Session 21

Achieving sustainable coral reef fisheries: policy development, implementation, management and enforcement

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Survey of boat-based recreational fishers in the US Virgin Islands

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Abstract Recreational fishing is important to the residents and economy of the United States Virgin Islands (USVI). Government management efforts primarily focus on commercial fisheries in the USVI, largely due to assumptions regarding the relative unimportance of the recreational fishery and the paucity of data. While recreational fishers fish from the shore as well as boats, data indicate that boat-based recreational fishing predominates. This study, conducted in 2014, characterized boat-based recreational fisheries, compared phone and mail survey methods, and determined if the annual vessel registration list maintained by the USVI, Division of Environmental Enforcement, could be used as a sampling frame to survey recreational fishers. Of the 769 boat owners who were randomly selected from the 2013 boat registration list, 378 responded to the surveys. Of these, 37% recreationally fished. More boaters responded to phone surveys (60%) than mail surveys (40%). They fished primarily from their own power boats (81%) with a much smaller percentage fishing from sailboats (16%), while 75% of recreational fishers fished for food and 42% considered themselves subsistence fishers. The primary fish families targeted by recreational fishers were the Scombridae (54%), Lutjanidae (49%), Coryphaenidae (37%), and Serranidae (32%). The most common recreational fishing technique was trolling. Fishers took an average of 3.3 trips per month with an average length of 4.4 h. The boat registration list can only be used to survey recreational fishers efficiently if the information is updated annually.

Key Words: coral reef fish, recreational fishing, US Virgin Islands, fisheries management

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Introduction

The US Virgin Islands (USVI) is an unincorporated territory of the United States located in the Caribbean. The majority of the USVI population of 103,574 (CIA 2016), live on three islands that range in size from 50.8 km^2 to 214.7km^2. There are two districts, St. Thomas and St. John District (STT/STJ), comprised of two main islands of the same names and numerous smaller islands, and St. Croix District (STX) with one main island and three smaller islands. A variety of coral reef communities extends from the shore to the shelf edge (Armstrong 2006, Rothenberger et al. 2008).

Saltwater recreational fishing is one of the most important outdoor activities in the USVI (CFMC 1985; Griffith et al. 1988; Friedlander and Contillo 1994; Hinkey et al. 1994; Friedlander 1995; Adams et al. 1996). Three broad types of recreational fishing occur: 1) big game fishing conducted from large (>9m) vessels), which targets primarily billfish; 2) private boat fishing, generally conducted from smaller boats, which targets primarily reef fish and offshore pelagic fish, and 3) shoreline fishing (beach, pier, dock, etc.), which targets primarily reef fish. Shoreline fishers expend the most effort fishing but boat-based fishers harvest more fish (Jennings 1992, Mateo 2004). In 2011 in Puerto Rico, 93% of recreationally caught fish were caught from private boats (C. Lilyestrom pers. comm.). Approximately 10% of households participate in at least one of the three types of recreational fishing (Jennings 1992, Mateo 2004).

Despite the potential for recreational fishing to impact fish populations, data collection efforts have focused primarily on commercial fisheries. This is largely due to the expense and difficulty of obtaining statistically valid recreational fishing data. For example, Goedeke et al. (2016) conducted an 11-month survey of shoreline fishers on St. Croix that cost almost $300,000, excluding substantial principal investigator labor, and volunteer time. The results were limited because the participation rate in shoreline fishing was low (< 2 fishers per hour) and only 61 fishers were encountered, of which five were commercial fishers and seven refused to be interviewed. Only 49 fishers were interviewed.

This study, conducted in 2014, characterized boat-based recreational fisheries, compared phone and mail survey methods, and determined if the annual vessel registration list maintained by the USVI, Division of Environmental Enforcement (DEE) could be used as a sampling frame to survey recreational fishers.

