>             | 901 | 39  | 1.31%      |
| <i>Ocyurus chrysurus</i>           | 140 | 37  | 1.24%      |
| <i>Lactophrys bicaudalis</i>       | 702 | 30  | 1.00%      |
| <i>Aluterus schoepfi</i>           | 727 | 29  | 0.97%      |
| <i>Calamus bajonado</i>            | 166 | 28  | 0.94%      |
| <i>Sparisoma chrysopteron</i>      | 675 | 24  | 0.80%      |
| <i>Lutjanus vivanus</i>            | 139 | 22  | 0.74%      |
| <i>Lutjanus buccanella</i>         | 138 | 17  | 0.57%      |
| <i>Lactophrys trigonus</i>         | 257 | 12  | 0.40%      |
| <i>Holacanthus ciliaris</i>        | 184 | 11  | 0.37%      |
| <i>Scyllarides aequinoctia.</i>    | 918 | 11  | 0.37%      |
| <i>Epinephelus morio</i>           | 87  | 10  | 0.33%      |
| <i>Mycteroperca interstitialis</i> | 752 | 10  | 0.33%      |
| <i>Lactophrys triqueter</i>        | 703 | 9   | 0.30%      |
| <i>Haemulon parrai</i>             | 501 | 7   | 0.23%      |
| Crab,marine                        | 906 | 6   | 0.20%      |

| Species                         | TIP | #     | % of Total |
|---------------------------------|-----|-------|------------|
| <i>Pomacanthus paru</i>         | 577 | 6     | 0.20%      |
| <i>Acanthurus bahainus</i>      | 218 | 5     | 0.17%      |
| <i>Haemulon striatum</i>        | 507 | 5     | 0.17%      |
| <i>Lachnolaimus maximus</i>     | 189 | 5     | 0.17%      |
| <i>Sparisoma aurofrenatum</i>   | 677 | 5     | 0.17%      |
| <i>Anisotremus surinamensis</i> | 162 | 4     | 0.13%      |
| <i>Scarus vetula</i>            | 676 | 3     | 0.10%      |
| <i>Bodianus rufus</i>           | 190 | 2     | 0.07%      |
| <i>Haemulon album</i>           | 153 | 2     | 0.07%      |
| <i>Haemulon aurolineatum</i>    | 506 | 2     | 0.07%      |
| <i>Haemulon carbonarium</i>     | 500 | 2     | 0.07%      |
| <i>Anisotremus virginicus</i>   | 501 | 1     | 0.03%      |
| <i>Haemulon flavolineatum</i>   | 157 | 1     | 0.03%      |
| <i>Holacanthus tricolor</i>     | 577 | 1     | 0.03%      |
| <i>Scarus coeruleus</i>         | 195 | 1     | 0.03%      |
|                                 |     |       |            |
| Total                           |     | 2,987 |            |
| # Species                       | 48  |       |            |

Box fish (Ostraciidae) accounted for 55% of the bycatch although they accounted for less than 6% of the landings. The Schoolmaster snapper (*Lutjanus apodus*), at 8% of the landings is a species that provides a high risk of Ciguatera fish poisoning and was totally absent from the retained catch.

Table 11. Bycatch from fish trap samples. The results have been adjusted to account for box fish which were not identified to species (Table 5).

| Species                        | TIP | #   | %   |
|--------------------------------|-----|-----|-----|
| <i>Lactophrys poligonius</i>   | 703 | 266 | 20% |
| <i>Acanthurus coeruleus</i>    | 224 | 176 | 13% |
| <i>Lactophrys triqueter</i>    | 703 | 158 | 12% |
| <i>Lactophrys quadricornis</i> | 702 | 132 | 10% |
| <i>Lutjanus apodus</i>         | 135 | 115 | 8%  |
| <i>Lactophrys bicaudalis</i>   | 704 | 81  | 6%  |
| <i>Lactophrys trigonus</i>     | 259 | 81  | 6%  |
| <i>Diodon holacanthus</i>      | 820 | 54  | 4%  |
| <i>Acanthurus chirurgus</i>    | 223 | 52  | 4%  |
| <i>Balistes vetula</i>         | 251 | 52  | 4%  |
| <i>Calamus pennatula</i>       | 165 | 29  | 2%  |
| <i>Lutjanus griseus</i>        | 132 | 24  | 2%  |
| <i>Caranx ruber</i>            | 115 | 17  | 1%  |
| <i>Panulirus argus</i>         | 901 | 12  | 1%  |
| <i>Scorpaena plumieri</i>      | 245 | 12  | 1%  |
| <i>Aluterus scriptus</i>       | 728 | 11  | 1%  |

|                                  |     |      |    |
|----------------------------------|-----|------|----|
| <i>Cantherhines macrocerus</i>   | 727 | 11   | 1% |
| <i>Lutjanus jocu</i>             | 133 | 9    | 1% |
| <i>Chaetodon striatus</i>        | 576 | 8    | 1% |
| <i>Pomacanthus paru</i>          | 577 | 8    | 1% |
| <i>Aluterus schoepfi</i>         | 725 | 7    | 1% |
| <i>Mulloidichthys martinicus</i> | 176 | 7    | 1% |
| <i>Epinephelus guttatus</i>      | 88  | 6    | 0% |
| <i>Lutjanus mahogoni</i>         | 137 | 5    | 0% |
| <i>Cantherhines pullus</i>       | 255 | 3    | 0% |
| <i>Holacanthus tricolor</i>      | 577 | 3    | 0% |
| <i>Lutjanus buccanella</i>       | 138 | 3    | 0% |
| <i>Acanthurus bahianus</i>       | 218 | 2    | 0% |
| <i>Aluterus monoceros</i>        | 730 | 2    | 0% |
| <i>Caranx latus</i>              | 118 | 2    | 0% |
| <i>Chilomycterus antillarum</i>  | 822 | 2    | 0% |
| <i>Holacanthus ciliaris</i>      | 184 | 2    | 0% |
| <i>Pomacanthus arcuatus</i>      | 578 | 2    | 0% |
| <i>Bothus lunatus</i>            | 249 | 1    | 0% |
| <i>Equetus lanceolatus</i>       | 172 | 1    | 0% |
| <i>Haemulon flavolineatum</i>    | 157 | 1    | 0% |
| <i>Ocyurus chrysurus</i>         | 140 | 1    | 0% |
| <i>Priacanthus arenatus</i>      | 98  | 1    | 0% |
| <i>Serranus tabacarius</i>       | 92  | 1    | 0% |
| Total By Catch                   |     | 1360 |    |
| # Species                        | 39  |      |    |

#### 4.4.2 Lobster Traps

The retained catch from lobster traps are highly dominated by lobster landings, with every other species constituting less than 5% of the catch (Table 12). This is also true of the bycatch (Table 13).

Table 12. Retained catch by the directed lobster fishery.

| Species                         | TIP Code | Number | Percent |
|---------------------------------|----------|--------|---------|
| <i>Panulirus argus</i>          | 901      | 834    | 65.41%  |
| <i>Epinephelus guttatus</i>     | 88       | 60     | 4.71%   |
| <i>Holocentrus rufus</i>        | 625      | 55     | 4.31%   |
| <i>Scyllarides aequinoctia.</i> | 918      | 34     | 2.67%   |
| <i>Sparisoma chrysopterum</i>   | 675      | 30     | 2.35%   |
| <i>Acanthurus chirurgus</i>     | 651      | 23     | 1.80%   |
| <i>Calamus pennatula</i>        | 165      | 23     | 1.80%   |
| <i>Haemulon melanurum</i>       | 506      | 23     | 1.80%   |
| <i>Lactophrys quadricornis</i>  | 700      | 22     | 1.73%   |
| <i>Balistes vetula</i>          | 251      | 18     | 1.41%   |
| <i>Acanthurus coeruleus</i>     | 652      | 15     | 1.18%   |

| Species                           | TIP Code     | Number | Percent |
|-----------------------------------|--------------|--------|---------|
| <i>Ocyurus chrysurus</i>          | 140          | 15     | 1.18%   |
| <i>Haemulon plumieri</i>          | 155          | 11     | 0.86%   |
| <i>Sparisoma viride</i>           | 196          | 11     | 0.86%   |
| <i>Lactophrys trigonus</i>        | 257          | 10     | 0.78%   |
| <i>Lutjanus synagris</i>          | 136          | 10     | 0.78%   |
| Crab,marine                       | 906          | 9      | 0.71%   |
| <i>Lutjanus analis</i>            | 134          | 9      | 0.71%   |
| <i>Epinephelus fulvus</i>         | 80           | 8      | 0.63%   |
| <i>Lactophrys bicaudalis</i>      | 702          | 8      | 0.63%   |
| <i>Lactophrys poligonius</i>      | 701          | 7      | 0.55%   |
| <i>Sparisoma rubripinne</i>       | 679          | 7      | 0.55%   |
| <i>Haemulon sciurus</i>           | 156          | 6      | 0.47%   |
| <i>Acanthurus bahianus</i>        | 218          | 5      | 0.39%   |
| <i>Scarus coeruleus</i>           | 195          | 4      | 0.31%   |
| <i>Pomacanthus arcuatus</i>       | 576          | 3      | 0.24%   |
| <i>Scyllarides aequinoctialis</i> | 918          | 3      | 0.24%   |
| <i>Aluterus schoepfi</i>          | 725          | 2      | 0.16%   |
| <i>Holacanthus ciliaris</i>       | 184          | 2      | 0.16%   |
| <i>Scarus taeniopterus</i>        | 678          | 2      | 0.16%   |
| African lobster                   | 999999       | 1      | 0.08%   |
| <i>Epinephelus morio</i>          | 87           | 1      | 0.08%   |
| <i>Haemulon chrysargyreum</i>     | 158          | 1      | 0.08%   |
| <i>Lachnolaimus maximus</i>       | 189          | 1      | 0.08%   |
| Majidae                           | 618701000000 | 1      | 0.08%   |
| <i>Pomacanthus paru</i>           | 577          | 1      | 0.08%   |
| Lobster Catch Sample              |              | 1275   |         |
| Number of Species                 |              | 36     | 100.00% |

Table 13. Bycatch by the directed lobster fishery.

| Species                        | TIP | #   |        |
|--------------------------------|-----|-----|--------|
| <i>Panulirus argus</i>         | 901 | 427 | 71.64% |
| <i>Lactophrys bicaudalis</i>   | 702 | 33  | 5.54%  |
| <i>Diodon holacanthus</i>      | 820 | 23  | 3.86%  |
| <i>Lactophrys quadricornis</i> | 700 | 17  | 2.85%  |
| Ostraciidae                    | 256 | 17  | 2.85%  |
| <i>Lactophrys triqueter</i>    | 703 | 16  | 2.68%  |
| <i>Acanthurus chirurgus</i>    | 651 | 12  | 2.01%  |
| <i>Lutjanus apodus</i>         | 137 | 7   | 1.17%  |
| <i>Chaetodon striatus</i>      | 561 | 6   | 1.01%  |
| <i>Holocentrus rufus</i>       | 625 | 6   | 1.01%  |
| Crab,marine                    | 930 | 5   | 0.84%  |

| <b>Species</b>                    | <b>TIP</b> | <b>#</b> |       |
|-----------------------------------|------------|----------|-------|
| <i>Lactophrys poligonius</i>      | 703        | 5        | 0.84% |
| <i>Priacanthus arenatus</i>       | 98         | 5        | 0.84% |
| <i>Lutjanus jocu</i>              | 133        | 3        | 0.50% |
| <i>Lutjanus mahogoni</i>          | 137        | 3        | 0.50% |
| <i>Caranx ruber</i>               | 115        | 1        | 0.17% |
| <i>Epinephelus adscensionis</i>   | 90         | 1        | 0.17% |
| <i>Eupomacentrus fuscus</i>       |            | 1        | 0.17% |
| <i>Gymnothorax moringa</i>        | 442        | 1        | 0.17% |
| <i>Haemulon flavolineatum</i>     | 157        | 1        | 0.17% |
| <i>Holacanthus tricolor</i>       | 577        | 1        | 0.17% |
| <i>Lutjanus synagris</i>          | 136        | 1        | 0.17% |
| <i>Pomacentridae</i>              | 185        | 1        | 0.17% |
| <i>Pseudupeneus maculatus</i>     | 175        | 1        | 0.17% |
| <i>Scyllarides aequinoctia.</i>   | 918        | 1        | 0.17% |
| <i>Scyllarides aequinoctialis</i> | 918        | 1        | 0.17% |
| Total By Catch                    |            | 596      |       |
| # Species                         | 26         |          |       |

### 4.4.3 Hand Line

The hand line catch is dominated by yellowtail snappers and hard nose which make up 86% of the total landings (Table 14).

