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Comparative Analysis of Shark Capture Data: Species Composition, Diversity, and Abundance Along the Northeast Coast of Trinidad

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Abstract

Sharks play a crucial role in balancing marine ecosystems. They occupy a wide range of habitats and play a significant role in maintaining biodiversity. Some shark species, such as reef sharks, help maintain the health of coral reef ecosystems. However, over one-third of shark species globally are threatened with extinction. In the Western Central Atlantic Fishery Commission (WECAFC) waters, which account for 14% of global shark species, many species face significant risks. Future Fishers (FF) 2022 baseline data collected across the seven landing sites shows that over 60% of shark species caught are vulnerable, and over 29% critically endangered. The continued harvesting of these vulnerable species poses a significant threat to ecosystem health, diversity and fisherfolk livelihoods. Accordingly, the purpose of this observational study is to examine the relation between shark species, fishing methods, and landing sites and quantity and price of sharks landed within Northeastern Trinidad and Tobago. Data was collected from extensive fieldwork resulting from 1288 unique observations from 62 fishers ranging from January 2022 to Dec 2022. Data collectors were employed and trained to collect catch records that were then entered into the FF database called "FISHNET". The data analysis will involve a comparative evaluation of records across landing sites as well as over the 12-month period. The result of these analyses will provide a greater understanding of the local context that may impact livelihood and future shark harvest. This information can aid in the development of targeted conservation strategies and measures that can be applied locally and regionally.

KEYWORDS: sharks, fishing methods, economic returns, ecosystem health, conservation strategies

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1. INTRODUCTION

The impact of shark fishing is an international concern. The Species Survival Commission (SSC) of the International Union for Conservation of Nature (IUCN) has formed a Shark Specialist Group (SSG) in 1991 whose mission was to secure the conservation, management and, where necessary, the recovery of the world's sharks. The parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) took unprecedented action in 1994 by mandating a review of the status and trade in sharks, a group of animals finally listed on the CITES Appendices in 2003. As part of this process, the United Nations Food and Agriculture Organization (FAO) formed a Technical Working Group (TWG) on sharks (FAO, 2002 a). In turn, FAO elaborated precise voluntary guidelines for the development and implementation of shark plans and assessment reports at the national, regional and international levels (FAO, 2002 b). So why have international watch groups become concerned about the harvest of sharks? Sharks can serve as an indicator of ocean health. They play a major ecosystem role by maintaining the species below them in the food chain as they remove the sick and the weak, they ensure species diversity by helping to keep balance with competitors, (Motivarash et al, 2020), and they help with nutrient cycling (Williams et al, 2018). More importantly, sharks are particularly vulnerable to over exploitation because of their K-selected life-history strategy, characterized by slow growth; late attainment of sexual maturity; long life spans; low fecundity; and natural mortality, and a close relationship between the number of young produced and the size of the breeding biomass (Stevens, Bonfil, and Walker, 2000).

Dulvy et al (2021) undertook the first global reassessment of Chondrichthyes against the IUCN Red List Criteria. It was found that 391 species or 32 % of species are considered threatened with extinction, that is, they are categorised as either Critically Endangered, Endangered, or Vulnerable. That statistic increases to more than one-third (37.5%) if Data Deficient species are assumed to be threatened in the same proportion as assessed species. Less than half of all species (44.1%) are of low conservation concern (Least Concern). The reassessment found twice as many threatened species as was found in the original assessment (181 species) in 2014. Chondrichthyes now rank second among vertebrates (after amphibians) regarding an extinction threat. Of interest, 536 species or 35.9 % of the threatened species of Chondrichthyes were sharks. The study revealed disproportionately high levels of threat for sharks in tropical and subtropical coastal waters, where more than three-quarters of species are threatened. Overfishing was identified as the main threat for all 391 threatened species and is the sole threat for two-thirds of species (n = 263, 67.3%). Large-scale (industrial) fisheries were the key threat, either on their own as a unique threat (36.5%) or in combination with other fisheries (96% of species). In 2021, during the Western Central Atlantic Fishery Commission (WECAFC) Working Group deliberations on the development of a Regional Plan of Action for the Conservation and Management of Sharks in the WECAFC Area, it was reiterated that over one-third of sharks are threatened with extinction globally and in the WECAFC waters which hosts 14% of the global number of shark species, relatively greater numbers are disproportionately threatened (FAO, 2021). This threat is due to overfishing as sharks are fished as target species, as a bycatch that is either commercialised or used locally as food, and sometimes as unwanted and discarded bycatch. This raises concern for biodiversity loss, health of aquatic ecosystems and the sustainability of fisheries for livelihoods, food and nutrition security, tourism and the overall ocean economy.

