

Defining the Spear Fishery of Trinidad

Definiendo la Pesca Submarina de Trinidad

Definir le Pêche au Harpon de la Trinidad

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ABSTRACT

Research on the spear fishery of Trinidad has been extremely limited to date. As such the fishery's characteristics and its contribution to the island's fishing industry and food security is relatively unknown. This study is the first island-wide study of the spear fishery and aims to provide novel detailed information, as well as update previous documented knowledge of the fishery in the northwest of Trinidad. The research was focused on the extent of the spear fishery, spearfisher demographics, fishing practices and effort, catch and economic data and management suggestions by fishers. Data were collected from 105 spearfishers between July and September 2016 using a standard questionnaire. Results indicate a minimum of 271 active spearfishers in Trinidad with perhaps as many as 600 in total. The spear fishery is predominantly recreational and the majority of spearfishers are male between the ages of 30-40 years. Spear fishers use dive sites all around the island, but the most popular spear fishing grounds lie along the north coast. Fishers access their grounds by swimming from shore or by boat, and spear fish by free diving and/or with the use of SCUBA gear. The main spearfishing season is during the summer months, due to the most suitable conditions being at this time of year. The spear fishery targets a variety of species including shallow shelf reef species, deep slope species and both small and large pelagic species. A very crude estimate of total annual landings based on the interview data from 92 fishers lies somewhere between 102 - 460 mt for the 271 active fishers identified. On average, individual spearfisher's stated expenses are TT\$6,857 (1 US\$ = 6.7 TT\$) on initial gear, a further TT\$3,833 on gear and maintenance annually and TT\$832 per spearfishing trip. Spearfishers are aware that there is currently no policy or regulations for spearfishing in the country, and most stated that they would be open to a 'best practices guidebook' for spearfishing in Trinidad and Tobago that covered diver safety and sustainable harvesting issues. The most common suggestions for management attention given by spearfishers included species-specific bag and size limits and closed seasons to protect vulnerable spawning periods.

KEYWORDS: Spear fishing, recreational fisheries, Trinidad

INTRODUCTION

In the Caribbean, spearfishing data are generally poorly documented and there have been very few published studies directly analysing spear fisheries. These include relatively recent studies in Jamaica (Passley et al. 2009), Barbados (Simpson et al. 2014) and Bermuda (Robertson and Pitt 2015). Although spearfishing is likely ubiquitous across the Caribbean especially in the reef fisheries, it is often not acknowledged. For example, under the fisheries information listed on the Caribbean Regional Fisheries Mechanism website for each of its member states, only St Lucia, The Bahamas, and Anguilla record spearguns among their fishing gear types (CFRM 2013).

Trinidad is no exception and lacks up-to-date quantitative data on its spear fishery, although it is acknowledged that a small but significant percentage of recreational fishers engage in spearfishing (Mike and Cowx 1996, Shoy 2010, and Mohammed et al. 2011), and there is evidence that spear fishing may be increasing in popularity (Shoy 2010). There has never been an island-wide study of spear fishing and there is little information on the current extent or importance of the recreational spear fishery with regard to the number of participants or contribution to the island's annual fish landings. Furthermore, there is no clear policy on spear fishing and no specific reference to spear fishing in the Trinidad and Tobago Fisheries Act or Fisheries Regulations (Ministry of Legal Affairs 2014).

This research is aimed at filling some of the significant knowledge gaps in the current characteristics of spear fishing in Trinidad including the current number and demographics of spearfishers island-wide, their catch composition, typical catch quantity, fishing areas and fishing practices, and their knowledge and interest in management issues.

METHODOLOGY

The data necessary for this research were collected primarily through in-depth conversation with key informants; direct observation and informal conversation with spearfishers, often whilst accompanying them on fishing trips; and formal interviews using a standard questionnaire administered face to face, over the phone, or electronically using an online questionnaire. Key informants from across the island were identified to assist with the research and to gain an insight into the spear fishery in Trinidad. They assisted with formulating the questionnaire and identifying species caught. They were also key in helping to locate other spearfishers, by 'starting the ball rolling' in the 'snowball' approach used to find spearfishers from different areas across the entire country.

A standard questionnaire was developed with approval from the Fisheries Division and field tested with key informants. The refined questionnaire was subsequently converted to an online version using SmartSurvey to collect general data swiftly and efficiently from a larger number of spearfishers located across the country than would have been feasible by face to face interviews. The survey questionnaire was designed to record information on spearfisher demographic characteristics, economic importance, fishing methods, fishing effort, catch composition, and perceptions on management issues (Table 1). Each non-demographic question in the survey included an open section for anecdotal information and comments. This ensured that spearfishers could respond more fully in cases where questions were too limited.

Table 1. Range of topics included in the standardized questionnaire

Topic of survey questions	
Diving practices (SCUBA/free diving)	Length of fishing trips
Use of catch	Frequency of fishing trips
Target species	Average CPUE
Boat dives or shore dives	Average cost of gear
Gear types	Average cost of trip
Fishing areas	Knowledge of and ideas for management

The web-based SurveySmart application was used to enter and store all of the interview data collected. The raw data were then exported into a Microsoft Excel 2013 database and manipulated in order to create graphical representations of data. ArcGIS including ArcMap 10.0, ArcCatalog and ArcToolbox extensions were used for mapping spearfishing sites.