Table 14. Landings by the hand line fishery

| Species                               | TIP        | #    | %      |
|---------------------------------------|------------|------|--------|
| <i>Ocyurus chrysurus</i>              | 140        | 1260 | 70.51% |
| <i>Caranx crysos</i>                  | 117        | 289  | 16.17% |
| <i>Epinephelus guttatus</i>           | 88         | 61   | 3.41%  |
| <i>Selar crumenophthalmus</i>         | 120        | 34   | 1.90%  |
| <i>Epinephelus fulvus</i>             | 80         | 32   | 1.79%  |
| <i>Rhomboplites aurorubens</i>        | 142        | 25   | 1.40%  |
| <i>Priacanthus arenatus</i>           | 98         | 16   | 0.90%  |
| <i>Epinephelus cruentatus</i>         | 82         | 14   | 0.78%  |
| <i>Balistes vetula</i>                | 251        | 8    | 0.45%  |
| <i>Elagatis bipinnulata</i>           | 124        | 5    | 0.28%  |
| <i>Holocentrus rufus</i>              | 625        | 5    | 0.28%  |
| <i>Lutjanus synagris</i>              | 136        | 4    | 0.22%  |
| <i>Scomberomorus cavalla</i>          | 233        | 4    | 0.22%  |
| <i>Calamus pennatula</i>              | 165        | 3    | 0.17%  |
| <i>Sparisoma viride</i>               | 196        | 3    | 0.17%  |
| <i>Sphyaena picudilla</i>             | 205        | 3    | 0.17%  |
| <i>Caranx latus</i>                   | 118        | 2    | 0.11%  |
| <i>Epinephelus adscensionis</i>       | 90         | 2    | 0.11%  |
| <i>Haemulon sciurus</i>               | 156        | 2    | 0.11%  |
| <i>Kyphosus sectatrix</i>             | 179        | 2    | 0.11%  |
| <i>Anisotremus surinamensis</i>       | 162        | 1    | 0.06%  |
| <i>Canthidermis sufflamen</i>         | 252        | 1    | 0.06%  |
| <i>Caranx crysos</i> shark bite       | 117        | 1    | 0.06%  |
| <i>Carcharhinus limbatus</i>          | 403        | 1    | 0.06%  |
| <i>Chaetodipterus faber</i>           | 183        | 1    | 0.06%  |
| <i>Haemulon bonariense</i>            | 502        | 1    | 0.06%  |
| <i>Haemulon plumieri</i>              | 155        | 1    | 0.06%  |
| <i>Lutjanus analis</i>                | 134        | 1    | 0.06%  |
| <i>Negaprion brevirostris</i>         | 12         | 1    | 0.06%  |
| <i>Ocyurus chrysurus</i> (Shark bite) | 140        | 1    | 0.06%  |
| <i>Rhizoprionodon porosus</i>         | 8708020303 | 1    | 0.06%  |
| <i>Trachinotus falcatus</i>           | 125        | 1    | 0.06%  |
| <i>Trachinotus goodei</i>             | 126        | 1    | 0.06%  |
| Total Line Catch Sample               |            | 1787 |        |
| # Species                             | 33         |      |        |

Yellowtail snapper is the most frequently caught bycatch species (Table 15), but does not dominate as for the hand line retained catch.

Table 15. Hand line fishery bycatch

| Species                        | TIP        | #   | %      |
|--------------------------------|------------|-----|--------|
| <i>Ocyurus chrysurus</i>       | 140        | 31  | 26.01% |
| <i>Epinephelus cruentatus</i>  | 82         | 28  | 22.76% |
| <i>Holocentrus rufus</i>       | 625        | 15  | 12.20% |
| <i>Sphyræna barracuda</i>      | 205        | 12  | 9.76%  |
| <i>Calamus pennatula</i>       | 165        | 6   | 4.88%  |
| <i>Caranx latus</i>            | 118        | 5   | 4.07%  |
| <i>Scomberomorus regalis</i>   | 234        | 5   | 4.07%  |
| <i>Caranx ruber</i>            | 115        | 3   | 2.44%  |
| <i>Holocentrus marianus</i>    | 8810080105 | 3   | 2.44%  |
| <i>Caranx crysos half fish</i> | 117        | 2   | 1.63%  |
| <i>Caranx lugubris</i>         | 119        | 2   | 1.63%  |
| <i>Echeneus naucratis</i>      | 108        | 2   | 1.63%  |
| <i>Epinephelus fulvus</i>      | 80         | 2   | 1.63%  |
| <i>Haemulon aurolineatum</i>   | 159        | 2   | 1.63%  |
| <i>Remora remora</i>           | 590        | 2   | 1.63%  |
| <i>Haemulon aurolineatum</i>   | 159        | 1   | 0.81%  |
| <i>Seriola rivoliana</i>       | 111        | 1   | 0.81%  |
| Hand Line By Catch             |            | 123 |        |
| # Species                      | 18         |     |        |

#### 4.4.4 Seine Nets

Seine net fishing in St. Thomas is carried out by fishermen of primarily French descent. They track schools of fish until they figure out the feeding patterns and then surround them with nylon nets that they purse by free diving. Boats are generally under 18 feet in length. Jacks and yellowtail snapper make up the bulk of the retained catch (Table 16). In the current study, bycatch was recorded simply as landed fish which were not sold. Seine net fishermen frequently surround large numbers of unmarketable fish such as Tarpon, Horseeye Jacks (high risk for ciguatera) and Little tunny (limited market potential, which they release). Seine net fishermen also make an effort to release undersize individuals of market species. They are reasonably successful as of the 257 yellowtail snapper and hardnose sampled for this study, only 9 (3.5%) showed up in the by catch (Table 17). Seine net fishermen sort these undesirable species while working the net and release them prior to boating the retained species.

Table 16. Seine net retained catch.

| Species                          | TIP | #   |        |
|----------------------------------|-----|-----|--------|
| <i>Caranx crysos</i>             | 117 | 192 | 25.20% |
| <i>Ocyurus chrysurus</i>         | 140 | 177 | 23.23% |
| <i>Tylosurus crocodilus</i>      | 58  | 170 | 22.31% |
| <i>Caranx ruber</i>              | 115 | 149 | 19.55% |
| <i>Euthynnus alletteratus</i>    | 230 | 44  | 5.77%  |
| <i>Scomberomorus cavalla</i>     | 233 | 6   | 0.79%  |
| <i>Scomberomorus regalis</i>     | 234 | 4   | 0.52%  |
| <i>Epinephelus cruentatus</i>    | 82  | 3   | 0.39%  |
| <i>Lutjanus synagris</i>         | 136 | 3   | 0.39%  |
| <i>Epinephelus guttatus</i>      | 88  | 2   | 0.26%  |
| <i>Negaprion brevirostris</i>    | 12  | 2   | 0.26%  |
| <i>Ablennes hians</i>            | 59  | 1   | 0.13%  |
| <i>Carcharhinus limbatus</i>     | 403 | 1   | 0.13%  |
| <i>Carcharhinus perezii</i>      | 400 | 1   | 0.13%  |
| <i>Epinephelus fulvus</i>        | 80  | 1   | 0.13%  |
| <i>Galeocerdo cuvier</i>         | 10  | 1   | 0.13%  |
| <i>Mulloidichthys martinicus</i> | 176 | 1   | 0.13%  |
| <i>Panulirus argus</i>           | 901 | 1   | 0.13%  |
| <i>Scarus vetula</i>             | 676 | 1   | 0.13%  |
| <i>Sparisoma viride</i>          | 196 | 1   | 0.13%  |
| <i>Sphyraena barracuda</i>       | 203 | 1   | 0.13%  |
| Total Seine Net Catch Sample     |     | 762 |        |
| # Species                        | 21  |     |        |

Table 17 Seine net bycatch.

| Species                       | TIP | #  | %      |
|-------------------------------|-----|----|--------|
| <i>Ocyurus chrysurus</i>      | 140 | 5  | 29.41% |
| <i>Caranx ruber</i>           | 115 | 4  | 23.53% |
| <i>Acanthurus coeruleus</i>   | 652 | 1  | 5.88%  |
| <i>Caranx hippos</i>          | 601 | 1  | 5.88%  |
| <i>Caranx latus</i>           | 118 | 1  | 5.88%  |
| <i>Gerres cinereus</i>        | 148 | 1  | 5.88%  |
| <i>Lutjanus griseus</i>       | 132 | 1  | 5.88%  |
| <i>Lutjanus mahogoni</i>      | 137 | 1  | 5.88%  |
| <i>Lutjanus synagris</i>      | 136 | 1  | 5.88%  |
| <i>Pseudupeneus maculatus</i> | 175 | 1  | 5.88%  |
|                               |     |    |        |
| Seine Net By Catch            |     | 17 |        |
| # Species                     | 10  |    |        |

#### 4.4.5 Long Line

Long lines and vertical set lines are not normally used by St. Thomas fishermen. The deep water snapper grouper fishery is not heavily exploited at present. The current sample contains two trips which employed this technique. No by catch was recorded.

Table 18 Long-line landings.

| Species                           | TIP          | #  | %       |
|-----------------------------------|--------------|----|---------|
| <i>Etelis oculatus</i>            | 143          | 25 | 56.82%  |
| <i>Lutjanus vivanus</i>           | 139          | 6  | 13.64%  |
| <i>Ocyurus chrysurus</i>          | 140          | 4  | 9.09%   |
| <i>Epinephelus fulvus</i>         | 80           | 3  | 6.82%   |
| <i>Epinephelus guttatus</i>       | 88           | 2  | 4.55%   |
| <i>Epinephelus mystacinus</i>     | 86           | 2  | 4.55%   |
| <i>Euthynnus alletteratus</i>     | 230          | 1  | 2.27%   |
| <i>Pristipomoides aquilonaris</i> | 883536070100 | 1  | 2.27%   |
| Long Line Catch Sample            |              | 44 | 100.00% |
| # Species                         |              | 8  |         |

#### 4.5 Reason for Discard

A total of seven possible reasons were given for discarding the catch. These ranged from Ciguatera fish poisoning, fish too small to market, unmarketable species, difficulties in the market place or dead in the traps. The bycatch was dominated by box fish and surgeon fish that were

too small for the market and these account for almost exactly the proportion returned because they were too small. Nearly 11% of the by catch was not landed because the fishermen feared that they would poison their customers.

The Lobster fishery has a high number of short lobsters and (seasonally) large numbers of lobsters with eggs. These are all returned in the lobster traps (and consequently not exposed to predation) where they are free to exit once on the bottom.

It should also be noted that, of the 868 landed lobsters measured, only two were below the legal size. This indicates a high degree of compliance with size regulations. A total of 395 lobsters were discarded because they were either too small or were females with eggs.

Fishermen and observers report that nearly all of the bycatch would have survived had it been discarded at sea. The fishers and observers based this determination on the activity levels of the fish brought on board. A detailed study of survival would be required in order to confirm this.

Table 8. Reasons for discarding catch.

| Reason for Discard               | Number | %     |
|----------------------------------|--------|-------|
| Ciguatera                        | 222    | 10.9% |
| Too Small                        | 1,459  | 71.2% |
| Unmarketable Species             | 148    | 7.2%  |
| Too much in Market               | 0      | 0%    |
| Small Lobsters Returned in Traps | 96     | 4.7%  |
| Dead                             | 0      | 0%    |
| Lobsters w/Eggs                  | 123    | 6.0%  |
| Total                            | 2,048  |       |

#### **4.6 Weight-Length Relationships**

For all species which sample size exceeded 40 individuals, weight and length data were fitted to the power curve using the EXCEL spreadsheet features:

$$W = a L^b$$

Where

W=Weight in Grams;

L=Length in mm

The results are shown in Table 19. All correlations were significant at the  $p < 0.01$  level.

Table 19. Weight/Length relationships for species which had more than 40 individuals.

| Species                        | TIP | Sample Size | Min Length | Max Length | a        | b      | R <sup>2</sup> |
|--------------------------------|-----|-------------|------------|------------|----------|--------|----------------|
| <i>Acanthurus chirurgus</i>    | 223 | 141         | 161        | 277        | 0.000040 | 2.8928 | 0.694          |
| <i>Acanthurus coeruleus</i>    | 652 | 274         | 171        | 284        | 0.000100 | 2.7188 | 0.864          |
| <i>Balistes vetula</i>         | 253 | 376         | 176        | 458        | 0.000060 | 2.8424 | 0.938          |
| <i>Calamus pennatula</i>       | 165 | 144         | 172        | 323        | 0.000290 | 2.5349 | 0.808          |
| <i>Caranx crysos</i>           | 117 | 163         | 232        | 532        | 0.000023 | 2.9610 | 0.769          |
| <i>Diodon holacanthus</i>      | 820 | 40          | 110        | 382        | 0.015907 | 1.8519 | 0.784          |
| <i>Epinephelus cruentatus</i>  | 82  | 45          | 155        | 297        | 0.000006 | 3.1523 | 0.963          |
| <i>Epinephelus fulvus</i>      | 80  | 49          | 200        | 360        | 0.000010 | 2.9641 | 0.960          |
| <i>Epinephelus guttatus</i>    | 88  | 238         | 198        | 492        | 0.000071 | 2.7189 | 0.746          |
| <i>Haemulon melanurum</i>      | 506 | 114         | 209        | 294        | 0.001056 | 2.2653 | 0.738          |
| <i>Haemulon plumieri</i>       | 155 | 205         | 161        | 350        | 0.000480 | 2.4305 | 0.778          |
| <i>Haemulon sciurus</i>        | 156 | 134         | 140        | 346        | 0.001946 | 2.1751 | 0.820          |
| <i>Holocentrus rufus</i>       | 625 | 179         | 165        | 264        | 0.000090 | 2.7097 | 0.872          |
| <i>Lactophrys bicaudalis</i>   | 704 | 94          | 142        | 363        | 0.000406 | 2.4635 | 0.937          |
| <i>Lactophrys polygonius</i>   | 701 | 275         | 145        | 300        | 0.000571 | 2.3592 | 0.762          |
| <i>Lactophrys quadricornis</i> | 700 | 165         | 128        | 405        | 0.004635 | 1.9565 | 0.699          |
| <i>Lactophrys trigonus</i>     | 259 | 95          | 140        | 390        | 0.000396 | 2.4832 | 0.949          |
| <i>Lactophrys triqueter</i>    | 703 | 107         | 80         | 270        | 0.014675 | 1.7863 | 0.445          |
| <i>Lutjanus analis</i>         | 134 | 61          | 264        | 536        | 0.000042 | 2.8390 | 0.845          |
| <i>Lutjanus apodus</i>         | 137 | 100         | 170        | 480        | 0.005113 | 2.0011 | 0.671          |
| <i>Lutjanus synagris</i>       | 136 | 84          | 211        | 351        | 0.000535 | 2.3654 | 0.820          |
| <i>Ocyurus chrysurus</i>       | 140 | 654         | 198        | 564        | 0.000025 | 2.9153 | 0.848          |
| <i>Panulirus argus</i>         | 901 | 387         | 85         | 387        | 0.012000 | 2.4160 | 0.891          |
| <i>Pomacanthus arcuatus</i>    | 576 | 51          | 152        | 387        | 0.000087 | 2.8183 | 0.908          |
| <i>Sparisoma chrysopterum</i>  | 675 | 50          | 224        | 340        | 0.000200 | 2.5444 | 0.813          |
| <i>Sparisoma rubripinne</i>    | 679 | 40          | 259        | 338        | 0.000080 | 2.7485 | 0.871          |
| <i>Sparisoma viride</i>        | 196 | 47          | 234        | 420        | 0.000009 | 3.1424 | 0.949          |

#### ***4.7 Length Frequency Distributions.***

Length/Frequency Distributions are shown in Table 20 with the Species names and TIP codes shown in Table 21. All measurements are Fork Lengths with the exception of the spiny lobster carapace measurements. All are in millimeters.