Unfortunately, there is limited literature available on the sharks of Trinidad and Tobago. Shing (2006) provided an overview of the shark fishery, Castro (1989) described the biology of the Golden Hammerhead (*Sphyrna tudes*), Ali et al (2020) evaluated public knowledge, attitude and practices of shark and shark consumption, and Fanovice et al (2017) reported on citizen observations of sharks and Mobulid in Tobago. However, there is a lack of information regarding shark landings from artisanal fishers as pertains to species, their respective numbers; economic return; and IUCN status in Trinidad and Tobago. This lack of information ensures

that Trinidad continues to contribute to the alarming rate of decline of sharks in the regional and by extension, global waters. As such, the purpose of this study is to investigate the relation between shark species and fishing methods, on the price and number of sharks caught across landing sites and time. This study will provide important insights and information to natural resource managers with respect to shark conservation.

This study is guided by the following two general research questions:

Research Question 1: To what extent is the price of shark related to the landing site and time of year caught, controlling for shark species and fishing methods?

Research Question 2: To what extent is the quantity of sharks caught related to the landings sites, time of year, shark species and fishing methods?

2. METHODS

Study Area

The study area is the northeast of the Island of Trinidad, West Indies (see Figure 1). The Caribbean Sea meets the northern side of the study area, and the Atlantic Ocean meets the land on the eastern side of the study area. These bodies of water have a variable mixing zone around the northeast of the island, sometimes pushing west, sometimes pushing east, but typically it can be found between the northeast of the island and the southwest of Tobago. Occasionally, discharges from the Orinoco also wash northwards along the east coast, can spill westward along the north coast, and can spread as far north as Tobago. This occurs mainly in the latter and early months of the year when the effects of the intertropical convergence zone (ITCZ) and the wet season are felt. Three landing sites, Matelot, Grande Riviere, and Toco are located on the northern side, while Cumana, Balandra, and Salybia-Matura are on the eastern side. Most fishers generally operate in the body of water immediately available to them.

Participants

Future Fishers' 2021 profile of the Matura to Matelot (M2M) Fishers revealed that there are 94 boats in the area and 190 fishers, of which 11 are women. These boats are fibreglass built, between 24 to 32 feet, with the majority around 28 ft. They are typically powered by a single outboard engine from 48 to 150 hp, with a few equipped with dual engines. The main fishing methods used are à-la-vive, banking, fillet, fishpot, gillnets, palangue, switchering and trolling. Gillnets are used mainly all year round to target Carite and Kingfish and is the most popular fishing method. Redfish, Salmon and Shark make up the rest of the top 5 species targeted by Fishers.

Data Collection

Data collection occurred from January to December in 2022. Each landing site had a data collector trained in the identification of species landed. The number of individuals for each species landed as well as the group weight for each species was recorded. Records were limited to 4 per day at every landing site and were collected over 5 days every week. The maximum quota of records was not met throughout the period as fishing was interrupted by adverse environmental and weather conditions, poor fish stock, and poor financial reward. Data were entered into the FISHNET database created and maintained by Future Fishers.

Variables

The variables used in the analyses were months of the year (Month), the Landing Sites (7 Site), Fishing Methods and Shark Species.