RESULTS

The Database

A total of 106 spearfishers were interviewed between 1st July and 31st September 2016 either face to face (n = 51), by phone (n = 15) or using the online questionnaire (n = 40). Additional information was also obtained whilst accompanying fishers on three separate fishing trips off the north coast and off the northwest tip of Trinidad (referred to as 'Down the Islands'). The response rate to interview questions was excellent averaging 89% across all 30 questions and all interviewees. The interviewed sample represents 39% of all named spearfishers identified in the snowball exercise and is therefore considered to be a good representation of the active spearfisher population.

Extent of Fishery

The snowball approach identified 271 active spearfishers nationwide. As the survey spread, the number of identified spearfishers increased exponentially in the first few weeks. After six weeks, the number of uniquely identified names plateaued significantly with very few new names within the last two weeks of data collection. Therefore this number is believed to be a good conservative estimate of total active spearfishers.

A second crude estimate was obtained using three key informants; two in the business of selling spearfishing equipment using their informal client lists and the other, a spearfishing charter operator. These persons were selected due to their knowledge of the fishery, being highly experienced and active spearfishers themselves, as well as having a large, diverse clientele. Each of them gave estimations of between 500 and 600 spearfishers nationwide. Taking into consideration these two independent estimates, the current number of spearfishers in Trinidad is believed to be somewhere between 271 up to a maximum of 600 persons.

Spearfisher Demographics

The spear fishery of Trinidad is heavily male dominated (96% of interviewed spearfishers; 99% of identified active spearfishers) with fisher ages ranging from 16 - 60

years old, most being between 30 - 40 years old. The spearfishing community is widespread across the island with fishers living in all districts. A few interviewed spearfishers live in Tobago, but occasionally spearfish in Trinidad waters, either on the east or west coasts.

The surveyed spearfishers had varying levels of experience up to 50 years although the majority of them are relatively new to the practice with just 5 years of experience. Most of the spearfishers were introduced to the fishing method by a friend or family member while a few happened to see spear fishing taking place on a fishing trip or via the media. Interestingly, 71% of beginner spearfishers (≤ 5 years of experience) were introduced to the sport through a friend or the media while 60% of more experienced spearfishers (≤ 10 years of experience) grew up in a spearfishing family. This suggests that the sport is becoming more popularised and that the spearfishing community is likely to be growing.

While the spear fishery is predominantly a recreational one with 92% of respondents stating that they spearfish primarily as a hobby, almost half of them stated that they do sell part of their catch to recuperate some of their fishing costs. For those that do not sell their catch, most said that they give away part of their catch to friends and family. A total of 8% of the interviewed spearfishers indicated that spearfishing contributes significantly to their annual income, and they should therefore be considered as commercial fishers.

Landing/operating Sites and Fishing Grounds

All spearfishing fishing grounds, shore dive access points, beaches with boat access for spearfishing trips, and the locations of marinas used by interviewed spearfishers are shown in Figure 1. This indicates that the spear fishery operates around the entire island of Trinidad, although the north coast is the main operating and landing area (Figure 1A). Approximately one quarter of the fishers living in Trinidad also spear fish in Tobago from time to time. Spearfishers do not need special facilities for shore dives and can therefore leave from and land at virtually any part of the coast of Trinidad. However, there are specific beaches which are used much more often due to the nature of the coast and sea conditions in those areas. When using a boat, spearfishers generally operate from marinas and fishing depots which are located in Chaguaramas in the northwest of the country and use fishing grounds along the north coast as they are more accessible and tend to be shallow and calm (Figure 1). There are also specific beaches that have boats, allowing spearfishers to take a boat trip directly from shore. As seen in Figure 1(B) oil rigs and platforms are also used as spearfishing grounds.

The majority of the spearfishers mainly use the landing and operating sites on the North and East coasts. Of the 27 landing sites recorded, the most used are Mayaro (56%), Island Properties Owners Association Limited marina (52%) and Maracas (41%). Of the 24 operating sites recorded, the most fished areas are Maracus and Down the islands (54% each) and La Fillette (42%).