Table 20 Length Frequency Distributions for most frequent species in study. Species names for the TIP codes are given in Table 21.

| Fork Length (mm) <sup>2</sup> | Frequencies for Species (Shown as TIP Codes) |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------------------------------|--|-----|-----|-----|-----|-----|-----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                               | 651  | 652 | 251 | 165 | 117 | 115 | 820 | 80 | 88 | 506 | 155 | 156 | 625 | 702 | 701 | 700 | 704 | 701 | 135 | 136 | 140 | 901 |     |
| 40                            |  |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     | 1   |
| 45                            |  |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     | 0   |
| 50                            |  |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     | 1   |
| 55                            |  |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     | 0   |
| 60                            |  |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     | 0   |
| 65                            |  |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     | 21  |
| 70                            |  |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |     |     | 1   |     |     | 24  |
| 75                            |  |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |     |     | 0   |     |     | 43  |
| 80                            |  |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |     | 1   | 1   |     |     | 67  |
| 85                            |  |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |     | 0   | 1   |     |     | 107 |
| 90                            | 1  |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |     | 0   | 1   |     |     | 107 |
| 95                            | 0  |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |     | 0   | 0   |     |     | 116 |
| 100                           | 0  |     |     |     |     |     |     |    |    |     |     |     |     | 1   |     |     |     |     | 0   | 2   |     |     | 155 |
| 105                           | 0  |     |     |     |     |     |     |    |    |     |     |     |     | 0   |     |     |     |     | 0   | 0   |     |     | 136 |
| 110                           | 0  |     |     |     |     |     | 2   |    |    |     |     |     |     | 0   |     |     |     |     | 0   | 0   |     |     | 98  |
| 115                           | 0  |     |     |     |     |     | 0   |    |    |     |     |     |     | 0   |     |     |     |     | 0   | 0   |     |     | 144 |
| 120                           | 0  |     |     |     |     |     | 0   |    |    |     |     |     |     | 1   |     | 0   |     |     | 0   | 0   |     |     | 108 |
| 125                           | 0  |     |     | 1   |     |     | 1   |    |    |     |     |     | 0   | 0   |     | 0   |     |     | 1   | 0   |     |     | 62  |
| 130                           | 0  | 1   |     | 0   |     |     | 0   |    |    |     |     |     | 0   | 0   |     | 1   | 0   |     | 2   | 0   |     |     | 58  |
| 135                           | 2  | 14  |     | 0   |     |     | 0   |    |    |     |     |     | 0   | 0   |     | 0   | 0   |     | 1   | 0   |     |     | 23  |
| 140                           | 6  | 16  |     | 0   |     |     | 0   |    |    |     |     |     | 1   | 1   | 0   | 0   | 5   |     | 9   | 0   |     |     | 22  |
| 145                           | 2  | 13  |     | 0   |     |     | 0   |    |    |     |     |     | 0   | 2   | 1   | 0   | 6   |     | 5   | 0   |     |     | 10  |

<sup>2</sup> Species 901 (*Panulirus argus*) were measured carapace lengths.

| Fork Length (mm) <sup>2</sup> | Frequencies for Species (Shown as TIP Codes) |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------------------------------|--|-----|-----|-----|-----|-----|-----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                               | 651  | 652 | 251 | 165 | 117 | 115 | 820 | 80 | 88 | 506 | 155 | 156 | 625 | 702 | 701 | 700 | 704 | 701 | 135 | 136 | 140 | 901 |
| 150                           | 1  | 12  | 0   | 2   |     | 0   | 4   |    |    | 0   | 0   |     | 1   | 3   | 0   | 0   | 4   | 4   | 0   | 0   |     | 17  |
| 155                           | 5  | 24  | 0   | 1   |     | 0   | 0   |    |    | 0   | 0   | 4   | 1   | 3   | 3   | 1   | 0   | 13  | 0   | 0   |     | 4   |
| 160                           | 7  | 31  | 0   | 0   |     | 0   | 7   | 0  |    | 0   | 0   | 0   | 0   | 5   | 3   | 2   | 1   | 5   | 0   | 0   |     | 5   |
| 165                           | 4  | 27  | 0   | 2   |     | 1   | 0   | 0  |    | 0   | 1   | 0   | 3   | 7   | 6   | 2   | 6   | 19  | 0   | 1   |     | 1   |
| 170                           | 4  | 30  | 0   | 1   |     | 2   | 4   | 0  |    | 0   | 0   | 1   | 0   | 6   | 14  | 2   | 5   | 8   | 1   | 0   |     | 2   |
| 175                           | 9  | 37  | 4   | 2   |     | 2   | 4   | 2  |    | 0   | 0   | 0   | 4   | 12  | 5   | 4   | 6   | 20  | 1   | 0   |     | 2   |
| 180                           | 17   | 32  | 1   | 2   |     | 1   | 3   | 2  | 0  | 0   | 0   | 1   | 3   | 2   | 1   | 4   | 4   | 19  | 1   | 0   |     | 3   |
| 185                           | 12   | 52  | 4   | 3   |     | 3   | 5   | 5  | 0  | 0   | 0   | 0   | 4   | 15  | 8   | 6   | 10  | 6   | 0   | 0   |     | 0   |
| 190                           | 22   | 31  | 6   | 4   |     | 3   | 7   | 3  | 0  | 0   | 0   | 0   | 8   | 5   | 14  | 14  | 11  | 10  | 0   | 0   |     | 0   |
| 195                           | 12   | 25  | 4   | 10  |     | 10  | 5   | 3  | 0  | 0   | 0   | 0   | 4   | 6   | 14  | 5   | 4   | 17  | 0   | 0   |     | 0   |
| 200                           | 23   | 30  | 17  | 22  |     | 3   | 3   | 3  | 0  | 0   | 2   | 0   | 5   | 5   | 22  | 6   | 7   | 12  | 0   | 0   | 1   | 0   |
| 205                           | 20   | 12  | 14  | 40  |     | 5   | 4   | 6  | 1  | 0   | 2   | 0   | 1   | 5   | 19  | 7   | 6   | 7   | 0   | 0   | 0   | 0   |
| 210                           | 25   | 16  | 16  | 18  |     | 1   | 8   | 3  | 0  | 1   | 10  | 0   | 8   | 7   | 40  | 7   | 0   | 2   | 1   | 1   | 4   | 4   |
| 215                           | 26   | 6   | 10  | 10  | 0   | 7   | 3   | 9  | 2  | 0   | 9   | 1   | 4   | 8   | 22  | 12  | 2   | 3   | 0   | 1   | 2   | 2   |
| 220                           | 24   | 17  | 7   | 9   | 0   | 3   | 2   | 2  | 2  | 6   | 16  | 1   | 12  | 5   | 25  | 7   | 0   | 1   | 1   | 0   | 4   | 4   |
| 225                           | 13   | 10  | 5   | 23  | 0   | 7   | 1   | 2  | 0  | 4   | 18  | 3   | 26  | 3   | 22  | 9   | 2   | 3   | 0   | 0   | 3   | 3   |
| 230                           | 15   | 6   | 7   | 10  | 0   | 1   | 0   | 2  | 2  | 12  | 15  | 8   | 39  | 7   | 35  | 12  | 1   | 0   | 0   | 0   | 6   | 6   |
| 235                           | 12   | 2   | 9   | 10  | 3   | 5   | 1   | 3  | 0  | 11  | 14  | 7   | 48  | 3   | 24  | 5   | 0   | 0   | 0   | 4   | 9   | 9   |
| 240                           | 9  | 5   | 11  | 9   | 3   | 3   | 1   | 3  | 3  | 19  | 32  | 7   | 51  | 5   | 10  | 12  | 2   | 0   | 1   | 1   | 7   | 7   |
| 245                           | 5  | 1   | 8   | 6   | 2   | 4   | 0   | 2  | 3  | 13  | 11  | 4   | 34  | 5   | 12  | 7   | 0   | 0   | 1   | 5   | 10  | 10  |
| 250                           | 10   | 2   | 10  | 6   | 4   | 4   | 0   | 3  | 0  | 15  | 18  | 11  | 21  | 6   | 7   | 10  | 0   | 0   | 2   | 6   | 12  | 12  |
| 255                           | 5  | 3   | 8   | 8   | 4   | 2   | 0   | 2  | 2  | 10  | 14  | 11  | 13  | 0   | 7   | 9   | 0   | 0   | 3   | 8   | 25  | 25  |
| 260                           | 8  | 1   | 5   | 7   | 7   | 0   | 0   | 2  | 2  | 8   | 25  | 18  | 10  | 6   | 8   | 15  | 0   | 0   | 9   | 12  | 18  | 18  |
| 265                           | 3  | 1   | 9   | 5   | 9   | 2   | 1   | 2  | 0  | 7   | 14  | 11  | 1   | 1   | 6   | 8   | 0   | 0   | 10  | 9   | 44  | 44  |
| 270                           | 6  | 0   | 11  | 9   | 19  | 1   | 0   | 5  | 3  | 12  | 21  | 14  | 1   | 1   | 2   | 9   | 0   | 1   | 4   | 13  | 37  | 37  |
| 275                           | 3  | 0   | 15  | 4   | 14  | 7   | 0   | 6  | 1  | 5   | 24  | 12  | 0   | 0   | 2   | 1   | 0   | 0   | 5   | 12  | 39  | 39  |
| 280                           | 1  | 0   | 20  | 5   | 12  | 3   | 0   | 4  | 4  | 3   | 18  | 9   | 0   | 2   | 4   | 4   | 0   | 0   | 7   | 5   | 43  | 43  |

| Fork Length (mm) <sup>2</sup> | Frequencies for Species (Shown as TIP Codes) |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------------------------------|--|-----|-----|-----|-----|-----|-----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                               | 651  | 652 | 251 | 165 | 117 | 115 | 820 | 80 | 88 | 506 | 155 | 156 | 625 | 702 | 701 | 700 | 704 | 701 | 135 | 136 | 140 | 901 |
| 285                           | 0  | 2   | 21  | 19  | 20  | 5   | 0   | 14 | 7  | 2   | 15  | 9   | 0   | 0   | 2   | 0   | 0   | 0   | 10  | 4   | 64  |     |
| 290                           | 0  | 0   | 23  | 7   | 20  | 1   | 0   | 4  | 6  | 1   | 11  | 8   | 0   | 0   | 0   | 2   | 2   | 0   | 8   | 13  | 58  |     |
| 295                           | 0  | 0   | 12  | 1   | 21  | 2   | 0   | 4  | 11 | 1   | 12  | 1   | 0   | 0   | 0   | 3   | 1   | 0   | 11  | 7   | 60  |     |
| 300                           | 0  | 0   | 22  | 3   | 35  | 5   | 1   | 2  | 15 | 0   | 6   | 10  | 0   | 0   | 2   | 2   | 0   | 0   | 4   | 9   | 79  |     |
| 305                           |  |     | 19  | 4   | 20  | 5   | 0   | 1  | 18 |     | 2   | 5   | 0   | 0   | 0   | 1   | 0   |     | 5   | 5   | 69  |     |
| 310                           |  |     | 17  | 1   | 32  | 4   | 0   | 0  | 15 |     | 8   | 0   | 1   | 1   | 1   | 1   | 3   |     | 2   | 3   | 62  |     |
| 315                           |  |     | 16  | 3   | 13  | 2   | 0   | 4  | 20 |     | 2   | 1   | 0   | 0   | 0   | 0   | 0   |     | 2   | 1   | 57  |     |
| 320                           |  |     | 8   | 2   | 19  | 3   | 0   | 1  | 13 |     | 0   | 0   |     | 2   | 0   | 1   | 2   |     | 4   | 0   | 56  |     |
| 325                           |  |     | 13  | 1   | 16  | 7   | 0   | 0  | 27 |     | 1   | 0   |     | 0   | 0   | 0   | 1   |     | 3   | 1   | 61  |     |
| 330                           |  |     | 17  | 1   | 22  | 4   | 0   | 0  | 8  |     | 2   | 1   |     | 1   | 1   | 1   | 1   |     | 3   | 1   | 58  |     |
| 335                           |  |     | 11  |     | 11  | 4   | 0   | 1  | 10 |     | 1   | 0   |     | 0   | 0   | 0   | 2   |     | 0   | 1   | 49  |     |
| 340                           |  |     | 18  |     | 11  | 8   | 2   | 0  | 16 |     | 0   | 0   |     | 1   | 0   | 0   | 0   |     | 0   | 0   | 42  |     |
| 345                           |  |     | 12  |     | 13  | 4   | 0   | 0  | 18 |     | 0   | 0   |     | 0   |     | 1   | 0   |     | 5   | 1   | 49  |     |
| 350                           |  |     | 17  |     | 15  | 1   | 0   | 1  | 10 |     | 1   | 0   |     | 0   |     | 0   | 3   |     | 1   | 0   | 36  |     |
| 355                           |  |     | 13  |     | 12  | 5   | 0   | 0  | 11 |     |     | 0   |     | 0   |     | 0   | 2   |     | 2   | 1   | 18  |     |
| 360                           |  |     | 14  |     | 11  | 2   | 0   | 1  | 8  |     |     | 1   |     | 1   |     | 0   | 2   |     | 0   | 0   | 38  |     |
| 365                           |  |     | 14  |     | 6   | 2   | 0   | 0  | 13 |     |     | 0   |     | 1   |     | 0   | 0   |     | 0   | 0   | 26  |     |
| 370                           |  |     | 8   |     | 22  | 1   | 0   | 0  | 8  |     |     | 0   |     | 0   |     | 0   | 1   |     | 0   | 0   | 35  |     |
| 375                           |  |     | 5   |     | 11  | 3   | 1   |    | 13 |     |     | 0   |     | 0   |     | 0   | 0   |     | 0   | 0   | 25  |     |
| 380                           |  |     | 7   |     | 17  | 2   | 0   |    | 4  |     |     | 1   |     | 1   |     | 0   | 0   |     | 0   |     | 24  |     |
| 385                           |  |     | 5   |     | 8   | 4   | 2   |    | 6  |     |     | 1   |     |     |     | 1   | 1   |     | 1   |     | 33  |     |
| 390                           |  |     | 6   |     | 13  | 1   | 0   |    | 9  |     |     |     |     |     |     | 0   | 1   |     | 0   |     | 17  |     |
| 395                           |  |     | 8   |     | 10  | 2   | 0   |    | 4  |     |     |     |     |     |     | 0   | 0   |     | 0   |     | 18  |     |
| 400                           |  |     | 5   |     | 1   | 1   | 0   |    | 6  |     |     |     |     |     |     | 0   | 0   |     | 0   |     | 19  |     |
| 405                           |  |     | 4   |     | 2   | 0   | 0   |    | 13 |     |     |     |     |     |     | 1   |     |     | 0   |     | 20  |     |
| 410                           |  |     | 1   |     | 5   | 2   | 0   |    | 7  |     |     |     |     |     |     | 0   |     |     | 5   |     | 18  |     |
| 415                           |  |     | 2   |     | 4   | 2   | 0   |    | 2  |     |     |     |     |     |     | 0   |     |     | 0   |     | 15  |     |







