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

MRAG Americas

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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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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).

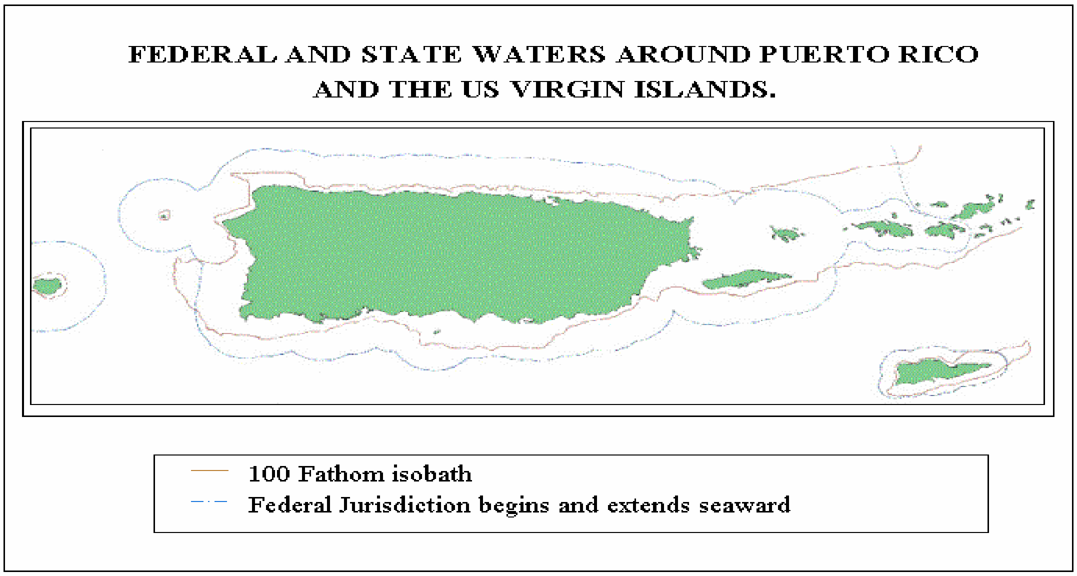


Figure 1. Federal and State waters around Puerto Rico and the U.S. Virgin Islands

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 catch. St. Thomas fishers together use over 10,000 traps, while St. Croix fishers use around 1,600 (Barbara Kojis, Former Director, USVI Division of Fish and Wildlife, pers. comm.). 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 might 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 gill 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 fishers are interested 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 biostatistical port sampling has occurred on ST. Thomas in recent years.

Recently the SEDAR stock assessment DW, AW, and RW workshops 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, SEDAR 8 yellowtail snapper Consensus Report, June 2005). Supplemental data collections by this pilot project provide 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, of STFA and former director of DFW during the late 1970s through the mid 1980s, 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. Croix.

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. McNeeley. 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 loaned 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 observer 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 reach the total number of proposed samples.

The sampling protocol worked well although the relatively small initial catches (100-200 pounds) took approximately two hours to measure. We projected a time requirement of up to 5 hours to process a large catch (400-600 pounds) and anticipated strong fisher opposition to waiting that long for completion of the sample. Consequently, we decided to systematically subsample abundant species (more than 50 individuals) for measurements 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 over 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 to shore 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. The payments played a substantial role in obtaining cooperation of St. Thomas fishers. Without the payments, may fewer of the fishers would have agreed to take observers or bring in captain samples.

Observer pay of $200 per observer day is roughly comparable to pay rates of observer programs managed by NMFS in other geographical areas of the US. 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 captain trips were nearly equally distributed 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 reported that since the fish trap mesh size was increased to 2 inches, with a consequent reduction in discards, the number of Frigate birds following the boats 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 as reported by fishers.

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. The payments to fishers for taking observers and for bringing in captain samples enticed many of the participants to cooperate. Many of the participants developed an appreciation of the value of data for providing a basis for management decisions and may agree to collaborate in future data collection without compensation. However, the refusal of many fishers to cooperate demonstrates that uncompensated data collection by fishers will have a difficult future for widespread participation.

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 Logbook 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 evaluate 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 bycatch 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	Captain's	Observer's	Total

Method	Trips	Trips	
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 bycatches 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 bycatch 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.

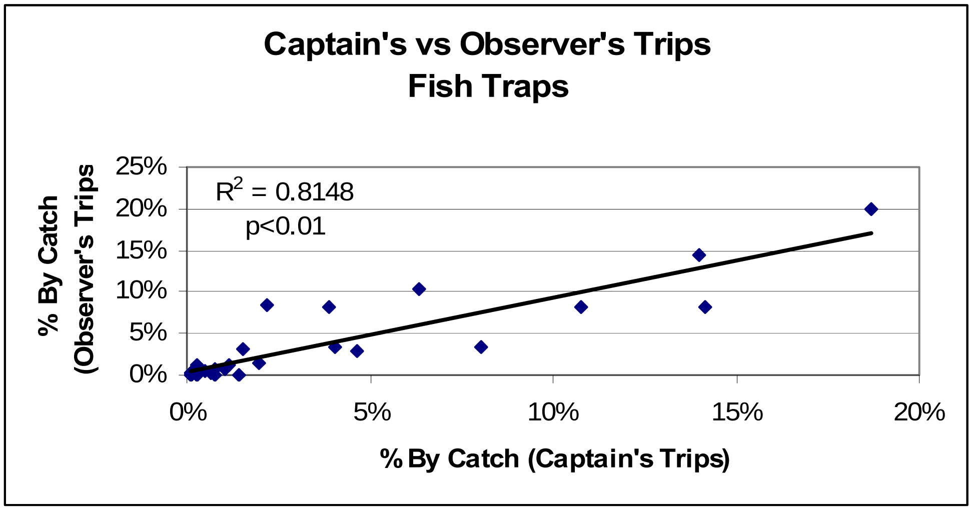


Figure 2. Percent species abundance of bycatch for Captain's trips and Observer Trips.

Captain's trips and Observer trips were also highly correlated (R^2=0.96) for the lobster trips although the dominance by lobster bycatch 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.

Soak Time for Fish and Lobster Traps (Hours)					
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.

Characteristics of Sampled Fishing Trips				
Fishing Depths (Feet)				
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
Crew				
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
Fishing Hours				
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.

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 trips sampled, in the absence of the observer program. A total of 89 species and 6,871 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
Ocyurus chrysurus	140	1500	21.83%
Panulirus argus	919	868	12.63%
Caranx crysos	117	483	7.03%
Balistes vetula	253	469	6.83%
Epinephelus guttatus	88	338	4.92%
Haemulon plumieri	155	320	4.66%
Acanthurus coeruleus	652	266	3.87%
Holocentrus rufus	625	398	5.79%
Acanthurus chirurgus	651	230	3.35%
Calamus pennatula	165	222	3.23%
Caranx ruber	115	149	2.17%
Haemulon sciurus	156	148	2.15%
Haemulon melanurum	506	130	1.89%
Lutjanus synagris	136	120	1.75%
Lactophrys quadricornis	700	97	1.41%
Sparisoma rubripinne	679	82	1.19%
Epinephelus fulvus	80	74	1.08%
Lactophrys poligonius	701	69	1.00%
Lutjanus analis	134	68	0.99%
Pomacanthus arcuatus	576	67	0.98%
Euthynnus alletteratus	230	65	0.95%
Sparisoma viride	196	63	0.92%
Scyllarides aequinoctia.	918	58	0.84%
Tylosurus crocodilus	58	58	0.84%
Sparisoma chrysopterum	675	54	0.79%
Lactophrys bicaudalis	702	38	0.55%
Selar crumenophthalmus	120	36	0.52%
Calamus bajonado	166	28	0.41%
Aluterus schoepfi	725	26	0.38%
Cantherhines pullus	255	25	0.36%
Etelis oculatus	143	25	0.36%
Rhomboplites aurorubens	142	25	0.36%
Holacanthus ciliaris	184	22	0.32%
Lactophrys trigonus	257	22	0.32%
Crab,marine	906	17	0.25%

Species in Landings	TIP Code	Number	% of Total
Epinephelus cruentatus	82	17	0.25%
Priacanthus arenatus	98	16	0.23%
Lutjanus buccanella	138	14	0.20%
Scomberomorus cavalla	233	10	0.15%
Scomberomorus regalis	234	10	0.15%
Mycteroperca interstitialis	752	10	0.15%
Lactophrys triqueter	703	9	0.13%
Lutjanus vivanus	139	8	0.12%
Mycteroperca venenosa	91	8	0.12%
Haemulon parrai	501	7	0.10%
Lachnolaimus maximus	189	7	0.10%
Acanthurus bahianus	218	5	0.07%
Anisotremus surinamensis	162	5	0.07%
Elagatis bipinnulata	124	5	0.07%
Haemulon striatum	507	5	0.07%
Pomacanthus paru	577	5	0.07%
Scarus coeruleus	195	5	0.07%
Sparisoma aurofrenatum	677	5	0.07%
Haemulon flavolineatum	157	4	0.06%
Scarus vetula	678	4	0.06%
Epinephelus morio	87	3	0.04%
Negaprion brevirostris	12	3	0.04%
Sphyraena picudilla	205	3	0.04%
Bodianus rufus	190	2	0.03%
Caranx latus	118	2	0.03%
Carcharhinus limbatus	403	2	0.03%
Epinephelus adscensionis	90	2	0.03%
Epinephelus mystacinus	86	2	0.03%
Haemulon album	153	2	0.03%
Haemulon aurolineatum	159	2	0.03%
Haemulon carbonarium	500	2	0.03%
Kyphosus sectatrix	179	2	0.03%
Remora remora	590	2	0.03%
Scarus taeniopterus	678	2	0.03%
Ablennes hians	59	1	0.01%
African lobster		1	0.01%
Anisotremus virginicus	501	1	0.01%
Canthidermis sufflamen	252	1	0.01%
Caranx crysos shark bite	117	1	0.01%

Species in Landings	TIP Code	Number	% of Total
Carcharhinus leucas	870802050200	1	0.01%
Carcharhinus perezi	400	1	0.01%
Chaetodipterus faber	183	1	0.01%
Galeocerdo cuvier	10	1	0.01%
Haemulon bonariense	502	1	0.01%
Haemulon chrysargyreum	158	1	0.01%
Holacanthus tricolor	577	1	0.01%
Lutjanus mahogoni	137	1	0.01%
Majidae	618701000000	1	0.01%
Mulloidichthys martinicus	176	1	0.01%
Pristipomoides aquilonaris	883536070100	1	0.01%
Rhizoprionodon porosus	8708020303	1	0.01%
Sphyraena barracuda	203	1	0.01%
Thunnus atlanticus	228	1	0.01%
Trachinotus falcatus	125	1	0.01%
Trachinotus goodei	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. The bycatch consists 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[1]
011	*Lutjanus apodus*	137	4	4	16
011	*Ostraciidae*	256	4	18	72
013	*Ostraciidae*	256	4	4	16
013	*Acanthurus coeruleus*	652	3	13	39
017	*Ostraciidae*	256	3	23	69
017	*Lutjanus apodus*	135	4	5	20
017	*Acanthurus coeruleus*	652	4	2	8
018	*Ostraciidae*	256	5	20	100

[1] To be added to landed bycatch. Total shown in Table 11.

Trip#	Species	TIP	Ratio	Returned to Shore	Adjusted Landings[1]
019	*Ostraciidae*	256	4	52	208
020	*Ostraciidae*	256	10	12	120
023	*Ostraciidae*	256	4	23	92
024	*Acanthurus coeruleus*	652	4	9	36
024	*Ostraciidae*	256	4	19	76
036	*Diodon holacanthus*	820	2	4	8
036	*Calamus pennatula*	165	4	1	4
036	*Balistes vetula*	253	3	4	12
036	*Acanthurus coeruleus*	652	4	8	32
041	*Ostraciidae*	256	4	15	60
041	*Acanthurus coeruleus*	652	4	23	92
051	*Diodon holacanthus*	820	5	2	10
069	*Ostraciidae*	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.

Table 7. Species composition of Ostraciidae samples.

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

4.3.3 Finfish bycatch

Risk of Ciguatera affected nearly 14% of the finfish bycatch. 78% of the bycatch was discarded because the fish were smaller than market size. Of these 56% of the total bycatch 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 8). Thus, it not unexpected that only 9% of the bycatch 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 bycatch.

Table 8. Species composition and reasons for discard of bycatch.