Materials and methods

The 2013 annual vessel registration database maintained by the USVI, DEE was used as a frame to survey and characterize boat-based recreational fishing in the USVI. Four hundred boaters were randomly selected from the 2013 boater registration database in each district (200 for phone interviews and 200 for mailed questionnaires) for a total sample size of 800. However, the final sample size was reduced to 785 owing to duplications. To determine if an incentive would increase participation in the mail survey, a $2.00 incentive was provided to half of the boaters from each district selected for the mail survey.

A questionnaire was developed to determine the recreational fishing participation rate of registered boat owners and to characterize the boat-based recreational fishery. Pilot telephone and mail surveys were conducted from June to September 2014. The protocol for conducting both surveys followed standard survey procedures (Dillman et al. 2014).

Results

Of the 785 boat registrants sampled, 394 (50%) completed the questionnaire. Recreational fishers comprised 37% (145) of the respondents (Table 1). Of the 63% (249) of boat registrants sampled that did not recreationally fish, 5% (21) were licensed commercial fishers who only fished commercially, 4% (16) did not own a boat in 2013, and 54% (212) owned a boat but did not recreationally fish.

Mail vs Phone Surveys

A higher number of boat registrants were able to be contacted through the phone survey (60%) compared to the mail survey (40%; Table 1). The lower mail contact rate was primarily a function of the high percentage of survey mailings that were not deliverable. The US Postal Service was unable to deliver mail to 51% (200) the addresses in the USVI: 119 of 197 (56%) were undeliverable on STT/STJ and 81 of 196 (46%) on STX.

The USVI mail surveys that included a $2.00 incentive had a slightly higher response rate (57% returned) than mail surveys without a $2.00 incentive (52% returned). The rate varied by district with STT/STJ having almost the same return rate: 60% (N = 68, N returned = 41)

with incentive and 59% (66, 39) without the incentive, while the response rate was higher on STX with the incentive: 54% (79, 43) vs without: 46% (79, 36).

Of the 30 boaters surveyed who commercially fished, 21 (70%) only fished commercially. Nine (30%) fished both recreationally and commercially. The nine fishers comprised 5% of recreational fishers surveyed. Three charter fishers were surveyed, comprising 2% of recreational fishers. Only one charter fisher was a licensed commercial fisher.

Marine Taxa (Family) Targeted

Recreational fishers were asked to provide a maximum of six species of fish and invertebrates that they preferred to fish for (Table 2). Most provided less than six, indicating that they targeted only a few species. Since fishers often provided common names that referred to family (e.g. snapper or grouper, rather than species), responses were summarized by fish families. Twenty families of fish were targeted, of which 13 were coral reef associated families. Only eight families were targeted by more than 10% of recreational fishers. Five of these are commonly associated with coral reefs. These include Lutjanidae (snappers) targeted by 49% of recreational fishers, Serranidae (groupers; 32%), Balistidae (triggerfish; 20%), Haemulidae (grunts; 19%) and Sphraenidae (specifically the great barracuda, *Sphyraena barracuda*; 11%).

Fishers listed several species targeted for the most commonly targeted reef fish families, snapper and grouper. Targeted snapper species were the shallower water yellowtail (*Ocyrurus chrysurus*), mutton (*Lutjanus analis*), schoolmaster (*L. apodus*), and lane (*L. synagris*), and the deeper water blackfin (*L. buccanella*) and queen snapper (*Etelis oculatus*). The yellowtail snapper was targeted by 61% of fishers who listed snapper by species. Mutton snapper were the next most commonly targeted species with 12% of fishers targeting this species. Only fishers on STX reported targeting mutton, schoolmaster and blackfin snapper, while queen and lane snapper were only targeted by fishers on STT/STJ.

Targeted grouper species (in descending order from most to least targeted; Table 2) were the smaller grouper species, red hind (*Epinephelus guttatus*) and coney (*Cephalopholis fulva*), and the large, deepwater misty grouper (*E. mystacinus*). The red hind and coney were targeted

by 71% and 19% of fishers, respectively, who listed grouper by species. The misty grouper was only targeted on STT/STJ.