Table 21 Species names for the TIP codes shown on Table 20 length/frequency distributions. Length at maturity, growth and mortality parameters are from FAO's FISHBASE<sup>3</sup>.

| Tip Codes | Species                      | Length at Maturity | k      | L <sub>∞</sub>   | M           |
|-----------|------------------------------|--------------------|--------|------------------|-------------|
| 651       | ACANTHURUS CHIRURGUS         | 120                | 0.1254 | 332              | 1.58        |
| 652       | ACANTHURUS COERULEUS         | 110-130            | 0.112  | 369              | 1.49        |
| 251       | BALISTES VETULA              | 230-260            | 0.230  | 600              |             |
| 165       | CALAMUS PENNATULA            |                    |        |                  |             |
| 117       | CARANX CRYOSOS               | 280                | 0.320  | 420              |             |
| 115       | CARANX RUBER                 | 220                | 0.143  | 560              |             |
| 820       | DIODON HOLACANTHUS           |                    |        |                  |             |
| 80        | EPINEPHELUS FULVUS           | 160                | 0.143  | 310              | 1.95        |
| 88        | EPINEPHELUS GUTTATUS         | 250                | 0.119  | 568              |             |
| 506       | HAEMULON MELANURUM           | 190                | 0.320  | 350              |             |
| 155       | HAEMULON PLUMIERI            | 110                | 0.280  | 420              |             |
| 156       | HAEMULON SCIURUS             | 120-200            | 0.300  | 371              |             |
| 625       | HOLOCENTRUS RUFUS            | 135                | .0940  | 235              | 4.56        |
| 702       | LACTOPHRYS BICAUDALIS        |                    |        |                  |             |
| 701       | LACTOPHRYS POLIGONIUS        |                    |        |                  |             |
| 700       | LACTOPHRYS QUADRICORNIS      | 200-220            |        |                  |             |
| 704       | LACTOPHRYS TRIGONUS          |                    |        |                  |             |
| 703       | LACTOPHRYS TRIQUETER         |                    |        |                  |             |
| 135       | LUTJANUS APODUS              | 250                | 0.350  | 349              |             |
| 136       | LUTJANUS SYNAGRIS            | 180-220            | 0.250  | 320              |             |
| 140       | OCYURUS CHRYSURUS            | 240                | 0.139  | 502              |             |
| 901       | PANULIRUS ARGUS <sup>4</sup> |                    | 0.432  | 152 <sup>5</sup> | 0.651-0.413 |

A comparison of length frequency distributions was made for a number of the more common species. The comparison also incorporated information from FISHBASE relating to lengths at maturity and maximum size in order to obtain an initial assessment of fishing practices' impacts upon the populations. In the following discussion, when values for per cent of species is given it is per cent of the individuals not weight.

<sup>3</sup> <http://filaman.ifm-geomar.de/search.php?lang=English>

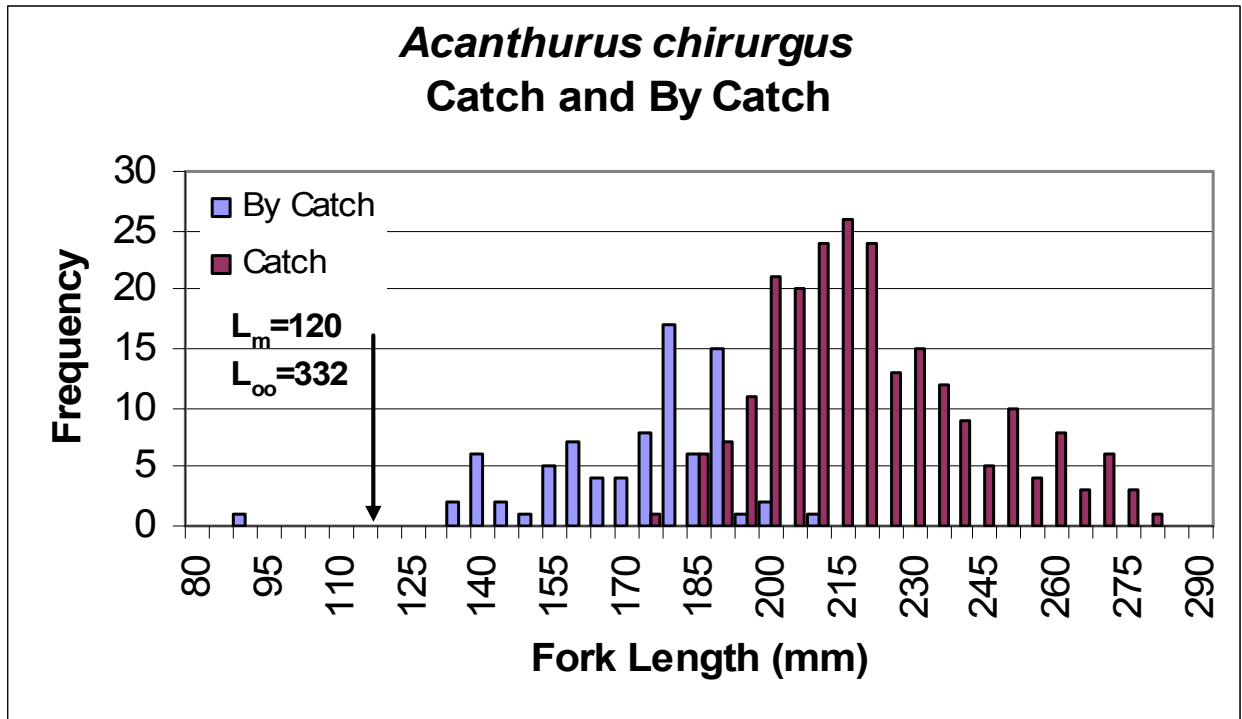
<sup>4</sup> Olsen, D.A. and I.G. Koblic. 1975. Population Dynamics, Ecology and Behavior of Spiny Lobsters, *Panulirus argus* of St. John, USVI.: (II) Growth and Mortality. Bull. So. Calif. Acad. Sci. Vol (20) pp.17-21

<sup>5</sup> As in the current study, the largest individual in Olsen's sample was 180 mm carapace length. The growth parameters were derived from tag-recapture results which nicely fit size class modes from a larger sample of length-frequency data.

#### 4.7.1 *Acanthurus chirurgus* (TIP=651)

The doctorfish (*Acanthurus chirurgus*) is preferred by many Virgin Islands consumers. It makes up 6.5% of the fish trap catch and 4% of the bycatch. Comparison of the catch and bycatch illustrates market preferences for larger individuals. Nearly every fish observed in the study was larger than the 120 mm Fork Length at first maturity reported in FISHBASE. The largest individuals in the study are smaller than  $L_{\infty}$ .

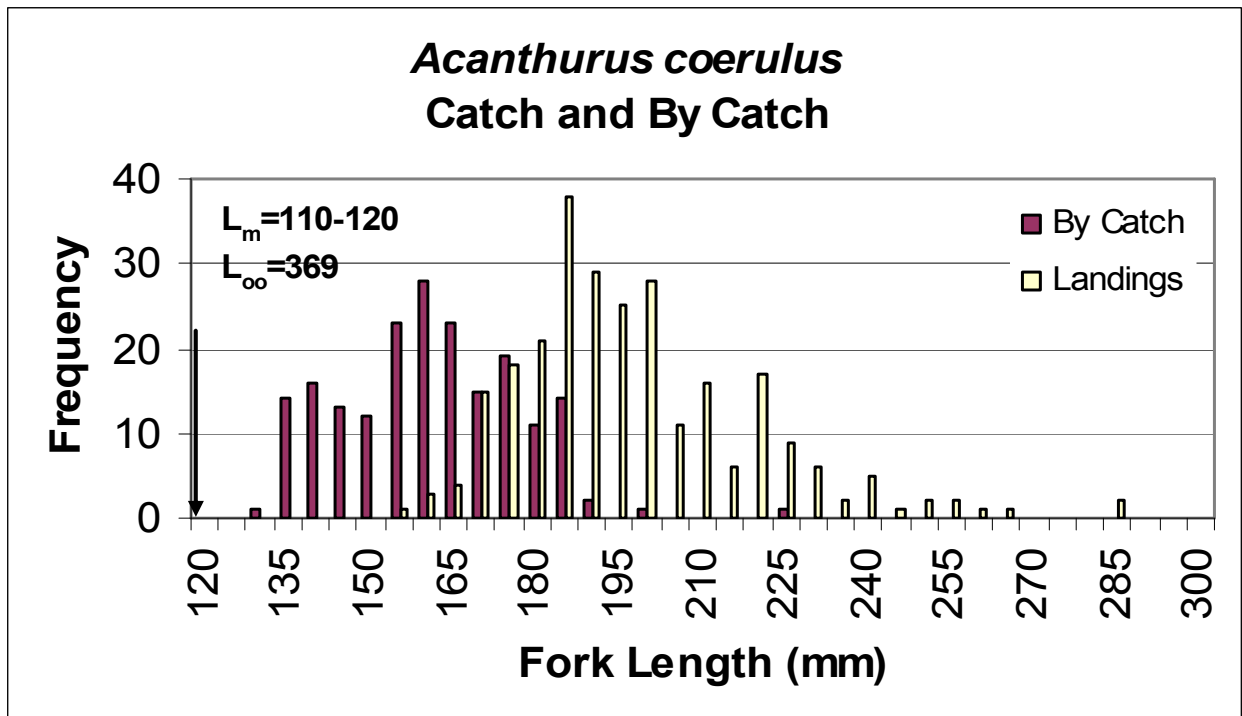
Figure 3. Comparison of catch and bycatch size frequency data for *Acanthurus chirurgus*.



#### 4.7.2 *Acanthurus coeruleus* (TIP=652)

The blue tang (*Acanthurus coeruleus*) is also preferred by many Virgin Islands consumers. It makes up 13% of the landings and 8% of the by catch. Comparison of the catch and by catch illustrates market preferences for larger individuals although there is more overlap in size between catch and by catch than with the doctor fish. Nearly every fish observed in the study was larger than the 110-120 mm Fork Length at first maturity reported in FISHBASE. According to FISHBASE, the blue tang grows to a larger size than the doctor fish and the largest individuals in the current study are significantly smaller than  $L_{\infty}$ .

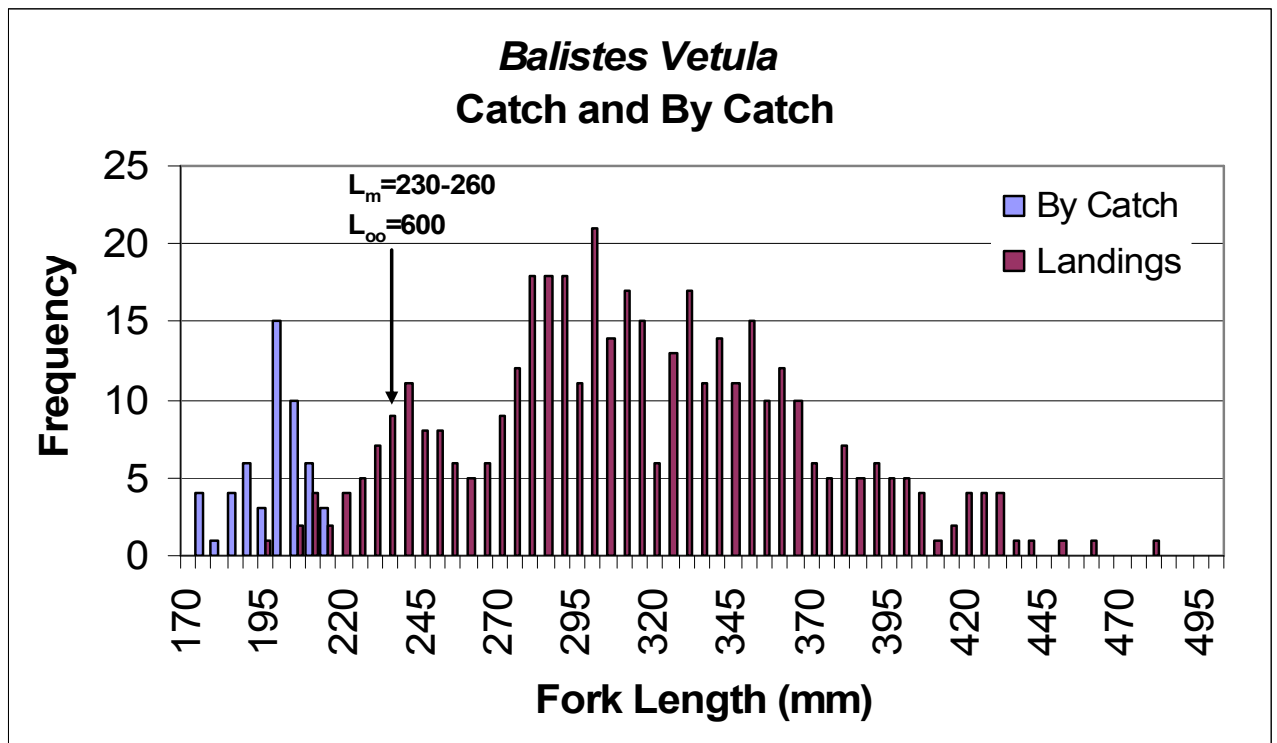
Figure 4. Comparison of catch and by catch size frequency data for *Acanthurus coeruleus*.