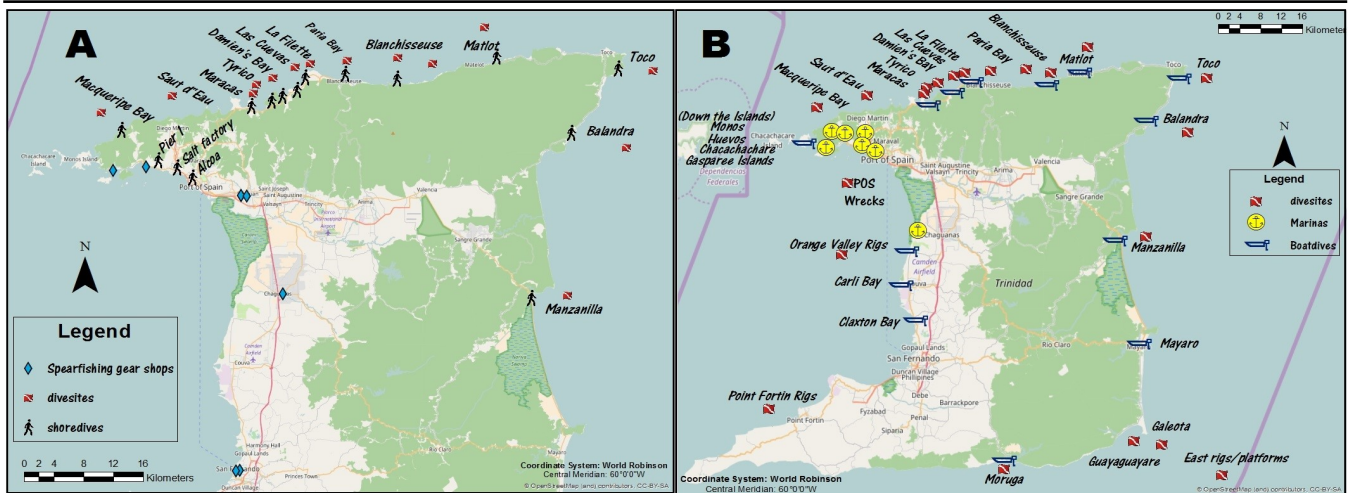


Figure 1. Maps of Trinidad showing locations of (A) spearfishing gear shops and popular shore diving beach access points used by spearfishers, and (B) marinas and boat dive sites used by spearfishers around the island.

Fishing Gear and Practices

Most of the divers (78%) take both boat trips and shore dives to spearfish while 14% take boat trips only and 8% always swim from shore. Spearfishers prefer boat dives because travel time is less and there is no physical exertion before spearfishing. Most spear fishers use small open motorized pirogues (8.5 – 9.4 m), a few use small dinghies or skiffs, whilst some rent unmotorised kayaks and paddle out to their fishing sites. A few others fish from private luxury sportfishing vessels.

Only 4% of the surveyed spearfishers always use SCUBA gear. This included a commercial lobster spearfisher and two SCUBA dive and spear fishing instructors. The rest either free dive only (63%) or participate in both practices (33%). Those who do both say that they choose whether to free dive or SCUBA based on visibility and depth; if visibility is very good, deeper dives can be made and therefore SCUBA gear will be used. More persons use SCUBA gear off the deeper east coast sites than off the north coast where dive sites are generally shallower. The majority of those that solely free dive explained that they enjoy the challenge of free diving and believe it to be more sporting. Average spear fishing depth ranged from 6 to more than 21 m, but most (77%) of the free divers spear fish between 9 - 15 m. Spearfishers using SCUBA gear also stated a range of depths depending on the dive location. Spearfishers using reefs, dive between 12 - 24 m while rig/platform dives are usually around 24 - 46 m, with fishers at these deep sites engaging in “bounce dives” meaning that they descend to the bottom (approx. 30 - 45 m) and then immediately ascend (to 21 - 24 m) after shooting a fish to retrieve the fish and reload the gun. This practice reduces bottom time at depth and therefore saves air to allow for a longer dive.

The average spearfisher has 2 - 3 guns, usually of varying sizes and powers for different locations, water conditions, depths and target species. Larger, more powerful spearguns are used for deeper waters to target groupers and snappers, usually off the east coast. Spearfishers explained that loading a larger gun is quite time and energy consum-

ing and so is either inefficient for use in areas with abundant fish or not worth it for small fish. Smaller guns are used in shallower waters, such as off the north coast to target smaller species in rocky sea bottom.

Fishing Frequency and Duration

Only two of the surveyed spearfishers fish alone while all others fish with a partner or group. A typical boat trip comprises four spearfishers. A majority (68%) of spearfishers stated that they take 2 - 4 trips per month (usually on weekends) while others fish more frequently, stating between 5 - 20 trips per month (Figure 2). Seasonal spearfishers usually take 4 trips per month while non seasonal spearfishers take 5 trips per month. Recreational fishers take 4 trips per month while those that spearfish to support their livelihoods take 14 trips per month.

Spearfishers spend varying lengths of time between 1 and 11 hours on a fishing trip (Figure 2). Shore diving trips are usually the shortest (1 - 5 hr), SCUBA dive trips are limited by the number tanks carried and by non-decompression bottom times, whilst free divers using a boat spend the most time on a trip, generally visiting many different dive sites on a single trip and being limited only by length of daylight. Only one surveyed spearfisher fishes at night and he does not spearfish during the day.

Seasonality

The majority (58%) of spearfishers stated that they fish year-round but that their activity is influenced by sea conditions and visibility. The remaining spearfishers stated that they fish seasonally with most attributing this to the fact that sea conditions and visibility are not suitable ‘out of season’. For most, the spear fishing season falls between March-October with the more popular months being July-September and the most favored month being August. Other reasons given for seasonal spear fishing included: work (many are commercial/offshore divers who spearfish during their off time); school; and ‘hunting season’ (that runs from the first day of October to the last day of February in Trinidad and Tobago).