Species	TIP Code	Number
Risk of Ciguatera		
Caranx latus	118	8
Caranx lugubris	119	2
Caranx ruber	115	21
Gymnothorax moringa	442	1
Lutjanus apodus	135	118
Lutjanus buccanella	138	3
Lutjanus griseus	132	26
Lutjanus jocu	133	10
Lutjanus mahogoni	137	6
Mulloidichthys martinicus	176	7
Priacanthus arenatus	98	1
Pseudupeneus maculatus	175	2
Scomberomorus regalis	234	5
Seriola rivoliana	111	1
Sphyraena barracuda	203	12
Risk of Ciguatera, Used to Bait Traps		
Lutjanus apodus	135	3
Lutjanus jocu	133	2
Lutjanus mahogoni	137	3
Priacanthus arenatus	98	4
Total		**235 (13.6%)**
Smaller Than Market Size		
Acanthurus bahianus	218	2
Acanthurus chirurgus	651	82
Acanthurus coeruleus	652	201
Balistes vetula	251	52
Calamus pennatula	165	38
Caranx hippos	601	1
Caranx ruber	115	4
Crab,marine	930	1
Epinephelus adscensionis	90	1
Epinephelus cruentatus	82	28
Epinephelus fulvus	80	2
Epinephelus guttatus	88	6

Species	TIP Code	Number
Gerres cinereus	148	1
Haemulon aurolineatum	159	2
Haemulon flavolineatum	157	2
Haemulon melanurum	506	2
Holacanthus ciliaris	184	2
Holacanthus tricolor	575	5
Holocentrus marianus	8810080105	3
Holocentrus rufus	625	32
Lactophrys bicaudalis	702	117
Lactophrys poligonius	701	273
Lactophrys quadricornis	700	149
Lactophrys trigonus	704	81
Lactophrys triqueter	258	41
Lactophrys triqueter	701	100
Lactophrys triqueter	703	33
Lutjanus apodus	135	1
Lutjanus synagris	136	3
Ocyurus chrysurus	140	37
Ostraciidae	256	32
Pomacanthus arcuatus	576	2
Pomacanthus paru	575	8
Priacanthus arenatus	98	1
Scyllarides aequinoctialis	918	1
Total		**1,346 (77.6%)**
Non Marketable Species		
Aluterus monoceros	730	2
Aluterus schoepfi	725	7
Aluterus scriptus	726	11
Bothus lunatus	249	1
Cantherhines macrocerus	727	11
Cantherhines pullus	255	3
Caranx crysos half fish	117	2
Chaetodon striatus	561	14
Chilomycterus antillarum	822	2
Crab,marine	930	2
Diodon holacanthus	820	77
Echeneus naucratis	108	2
Equetus lanceolatus	172	1
Eupomacentrus fuscus		1

Species	TIP Code	Number
Ocyurus chrysurus (shark bite)	140	1
Pomacentridae	185	1
Scorpaena plumieri	244	12
Serranus tabacarius	92	1
Total		**151 (8.7%)**
Too Much in Market		**0**
Used as Bait		
Crab,marine	906	1
Haemulon aurolineatum	159	1
Total		**2 (0.1%)**

4.3.4 Lobster bycatch

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 bycatch were undersize lobsters and 32% were lobsters with eggs (Table 9). Almost all of the bycatch 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 9. Reasons for discard of spiny lobster bycatch.

Species	TIP	Number	% of Total
Spiny Lobsters *Panulirus argus*	901		
Smaller than Legal Size		312	67.5%
Smaller than Legal Size, With Eggs		11	2.4%
With Eggs		139	30.1%
Scyllarides aequinoctia.	918	1	

4.3.5 Total of all bycatch 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 10).

Table 10. Summary of all bycatch samples combined for all methods.

Bycatch Species	TIP Code	# Observed on Shore	% of Total	Including Not Returned to Shore	Including Sub Sampled and Not Returned	Combined % of Total
Panulirus argus	901	395	17.56%	25	420	11.85%
Lactophrys poligonius	703	273	12.14%	2	696	19.65%
Ostraciidae	256	256	11.38%	6		0.00%
Acanthurus coeruleus	224	169	7.51%	5	377	10.64%
Lactophrys triqueter	703	160	7.11%		407	11.48%
Lactophrys quadricornis	700	147	6.54%	6	380	10.72%
Lutjanus apodus	137	123	5.47%		159	4.49%
Lactophrys bicaudalis	704	108	4.80%	2	277	7.81%
Lactophrys trigonus	704	80	3.56%		203	5.74%
Diodon holacanthus	820	73	3.25%	10	101	2.85%
Acanthurus chirurgus	651	64	2.85%	3	67	1.89%
Balistes vetula	253	52	2.31%	3	67	1.89%
Calamus pennatula	165	28	1.24%		28	0.79%
Epinephelus cruentatus	82	28	1.24%		28	0.79%
Ocyurus chrysurus	140	26	1.16%	2	28	0.79%
Caranx ruber	115	25	1.11%	1	26	0.73%
Lutjanus griseus	132	25	1.11%		25	0.71%
Holocentrus rufus	625	21	0.93%	3	24	0.68%
Chaetodon striatus	561	14	0.62%		14	0.40%
Scorpaena plumieri	244	12	0.53%	6	18	0.51%
Sphyraena barracuda	205	12	0.53%	1	13	0.37%
Aluterus scriptus	728	11	0.49%	1	12	0.34%

Bycatch Species	TIP Code	# Observed on Shore	% of Total	Including Not Returned to Shore	Including Sub Sampled and Not Returned	Combined % of Total
Cantherhines macrocerus	727	11	0.49%		11	0.31%
Lutjanus jocu	133	11	0.49%	3	14	0.40%
Lutjanus mahogoni	137	9	0.40%	4	13	0.37%
Caranx latus	118	8	0.36%		8	0.23%
Haemulon aurolineatum	159	8	0.36%		8	0.23%
Pomacanthus paru	577	8	0.36%	2	10	0.28%
Aluterus schoepfi	725	7	0.31%	1	8	0.23%
Mulloidichthys martinicus	176	7	0.31%		7	0.20%
Epinephelus guttatus	88	6	0.27%		6	0.17%
Priacanthus arenatus	98	6	0.27%	1	7	0.20%
Holacanthus tricolor	577	5	0.22%		5	0.14%
Scomberomorus regalis	234	5	0.22%		5	0.14%
Cantherhines pullus	255	3	0.13%		3	0.08%
Holocentrus marianus	8810080105	3	0.13%		3	0.08%
Lutjanus buccanella	138	3	0.13%		3	0.08%
Ocyurus chrysurus (shark bite)	140	3	0.13%		3	0.08%
Acanthurus bahianus	218	2	0.09%		2	0.06%
Aluterus monoceros	730	2	0.09%		2	0.06%
Caranx lugubris	119	2	0.09%		2	0.06%
Chilomycterus antillarum	822	2	0.09%		2	0.06%
Echeneus naucratis	108	2	0.09%		2	0.06%
Epinephelus fulvus	80	2	0.09%	1	3	0.08%
Haemulon aurolineatum	159	2	0.09%		2	0.06%
Haemulon flavolineatum	157	2	0.09%		2	0.06%

Bycatch Species	TIP Code	# Observed on Shore	% of Total	Including Not Returned to Shore	Including Sub Sampled and Not Returned	Combined % of Total
Holacanthus ciliaris	184	2	0.09%		2	0.06%
Lutjanus synagris	136	2	0.09%		2	0.06%
Pomacanthus arcuatus	578	2	0.09%		2	0.06%
Pseudupeneus maculatus	175	2	0.09%		2	0.06%
Scyllarides aequinoctia.	918	2	0.09%		2	0.06%
Bothus lunatus	249	1	0.04%	1	2	0.06%
Caranx crysos half fish	117	1	0.04%		1	0.03%
Caranx hippos	601	1	0.04%		1	0.03%
Crab,marine	930	1	0.04%		1	0.03%
Epinephelus adscensionis	90	1	0.04%		1	0.03%
Equetus lanceolatus	172	1	0.04%	1	2	0.06%
Eupomacentrus fuscus	185	1	0.04%		1	0.03%
Gerres cinereus	148	1	0.04%		1	0.03%
Gymnothorax moringa	442	1	0.04%		1	0.03%
Pomacentridae	185	1	0.04%		1	0.03%
Seriola rivoliana	111	1	0.04%		1	0.03%
Serranus tabacarius	92	1	0.04%		1	0.03%
Gymnothorax funebris	34	1	0.04%	1	2	0.06%
Ginglymostoma cirratum	5	1	0.04%	5	6	0.17%
Epinephelus stratus	89	1	0.04%	1	2	0.06%
Lutjanus analis	134	1	0.04%	1	2	0.06%
Megalops atlanticus	25	1	0.04%	3	4	0.11%
Tylosauris crocodilus	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 retained catch included 48 species, 10 species (topped by the Queen Triggerfish, Balistes vetula at 14.6%) made up 70% of the landings (Table 11).

Table 11. Retained from fish trap samples.

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

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

Box fish (Ostraciidae) accounted for 55% of the trap bycatch by number although they accounted for less than 6% of the retained catch by weight (Table 12). The Schoolmaster snapper (*Lutjanus apodus*), at 8% of the bycatch landings weight is a species that provides a high risk of Ciguatera fish poisoning and was totally absent from the retained catch.

Table 12. Bycatch from fish trap samples. The results have been adjusted to account for box fish which were not identified to species (see Table 7).

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

Species	TIP code	Number	
Cantherhines macrocerus	727	11	1%
Lutjanus jocu	133	9	1%
Chaetodon striatus	576	8	1%
Pomacanthus paru	577	8	1%
Aluterus schoepfi	725	7	1%
Mulloidichthys martinicus	176	7	1%
Epinephelus guttatus	88	6	0%
Lutjanus mahogoni	137	5	0%
Cantherhines pullus	255	3	0%
Holacanthus tricolor	577	3	0%
Lutjanus buccanella	138	3	0%
Acanthurus bahianus	218	2	0%
Aluterus monoceros	730	2	0%
Caranx latus	118	2	0%
Chilomycterus antillarum	822	2	0%
Holacanthus ciliaris	184	2	0%
Pomacanthus arcuatus	578	2	0%
Bothus lunatus	249	1	0%
Equetus lanceolatus	172	1	0%
Haemulon flavolineatum	157	1	0%
Ocyurus chrysurus	140	1	0%
Priacanthus arenatus	98	1	0%
Serranus tabacarius	92	1	0%
Total Bycatch		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 numbers (Table 13). This is also true of the bycatch (Table 14).

Table 13. Retained catch by the directed lobster fishery.

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

Species	TIP Code	Number	Percent
Acanthurus coeruleus	652	15	1.18%
Ocyurus chrysurus	140	15	1.18%
Haemulon plumieri	155	11	0.86%
Sparisoma viride	196	11	0.86%
Lactophrys trigonus	257	10	0.78%
Lutjanus synagris	136	10	0.78%
Crab,marine	906	9	0.71%
Lutjanus analis	134	9	0.71%
Epinephelus fulvus	80	8	0.63%
Lactophrys bicaudalis	702	8	0.63%
Lactophrys poligonius	701	7	0.55%
Sparisoma rubripinne	679	7	0.55%
Haemulon sciurus	156	6	0.47%
Acanthurus bahianus	218	5	0.39%
Scarus coeruleus	195	4	0.31%
Pomacanthus arcuatus	576	3	0.24%
Scyllarides aequinoctialis	918	3	0.24%
Aluterus schoepfi	725	2	0.16%
Holacanthus ciliaris	184	2	0.16%
Scarus taeniopterus	678	2	0.16%
African lobster	999999	1	0.08%
Epinephelus morio	87	1	0.08%
Haemulon chrysargyreum	158	1	0.08%
Lachnolaimus maximus	189	1	0.08%
Majidae	618701000000	1	0.08%
Pomacanthus paru	577	1	0.08%
Lobster Catch Sample		1275	
Number of Species	36		100.00%

Table 14. Bycatch by the directed lobster fishery.

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

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

4.4.3 Hand Line

The hand line retained catch is dominated by yellowtail snappers and hard nose which make up 86% of the total landings weight (Table 15).

Table 15. Landings by the hand line fishery

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

Yellowtail snapper is the most frequently caught bycatch species (Table 16), but does not dominate as for the hand line retained catch.

Table 16. Hand line fishery bycatch

Species	TIP Code	Number	%
Ocyurus chrysurus	140	31	26.01%
Epinephelus cruentatus	82	28	22.76%
Holocentrus rufus	625	15	12.20%
Sphyraena barracuda	205	12	9.76%
Calamus pennatula	165	6	4.88%
Caranx latus	118	5	4.07%
Scomberomorus regalis	234	5	4.07%
Caranx ruber	115	3	2.44%
Holocentrus marianus	8810080105	3	2.44%
Caranx crysos half fish	117	2	1.63%
Caranx lugubris	119	2	1.63%
Echeneus naucratis	108	2	1.63%
Epinephelus fulvus	80	2	1.63%
Haemulon aurolineatum	159	2	1.63%
Remora remora	590	2	1.63%
Haemulon aurolineatum	159	1	0.81%
Seriola rivoliana	111	1	0.81%
Hand Line Bycatch		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 buld of the retained catch (Table 17). 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 tunnys (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 bycatch (Table 18). Seine net fishermen sort these undesirable species and release them prior to boating the retained species.

Table 17. Seine net retained catch.

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

Table 18 Seine net bycatch.