### 4.7.3 *Balistes vetula* (TIP=251)

The Queen triggerfish or Olewife (*Balistes vetula*) is the most common species in the trap fishery and is highly preferred by many Virgin Islands consumers. Olewife makes up nearly 15% of the total landings. Approximately 16% of the landings are smaller than the 260mm length at maturity shown in FISHBASE. There is a ready market for small olewife but fishermen seldom bring them ashore as they recognize the higher returns if they are allowed to grow. According to FISHBASE, the Olewife grows to 60 cm fork length, substantially larger than the largest individuals in our study. The size frequency distribution appears to show as many as eight modes which would indicate a diverse age structure.

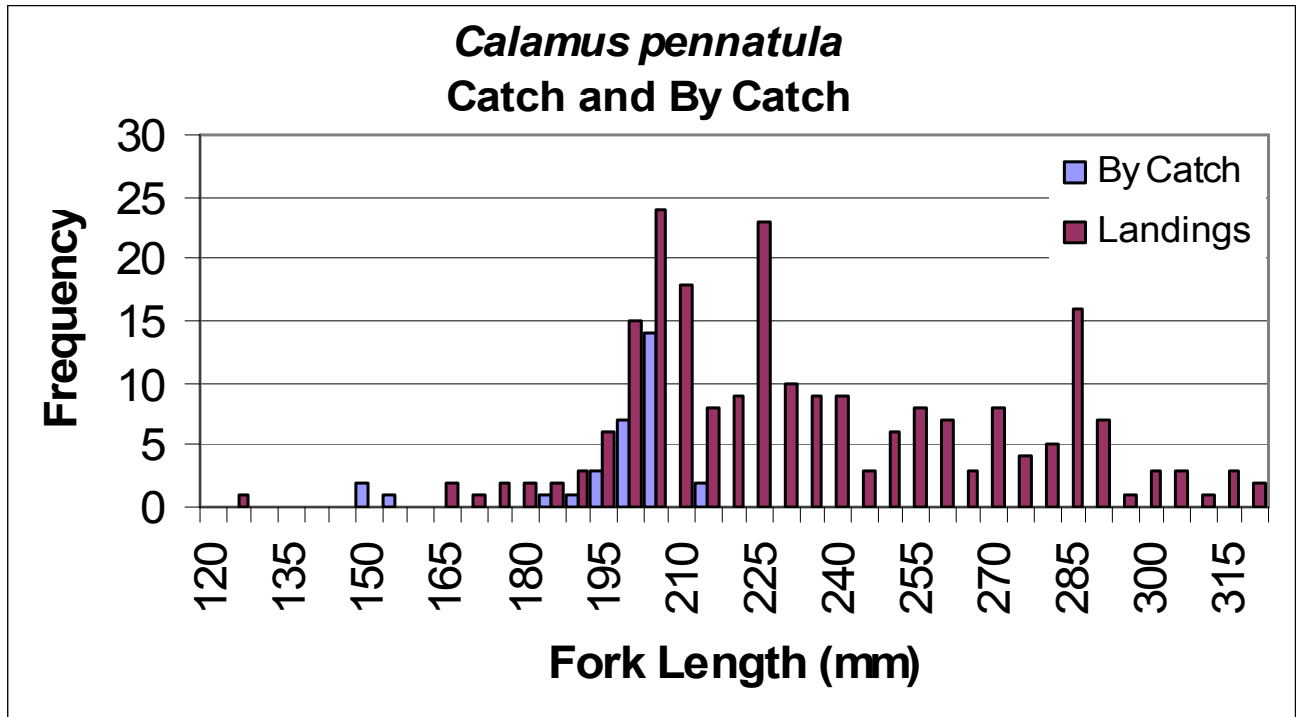
Figure 5. Comparison of catch and by catch size frequency data for *Balistes vetula*.



#### 4.7.4 *Calamus pennatula* (TIP=165)

The Porgy (*Calamus pennatula*) makes up 6.5% of the landings in the trap fishery. It is generally not preferred by Virgin Islands consumers. It appears in the by catch at larger sizes because several of the fishermen in our sample simply discard porgies since they are slow to sell. FISHBASE does not contain information regarding length at maturity and maximum size. The size frequency distribution appears to show a number of modes which would indicate a diverse age structure.

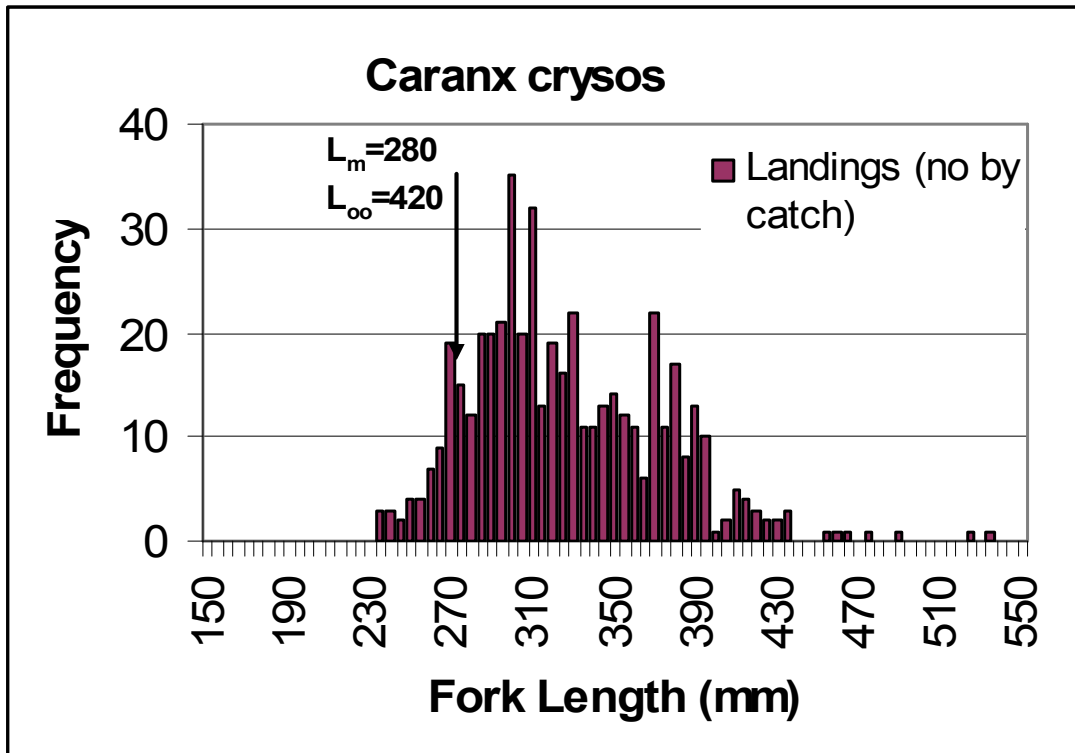
Figure 6. Comparison of catch and by catch size frequency data for *Calamus pennatula*.



#### 4.7.5 *Caranx crysos* (TIP=117)

Blue runners, known locally as Hardnose (*Caranx crysos*) are extremely popular among St. Thomas consumers. They are caught in both the Hand Line (16% of landings) and Seine Net (25% of landings). The only reported by catch was single fish that had been attacked by a predator. Approximately 14% of the landings are smaller than the 280mm length at maturity shown in FISHBASE. Nearly 3% of our sample was larger than the maximum size ( $L_{\infty}$ ) reported in FISHBASE.. The size frequency distribution appears to show as many as six modes which would indicate a diverse age structure.

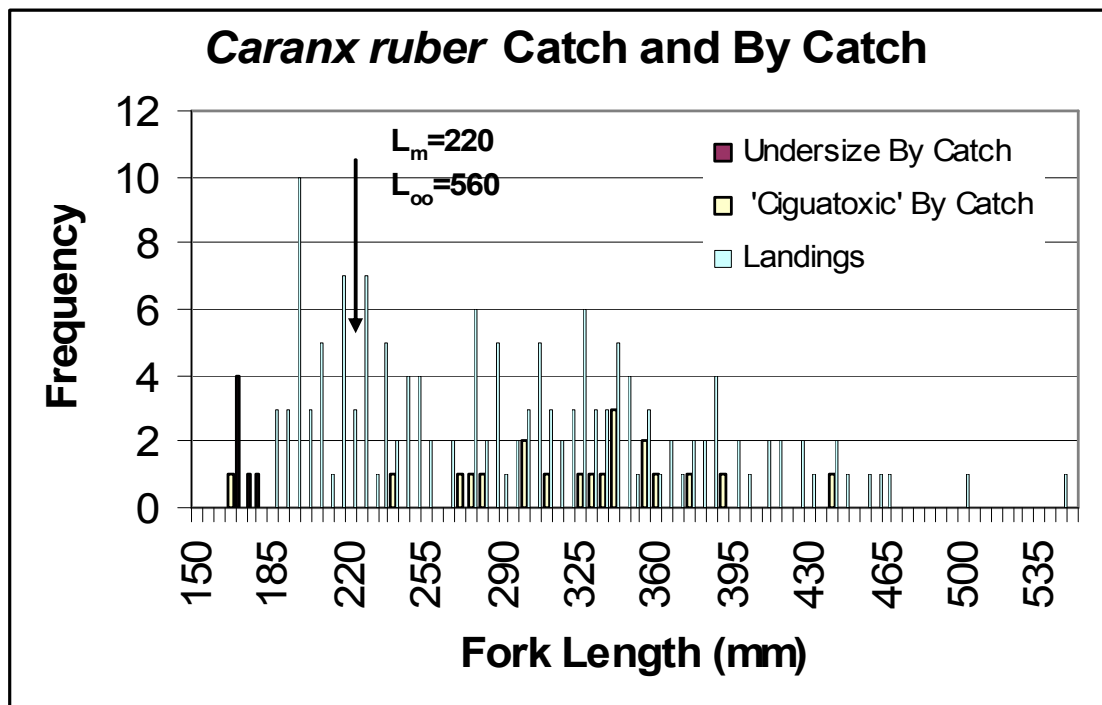
Figure 7. Comparison of catch and by catch size frequency data for *Caranx crysos*.



#### 4.7.6 *Caranx ruber* (TIP=115)

Bar Jacks, known locally as Carang (*Caranx ruber*) are occupy a peculiar position among St. Thomas consumers. While preferred like the Hardnose, according to local information, they pose a significant risk of Ciguatera fish poisoning if caught in traps or from the South of the island. They are a major element of the Seine Net fishery(19% of landings). Only one fish in our landings sample was smaller than the 220mm length at maturity shown in FISHBASE. The largest individual in our sample at 545 mm, approached the 560 mm maximum size reported in FISHBASE.. The size frequency distribution appears to show at least seven modes which would indicate a diverse age structure.

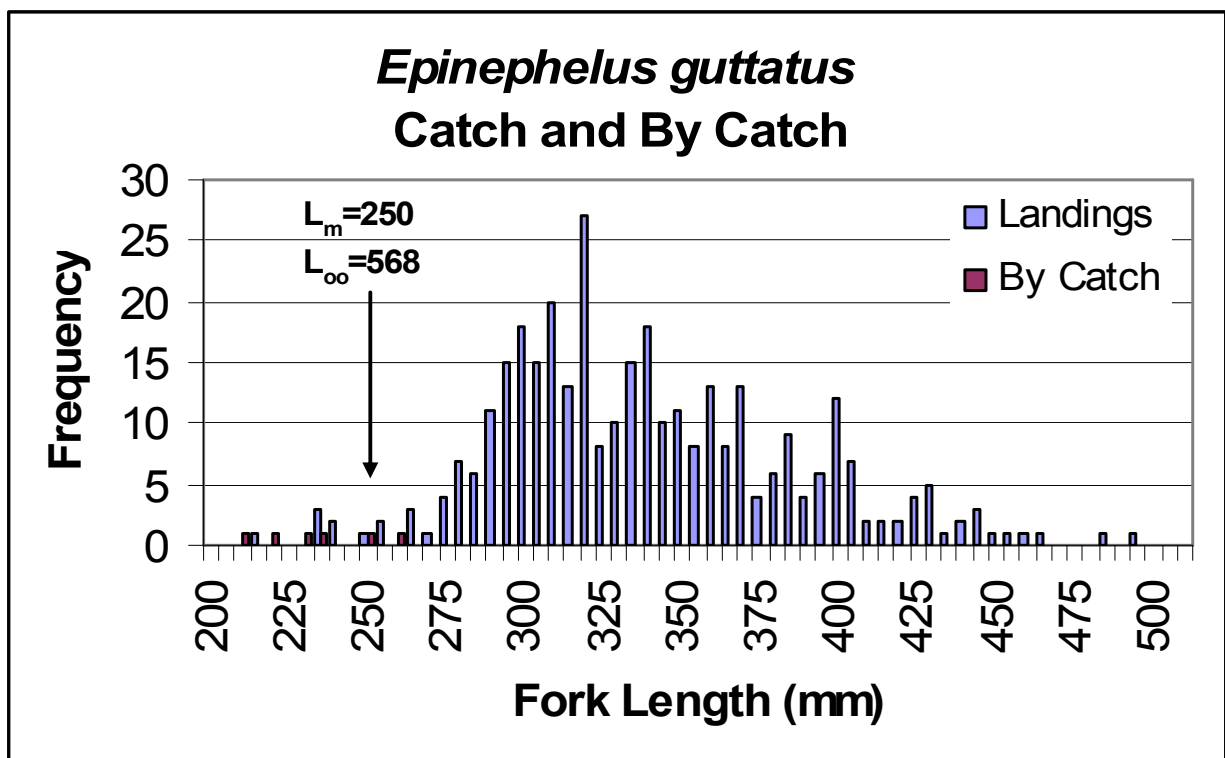
Figure 8. Comparison of catch and by catch size frequency data for *Caranx ruber*.