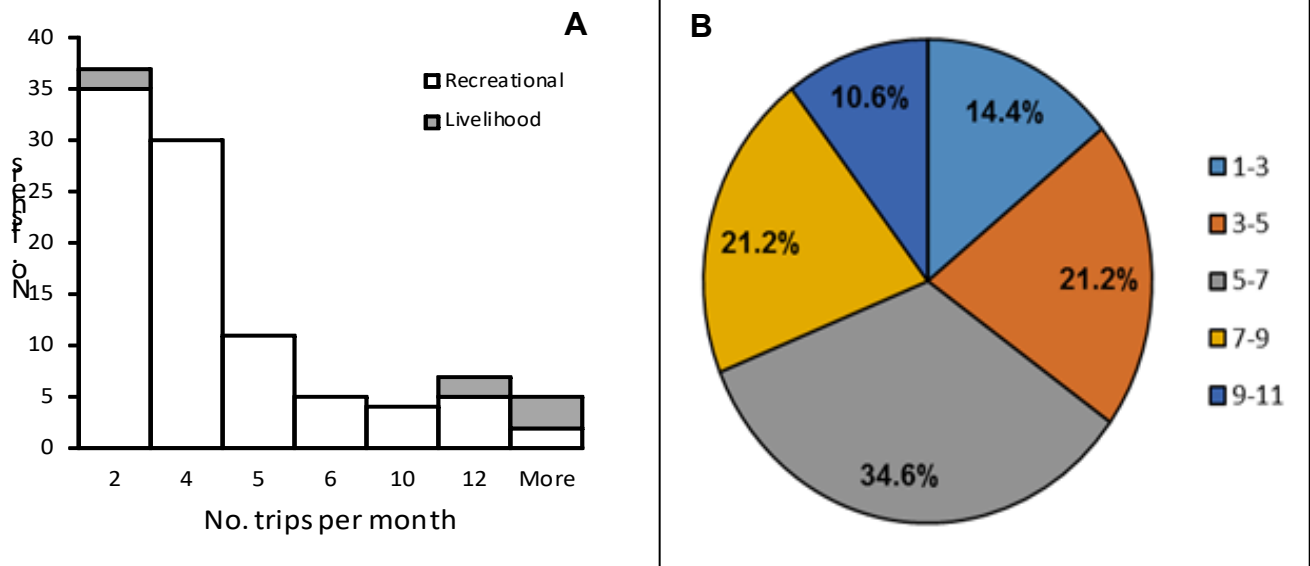


Figure 2. Stated frequency of spearfishing trips per month (n = 105 respondents) (A) and of length of spearfishing trips in hours (n = 104 respondents) (B).

Target species

A total of 37 species from 17 families were listed as target species across all interviewed spearfishers. These included shallow shelf reef species, deep slope species, and both small and large pelagic species (Figure 3, Table 2). Individual spearfishers listed between one and fifteen target species, with the most commonly mentioned being carite, barracuda, cavalla, snapper and grouper, and the most frequently sold being spiny lobster, cavalli, grouper, and snapper.

Catch per Trip

Spearfishers stated that catch per trip was highly variable depending on fishing location, depth and intended target species for that trip. Catch per trip was stated to range from nothing at all ('pailass') to many fish of different sizes and species. Spearfishers stated that they may catch a few large fish, many small fish, a mix of species or all the same species. While this is influenced by location, depth and skill, it is also highly dependent on availability of species on any given trip. Spearfishers that dive off both the

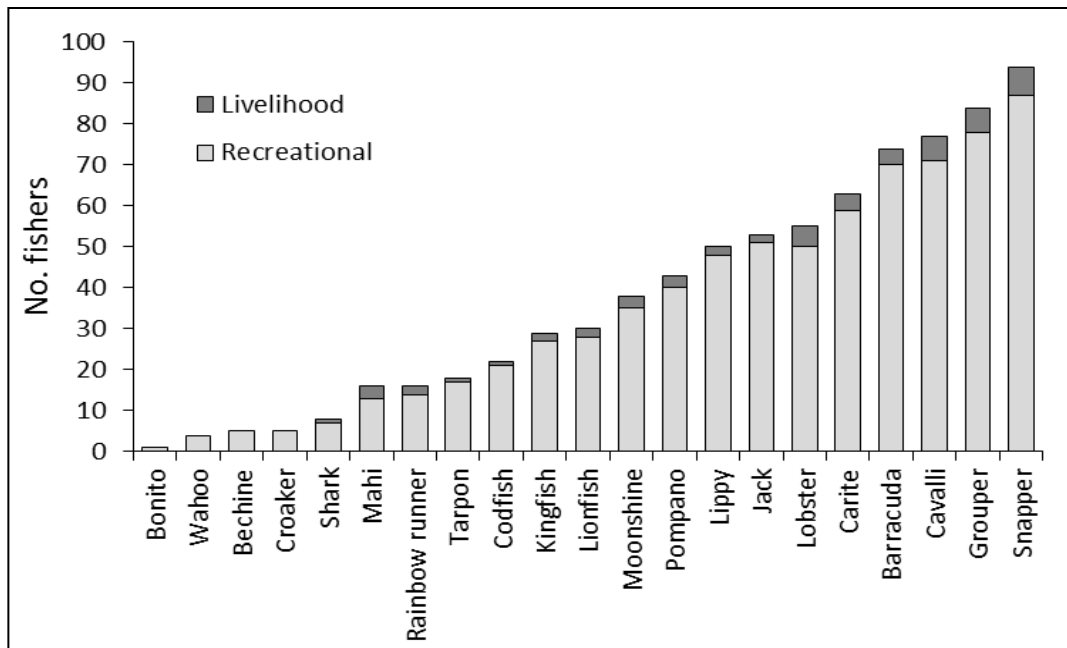


Figure 3. Species most frequently targeted by interviewed spearfishers in Trinidad