Species	TIP Code	Number	%
Ocyurus chrysurus	140	5	29.41%
Caranx ruber	115	4	23.53%
Acanthurus coeruleus	652	1	5.88%
Caranx hippos	601	1	5.88%
Caranx latus	118	1	5.88%
Gerres cinereus	148	1	5.88%
Lutjanus griseus	132	1	5.88%
Lutjanus mahogoni	137	1	5.88%
Lutjanus synagris	136	1	5.88%
Pseudupeneus maculatus	175	1	5.88%
Seine Net Bycatch		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 (Table 19). No bycatch was recorded. The project did not have longlines on the sampling protocol, and these samples should be considered incidental to the main objective of the program.

Table 19. Long-line landings.

Species	TIP Code	Number	
Etelis oculatus	143	25	56.82%
Lutjanus vivanus	139	6	13.64%
Ocyurus chrysurus	140	4	9.09%
Epinephelus fulvus	80	3	6.82%
Epinephelus guttatus	88	2	4.55%
Epinephelus mystacinus	86	2	4.55%
Euthynnus alletteratus	230	1	2.27%
Pristipomoides aquilonaris	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 (Table 20). These ranged from Ciguatera fish poisoning, fish to 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 bycatch 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 20. 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 21. All correlations were significant at the $p<0.01$ level.

Table 21. Weight/Length relationships for species which had more than 40 individuals.

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

4.7 Length Frequency Distributions

Length/Frequency Distributions are shown in Table 22 with the Species names and TIP codes shown in Table 20. All measurements are Fork Lengths with the exception of the spiny lobster carapace measurements. All are in millimeters.

Table 22. Length Frequency Distributions for most frequent species in study. Species names for the TIP codes are given in Table 23.

Fork Length (mm)[2]	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			2			0	0		0		1	0			62
130	0	1		0			0			0			0	0		1	0	2	0			58
135	2	14		0			0			0			0	0		0	0	1	0			23
140	6	16		0			0			0			1	1	0	0	5	9	0			22
145	2	13		0			0			0			0	2	1	0	6	5	0			10
150	1	12	0	2		0	4			0	0		1	3	0	0	4	4	0	0		17

[2] Species 901 (Panulirus argus) were measured carapace lengths.

Fork Length (mm)[2]	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
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	
210	25	16	16	18		1	8	3	0	1	10	0	8	7	40	7	0	2	1	1	4	
215	26	6	10	10	0	7	3	9	2	0	9	1	4	8	22	12	2	3	0	1	2	
220	24	17	7	9	0	3	2	2	2	6	16	1	12	5	25	7	0	1	1	0	4	
225	13	10	5	23	0	7	1	2	0	4	18	3	26	3	22	9	2	3	0	0	3	
230	15	6	7	10	0	1	0	2	2	12	15	8	39	7	35	12	1	0	0	0	6	
235	12	2	9	10	3	5	1	3	0	11	14	7	48	3	24	5	0	0	0	4	9	
240	9	5	11	9	3	3	1	3	3	19	32	7	51	5	10	12	2	0	1	1	7	
245	5	1	8	6	2	4	0	2	3	13	11	4	34	5	12	7	0	0	1	5	10	
250	10	2	10	6	4	4	0	3	0	15	18	11	21	6	7	10	0	0	2	6	12	
255	5	3	8	8	4	2	0	2	2	10	14	11	13	0	7	9	0	0	3	8	25	
260	8	1	5	7	7	0	0	2	2	8	25	18	10	6	8	15	0	0	9	12	18	
265	3	1	9	5	9	2	1	2	0	7	14	11	1	1	6	8	0	0	10	9	44	
270	6	0	11	9	19	1	0	5	3	12	21	14	1	1	2	9	0	1	4	13	37	
275	3	0	15	4	14	7	0	6	1	5	24	12	0	0	2	1	0	0	5	12	39	
280	1	0	20	5	12	3	0	4	4	3	18	9	0	2	4	4	0	0	7	5	43	
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	

Fork Length (mm)[2]	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
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	
420			4		3	0	0		2							0			0		10	
425			4		2	2	0		2							0			0		15	
430			4		2	1	0		4							0			2		15	

Fork Length (mm)[2]	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
435			1		3	0	0		5							0			0		12	
440			1		0	3	0		1							0			0		13	
445			0		0	1	0		2							1			0		6	
450			1		0	0	0		3										1		3	
455			1		1	1	1		1										0		7	
460			1		1	1	0		1										0		5	
465			0		1	1			1										0		2	
470			0		0	0			1										0		4	
475			0		1	0			0										0		5	
480			1		0	0			0										1		5	
485					0	0			0												6	
490					1	0			1												3	
495					0	0			0												5	
500					0	1			1												3	
505					0	0															4	
510					0	0															0	
515					0	0															0	
520					0	0															4	
525					1	0															4	
530					0	0															0	
535					1	0															0	
540						0															1	
545						1															2	
550																					1	
555																					1	
560																					1	
565																					2	
570																					2	

Fork Length (mm)[2]	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
575																					0	
580																					2	
585																					1	
590																					0	
595																					1	
600																					0	
605																					0	
610																					1	
615																					0	
620																					1	
625																					0	
630																					1	
635																					1	
640																					1	
645																					2	
650																					2	
655																					0	
660																					1	
665																					0	
670																					0	
675																					0	
680																					1	
685																					0	
690																					1	

Table 23. Species names for the TIP codes shown on Table 22 length/frequency distributions. Length at maturity, growth and mortality paramaters are from FAO's FISHBASE[3].

Tip Codes	Species	Length at Maturity	k	L_{oo}	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 CRYSOS	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[4]		0.432	152[5]	0.651-0.413

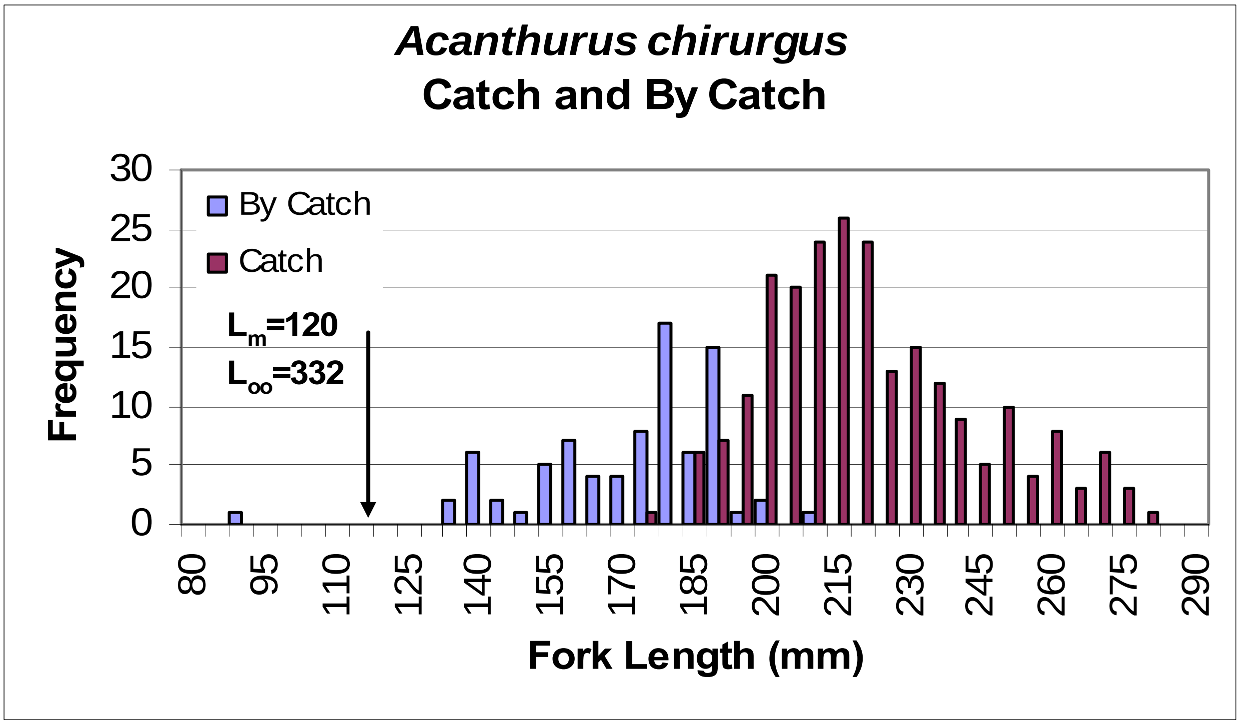
A comparison of length frequency distributions was made for a number of the more common species. The comparison also incorporated information from FISHBASE relating to lengths at maturity and maximum size in order to obtain an initial assessment of fishing practices' impacts upon the populations. In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

[3] http://filaman.ifm-geomar.de/search.php?lang=English
[4] 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
[5] 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 (Figure 3) was larger than the 120 mm Fork Length at first maturity reported in FISHBASE. The largest individuals in the study are smaller than L_{oo}.

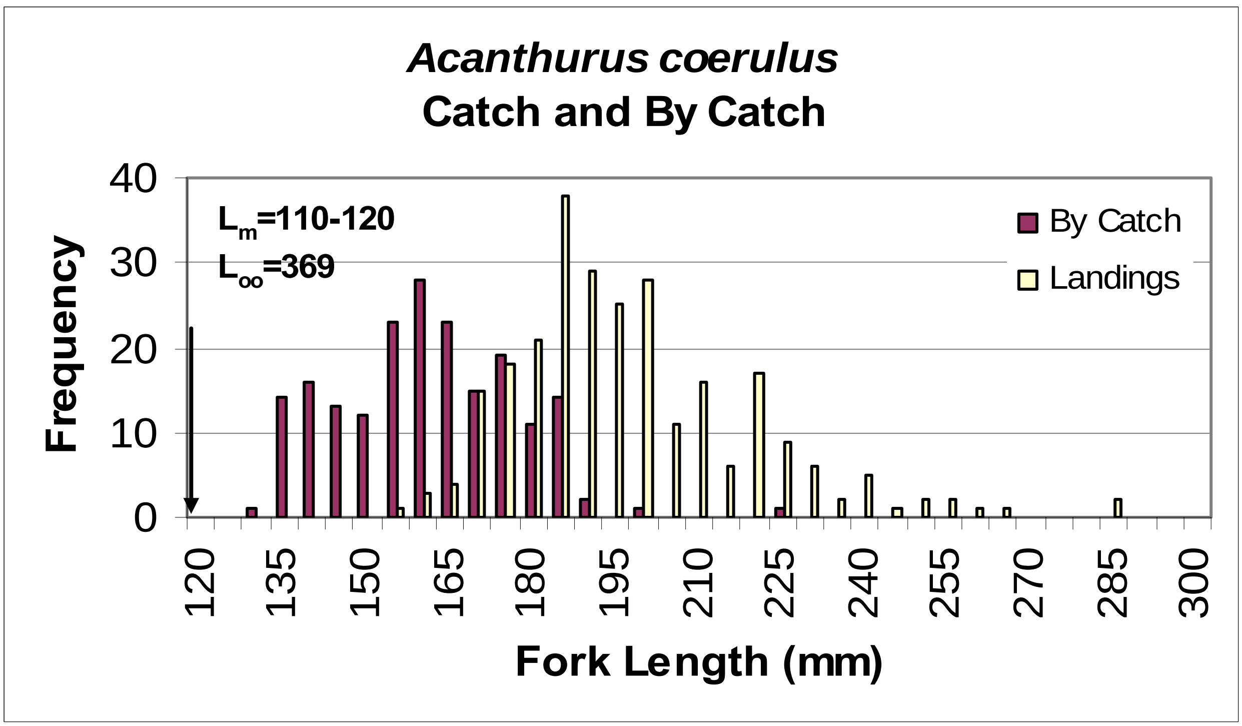
Figure 3. Comparison of catch and bycatch size frequency data for *Acanthurus chirurgus.*



4.7.2 Acanthurus coerulus (TIP=652)

The blue tang (*Acanthurus coerulus*) is also preferred by many Virgin Islands consumers. It makes up 13% of the landings and 8% of the bycatch. Comparison of the catch and bycatch illustrates market preferences for larger individuals although there is more overlap in size between catch and bycatch than with the doctor fish. Nearly every fish observed in the study (Figure 4) 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_{oo}.