Coral reef fish families, with few exceptions, were targeted by similar percentages of fishers in both districts though target species varied (see above). Exceptions include the barracuda (Sphyraenidae), which was targeted by 15% of fishers in STX, but only 6% in St. STT/STJ and porgies (Sparidae), which were only targeted in STT/STJ (12%).

The family Scombridae (tunas and mackerels) was targeted by over half of recreational fishers (54%). The mackerels were the most commonly targeted subfamily (61% of scombrid fishers targeted mackerel), primarily wahoo and kingfish. Tunas were targeted by 38% of fishers. Only a few fishers listed the species of tuna they caught, most just said tuna. Listed tuna species include skipjack, blackfin, and yellowfin. Coryphaenidae (dolphinfish) was the third most targeted family (37% of fishers), of which two species are found in USVI waters: *Coryphaena hippurus* and *C. equiselis*. Both these families along with the Istiophoridae (marlin), targeted by 4% of fishers, are comprised primarily of offshore pelagic species.

The Carangidae, a coastal pelagic family, was the fifth most targeted family and fishers listed the following species/subfamilies (in order): blue runner (*Caranx crysos*), rainbow runner (*Elagatis bipinnulata*), permit (*Trachinotus falcatus*), pompano (*Alectis ciliaris*), horse-eye jack (*C. latus*) and crevalle jack (*C. hippos*).

Parrotfish (Scaridae) is an important herbivore on reefs along with the surgeonfish (Acanthuridae). Parrotfish were targeted by only 6% of fishers. No fisher reported targeting surgeonfishes.

Bonefish, tarpon, and snook were targeted by only 2 – 3% of fishers. These species are fished in shallow water and often targeted by catch and release fishers, though they are sometimes eaten. Sharks and stingrays were not commonly targeted by recreational fishers. The lionfish, an invasive species in the Caribbean, was targeted by only 3% of fishers.

Only three families of invertebrates were targeted by recreational fishers. These include the Palinuridae, primarily the spiny lobster (*Panulirus argus*), targeted by 8% of fishers, the Strombidae, primarily the queen conch (*Strombus gigas*), targeted by 4% of fishers, and the Tegulidae, exclusively the intertidal West Indian Top Shell (*Cittarium pica*), targeted by 1% of fishers.

Gear Used by Recreational Fishers

Recreational fishers are prohibited from using nets, other than cast nets, and traps of any sort. Most recreational fishing is done using line fishing gears such as plastic spool (Yo-Yo reel) or rod and reel (Table 3). Inshore trolling and offshore trolling had the highest participation rates in STT/STJ while offshore trolling and bottom fishing had the highest participation rates in STX. More fishers participated in offshore and inshore trolling on STT/STJ (65%, 61%, respectively) than on STX (55%, 42%, respectively). These gears are used to catch the primary fish families targeted by recreational fishers: tuna, mackerel, dolphinfish and jacks. The participation rates were similar in both districts for shallow bottom fishing (STT/STJ: 52% and STX: 53%), shallow drift line fishing, which targets yellowtail snapper and blue runner (STT/STJ: 30%, STX: 31%), deepwater buoy fishing (11%, 13%), and deep drop fishing daytime (8%, 8%). Deepwater fishers primarily target deepwater snapper. Deep bottom fishing, spearfishing, casting (rod and reel), hand collecting and cast net fishing had higher participation rates on STT/STJ. Lobster, conch, and whelks are collected by hand by skin and scuba divers. Though 37% of fishers on STT/STJ and 26% on STX said they spearfished, only 6% of fishers on STT/STJ and 7% on STX said that the Scaridae were among the top six families of fish that they target. Deep drop fishing at night had a low participation rate in both districts.

Cast net fishing, principally for baitfish, was very popular. Thirty-five percent of the respondents in the USVI used a cast net (STT/STJ – 41%; STX-31%).