north and east coasts all attest to the east coast having larger and more abundant fish. The east coast is also deeper and has harsher conditions making a dive more challenging. Despite the variability, most spearfishers attempted to give an estimate of the catch for an 'ordinary' fishing trip to their most frequented location (Figure 4). Recreational spearfishers stated that they catch between 1 - 25 fish per trip weighing between 2 - 70 kg. On average, recreational fishers take 7 fish or 16 kg of fish per trip. Those that spearfish to support their livelihood reported that they take between 14 - 35 fish per trip weighing from 20 - 160 kg. This averages as 21 fish and 104 kg of fish taken per trip. Spearfishers also estimated that they catch between 1 - 8 different species per trip (mode 4 species).

Minimum Target Size

As spearfishing is a highly selective method of fishing, spearfishers have control over what fish they target; this includes size and species. Fishers pointed out that the minimum size of fish they would shoot on any trip is largely dependent on the species and availability, such that a fisher

may intend to target fish between 3 - 10 kg, but in the absence of larger fish, they would take something smaller. Most spearfishers, however, stated that they would not shoot a fish weighing less than 1 - 2 kg.

Crude Estimate of Annual Landings

Three methods were used to obtain crude estimates of total annual landings by the spear fishery, based on the interview data from 92 spearfishers. The first method used the actual stated estimate of catch per trip for each fisher, whilst the second and third methods took the average catch per trip and the modal catch per trip for the entire sample respectively and applied it to each fisher. The spearfishers were then assigned to one of two categories, either into year-round (12 months) or seasonal (4 months) fishers to estimate the number of trips each made per year, based on their stated average number of trips per month. These three crude estimates are summarized in Table 3. Extrapolating these estimates up to the total number of active spearfishers identified in this study gives a crude annual landings estimate of between 102 - 460 mt (Table 3).

Table 2. Target species listed by interviewed spearfishers in Trinidad

Family	Species	Common names
Scombridae	<i>Scomberomorus brasiliensis</i>	Carite
	<i>Scomberomorus cavalla</i>	Taza, kingfish
	<i>Auxis thazard</i>	Bonito
	<i>Euthynnus alletteratus</i>	Bonito
	<i>Acanthocybium solandri</i>	Wahoo
Sphyraenidae	<i>Sphyraena guachancho</i>	Bechine
	<i>Sphyraena barracuda</i>	Barracuda
Lutjanidae	<i>Lutjanus synagris</i>	Lane snapper, redfish
	<i>Lutjanus campechanus</i>	Red snapper, redfish
	<i>Lutjanus jocu</i>	Dog snapper, redfish
	<i>Lutjanus analis</i>	Mutton snapper, Sub, redfish
	<i>Lutjanus mahogoni</i>	Mahogany snapper
	<i>Lutjanus cyanopterus</i>	Cubera snapper, redfish
Serranidae	<i>Epinephelus itajara</i>	Goliath grouper, Jewfish
	<i>Mycteroperca bonaci</i>	Black grouper
	<i>Epinephelus striatus</i>	Nassau grouper
Haemulidae	<i>Anisotremus surinamensis</i>	Black margate, lippy
Coryphaenidae	<i>Coryphaena hippurus</i>	Dolphinfish, mahi-mahi
Carangidae	<i>Seriola dumerili</i>	Yellow jack
	<i>Caranx latus</i>	Horse-eye jack
	<i>Caranx lugubris</i>	Black jack
	<i>Caranx ruber</i>	Bar jack
	<i>Seriola rivoliana</i>	Amber jack
	<i>Seriola dumerili</i>	Amberjack
	<i>Caranx hippos</i>	Cavalli jack
	<i>Elagatis bipinnulata</i>	Rainbow runner
	<i>Selene brownii</i>	Moonshine
	<i>Alectis ciliaris</i>	Pompano
	Ginglymostomatidae	<i>Ginglymostoma cirratum</i>
Palinuridae	<i>Panulirus argus</i>	Lobster
Rachycentridae	<i>Rachycentron canadum</i>	Codfish, cobia
Scorpaenidae	<i>Pterois volitans</i>	Lionfish
Megalopidae	<i>Megalops atlanticus</i>	Grand-écaille, tarpon
Centropomidae	<i>Centropomus undecimalis</i>	Brochet, snook
Scaridae	<i>Scarus iseri</i>	Parrotfish
Ephippidae	<i>Chaetodipterus faber</i>	Atlantic spadefish, Paoua
Sciaenidae	<i>Micropogonias furnieri</i>	Whitemouth croaker, Cro Cro