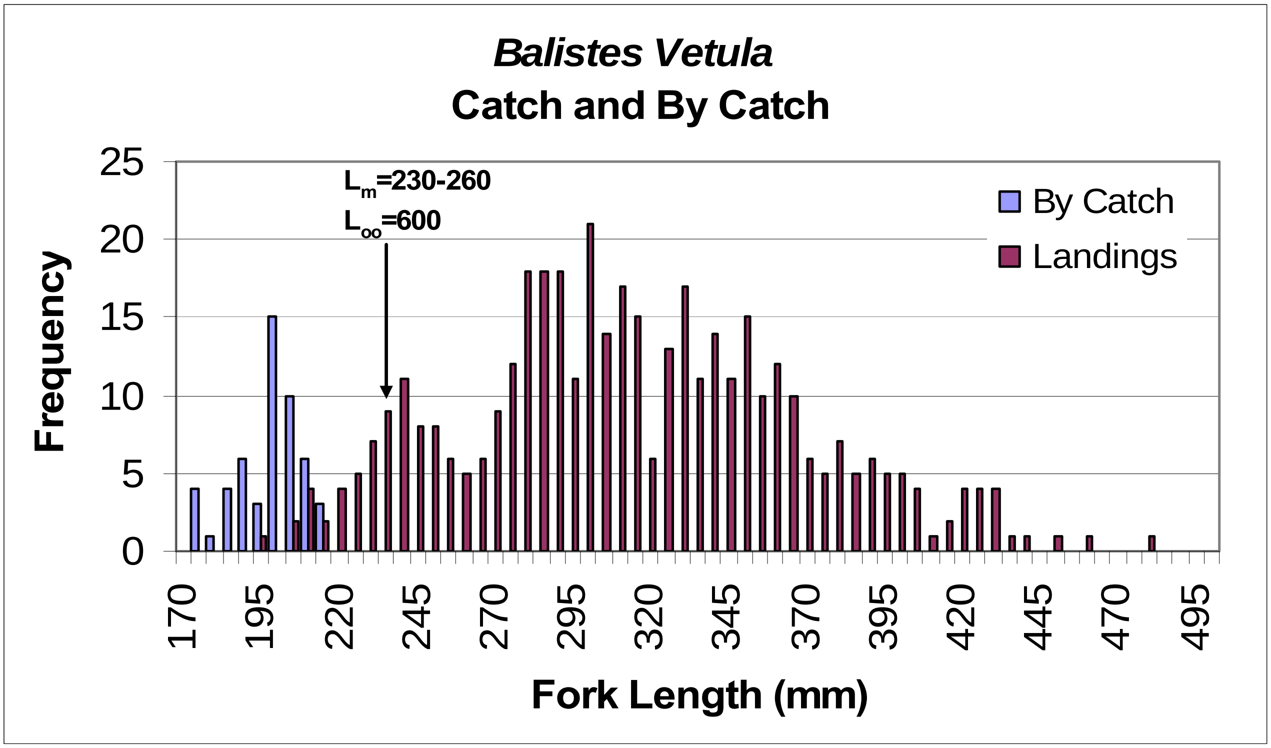
Figure 4. Comparison of catch and bycatch size frequency data for *Acanthurus coerulus.*



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 (Figure 5) appears to show as many as eight modes which would indicate a diverse age structure.

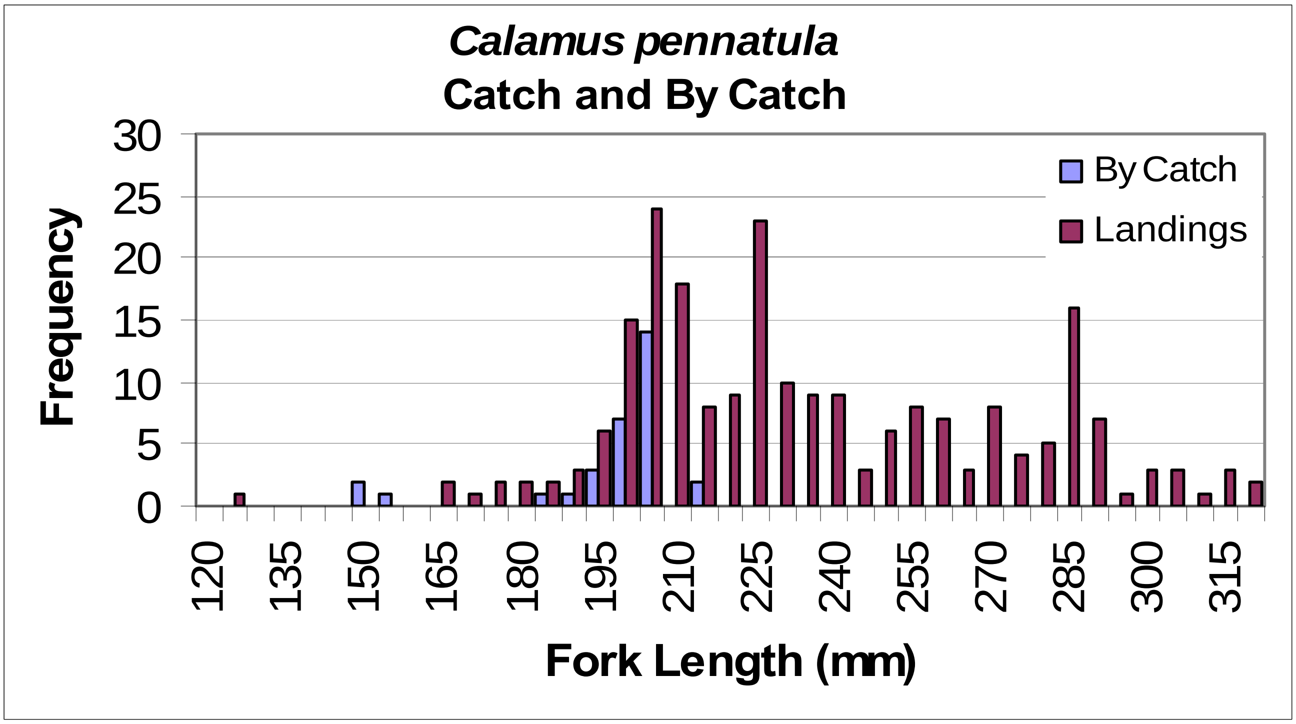
Figure 5. Comparison of catch and bycatch size frequency data for *Balistes vetula*.



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 bycatch 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 (Figure 6) appears to shows a number of modes which would indicate a diverse age structure.

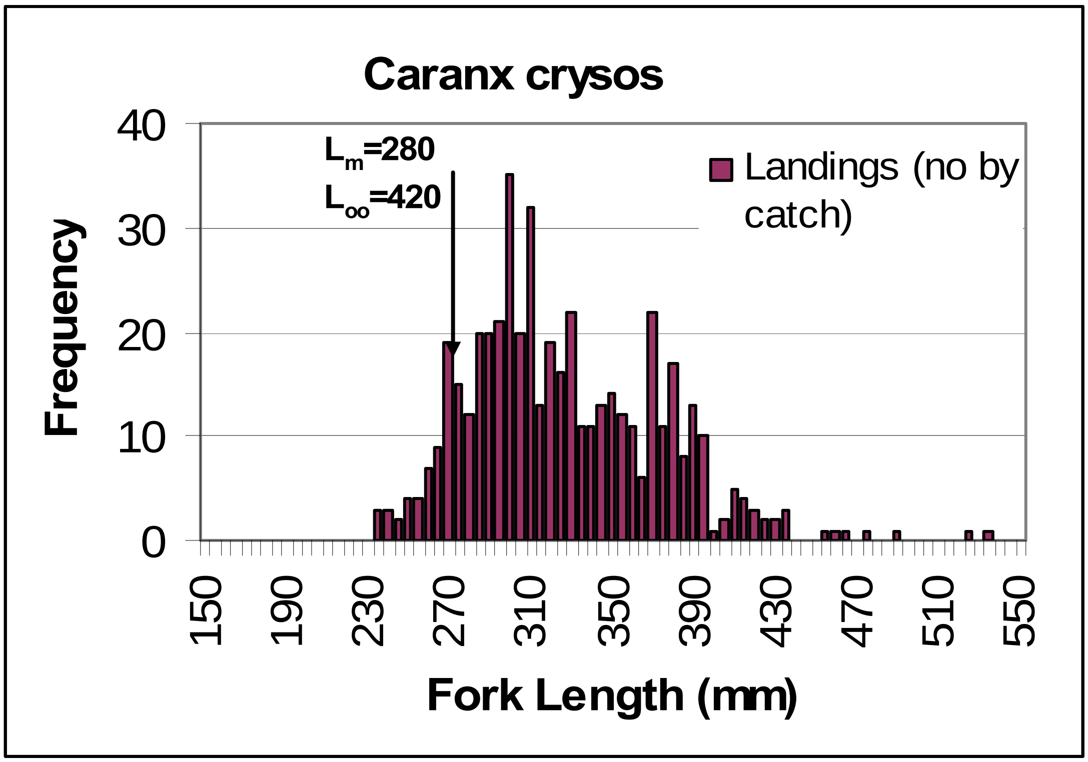
Figure 6. Comparison of catch and bycatch size frequency data for *Calamus pennatula*.



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 bycatch was a 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_{oo}) reported in FISHBASE. The size frequency distribution (Figure 7) appears to show as many as six modes which would indicate a diverse age structure.

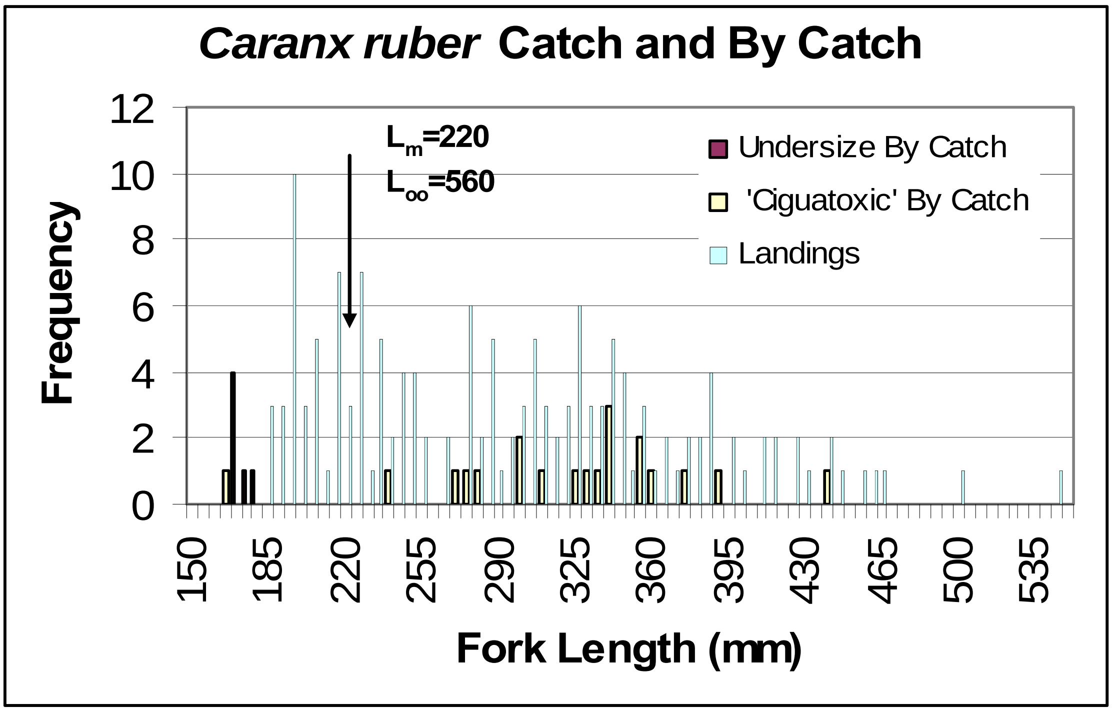
Figure 7. Comparison of catch and bycatch size frequency data for *Caranx crysos.*



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 220 mm 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 (Figure 8) appears to show at least seven modes which would indicate a diverse age structure.

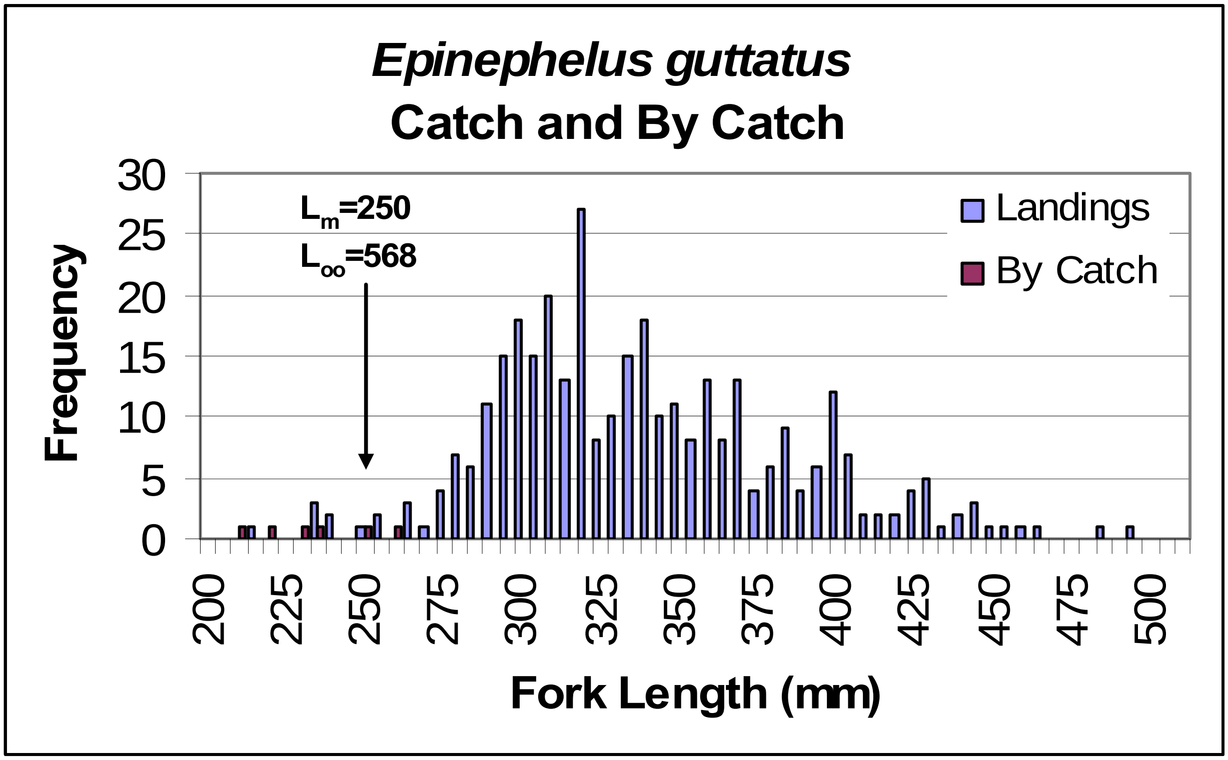
Figure 8. Comparison of catch and bycatch size frequency data for *Caranx ruber*.