Data Analysis Steps

The analysis proceeded in two phases: descriptive and inferential. The descriptive analysis comprised summaries of the variables with respect to price and number of sharks caught. The frequencies represent the percentage or proportion of observations per level of each category i.e., percent of the total number of sharks caught. The number summaries depict results of the price of shark caught across time of year (Month) and landing site (Site) including the mean (M), standard deviation (*SD*), Median, Mode, Minimum (Min) and Maximum (Max) value. The mean represents the average price of sharks caught across Month and Sites respectively and depicts the most typical value in the sample, the standard deviation (SD) is a measure of spread or dispersion of the sample values around the mean. Higher values indicate more variable shark prices around the mean. The median represents the shark prices that fall within the middle of the distribution of shark prices. The Min and Max values represent the smallest and largest shark prices obtained across months and sites. 95% Confidence Intervals (C.I.) for the prices represent the range of shark prices the average shark prices are expected to fall within. The 95% C.I. measures provides a measure of the uncertainty associated with the mean shark prices.

The inferential analysis consisted of multi-factorial analysis of covariance (ANCOVA) in which the price of sharks were compared across Month and Sites controlling for fishing methods and shark species. A Negative Binomial regression was used to estimate the expected number of sharks caught by the aforementioned variables.

3. RESULTS

The descriptive analysis results are presented first. Summaries of shark prices across months and sites are followed by summaries of the number of sharks caught by Month, Site, Fishing Method and Shark Species. The inferential analyses will follow a similar pattern.

Descriptive Analyses

Table 1 presents the price of sharks landed by Month. On average, the price per lb of shark caught was lowest for the month of September (M = $5.25TT, *SD* =1.39) and highest for April (M = $8.07, *SD*=2.83). These prices ranged from $2 to $15 per lb.

Table 2 presents the price of shark landed by landing site (arranged from nearest-market Site-Salybia). On average, the price per lb of sharks caught by Site was lowest for Matelot (*M* = $5.72, TT, *SD* =2.22) per lb and highest for Toco (*M* = $7.72, *SD*=2.35). These prices ranged from $1 to $15 per lb.

Table 1. Descriptive Statistics for Price (TT) of Shark Caught by Month

							95% CI	
	Mean	*SD*	Median	Mode	Min	Max	Lower Limit	Upper Limit
January	6.26	2.11	6	6	0	12	5.96	6.55
February	6.63	1.82	6	6	0	11	6.33	6.92
March	8.50	1.96	8	8	0	15	8.15	8.85
April	8.07	2.83	8	10	0	15	7.68	8.45
May	7.09	2.09	7	6	0	12	6.69	7.49
June	6.95	1.61	7	6	2	10	6.58	7.31
July	7.01	1.97	8	8	0	12	6.65	7.37
August	5.85	1.88	6	6	0	10	5.50	6.19
September	5.25	1.39	5	5	0	10	5.00	5.50
October	5.86	1.77	6	6	3	10	5.25	6.46
November	5.92	1.52	6	6	0	8	5.31	6.54
Total	6.83	2.28	6	6	0	15	6.71	6.96

The subsequent tables present the descriptive results for the number of sharks caught by Month, Site, Fishing Method and Shark Species. Table 3. indicates that the largest number of sharks were caught in January (20%), followed by August and September (14%).

Table 2. Descriptive Statistics for Price (TT) of Shark Caught by Site

							95% Confidence Interval	
	Mean	*SD*	Median	Mode	Min	Max	Lower Limit	Upper Limit
Salybia	7.31	2.35	8	8	0	15	7.05	7.57
Balandra	6.80	2.44	6	6	0	12	6.49	7.12
Cumana	6.75	1.63	6	6	0	12	6.56	6.94
Toco	7.72	2.66	8	5	0	15	7.29	8.14
Sans Souci	6.84	1.79	6	6	2	10	6.35	7.32
Grande Riviere	6.01	2.19	6	5	0	12	5.58	6.44
Matelot	5.72	2.25	5	4	1	12	5.32	6.12

NOTE: Zero "0" under minimum price could be either no data or that the fish was given away for free.