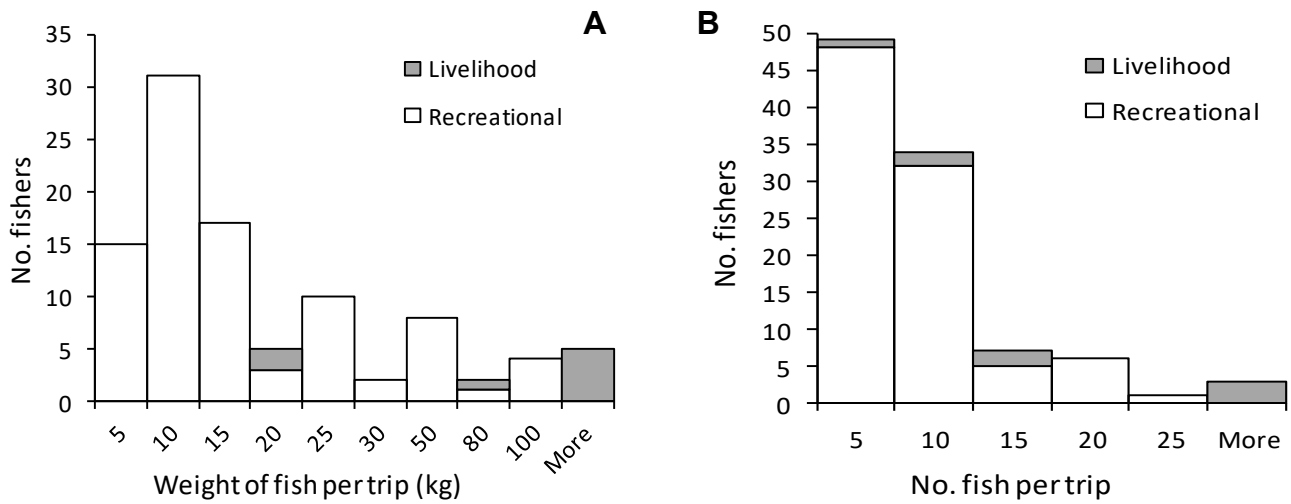


Figure 4. Estimated catch per trip for an ‘ordinary’ dive at their most frequented location as stated by interviewed spearfishers. (A) shows as weight of fish (n = 102 respondents), and (B) shows number of fish (n = 101 respondents).

Table 3. Crude estimates of total annual landings by the spear fishery in Trinidad.

Category	No. of Fishers	Annual Catch Estimates (kg)		
		Actual (stated catch per trip)	Average (23.29 kg per trip)	Modal (9.09 kg per trip)
Seasonal	36	23,032	14,021	5,472
Year-round	56	137,825	77,472	30,237
All interviewed spearfishers	92	160,857	91,492	35,709
Total active spearfishers identified	271	473,829	274,485	105,186

Cost of Gear and Fishing Trips

The main spearguns used in Trinidad are commercially manufactured by Champion, JBL, Riffe, Rob Allen or Beuchat. The only other essential gear is mask, snorkel and fins. Initial gear costs for a spearfisher were stated by interviewers as ranging from TT\$1,450 - TT\$15,475 according to the quantity of gear bought in addition to a speargun. Additional gear is optional. The average stated cost of initial gear is TT\$6,857.

Persons spearfishing for more than two years were asked how much they spend on gear purchases and maintenance per year. While individual spearfishers spend between TT\$200 and TT\$12,000 annually, most spend less than TT\$5,000 and the average spearfisher spends \$3,833 annually. Foundational spearfishing gear (gun, mask and snorkel, fins, wetsuit) are quite resilient and therefore do not need regular replacement or repair. Persons spending more than around TT\$1,000 a year are likely buying additional gear or upgrading gear for enhanced performance or aesthetics. Those spending less are mostly just maintaining their gear, which will include replacement of gloves, speargun rubbers and bent or lost spears.

Most spearfishers that use a boat reported that they would normally take trips with a spear fishing friend and boat owner and simply contribute to gas which may cost between TT\$100 - \$500 per person. In these cases, they usually take turns driving the boat to different fishing grounds, ensuring that there is always one person left

onboard during a dive. Approximately 20% of the surveyed spearfishers reported that they may sometimes charter a boat and driver as a group to go spear fishing at selected sites. Spear fishing charters range in price from TT\$700 - \$2,500 per trip depending on distance and duration. North coast and ‘Down the Islands’ trips are generally the least expensive (TT\$700 - \$1,500) due to the calm conditions and proximate dive sites, whilst east coast charters range from TT\$1,500 - \$2,500 due to a longer trip in harsher conditions.

Spearfishers reported that they eat very little while on fishing trips, since it can cause sea sickness or discomfort while diving, and decreases breath holding capacity in free divers. As such food and drink expenses per boat trip are low, ranging from TT\$40 - \$300 per person; with 69% of fishers spending less than \$200. Other trip expenses include ice (TT\$20) and filling SCUBA tanks (TT\$60 - \$100 per tank). Overall, stated expenses per fisher per boat trip average TT\$832.

Knowledge of and Suggestions for Management

Spearfishers were generally aware that there is currently no stated policy or regulations regarding spear fishing in Trinidad and Tobago. When asked if they would be open to the development of a best practices guidebook to educate spearfishers on diver safety and sustainable fishing practices such as what species and sizes would be appropriate, almost all respondents (98%, n = 47) supported the idea,

and some added that it should be made accessible to the general public. Only two spearfishers had negative comments about such a guideline book stating that it would be useless as no one would read it. One fifth of those that made management suggestions ($n = 63$ respondents), suggested that some form of education and awareness should be provided regarding safe spear fishing practices to prevent accidents. Comments were made about new spearfishers being ignorant of simple safety precautions such as not spearfishing around sea bathers and how to handle a loaded gun out of the water (Figure 5).