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 (Figure 9) appears to show eight or more modes which would indicate a diverse age structure.

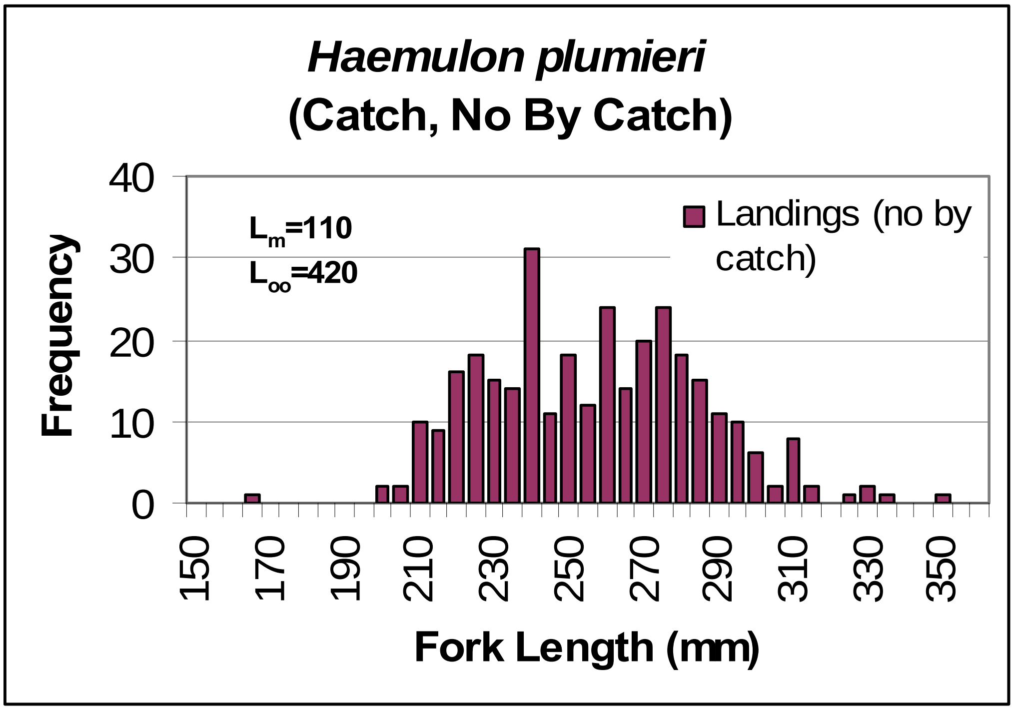
Figure 9. Comparison of catch and bycatch size frequency data for *Epinephelus guttatus.*



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 (Figure 10) appears to show a number of modes which would indicate a diverse age structure.

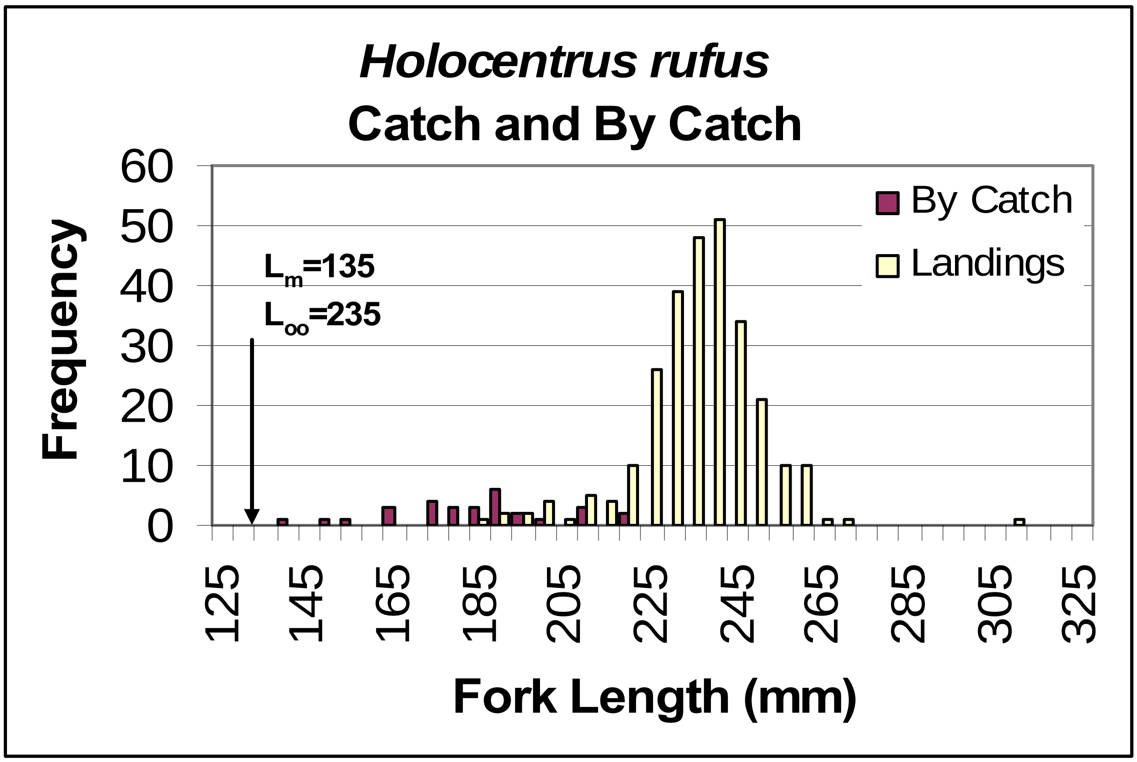
Figure 10. Size frequency data for *Haemulon plumieri*.



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 bycatch. 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 (Figure 11) appears to show a 3-5 of modes which would indicate a diverse age structure.

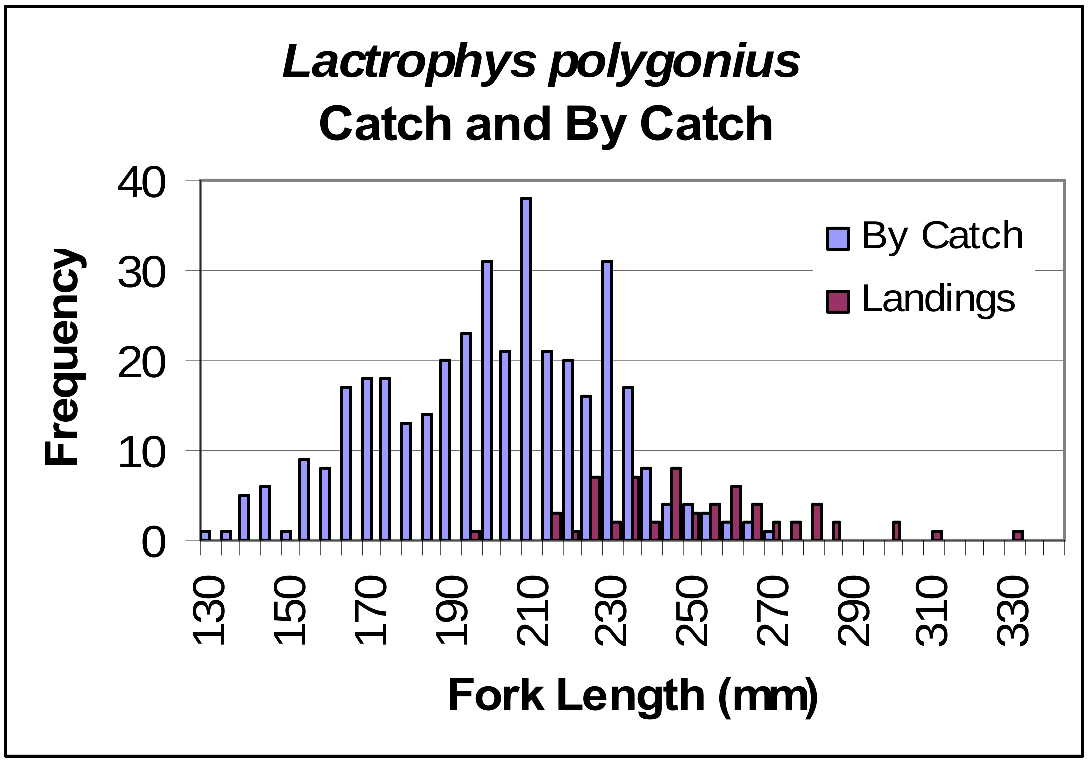
Figure 11. Comparison of catch and bycatch size frequency data for *Holocentrus rufus.*



4.7.10 Lactrophys polygonius (TIP=701)

Honeycomb cowfish (*Lactrophys polygonius*) represent 2% of the fish trap landings and 20% of the bycatch. 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 (Figure 12) appears to show a 4-5 of modes which would indicate a diverse age structure.

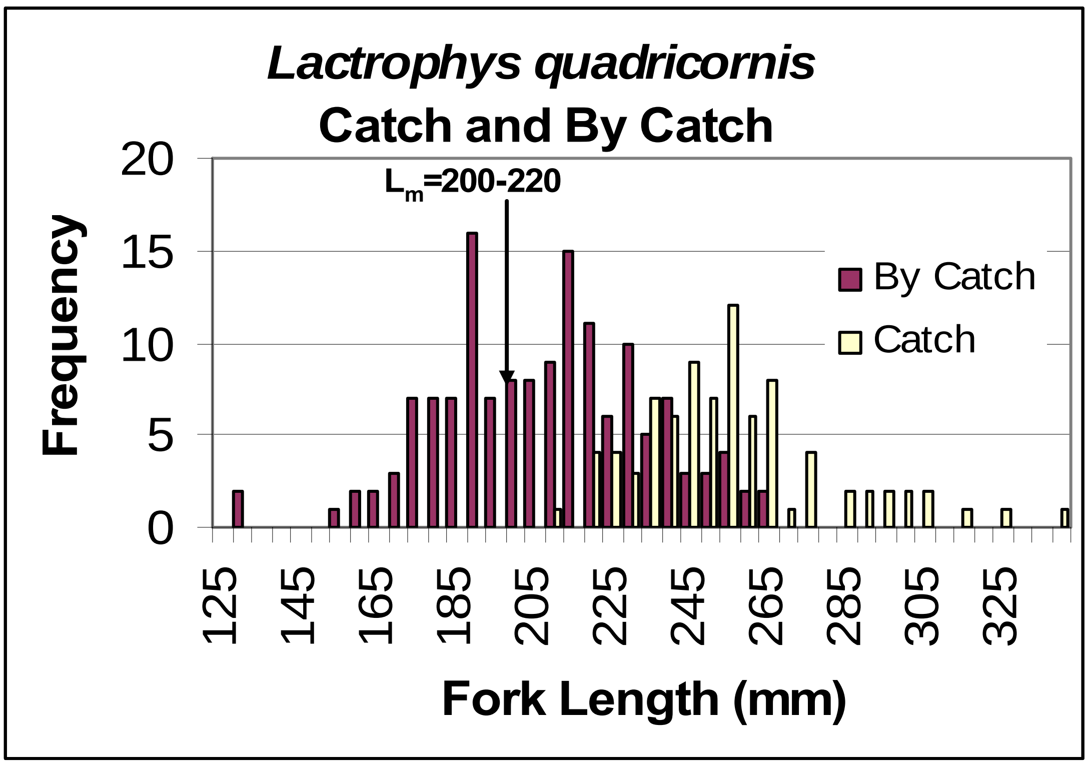
Figure 12. Comparison of catch and bycatch size frequency data for *Lactrophys polygonius.*



4.7.11 Lactrophys quadricornis (TIP=700)

Scrawled cowfish (*Lactrophys poligonius*) represent 2.5% of the fish trap landings and 10% of the bycatch. 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 (Figure 13) appears to show a 4-5 of modes which would indicate a diverse age structure.