Ninety-five percent of the respondents from both districts used their own boat most of the time when they fished, including charter and commercial fishers. Fishers reported that the most important reasons for recreational fishing were to obtain food, have fun and relax, and for sport. Fishers reported obtaining an average of 8.9% of their household's food from recreational fishing (Table 4). Crucian fishers reported supplying a higher percentage of household food by recreational fishing (10.4%) than STT/STJ (7.3%) with STX reporting up to 100% of household food coming from fishing in contrast to a maximum of 40% in STT/STJ.

Powerboats were used for fishing by 81% of recreational fishers and sailboats by only 16% of fishers. Rowboats, jet skis and kayaks were used by 2% or less of recreational fishers on STT/STJ and STX. The mean length of power boats used for recreational fishing was 6.5m

(21.4 ft). Sailboats were on average nearly twice as large with a mean length of 12.1 m (39.7 ft). Recreational fishers fished more in territorial waters (85% of recreational fishers fished < 3 nm from shore) than federal waters (56% fished >3 nm from shore).

The most common time of day that boat-based recreational fishers landed fish was 9 am to 9 pm with a peak landing period from 3 – 6 pm. The mean length of an average recreational fishing trip was 4.4 h with a mean of 3.3 trips per month. Fourteen percent of the Virgin Islands respondents participated in recreational fishing tournaments (22% from STT/STJ and 6% from STX). The mean annual number of tournaments participated in by anglers who fished in tournaments was 2.8.

St. Croix recreational fishers identified "marine protected areas", "overfishing" and "weather" as the three most important issues negatively affecting their recreational fishing experience at nearly equal priority (13%, 12% and 12%, respectively). "Overfishing" (23%), "enforcement" (lack thereof; 13%) and "environmental degradation" (11%) were cited by STT/STJ fishers as the three most important issues negatively affecting their recreational fishing experience. The "need for regulations" regarding recreational fishing was identified by fishers as the most important additional comment write-in issue with 23 specific comments (18% of total comments).

Discussion

The USVI population has varied little since 1990 when the US Census counted 101,809 residents. In 2000, the population peaked at 108,612 (US Census 2000), declined to 106,405 (US Census 2010), and is currently estimated at 103,574 (estimate; CIA 2016). In 2013, there were 3,194 registered boat owners. In 2000, a telephone survey of registered boat owners conducted by the Eastern Caribbean Center (2002) estimated that 38% (938 of 2462 boat owners) were recreational fishers. The percentage was nearly identical to this study (37%) (1182 of 3194). While the population declined between 2000 and 2013 by 3%, the number of boat owners increased by 29% and boat-based recreational fishers increased by 26%.

Other studies of boat-based fishers have achieved similar results. Tobias and Dupigney (2009) identified 742 vessels in the 2005-2006 DEE boater registration database (>16 ft; omitting sailboats) that potentially could fish offshore for billfish and pelagic species. Of the 646 vessel owners that were contacted by phone, 38% used their vessel for recreational

fishing. Sixty percent of the vessel owners identified by Tobias and Dupigney (2009) practiced some form of catch and release fishing, releasing all or part of the catch or a particular species.

Household telephone surveys, which included boat and shore based recreational fishing, conducted by Jennings (1992) in 1988 and Mateo (2004) in 1999 estimated that 10,800 (10.8%) and 11,999 (9.2%) residents, respectively, participated in private boat and shore-based recreational fishing. Jennings (1992) estimated that an average fishing party on STT/STJ was 2.4 fishers and on STX 2.8 fishers. In 2013, recreational fishers fished an average of 3.3 times a month and fished an average of 4.4 h. Thus, the average number of boat-based recreational fishing trips participating each month is approximately at 3,900 and total boat h spent fishing about 17,000. If the mean party size is 2.6, based on Jennings (1992), then a rough estimate of the number of boat-based fishers fishing each month is 10,000. This does not include shoreline fishers, which are included in the residents' totals in the above studies.