DISCUSSION

Spear fishing is ubiquitous across the Caribbean, yet is typically poorly documented. This study represents the first island-wide description of the spear fishery in Trinidad and provides an update of limited information collected on spear fishing in three marinas in the northwest of Trinidad in 1992 (Mike and Cowx 1996) and in 2010 (Shoy 2010).

The results of the current study indicate that there are at least 271 active spear fishers operating nationwide and that there may be as many as 600 involved at least occasionally in spear fishing. The previous studies did not give island wide estimates as data collection was restricted to three marinas in North-West Trinidad. Mike and Cowx (1996) estimated that there were 34 boats registered for spearfishing, each with 3 spearfishers per boat while, the 2010 study (Shoy 2010) surveyed 16 spearfishers. Shoy inferred that the spear fishery was growing however, as the sample size for spearfishers in the total population for the survey was considerably larger in 2010 than in 1992, and over that time, the estimated number of spearguns being used in the fishery more than doubled.

Mike and Cowx (1996) collected data showing that on average, spearfishers take 32 trips per year, lasting 4 hours each. This study shows that seasonal spearfishers take 16 trips per year and non-seasonal fishers take 59 trips per year, the majority of which last between 5 - 7 hours. The current study indicates that there has been a considerable

increase in the estimated catch per trip and annual catch of spearfishers over the last two decades. Mike and Cowx (1996) stated that an average of 40 kg of fish were caught per spearfishing trip, consisting of three spearfishers (i.e. 13.3 kg per person per trip) and that the fishery lands approximately 45 mt of fish per year. This study used actual, average and modal stated catch data and the minimum list of total active fishers (271 persons) to arrive at crude estimates for the spear fishery, resulting in estimates between 18 - 72 kg of fish caught per person per trip and a total landed weight of between 105 - 474 mt of fish per annum. Using average data only, to relate to the 1992 study, this current study estimates that recreational and livelihood fishers catch 16 kg and 104 kg of fish per trip respectively and 274 tonnes of fish are landed annually by the spear fishery.

As reported by the previous studies, the current study confirmed that the spear fishery of Trinidad is predominantly recreational, male dominated, with a majority of fishers between the ages of 30 - 40 years. The majority of fishers free dive rather than use SCUBA gear and prefer to take boat trips to several fishing grounds, spending between 3 and 7 hours spearfishing. The most popular marinas are all located in Chaguaramas (north-western part of Trinidad) and the most popular fishing grounds are located along the North Coast and East coasts. Most spearfishers leave from Chaguaramas or different beaches along the North coast as these areas have the calmest sea conditions and best visibility, along with shallow fishing grounds.

Trinidad and Tobago's recreational, artisanal and commercial fishery sectors are all multi-gear and multi-species fisheries (Mohammed and Chan A Shing 2003). Therefore, spearfishing competes with some of these fisheries. While spearfishing is highly selective, the fishery lands a variety of species. However, the majority of landings consist of shallow shelf reef species and deep slope species (snappers, groupers, barracuda and lobsters) and nearshore pelagic species (cavali, carite and jacks).

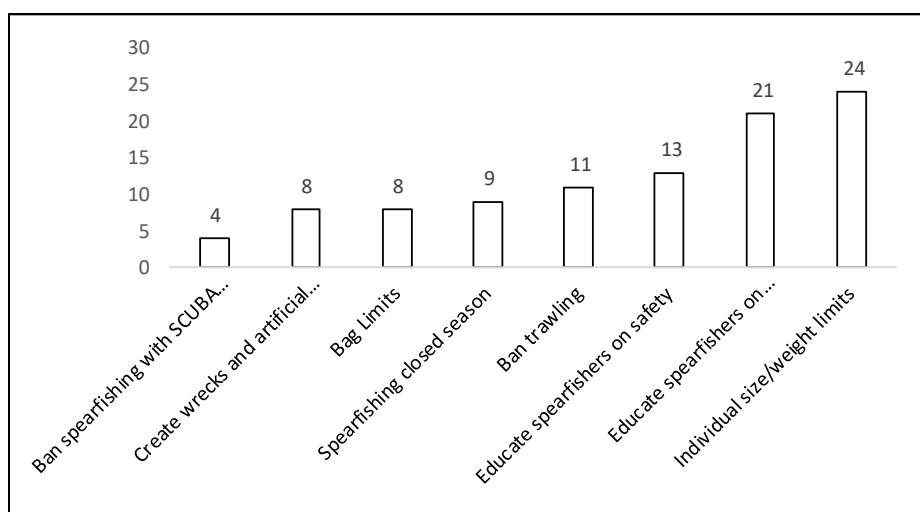


Figure 5. Most frequent recommendations made by spearfishers in Trinidad when asked for their ideas about managing the spear fishery ($n = 63$ respondents).

Mohammed et al. (2011) stated that due to Trinidad's location on the South American shelf, the fishery resources are diverse, including the soft-substrate demersal fishery (shrimp and groundfish), the hard-substrate demersal fishery, the coastal pelagic fishery, and the oceanic (highly migratory) pelagic fishery.