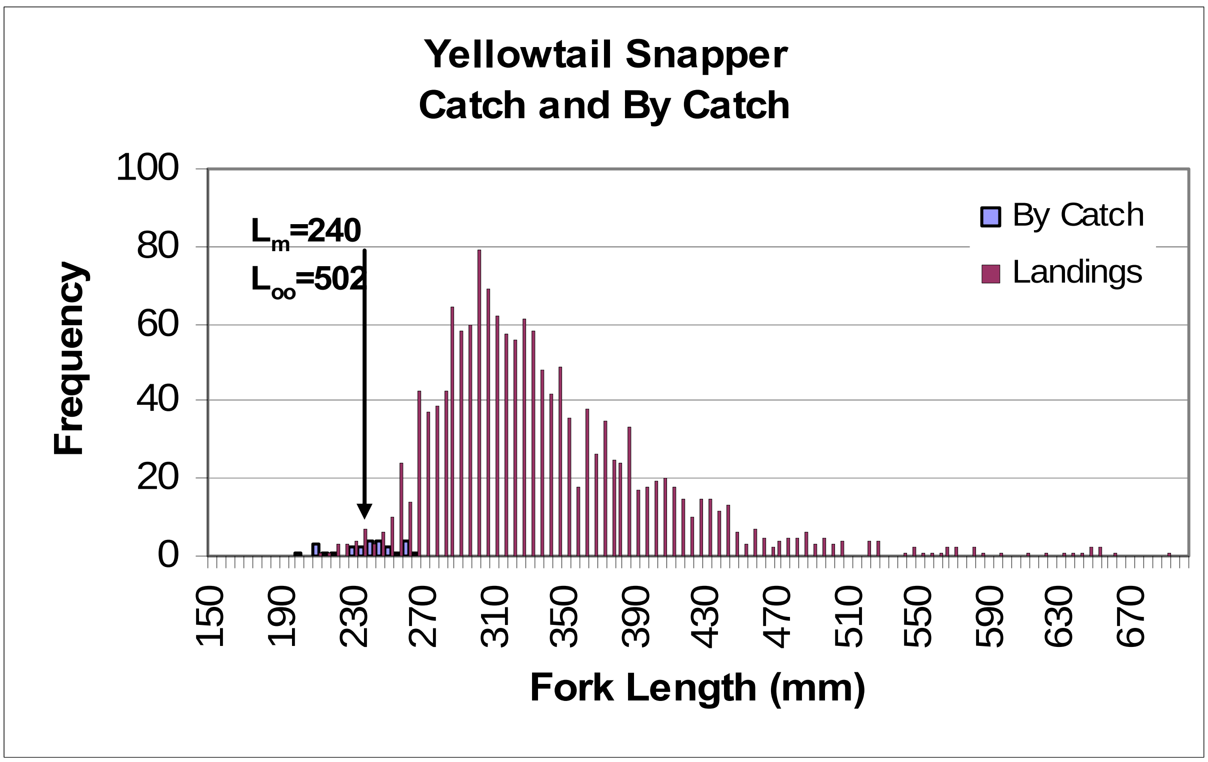
Figure 13. Comparison of catch and bycatch size frequency data for *Lactrophys quadricornis.*



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. Bycatch was a very small portion of the landings. The size frequency distribution (Figure 14) 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 bycatch size frequency data for *Ocyurus chrysurus.*

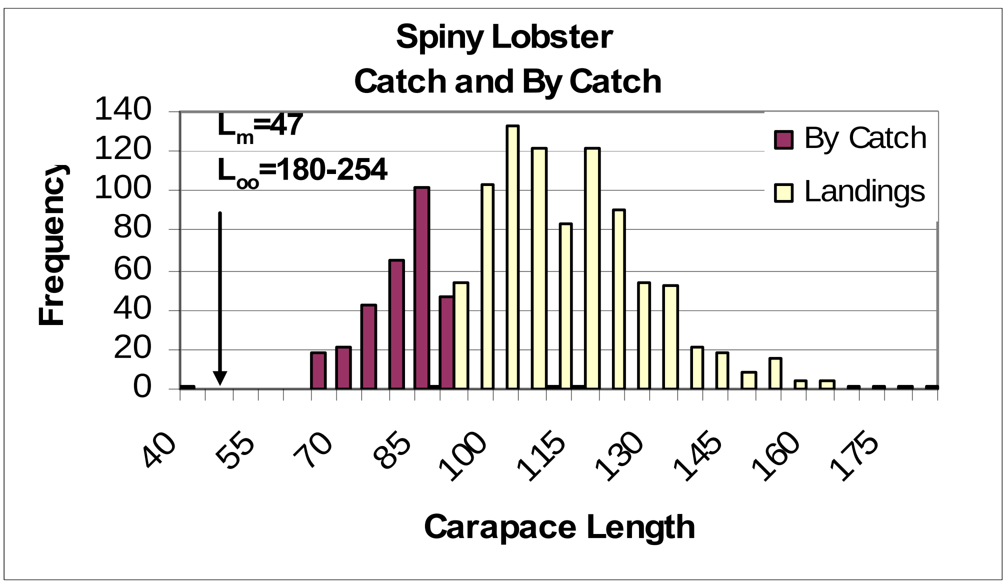


4.7.13 Panulirus argus (TIP=901)

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 was taken in plastic lobster traps. Lobster are a major feature on the menus of local restaurants and hotels, which 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.[6]. In that study, tag-recapture techniques were used to obtain an estimate of L_{oo} 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 those at 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. Bycatch was a very small portion of the landings. The size frequency distribution (Figure 15) 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 15. Comparison of catch and bycatch 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.

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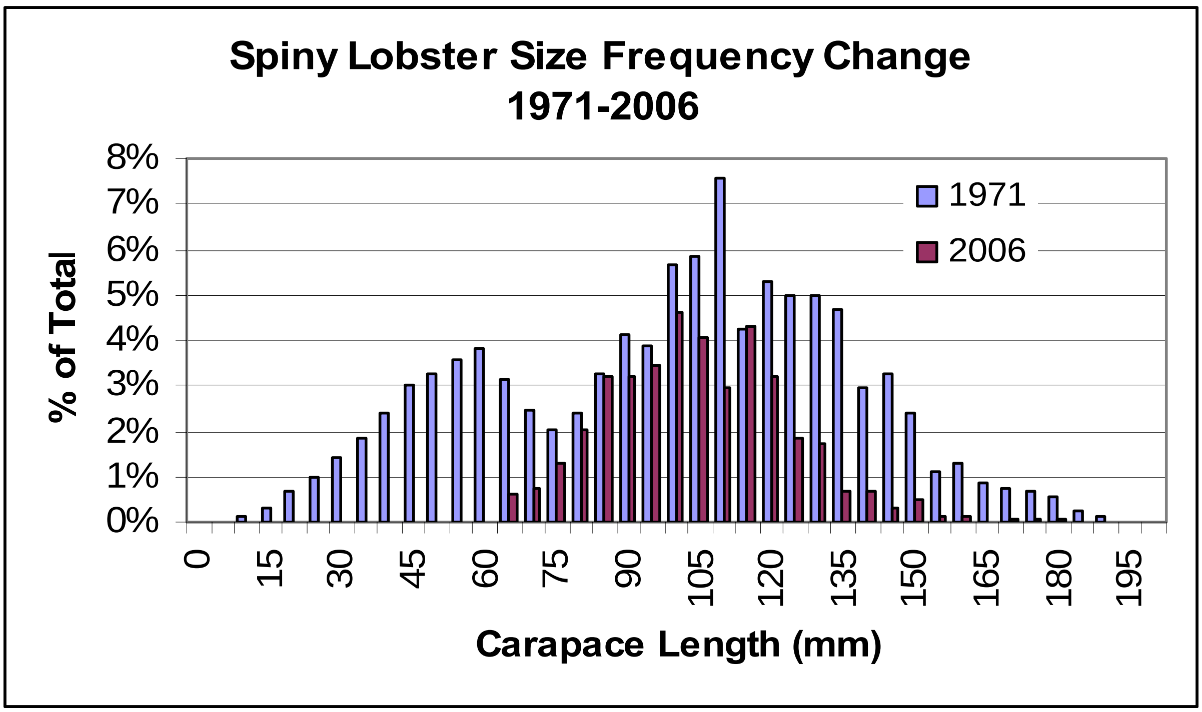
[6] Olsen, D.A. and I.G. Koblic. 1975. Population Dynamics, Ecology and Behavior of Spiny Lobsters, *Panulirus argus* of St. John, USVI.: (II) Growth and Mortality. Bull. So. Calif. Acad. Sci. Vol (20) pp.17-21

The average size of all lobsters (bycatch and landed catch) was 103mm. This is almost exactly 10mm less than the average for Olsen and Koblic'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 16. 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 bycatch from commercial landings from throughout the St. Thomas/St. John shelf.

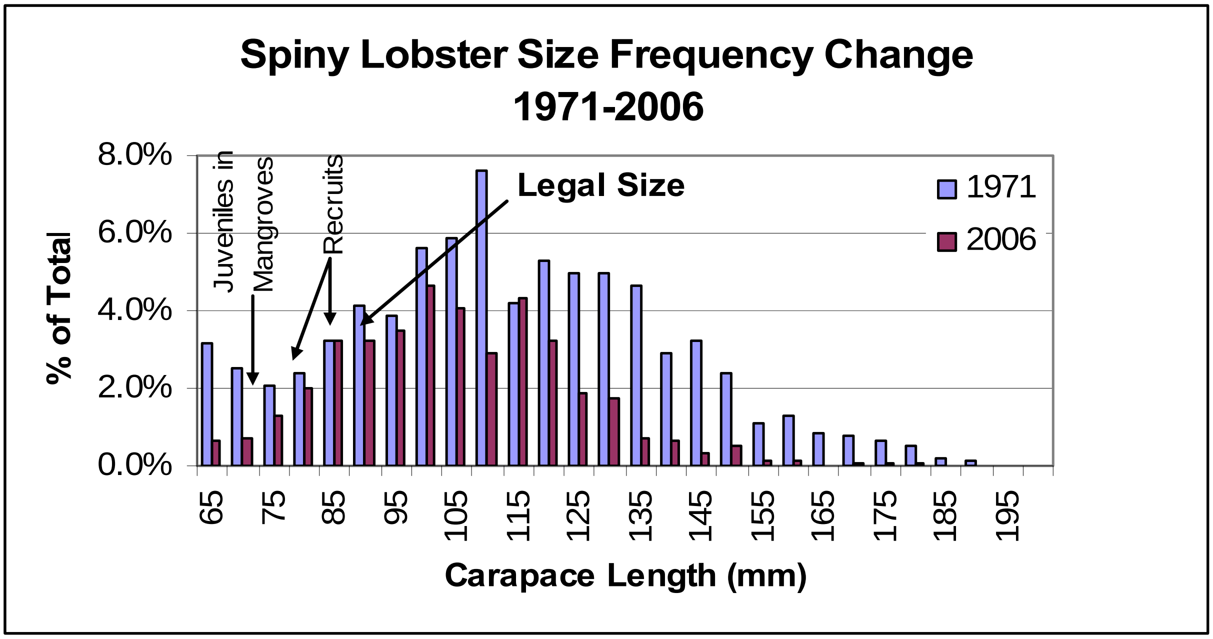
Figure 16. Comparison of size frequency data for *Panulirus argus samples from 1971-72 and 2006.*



If the comparison includes pre-recruit size classes 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 17, 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 17. 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 that 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 support a conclusion 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

Objectives

The purpose of this project is to assess the potential for obtaining information on bycatch, discards, and biological data from the commercial fisheries of the US Caribbean, to help characterize the total catch for the US Caribbean region. This type of information does not exist in the US Caribbean, although it is required by the Magnuson-Stevens Fishery Conservation and Management Act. The project will focus on St. Thomas fisheries to develop 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. The St. Thomas Fishermen's Association (STFA), MRAG Americas, Inc., and the Southeast Fisheries Science Center (SEFSC), will team with commercial fishers from the US Virgin Islands to conduct the pilot observer program. The results of the project could help management agencies determine whether bycatch and discards are a problem, and whether an observer program could help obtain necessary data.

The immediate objective is to develop and implement a pilot observer scheme capable of monitoring catch and discards on small-scale vessels using fishing gears most commonly used by St. Thomas commercial fishers. The project will primarily address feasibility issues associated with placing of observers onboard commercial fishing vessels in the US Caribbean, with emphasis on the fisheries of St. Thomas:

- Financial, space, and safety considerations for placing observers on board
- Limitations to data collection on board
- Coordination and cooperation issues with fishers
- Alternatives to placing observers on board.

This project is a continuation of a project started in St. Croix in 2004, and is intended to gain information to compare and contrast the fisheries in the St. Croix-St. Thomas areas. The fishers and fisheries of St. Croix and St. Thomas exhibit substantially different characteristics (Barbara Kojis, 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 nets. 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, fishery managers need to know if the slatted plastic lobster traps catch 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.

This and the previous St. Croix project will obtain the only available data on bycatch and discards in the US Virgin Islands, and will supplement the USVI biostatistical sampling program. Therefore, collecting and maintaining high quality data is a high priority for the project. It will be important to provide an explanation to fishers of why the information is being collected and how it will be used. This can be provided by the observer and the observer supervisor when contacting fishers.