#### 4.7.7 *Epinephelus guttatus* (TIP=88)

Red Hinds (*Epinephelus guttatus*) are popular among St. Thomas consumers and represent 5% of the fish trap landings and are targeted by a seasonal hand line fishery not represented in the current study. Protection of Red hinds spawning aggregations has been in place in St. Thomas for nearly 20 years. Only six fish in our landings sample was smaller than the 220mm length at maturity shown in FISHBASE. The largest individual in our sample at nearly 500 mm, was considerably smaller than the 568 mm maximum size reported in FISHBASE.. The size frequency distribution appears to show eight or more modes which would indicate a diverse age structure.

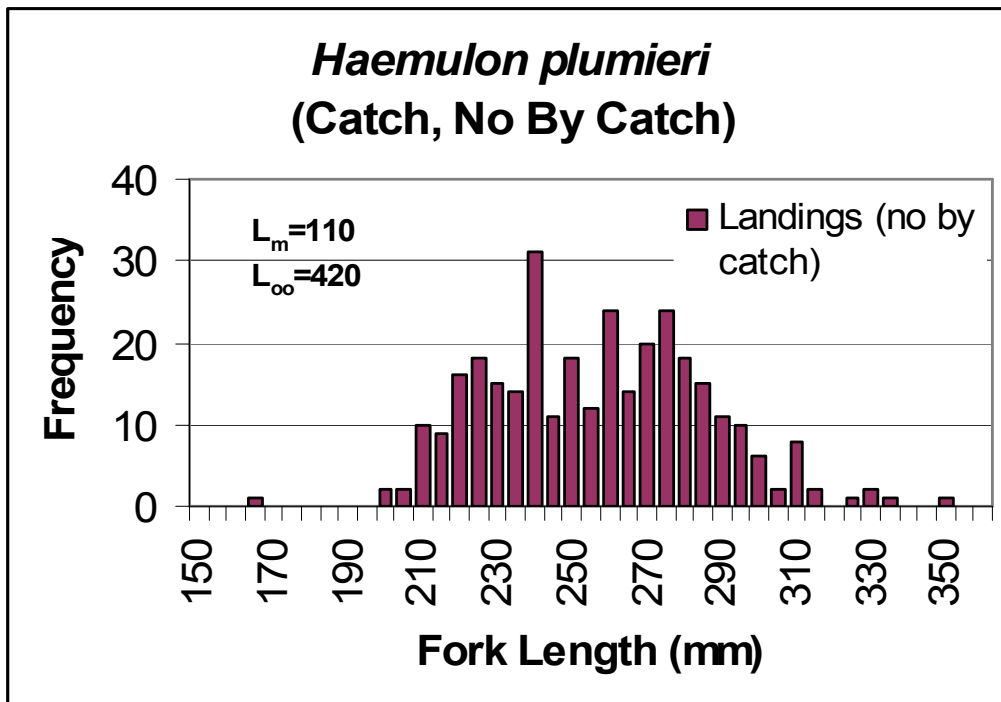
Figure 9. Comparison of catch and by catch size frequency data for *Epinephelus guttatus*.



#### 4.7.8 *Haemulon plumieri* (TIP=155)

White Grunts (*Haemulon plumieri*) represent 10% of the fish trap landings and seasonal peaks in abundance during the fall and winter months. None of the fish in our landings sample was smaller than the 110mm length at maturity shown in FISHBASE. The largest individual in our sample was 350 mm, was considerably smaller than the 420 mm maximum size reported in FISHBASE.. The size frequency distribution appears to show a number of modes which would indicate a diverse age structure.

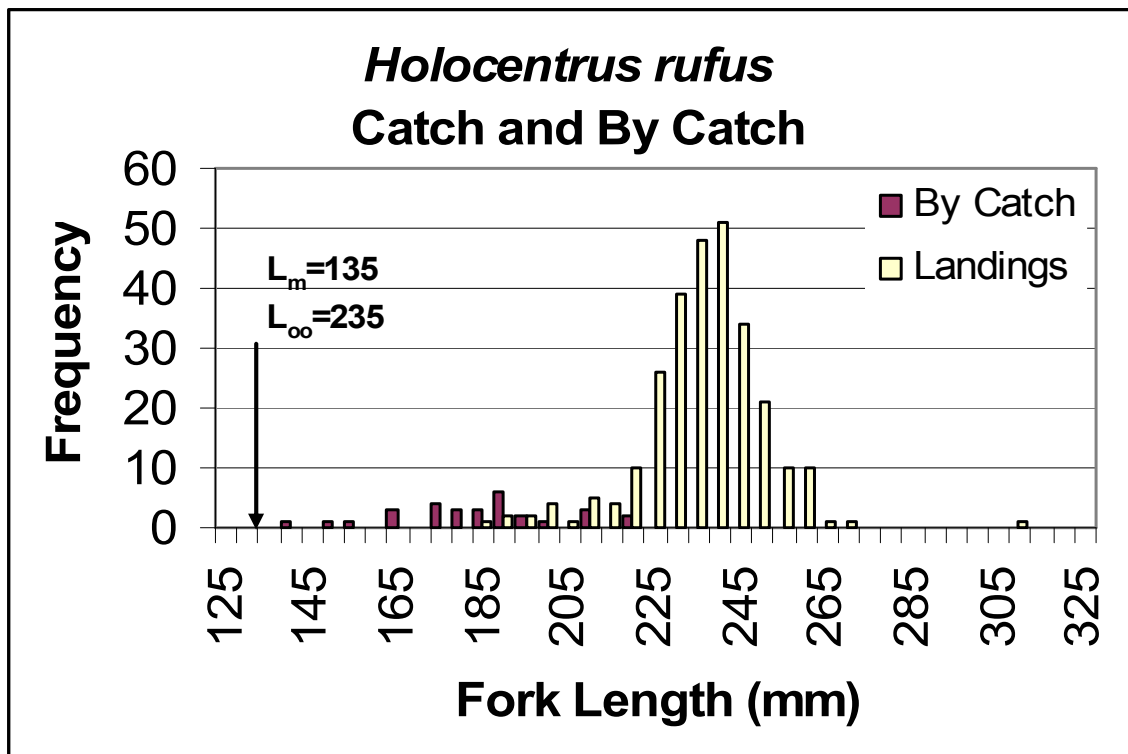
Figure 9. Size frequency data for *Haemulon plumieri*.



#### 4.7.9 *Holocentrus rufus* (TIP=625)

Squirrel fish known locally as Wenchmen (*Holocentrus rufus*) represent 11% of the fish trap landings and a small portion of the Hand Line by catch. None of the fish in our landings sample was smaller than the 135mm length at maturity shown in FISHBASE. The largest individual in our sample was 315 mm In all over 48% of the individuals in the current study were larger than the 235mm maximum size reported in FISHBASE.. The size frequency distribution appears to show a 3-5 of modes which would indicate a diverse age structure.

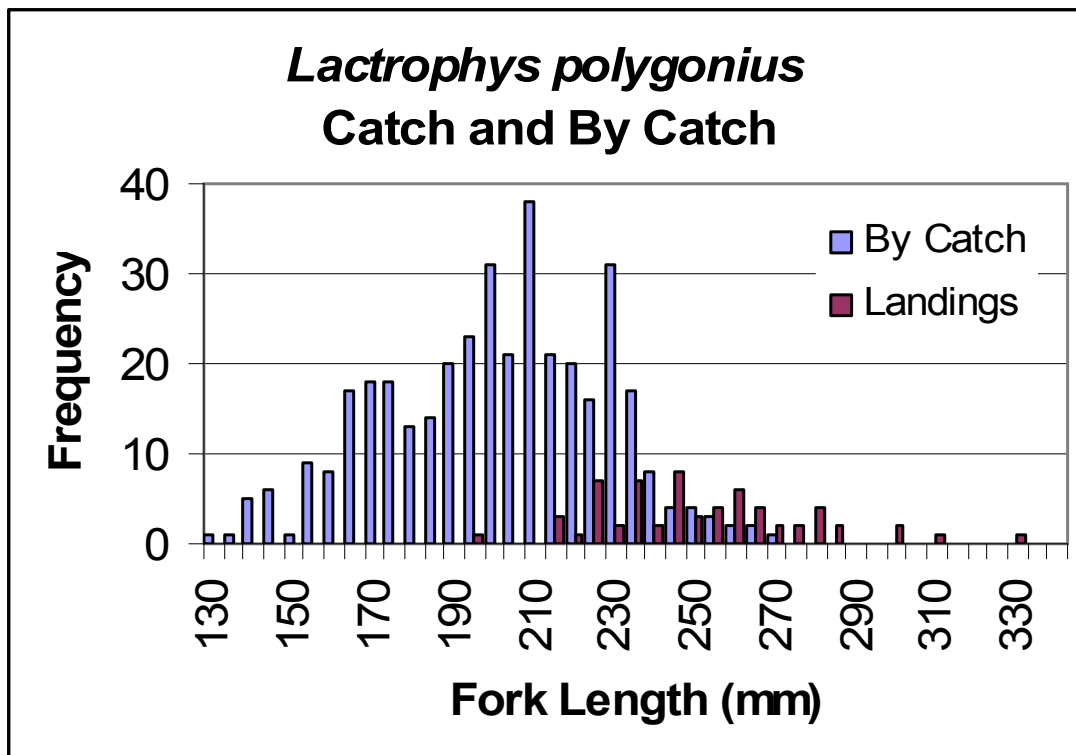
Figure 10. Comparison of catch and by catch size frequency data for *Holocentrus rufus*.



#### 4.7.10 *Lactrophys polygonius* (TIP=701)

Honeycomb cowfish (*Lactrophys polygonius*) represent 2% of the fish trap landings and 20% of the by catch. No growth or maturity information on this species can be found in FISHBASE. The largest individual in our sample was 335 mm. Very few individuals of market size were taken during the course of the study. The size frequency distribution appears to show a 4-5 of modes which would indicate a diverse age structure.

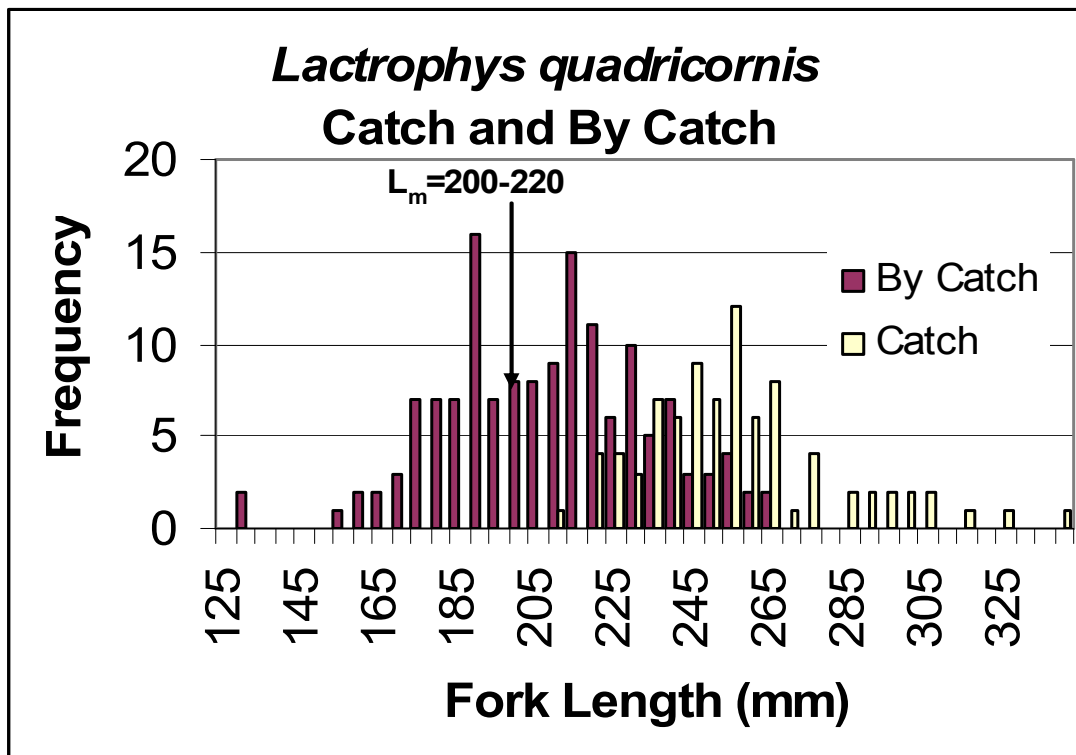
Figure 11. Comparison of catch and by catch size frequency data for *Lactrophys polygonius*.



#### 4.7.11 *Lactrophys quadricornis* (TIP=700)

Scrawled cowfish (*Lactrophys polygonius*) represent 2.5% of the fish trap landings and 10% of the by catch. No growth information on this species can be found in FISHBASE although a length at first maturity value of 200-220mm was given. None of the individuals in the landed catch was as small as this value. The largest individual in our sample was 325 mm. Scrawled cowfish are a more common element in the landings than the prior species. The size frequency distribution appears to show a 4-5 of modes which would indicate a diverse age structure.