Table 5 compares the fishing effort of the USVI commercial fishery in 2010-11 (Kojis and Quinn 2011a, 2011b) and recreational fishery. While recreational fishing effort is higher than commercial fishing effort in terms of the number of fishers and man hours spent fishing, this does not necessarily equate to higher total catch. Recreational fishers are prohibited from using traps and seine nets. These are very effective gears for catching fish and trapping lobster. A commercial fisher on St. Thomas may haul 100 traps each trip and harvest 150 lbs of lobster and >400 lbs of fish (W. LeDee pers. comm.). A seine fisher and crew may harvest >300 lbs of fish in a trip (G Martinez, pers. comm.). However, given that recreational effort in terms of man hours exceeds commercial fishing effort, it is important to obtain catch statistics for recreational fishing to determine the impact on stocks.

Recreational fishers target a smaller range of species than commercial fishers and likely have a significant impact on at least some species of reef fish, particularly species in the snapper, grouper, triggerfish, grunt and barracuda families. Specific species within these families are targeted by fishers; however, the species targeted are not necessarily the same in each district. For example, snapper is one of the most commonly targeted families (Jennings 1992; this study). The high incidence of ciguatera in large, predatory fish on the south side (leeward) of STT/STJ means that knowledgeable fishers will not target or retain most species

of snapper caught there. *Ocyurus chrysurus*, the yellowtail snapper, a planktivore, is the only species of snapper that is not considered ciguatoxic, and as a result is the primary species targeted on STT/STJ. Mutton snapper is prized on STX, but has a high incidence of ciguatera on STT/STJ (Olsen and Wood 1984). It is sometimes retained, especially if caught on the north side of STT/STJ. Lane snapper is targeted by a few fishers on STT/STJ, but not on STX, where it is rare. All other snapper species are considered ciguatoxic on STT/STJ and usually not targeted or retained if caught. There is less incidence of ciguatera in deepwater snapper, but one STT chef said he refused to buy deepwater snapper because of a previous incident of guests getting ciguatera poisoning (Hook Line and Sinker pers. comm.). While ciguatera poisoning occasionally occurs on STX, Crucians do not generally consider the frequency high enough to prevent them from eating most reef fish with the exception of large barracuda and greater amberjack.

Other species are also seldom harvested on STT/STJ, but targeted on STX because of differences in the incidence of ciguatera. Barracuda, a top predator, is commonly targeted and harvested on STX, but seldom harvested on STT/STJ. Similarly, the primary carangids targeted in both districts are two offshore species that rarely visit reefs, the blue runner and rainbow runner. Other jack species are known to be ciguatoxic at times on STT/STJ, as well as at least one scombrid species, the king mackerel (Olsen and Wood 1984).

Significant numbers of boat-based recreational fishers in the USVI target offshore, seasonally abundant, pelagic species, such as Scombridae (tunas and mackerel – 54%) and Coryphaenidae (dolphinfish – 37%).

Until recently recreational fishers were primarily regulated by prohibiting use of "commercial fishing gear," e.g. gill and seine nets and fish and lobster traps, and a subset of fishing regulations pertaining primarily to seasonal and area closures for fish, minimum sizes for spiny lobster and queen conch, and bag limits for queen conch. Recent regulations include size and bag limits in federal waters (3 – 200 nm from shore) for a number of recreationally caught fish (USGPO 2016). These regulations are primarily based on broad concerns about the status of coral reef species gathered from commercial fisheries dependent and independent surveys and academic surveys. While recreational fishers fish from the shore as well as boats, previous studies indicated that boat-based recreational fishers harvest significantly more fish than shore-based fishers (Jennings 1992, Mateo 2004, Lilyestrom pers. comm.).