Summary of fisheries

There are about 342 registered commercial vessels in the USVI. In St. Thomas, most boats are "small vessels", 16-19 feet long and of wooden construction, with a much smaller number of "large vessels" (8-9 vessels) greater than 30 feet long. Fishers in St. Thomas predominately use traps and pots. In the USVI, there is presently a moratorium on issuing new commercial fishing licenses. DFW report about 160 licensed fishers for St. Thomas and St. John. Approximately 30-40 full-time trap fishers operate out of St. Thomas/St. John, and another 30-40 out of St. Croix (Sheridan *et al.*, in review). Recent estimates by Sheridan *et al.* (in review) put the overall number of traps fished in the USVI at around 8,500, with about 1,500 fished off St. Croix and 7,000 fished off St. Thomas/St. John. Traps are fished most frequently off southwestern and northeastern St. Croix, and southwestern and southeastern St. Thomas. Sheridan *et al.* (in review) reported that while fishing multiple traps connected by trotlines (buoys on each end) is common among St. Thomas fishers, it is rare among St. Croix fishers who typically fish single traps with a single buoy attached. Additionally, St. Thomas trap fishers use mechanical pot haulers, fish their traps in deeper water (< 183m with a mean of 48m), and grapple off the bottom to snag buoyant trap lines and recover lost traps. St. Croix fishers generally pull traps by hand, fish in relatively shallow water (< 30m with a mean depth of 18m), and dive to locate missing traps (Sheridan *et al.*, in review). However, the habitat makeup of waters deeper than 30 m is largely unknown (Sheridan *et al.*, in review). These authors also stated that coral damage from traps may be more prevalent in St. Croix where reef habitat dominates, than in St. Thomas/St. John where macrolagal plains are more common. Recent dive surveys observed that pots on coral habitat in the USVI typically had no markings required of legal pots, indicating that pot damage may occur primarily from illegal fishers (Roger Uwate, William Tobias, DFW, USVI, pers. comm.).

Fishers may have a preferred species or set of species in mind at the beginning of each trip, but the large diversity of species in the US Caribbean will mean that fishers often catch species in addition to those preferred. Fishers will retain those fish with market (sale) or subsistence (take home) value, and may discard fish without value. The proportion of discards from the total catch in St. Croix is unknown; however, the gears that catch the majority of landings probably have the greatest amount of discards. These gear types are:

- Hook and line
- Wire mesh pots/trap
- Plastic slatted pots/traps
- Seine Net

The observer will have the following priorities, described in more detail in following sections:

- Maintain four vessels per month sampling schedule – one for hook and line, one for mesh pot, one for plastic slatted pot, and one additional depending on fishing.
- Try to ride a different vessel for each observation.
- Obtain individual length and weight measurements by species for the discarded catch
- Obtain individual length and weight measurements by species for the retained catch
- Record interactions with marine mammals, sea turtles, and seabirds
- Select approximately 20 fishers to collect discard data with no observer on board.

Approach

The approach presented below will address those components of the program associated with the following areas:

- Selecting vessels for observer deployment
- Identifying data that can be collected at sea and ashore
- Operational procedures for fishers and observers
- Safety

Stage 1: Select vessels for observer deployment

The Division of Fish and Wildlife (DFW) maintains the license registry for commercial licenses. The observer supervisor will obtain a list of currently-licensed vessels from DFW, sorted into the three gear types: pot/trap, hook and line, and other. The observer supervisor will request that the list of vessels be ranked by vessel length.

The observer will contact license holders on the list and determine 1) if they are planning to fish during the pilot program period, and 2) if they will voluntarily take an observer. The observer, in consultation with the observer supervisor, will remove the names of fishers who will not fish during the experiment or who refuse to carry the observer. From the remaining license holders, the observer, in consultation with the observer supervisor, will establish which boats are suitable for observer deployment. Because so many of the vessels from St. Thomas are small (less than 20 feet in length), observing will begin with the largest vessels, and work toward smaller vessels. Using information collected during observer trips (as described later in this document), the observer and observer supervisor will determine when remaining vessels are too small or otherwise unsuitable for observations.

The selection criteria will be based on the following elements:

- Willingness of captain/skipper to accept an observer;
- Gear type and characteristics;
- Size – is there adequate space for an observer;
- Seaworthiness of the vessel;
- Work space availability for sampling tasks;
- Safety equipment onboard.

To the degree possible, we will select appropriate vessels in advance, and make arrangements with captains who agree to accommodate the observer. The observer will start with the largest vessels for each target gear, and contact fishers until he can schedule a ride. The observer will select the first vessel on the list, try to set up a ride, go to the next if necessary. If insufficient fishers volunteer to carry an observer to provide approximately 10 vessels per gear type, a second ride on a boat is acceptable if the boat uses a different gear from the first observation on the vessel. If second rides on vessels using a different gear are insufficient to meet distribution goals, then it is OK to ride the same vessel with same gear twice. During the vessel selection process, the observer will explain to the vessel owner/operator that the pilot observer project intends to help collect information on the entire catch (retained and discards – see Introduction), and that the $100 payment will require assistance from the operator in making retained catch accessible to the observer for sampling.

While on board with a volunteer fisher, the observer will discuss the captain data-collection program. The observer will indicate that the project will pay $200 for each captain trip, and that the payment will require assistance from the operator in making retained and discarded catch available to the observer. The observer will determine which captains have the capacity and interest to fill out the forms and bring in the samples. The observer will also discuss captain data-collection with captains of vessels too small to carry an observer, with the intent of determining if captain data-collection is a suitable substitute for observer trips. If possible, the observer will schedule the first 10 captain-collection trips on different vessels. If a substantial proportion of the St. Thomas vessels are too small to carry an observer, the observer will emphasize obtaining captain-collected samples. After the first 10 trips, the project team will decide whether to repeat collections from prior vessels or to continue with different vessels. The observer will explain that the $200 payment will require assistance from the operator in making retained catch accessible to the observer for sampling.

The project design calls for four trips per month, one on hook and line, one on wire mesh pots/traps, one on plastic slatted pots/traps, and one other depending on fishing.

The observer will notify the fisher that we will record all catch information; fisher must agree to fish legally for duration of observed trip.

When an observer completes a trip on a vessel or picks up a sample from a captain's trip, the observer and captain will sign the trip confirmation form. Payment to the captain cannot occur without this form.

Stage 2: Identifying data that can be collected at sea and ashore

Data collected during this project will have two main components: biological data and fishing operations data. Biological data will consist of lengths and weights for all individuals of each species in the retained catch and in the discarded catch of each haul or set; estimates of survival potential for individuals to be discarded (at the time the fisher would have thrown them over the side); interactions with marine mammals, sea turtles, and/or sea birds; and other data to be determined based on observer experience. Fishing operations data will consist of date, time, vessel, captain, etc. Specific information and procedures are described in the Stage 3 section.

This project assumes that the small size of vessels in St. Thomas will prevent most cases of weighing and measuring specimens on-board the vessels. In most cases, the observer will retain fish to be discarded for processing on shore, although some prohibited species (undersized lobster and conch or berried lobster) may require efforts to collect data at sea. However, the Observer will note for each trip the feasibility for sampling on-board. The observer will:
Describe the procedures used for on-board sampling of lobster and conch, if any, and any problems encountered with the sampling
Evaluate whether any on-board sampling for fish was feasible, and if so, what level of sampling
Describe how the captain felt about the possibility of on-board sampling (likely to participate, opposed, etc.)

The project will provide a digital camera for use by the observer to record unusual incidents.

The data collected should be prioritized to fulfill program objectives, but where possible collect as much baseline information as practically possible to provide a complete picture of fishing activity. The data recording formats will be differentiated into information that can be collected at sea or ashore by either observers or skippers.

Stage 3: Data collection procedures

The Observer will keep sampling protocol as similar as practical to the current bio-sampling conducted under the Federally-sponsored Trip Interview Program (TIP) biosampling. The goal of TIP is to obtain representative samples from targeted fisheries. A representative sample is a sample that meets sound statistical criteria for (at minimum) describing a population. The populations are defined by fishery-time-area strata. For practical reasons area is defined here by area of landing, not the fishing area. The objectives of the TIP differ from the objectives of the pilot observer program, but all biological sampling will follow TIP as closely as possible. The instructions for collecting biological data and filling out forms for TIP are attached in the Appendix.

The pilot observer project will collect data from entire trips, rather than try to sample on a haul-by-haul basis. However, the observer will keep in mind the desirability of sampling sets or hauls, and help determine if fishers fish in a way that could constitute a "set" or "haul." To maintain consistency among vessels, the observer will collect biological data from retained catch as soon as possible after the vessel returns to port, but place all discards in labeled bags for processing the next day or days. The observer may place all discarded fish in a cooler while on board, for transfer to a bag or bags later. The observer will attempt to weigh and measure every specimen of the discarded catch and of the retained catch. If fishers sort retained catch into market and subsistence categories, the observer will sample each separately. The observer will weigh and measure undersized and berried lobsters and undersized queen conch on board; the observer will return these animals to sea as quickly as possible in as good a condition as possible. The observer will make notes on the capability of collecting data at sea.

Even though observer instructions call for weights for every specimen in the catch, which would provide the total catch by addition, observers may not be able to sample all specimens in every case. Therefore, a procedure for estimating total catch may be needed. US Caribbean fishers typically place retained catch in coolers. Observers could estimate weight of retained catch by standardizing the weight of catch to the volume of the coolers. The sum of retained catch (determined from direct weights or estimated by volume) and weight of discarded catch (determined from laboratory samples) would represent total catch.

Biosample data collection

The observer, with assistance from other observers, STFA members, or DFW staff, will collect biological and fishery information for each observer trip and each captain trip on the SEFSC TIP forms. This is one of the high priority data collection procedures. TIP forms and instructions for filling out the TIP forms are presented in the Appendix. Following each completed

Discard survival

The chance for fish to survive after being discarded (viability) is an important bit of information for assessing the impacts of discards on fish stocks. The requirement for observers to place discards in bags in a cooler prevents an observation of viability of discarded fish in the water. However, estimation of discard survival is important information. To help assess the feasibility of collecting this information, the observer will make qualitative observations on a tally sheet for each haul or set of viability as fish go into the bag:
Strong – active when stimulated, firm opercular pressure, no or minor bleeding, gills red
Weak – limited activity when stimulated, weak opercular pressure, moderate bleeding, gills pink
Dead – no activity when stimulated, no opercular pressure, extensive bleeding, gills pale
The observer supervisor will discuss this component of the project with the observer during debriefing to determine if modifications are needed in-season, or if the collection is feasible at all. For example, a live/dead division may be all that can be reasonably obtained.

Protected species

The observer will record basic information for each trip on interactions with marine mammals, sea turtles, and sea birds. The form will document the gear, the species, and the interaction.

Debriefing

Following each 1 or 2 trips, the observer and supervisor will meet to debrief the previous trips, and specifically discuss:

- Problems found on the vessel caused by vessel
- Problems found on the vessel caused by captain or crew
- Opportunities to sample on board
- Protected species interactions
- Illegal activities
- Capability of captain to perform captain-sample duties
- Amount of biological sampling time relative to 5-hr per trip time budget
- Review of data forms

Confidentiality

MRAG employees must understand that all observer data are the property of NOAA Fisheries and agree to turn in all data and reports on return from duty and retain no copies of data for personal use without the express written permission of NOAA Fisheries. Employees must understand that the fishing or processing operations they will observe include proprietary fishing strategies, locations, data, and business practices. Observers, subcontractors and their employees agree not to discuss or communicate any of this information to third parties other than in any communication required by NOAA Fisheries as a normal part of program duties. Data shall not be released, reproduced, distributed, or published.

Stage 4: Safety

Observers will not ride on vessels deemed as unsafe. Commercial fishing vessels in US waters are subject to US Coast Guard safety regulations. Observers will confirm that each vessel selected for an observation, and for which the captain has agreed to carry an observer, has a current Coast Guard or DPNR safety inspection. The observer should ask the captain about safety inspections at the time of the selection, and confirm that the vessel has a current inspection before boarding.

The observer may assist fisher with sorting, icing, or other activities that constitute minimal danger to the observer or to the vessel. The observer may not haul or retrieve gear, operate the fishing vessel, or any other activity that may result in danger to the observer or to the vessel. The observer should consult first with Dr. David Olsen and if necessary with Dr. Trumble on a case by case basis for specific activities that may arise.

The observer will notify the observer supervisor of each trip, and will report estimated time of departure and estimated time of return. The observer will notify the observer supervisor at the end of each trip. Observers will be outfitted with a life jacket and a personal EPIRB. Observers should, but are not required to, wear the life jacket during fishing operations. However, the observer must have the life jacket stored in a safe, accessible location, not subject to blowing or washing off the vessel and easily reached in an emergency. The EPIRB must be attached to the lifejacket or the to the observer's person at all times while on board. The observer will be outfitted with a handheld marine VHF radio to supplement cellular telephone access.