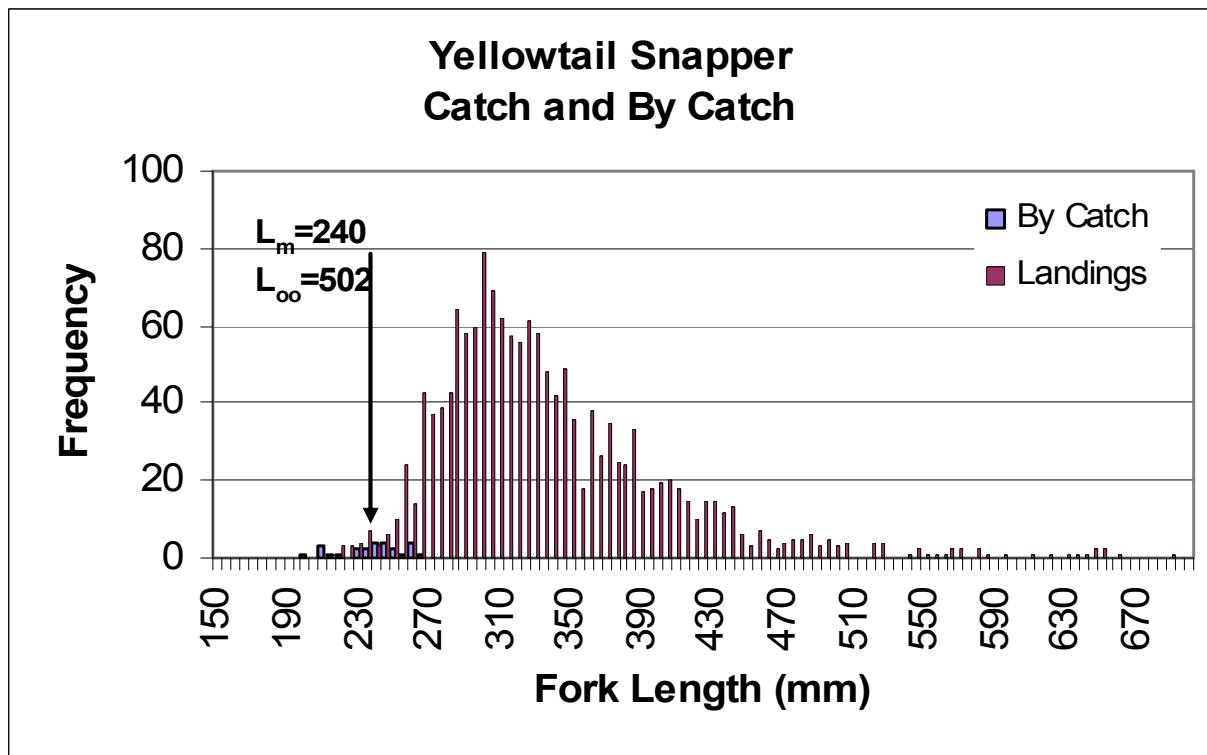
Figure 12. Comparison of catch and by catch size frequency data for *Lactrophys quadricornis*.



#### 4.7.12 *Ocyurus chrysurus* (TIP=140)

Yellowtail snappers (*Ocyurus chrysurus*) are perhaps the most important species in the St. Thomas landings. They are taken by traps (1.2% of the total) seine nets (23% of total landings) and Hand Line (70% of total landings). They are the only snapper species that is almost completely free of Ciguatera fish poisoning and are a major contribution to restaurant menus. FISHBASE indicates that the size at first maturity is 240mm and that the maximum size is 502 mm. Only 1.2% of the landed catch was less than the length at first maturity. The current sample contained 37 individuals (2.5% of the total) that were larger than the maximum reported in FISHBASE. The largest individual in our sample was 690 mm. By catch was a very small portion of the landings. The size frequency distribution appears to show numerous modes which would indicate a diverse age structure and a long lived fish as evidenced by the low growth rate value ( $k=0.139$ ) shown in FISHBASE.

Figure 13. Comparison of catch and by catch size frequency data for *Ocyurus chrysurus*.

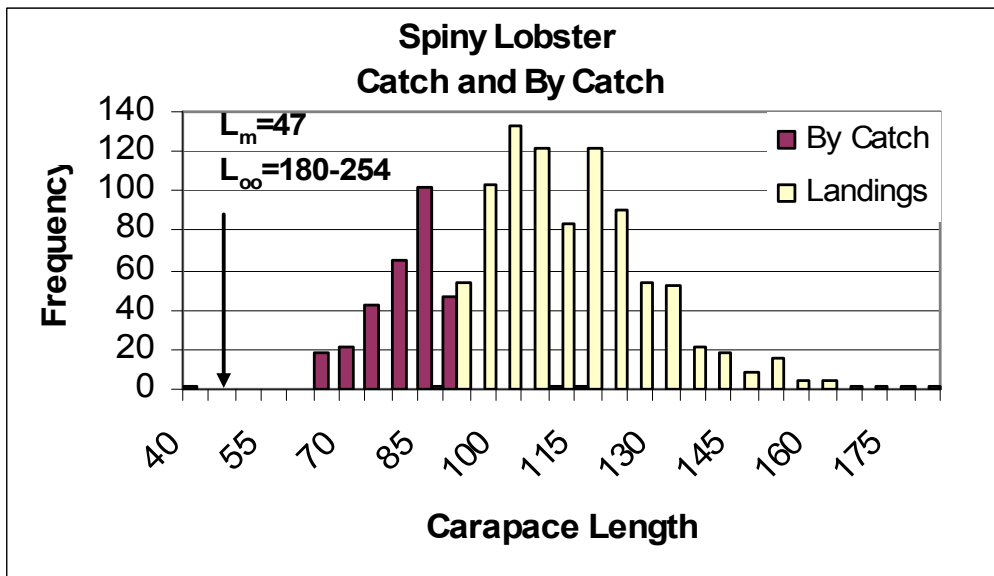


#### 4.7.13 Panulirus argus (TIP=901)

Spiny lobsters (*Panulirus argus*) are perhaps the second most important species in the St. Thomas landings. Less than 6% of the landings come from fish traps and the remainder in our sample were taken in plastic lobster traps. They are a major feature on the menus of local restaurants and hotels who prefer the whole lobster and larger sizes available in the local catch to imported tails.

FISHBASE does not have information on invertebrates. The smallest female with eggs in our sample was 47mm carapace length which we consider to be size at first maturity. A 1975 study of spiny lobsters was undertaken as part of the TEKTITE undersea habitat program.<sup>6</sup> In that study, tag-recapture techniques were used to obtain an estimate of  $L_{\infty}$  of 154 mm and a growth rate of  $k=0.432$ . These results were then compared to size class means which closely fit the tag-recapture results. Olsen's sample contained a 180 mm individual and one 180 mm individual was present in the current sample. Fishermen consistently report having captured "17 lb" lobsters which would correspond to a 254 mm carapace lobster. These exceptionally large lobsters would have a difficult time entering lobster traps. .than the length at first maturity. The current sample contained 37 individuals (2.5% of the total) that were larger than the maximum reported in FISHBASE. The largest individual in our sample was 690 mm. By catch was a very small portion of the landings. The size frequency distribution appears to show numerous modes which would indicate a diverse age structure and a long lived fish as evidenced by the low growth rate value ( $k=0.139$ ) shown in FISHBASE.

Figure 14. Comparison of catch and by catch size frequency data for *Panulirus argus*.



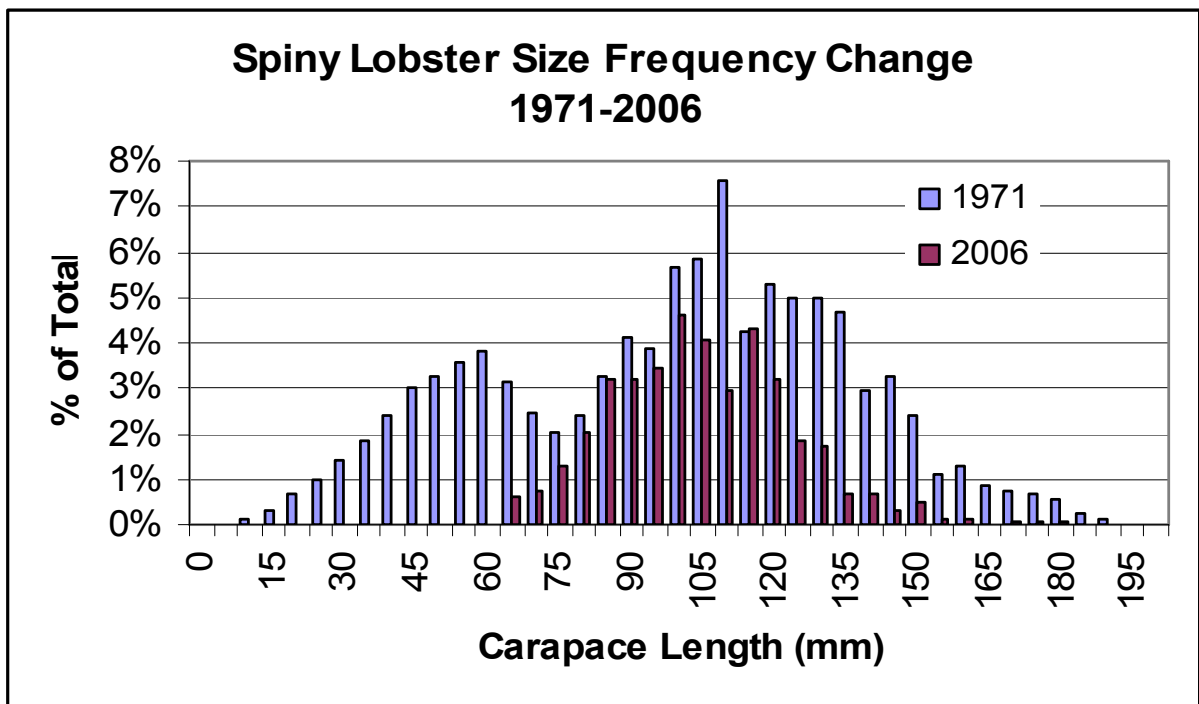
Only 2 of the 896 lobsters landed as catch were less than the 89mm minimum legal size, indicating a high degree of compliance with size regulations. No berried females were landed.

<sup>6</sup> Olsen, D.A. and I.G. Koblac. 1975. Population Dynamics, Ecology and Behavior of Spiny Lobsters, *Panulirus argus* of St. John, USVI.: (II) Growth and Mortality. Bull. So. Calif. Acad. Sci. Vol (20) pp.17-21

The average size of all lobsters (bycatch and landed catch) was 103mm. This is almost exactly 10mm less than the average for Olsen and Kobic's 1971-72 sample of 923 lobsters around St. John. When the "legal" size lobsters (90mm and greater) were compared, the 1971 average value was 121 mm carapace length and the 2006 average was 111 mm carapace length.

A comparison to the size classes from the two studies is shown below in Figure 15. The two studies were not exactly comparable. The 1971-72 study was a fishery independent study in which a considerable amount of effort was spent sampling in juvenile habitats in mangrove lagoons. Most of the lobsters were captured inside of the Virgin Islands National Park where, even in 1971, Park rangers discouraged fishing activities. The 2006 study is entirely made up of catch and by catch from commercial landings from throughout the St. Thomas/St. John shelf.

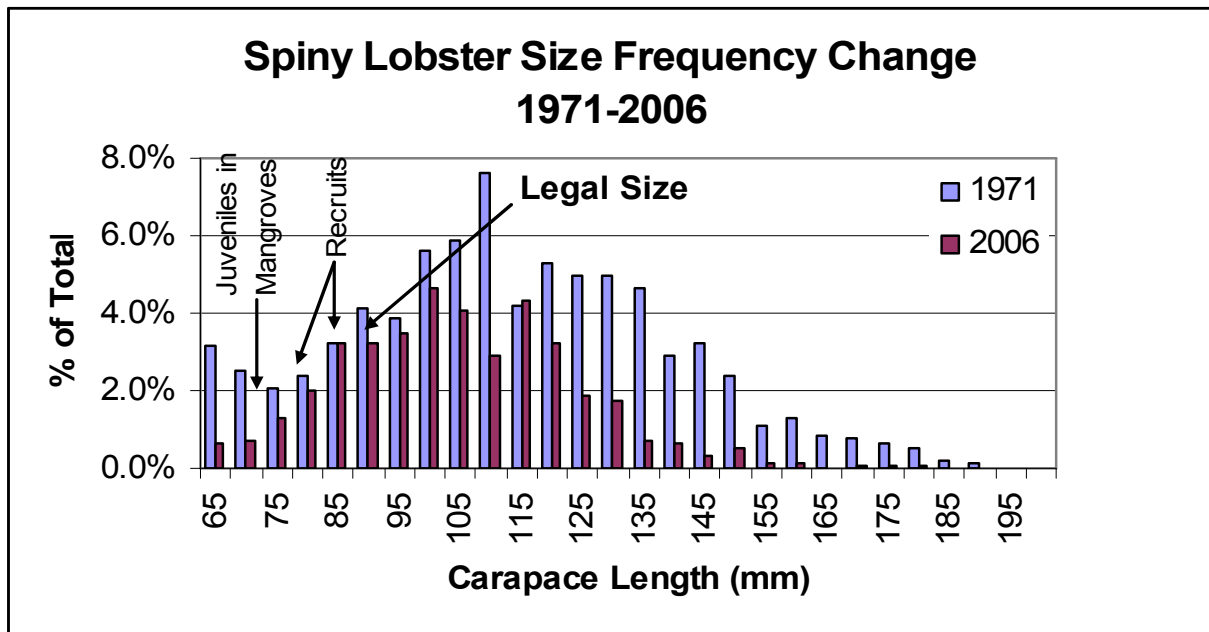
Figure 15. Comparison of size frequency data for *Panulirus argus* samples from 1971-72 and 2006.



If the comparison includes pre-recruit size classes which have largely departed from the juvenile habitat but not yet reached legal size a pattern emerges which indicates the impact of the extensive directed lobster trap fishery which has developed primarily in the last 20 years.