Mike and Cowx (1996) listed the principal target species of recreational fishers overall, as kingfish, carite, cavalli, snappers and groupers. This confirms that the spear fishery's target species overlap with other recreational fisheries especially those live baiting, banking and trolling. There is also overlap with some artisanal and commercial fisheries such as gillnetting, trawling using fish pots, hand lining. The overlapping species are dolphinfish, snappers, wahoo, carite, groupers, and kingfish.

Therefore, the spearfishery mostly overlaps with the country's other recreational fisheries and some commercial fisheries. The country's fishers do not target reef species. The few spearfishers that admitted to shooting parrotfish, a reef species, stated that this is done for Tobagonians, Barbadians, Jamaicans and Vincentians living in Trinidad and Tobago as it is not desired by Trinidadians.

This earlier study only included data from three spearfishers and was limited in geographical scope to the north-western part of Trinidad. Although Mike and Cowx (1996) collected some economic and catch data on the spear fishery, their sample size was considered too small for a meaningful comparison with my own economic data collected from a much larger sample size and over the entire country.

Mohammed and Lindop (2015) stated that, in Trinidad, fisheries landings comprise of artisanal landings (37%), subsistence fisheries (28.6%), recreational fisheries (4.5%) and industrial landings (7.1%), with discards contributing 22.7%. Overall catches stabilized at an average of 13,600 mt per year for 2006 - 2010 (Mohammed and Lindop 2015). From 2006 - 2010 the recreational fishery would have landed approximately 612 mt per year. Approximations done for annual landings of the spear fishery in this study are assumed to be overestimated as various extrapolations were done using average data for catch estimates and fishing effort. This study estimated that the spearfishery lands approximately 91 mt per year. Mike and Cowx's study (1996) also provided annual estimates for the spearfishery in comparison to other recreational fishing methods which estimated that spearfishing contributed 4.8% of the recreational fishery's annual landings. Using the estimates obtained in this study, in relation to those stated by Mohammed and Lindop (2015), the current study shows that spearfishing may contribute between 14% - 44% of recreational fisheries annual landings.

There appears to have been a change in spearfishing practices since the 2010 study as Shoy (2010) reported a much greater percentage of spearfishers using SCUBA gear (18.8% SCUBA only and 43.8% using both) than was obtained in the current study (4% SCUBA only and 33% use both). The studies also differed in the reported frequency of spearfishing trips, with Shoy (2010) reporting that all fishers stated that they spearfish all year round, while current information suggests that almost half of the fishers are seasonal. Both studies however agree that water clarity is one of the key factors influencing their fishing frequency. Dif-

ferences between the previous studies and the current research are not surprising, as the previous studies were restricted three marinas in one area of Trinidad while this study was done island wide and specifically focused on the spear fishery. This led to a higher quantity and quality of detailed information for the spear fishery.

With minimal documentation and knowledge on spear fisheries in the region, there is a general lack of management regulations specific to this fishery. Only three CARICOM countries, St Lucia, The Bahamas and Anguilla, have legislation relating to management of the spear fishery. This is corroborated by the Director of the Fisheries Division of Trinidad and Tobago who expressed concern for the management of the local spear fishery, admitting that a major limitation is a lack of research on the topic (pers. comm. Christine Chan A Shing). In light of this, the study was designed to be as thorough and comprehensive as possible, including thoughts and suggestions for management by spearfishers. This proved to be useful, as a large percentage of fishers showed interest in the management of the fishery, and volunteered comments and suggestions, that likely reflect the spearfishers' respect for the resource and willingness to participate in such management efforts.

While there were various suggestions on potential management actions to improve the fishery and protect the resource, the spearfishers were most interested in spearfisher safety and awareness. As it is a predominantly recreational activity, the community is growing as the sport is becoming increasingly popular (mostly due to social media). The more experienced spearfishers are aware that many persons are getting interested in the sport and trying it without any knowledge or training. The community shared their concerns for these spearfishers as well as the public as spearfishing is considered a relatively high risk sport.

Furthermore, concern was expressed for a general lack of awareness of resource conservation and sustainable spearfishing practises. While fishers requested regulations relating to species specific size limits and catch quotas, significant emphasis was placed on the fact that spearfishers simply were not educated on how they can conserve the resource and the long term benefits of their actions. This suggests that new spearfishers may adopt safety and conservation efforts once informed of the techniques and significance.

Notably, some of the spearfishers that suggested protecting particular species, specifically mentioned the goliath grouper. The goliath grouper, *Epinephelus itajara* is the largest of the Atlantic Ocean groupers; they can exceed 400 kg. They are extremely vulnerable to overfishing due to critical life history traits such as late sexual maturity (5 years), long life (> 38 years), strong site fidelity, slow growth and formation of spawning aggregations (Gerhardinger et al. 2006)). The goliath grouper is listed on the IUCN Red List of Threatened Species. This species is rarely speared, but is a well sought after species by spearfishers, due to its size, tasty meat and profitable sale. They are very often killed prematurely as they are so large. Notes from this study documented that the largest goliath grouper killed was 159 kg and are shot at as little as 28 kg.

As social media has played a large role in the increased popularity of the sport and the spearfishing community, it is recommended that the initial stages of the management process incorporate conservation education and spearfishing safety into media formats. There are a few popular Facebook pages and Youtube channel specific to spearfishing in Trinidad that have a significant following. Educating the community on how and why they should conserve the resource can change the mentality of the average spearfisher and possibly create new conservational norms in the sport.

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