St. Thomas Pilot Observer Project
Discard mortality tally form: September 2004

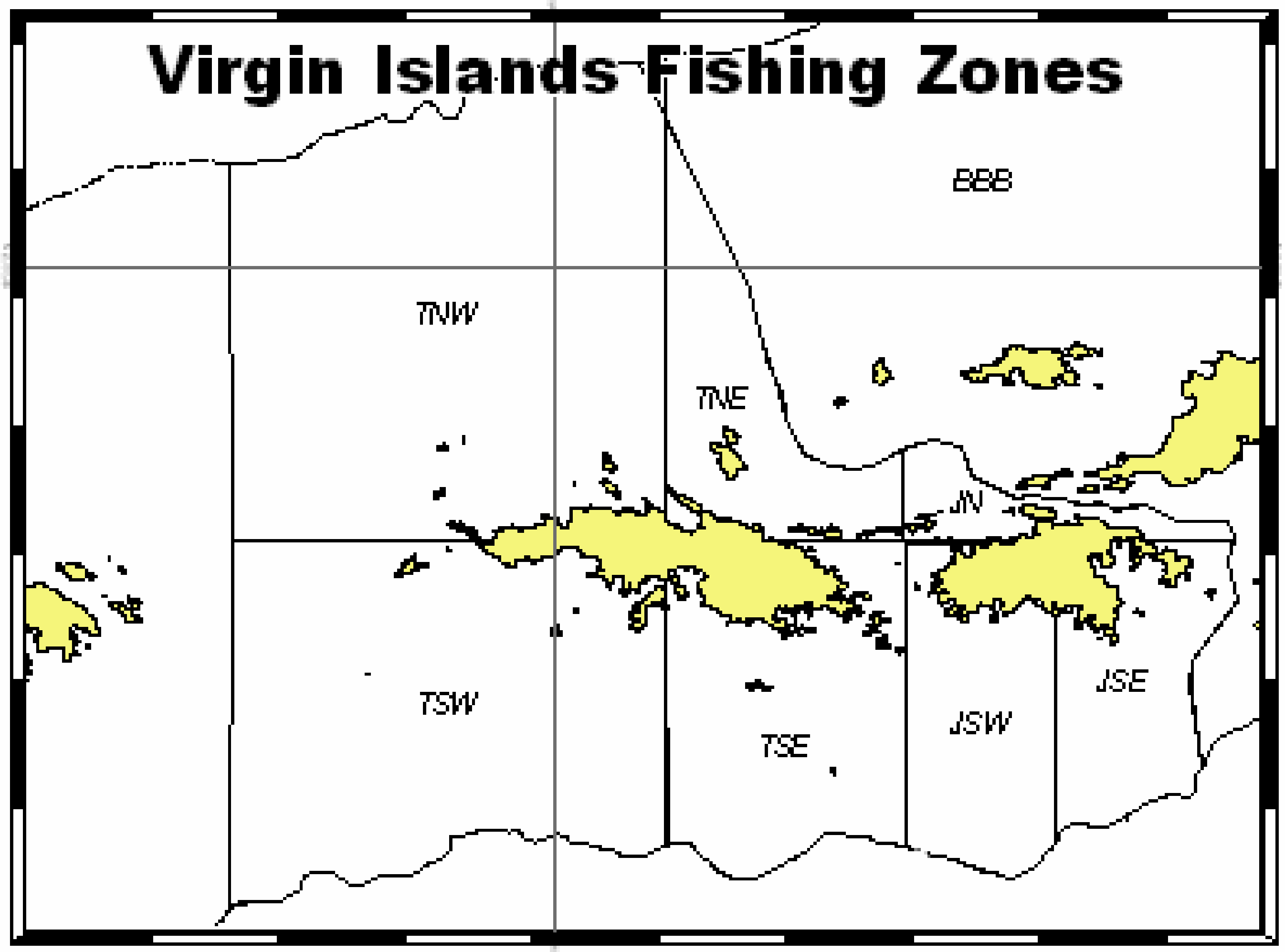
Vessel Name	Gear			
Vessel ID	Date			
	Condition			
Species	Strong	Weak	Dead	Discard reason
Reason codes: 1. Ciguatera; 2 Too small; 3 Unmarketable; 4. Caught more than can sell5. Used as Bait				

St. Thomas Pilot Observer Project
Protected species interaction form

Vessel Name			**Vessel ID**
Date			**Gear**
Fishing Zone			
Species	**Size**	**Interaction Code**	**Comments**

Interaction code - Enter the interaction code. If an animal is involved with more than one interaction during one haul or set, list them as separate records with different interaction numbers.

1. Deterrence Used – Protected species was deterred or a deterrent was attempted. Log this interaction using this code even if the deterrence was not successful.
2. Entangled in Gear (Not Trailing Gear) - A protected species was captured by the fishing gear and the animal was released/escaped without fishing gear attached.
3. Entangled in Gear (Trailing Gear) - A protected species was captured by the fishing gear and the animal was released/escaped alive with some fishing gear attached.
4. Killed By Gear - A protected species was captured and died due to interactions with the fishing gear.
5. Killed By Propeller - A protected species hit the propeller and died.
6. Previously dead - A protected species was captured by the fishing gear and was dead prior to coming into contact with the vessel or fishing gear.
7. Lethal removal - Vessel personnel killed a protected species entangled in fishing gear, but death was not due entirely to the entanglement.
8. Boarded Vessel - A protected species boarded the vessel on its own volition.
9. Feeding on Catch -A protected species was observed feeding on catch not yet landed.
10. Other - Interaction occurred that is not included in the list of interaction codes.
11. Unknown - The vessel or vessel personnel had some interaction with a protected species, but the observer did not directly view the interaction and/or ascertain what the interaction was.



Virgin Islands Fishing Zones
BBB
TNW
TNE
JN
TSW
TSE
JSW
JSE

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Tampa, Florida 33609-2458
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Email: MRAG.Americas@mragamericas.com

President: Professor John Beddington F.R.S.

St. Thomas Observer Project
Vessel Participation Confirmation

Captain: ______________________

Vessel: _______________________

Date: ________________________

Check one:

☐ I confirm that Observer _______________________ performed at-sea observer duties on the vessel above ($150 compensation to the Captain).

☐ I confirm that the captain of the vessel above collected discard samples at the request of Observer _________________________ ($150 compensation to the Captain).

Please Fax or mail this form to Beth Weiland, MRAG Americas to initiate payment.

_______________________	__________________________
Signature of Captain	**Signature of Observer**

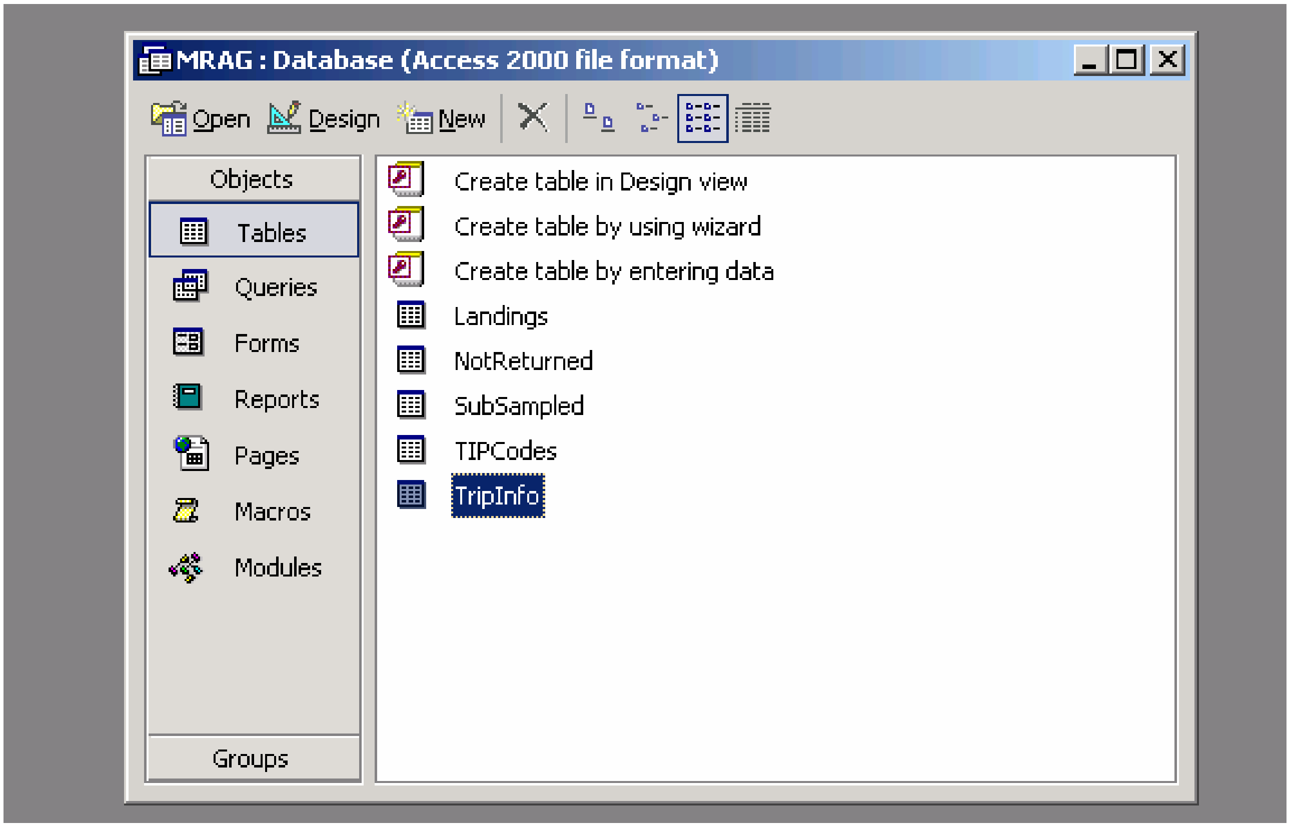
Captains' Address:

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 MS Access database was constructed to facilitate data analysis.

Data Tables



1. Landings table. This table includes all individual fish captured during the study, both catch and bycatch. 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. Bycatch (Yes/No)
    g. Discard reason
    h. Survival (for bycatch)
    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.

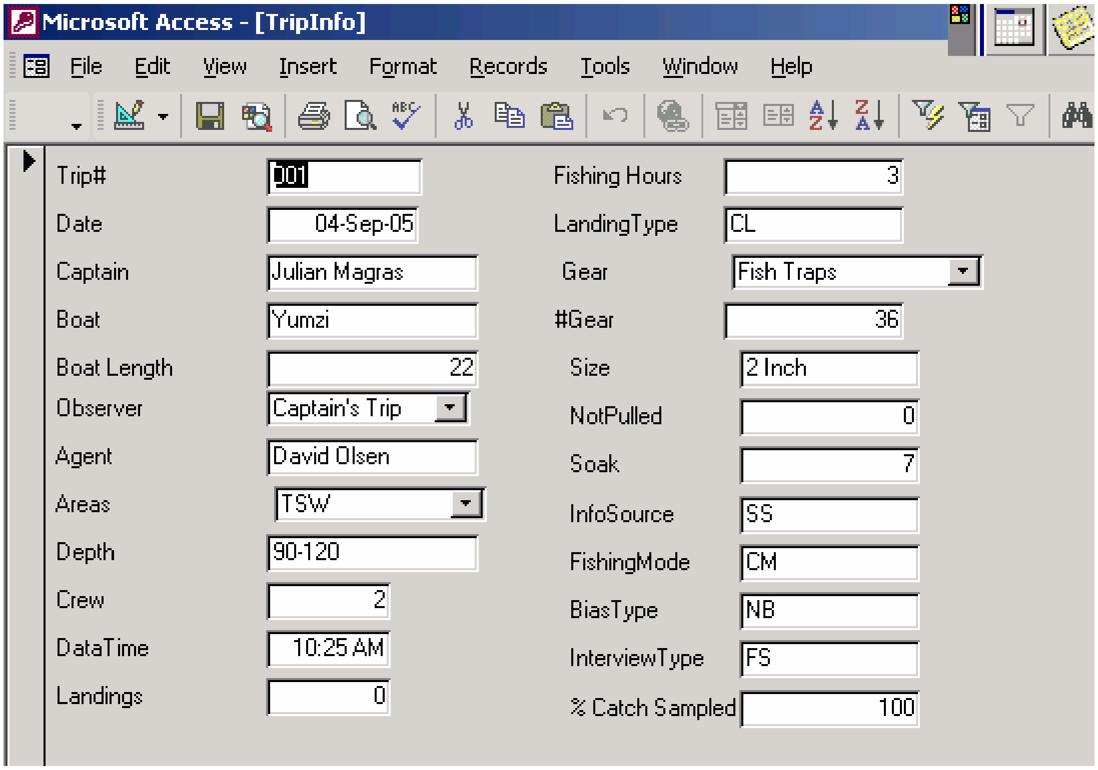
5. TripInfo. This table contains all of the qualitative data regarding each trip. Variables include:
    a. Trip#
    b. Date
    c. Captain
    d. Boat (Name and Registration)
    e. Length
    f. Observer (or Captain's trip)
    g. Agent
    h. Areas (DFW designations)
    i. Depth (given as range)
    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 bycatch 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.



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.