This comparison, shown in figure 16 shows that the directed lobster trap fishery does not capture many small lobsters until they reach around 80 cm carapace length, about the time that they depart from the juvenile habitat. Between 80 cm and 89 cm when the lobsters reach legal size, the results from 1971 and 2006 provide very similar results. Following entry into the fishery, the 2006 results begin to depart from the 1971 size class values. The resulting picture is one where, even though large lobsters are still caught regularly, in 1971 larger lobsters constituted a larger proportion of the population.

Figure 16. Comparison of size frequency data for *Panulirus argus* samples from 1971-72 and 2006 indicating life history and fishery effects.



#### 4.7.14 Summary of Size/Frequency Analysis.

Size frequency summaries indicate the following:

1. Multiple size class modes are apparent for all of the species analyzed.
2. In very few species are individuals smaller than the reported length at maturity present in the landings.
3. Large individuals are present in most of the species analyzed. In some cases numerous individuals are present that are larger than the reported “maximum” size.
4. Market practices do not favor very small fish with the possible exception of *Balistes vetula*. In this case fishermen still prefer to release small fish as they understand the increased value when the fish are allowed to grow.
5. In the case of spiny lobsters, current population average size is within 10 cm of the average size reported 35 years ago.
6. The current study does seem to indicate that lobster size frequency distribution contains fewer large individuals than were present in 1971. This is not unexpected since the market for and consequent fishery for lobsters has largely developed since the 1970s.

## 5 Summary and Conclusions

The successes obtained by this project resulted from two key points: rapport with fishers on the part of the observers, port samplers, and observer coordinator, and payments to fishers for their participation. While some fishers, those who generally cooperate, would have participated in any event, many others did not want to participate. The combination of personal contact and payments convinced others to take part. As a result, the observers obtained useful information from fishers.

All of the STFA observers had ties to the local fishing community. It was anticipated that this would be an asset in placing observers but in fact, it turned out to be a detriment as the fishermen/participants were uneasy about revealing their fishing areas to observers who might relay the information to other fishermen.

The project demonstrated that implementing an observer program would be difficult under the best of circumstances and would require flexibility in nearly all logistical operations. The small vessels have little room for an observer, and many have no room at all, making it difficult for direct observer placement. With an already small crew size (including captain) of 1-3 people, fishers could not afford to reduce fishing capacity by 25-50% by leaving a crew member home to make room for an observer. Doing so would negatively impact the fishing operation.

However, this project demonstrated that fishers can bring in fish (catch) otherwise destined for discarding for later sampling by observers at the dock. The captain samples obtained during this project demonstrated similarities in attributes to the samples collected by observers, with a high correlation. This method has potential for data collection that warrants additional research. Data collected by fishers has a high potential for bias, if fishers have something to hide or a desire to portray the fishery in more favorable light. In this project, we could find no reason for participating fishers to bias the data. Although a substantial portion of the fishers refused to participate, those that did became very enthusiastic for the program and actively supported it. Success of captain samples as a data collection method would greatly benefit from the buy-in by fishers experienced in this project. However, a program that utilizes captain samples would require an assessment of the probability that bias would occur, and if the level of bias is small enough relative to the overall value of the data to justify establishing the program. That is, if the choice is biased data or no data, which choice leaves the program better off.

The lack of participation by many fishers suggests that fishers would have a strong resistance to any mandatory program. This is not a surprising conclusion, as most observer programs start with opposition from fishers. An initial opposition to observers would not mean that an observer program would fail. However, a successful program in St. Thomas would take careful and detailed planning to implement (AFSC 2003), and to minimize the opposition:

- Determine goals and objectives
- Design a program to meet goals and objectives

- Determine logistic support required, especially enforcement and who pays
- Implement the program
- Monitor progress toward and achievements of goals and objectives, and provide a mechanism to modify as necessary.

This project succeeded in part because of payments to fishers for participating in the observer or captain trips. Direct payments to fishers are highly unlikely in a normal observer program, and many observer programs (e.g., the North Pacific Groundfish Observer Program) require payments by fishers for observers. Efforts to develop non-monetary incentives would benefit an observer program and would be worthwhile exploring if authorities decide to further develop an observer program for St. Thomas. Because many fishers often believe that data collection programs will find (or produce) information that could be used against them, development of an observer program should focus on explaining the how the data will be used and the benefits that will accrue to fishers from management improvements. When fishers buy in into a program because they expect some benefits, long or short term, support will increase and opposition will decrease. Providing concrete information, such as from meetings with questions and answers and from reports of plans and progress, to fishers during development and operations of a program will help alleviate suspicion and enhance buy-in.

## **6 Recommendations**

This project demonstrated the feasibility of collecting observer data on the small vessels of St. Thomas, the difficulties and limitations to the observer coverage, and presented an alternative to observers for collecting data. Under some conditions, data collected by an observer program or captain sample program of the type tested here may be suitable for management needs. However, to determine that, careful planning for the program should occur, that includes determination if a USVI observer program can achieve specified goals and objectives. We recommend that management agencies considering development of an observer program use a report on observer coverage prepared for NMFS (AFSC 2003) to assist with this evaluation and planning.

If management agencies in the US Caribbean determine that an observer program is needed, we recommend the following:

This project demonstrated a need to provide fishers with an incentive to support, or at least not oppose, an observer program. We recommend explaining the benefits of an observer program through an education effort of meetings and reports that clearly lay out the goals of the program, how the program will operate, and what it will achieve.

Observers ride on small, open vessels, often in rough weather. We recommend enhancing safety for observers by requiring a Coast Guard (or other maritime agency) safety inspection for each vessel prior to taking an observer, providing a personal locator beacon for each observer, and providing a personal first aid kit for each observer.

As part of a Cooperative Research Program project, requiring participation of fishers, this project used a commercial fisher as the primary observer. Some fishers may not have carried an observer to avoid possible publicizing proprietary fishing locations. We recommend establishing a conflict of interest policy in which observers could have no financial interest in the fishery other than through observing.

Trap samples are more difficult and time consuming for observers to process, and delays can negatively impact fishers' schedules. We recommend development of a standardized method for treating samples to minimize disruption to fishers. Trap bycatch may require a special study to develop efficient and effective measures.

## **Literature Cited**

AFSC. 2003. NMFS Fisheries Observer Coverage Level Workshop: Defining a Basis. Alaska Fisheries Science Center, Seattle, WA. 45pp.

Kojis, B. 2004. Census of the marine commercial fishers of the U.S. Virgin Islands. Caribbean Fishery Management Council Report. 87pp.

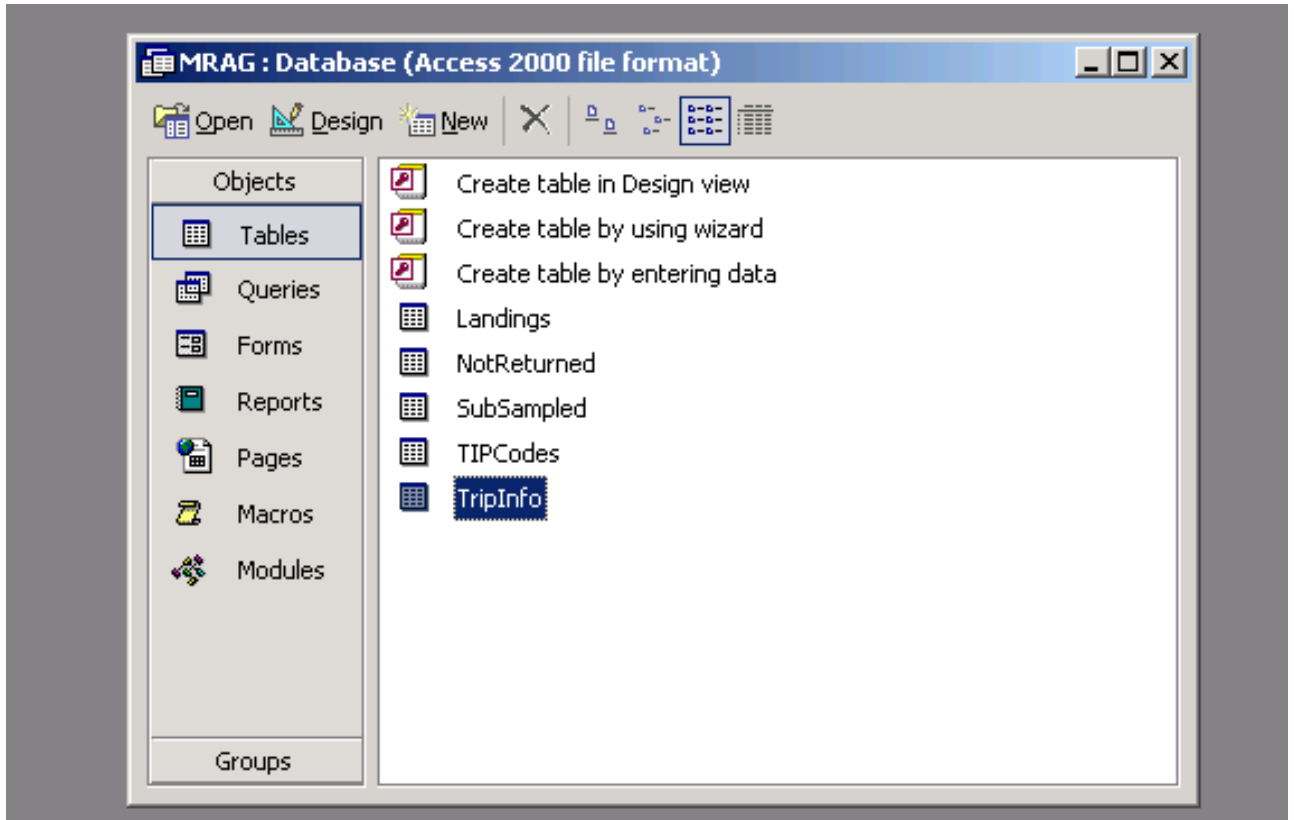
# Appendix 1 Protocol

## **Appendix 2 Description of Project Data Base**

## Description of the database

Sampling data were originally stored in Excel spreadsheets which made data analysis difficult. Consequently an MSAccess data base was constructed to facilitate data analysis.

### Data Tables



1. Landings table. This table includes all individual fish captured during the study, both catch and by catch. Variables contained in this table include:
  - a. Trip# which is the linking variable for the trip information table.
  - b. Species
  - c. TIP number
  - d. Length (in mm)
  - e. Weight (in g)
  - f. By catch (Yes/No)
  - g. Discard reason
  - h. Survival (for by catch)
  - i. Sex (Lobsters)
  - j. Reproduc (Lobsters)
2. NotReturned. For fish which were not returned to shore. This table includes the same variables as the Landings table.
3. Subsampled. For fish which were "subsampled" by the fishermen. This table includes the same variables as the landings table but has a variable "ratio" for the proportion sampled (eg. "4" if the fisherman kept 1 in 4 of that particular species). For tips with subsampling, the total number returned to shore was input into this table.
4. TIPCodes. Contains TIP codes used in study.

5. TripInfo. This table contains all of the qualitative data regarding each trip. Variables include:
  - a. Trip#
  - b. Date
  - c. Captain
  - d. Boat (Name and Registration)
  - e. Length
  - f. Observer (or Captain's trip)
  - g. Agent
  - h. Areas (DFW designations)
  - i. Depth (given as range)
  - j. Crew
  - k. Data (Collection time)
  - l. FishingHours
  - m. Landings (we are awaiting landings data from the Division of Fish and Wildlife)
  - n. LandingType
  - o. Gear
  - p. #Gear
  - q. NotPulled
  - r. Soak
  - s. InfoSource
  - t. FishingMode
  - u. BiasType
  - v. InterviewType
  - w. %CatchSampled

## **Queries**

The following data queries are included in the data base:

1. Bycatch. Queries the landings table for by catch species
2. Bycatch query. Bycatch query linked to the TripInfo table so that bycatch can be related to gear type, depths, areas etc can be summarized.
3. Catch. Queries the landings for non-bycatch species.
4. Catch by Method. Catch query linked to the TripInfo table so that catch can be related to gear type, depths, areas etc.
5. Discard Reasons. Queries by Bycatch query to summarize results by discard reason.
6. Fishing Methods. Queries the TripInfo table to summarized trips by the fishing methods employed.
7. Landings summary. Queries landings table and provides average, minimum, maximum and count of weight and length for each species for each trip. Landings Summary by Species. Provides totals for each species.
8. Subsampled query. Summarizes the information for subsampled species.
9. TripInfo query. Allows for summary of the information contained in the TripInfo table.

## Data Entry Forms.

The screenshot shows a Microsoft Access window titled "Microsoft Access - [TripInfo]". The window contains a data entry form with the following fields and values:

|             |                |                 |            |
|-------------|----------------|-----------------|------------|
| Trip#       | 001            | Fishing Hours   | 3          |
| Date        | 04-Sep-05      | LandingType     | CL         |
| Captain     | Julian Magras  | Gear            | Fish Traps |
| Boat        | Yumzi          | #Gear           | 36         |
| Boat Length | 22             | Size            | 2 Inch     |
| Observer    | Captain's Trip | NotPulled       | 0          |
| Agent       | David Olsen    | Soak            | 7          |
| Areas       | TSW            | InfoSource      | SS         |
| Depth       | 90-120         | FishingMode     | CM         |
| Crew        | 2              | BiasType        | NB         |
| DateTime    | 10:25 AM       | InterviewType   | FS         |
| Landings    | 0              | % Catch Sampled | 100        |

## Reports

1. Bycatch not returned to shore. Summarized the NotReturned table.
2. Bycatch. Prints a table of bycatch species with average, minimum and maximum lengths.
3. Bycatch by Method. Prints a table for each fishing method in Bycatch by Method query that contains each species and the total number of individuals.
4. Catch by Method. Prints a table for each fishing method in Catch by Method query that contains each species and the total number of individuals.
5. DiscardReasons. Prints a table showing the species and numbers for each reason for discard.
6. Landings. Prints a table of Landed species with average, minimum and maximum lengths
7. TripInfo. Summarizes the TripInfo query for total number of gear units employed.