Coral reefs are found predominately within 3 nm of shore with the exception of Lang Bank, east of St. Croix. However, very important and extensive mesophotic reefs are found >3nm from shore (Armstrong et al. 2006). Many of the remaining snapper and grouper spawning aggregations utilize these mesophotic reef habitats for spawning on both STT/STJ and STX.

None of the methods/gears used in recreational fishing are particularly damaging to coral reef habitat. Most of the gears used for recreational fishing are variations of line fishing. Trolling and bottom fishing were the first and second most common fishing methods. Both methods use rod and reel or hand lines. Fishing line has been observed during underwater surveys wrapped around coral sometimes, however, the types of gears used in that have the largest potential impact on reef habitats, fish and lobster traps and seine nets, are reserved for commercial fishers. Gill nets and trawl gear are prohibited for all fishers. Cast net fishing is primarily used to catch bait in shallow coastal waters over sand or seagrass. Snorkel or scuba equipment is used to harvest lobster and conch. Damage to habitat can occur if a fisher moves or breaks coral to get access to a lobster hiding in a hole in the reef. Lobsters are targeted using snares. Spearfishing lobster is prohibited, which reduces the damage to coral reefs from wayward spears.

Deep bottom fishing by recreational boat-based fishers is more common on STT/STJ because the maximum shelf depth is greater (>200 ft STT/STJ vs about 80 ft STX). Deep bottom fishing on St. Croix is a more popular fishing method employed by commercial fishers due to the specialized gear required to fish steeply sloping bottom topography.

Line fishing, the most common type of fishing, does not target herbivores, (parrotfish and surgeonfish). Recreational fishers use spear guns to target parrotfish and surgeonfish. Since 30% of recreational fishers used spear guns, they have the potential to significantly impact these species (Table 3). However, surgeonfish were not listed as a target species and only 6% of spearfishers said they targeted parrotfish. These two families of fish are important grazers on coral reefs. With the reduction of living coral cover on coral reefs in the USVI owing primarily to bleaching and disease (Muller et al. 2008, Miller et al. 2009) and the massive reduction in the long-spined sea urchin (*Diadema antillarum*) owing to disease (Lessios et al. 1984), the importance of these two fish families as grazers on reefs has increased. As a result, there are now recreational size and bag limitations for parrotfish (USGPO 2016).

Recreational fishing is important economically and culturally in the USVI. Strickland et al. (1992) estimated that more than $25 million dollars were spent on activities associated with recreational fishing, primarily during the seasonal blue marlin fishery. Dolphin, wahoo, and billfish tournaments occur during the spring and summer migrations of pelagic species. These tournaments attract sport fishers from Puerto Rico, the mainland US, and from other countries and are a boost to the USVI economy. Local tournaments occur on STT/STJ sponsored by the ethnically French fishing community to celebrate Mother's Day, Father's Day and Bastille Day.

In conclusion, the phone survey methodology was more successful than mail because of the higher contact rate and, especially on STX, the more complete answers to questions. Recreational fishing is more selective in the species targeted because of the differences in gear used compared with commercial fishing (primarily line vs traps, nets and spearfishing). Species targeted varies between districts primarily because of the difference in the incidence of ciguatera poisoning, species/habitat preferences due to the differences in the size and depth of the shelves around the islands and cultural preferences of the recreational fisher. The potential impact of fishing on the three commonly harvested invertebrate species appears to be low given current regulations and the low percentages of fishers harvesting these species. Future studies should update this survey and include port sampling to obtain information on the fishing party size, length of fishing trip, fishing location, gear used, species harvested and the individual length and weight of each species.

Implementation of a recreational fishing license in the USVI would provide a more comprehensive sampling frame that would include boat-based and shoreline fishers. However, there is little support for a recreational fishing license in the USVI. In 2010, the STT/STJ and STX drafted a recreational fisher license program, including regulations (Tobias 2010), but the USVI Government has not been implemented the program and it is unlikely to do so in the near future. Recreational fishing is seen as a local right that should not be impeded by requiring a license.

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