Table 4 presents the results of the number of sharks caught by Site. The results indicate a relatively even distribution in the number of sharks caught by the landing sites, except for

Table 3. Number of Sharks Caught by of Month

	Fishing Trips	Number of Sharks Caught	Min	Max	% of Total
January	210	1958	1	48	20.30
February	159	808	1	28	8.40
March	125	420	1	23	4.30
April	221	788	1	23	8.20
May	110	692	1	74	7.20
June	79	246	1	37	2.50
July	122	1227	1	151	12.70
August	122	1360	1	126	14.10
September	124	1377	1	57	14.20
October	36	337	1	35	3.50
November	26	451	1	33	4.70
Total	1334	9664	1	151	100.0

Balandra that caught a low number of sharks (3.7%, n = 359) compared to the other sites. Cumana reported the largest number of sharks caught (19.6 %, n = 1,895).

Table 4. Number of Sharks Caught by Site

	Fishing Trips	Sum	Min	Max	% of Total
Matelot	133	1596	1	35	20
Grande Riviere	104	371	1	28	5
Sans Souci	55	1036	1	151	13
Toco	161	1023	1	35	13
Cumana	286	1285	1	23	16
Balandra	243	1190	1	34	15
Salybia	328	1576	1	31	20
Total	1310	8077	1	151	100

Table 5 presents the results of the number of sharks caught by the fishing method. The results indicate that the vast majority of the sharks were caught by either Green Net (47.7%, n = 621) and White Net (46.9%, n = 570) fishing methods.

Table 5. Number of Sharks Caught by Fishing Method

	Count	Sum	Min	Max	% of Total
Other Fishing Methods	143	520	1	27	5.4%
Green Net	621	4614	1	151	47.7%
White Net	570	4530	1	126	46.9%
Total	1334	9664	1	151	100.0%

Note: Count is the number of shark capture trips for a given fishing method

Table 6 presents the results of the number of sharks caught by Shark Species. The results indicate that the majority of sharks caught were either Sharpnose/Waterbelly (57.1%) or Small Tail Sharks (24.8%).

Table 6. Number of Sharks Caught by Shark Species

	Count	Sum	Min	Max	% of Total
Blacknose Shark *Carcharhinus acronotus*	25	34	1	3	0.4
Blacktip Shark… *Carcharhinus limbatus*	83	125	1	5	1.3
Caribbean Reef *Carcharhinus perezi*	15	22	1	3	0.2
Dusky Shark *Carcharhinus obscurus*	10	18	1	4	0.2
Great Hammerhead *Sphyrna mokarran*	35	48	1	4	0.5
Nurse Shark *Ginglymostoma cirratum*	15	18	1	2	0.2
Scalloped Hammerhead *Sphyrna lewini*	141	331	1	15	3.4
Shark Un ID (unidentified shark)	41	297	1	37	3.1
Shark X HH (unidentified hammerhead shark)	12	22	1	3	0.2
Shark X NHH (unidentified non hammerhead shark)	44	345	1	24	3.6
Silky Shark *Carcharhinus falciformis*	6	10	1	4	0.1
Sharpnose / Waterbelly Shark	597	5521	1	93	57.1
Smalleye Hammerhead *Sphyrna tudes*	107	250	1	9	2.6
Smalltail Shark *Carcharhinus porosus*	132	2398	1	151	24.8
Tiger Shark *Galeocerdo cuvier*	13	19	1	4	0.2
Total	1334	9664	1	151	100

NOTE: Count refers to the number of trips that resulted in the capture of a species

Inferential Analyses

Following the descriptive analysis a multi-factor analysis of covariance (ANCOVA) to investigate differences in the Price of Shark Caught (dependent variable) among Sites, and Month controlling for Fishing Method and Shark Species. A Negative Binomial regression analysis was conducted to estimate the expected quantity of shark caught across Months, Site, Fishing Methods and Shark Species. Preliminary analyses were conducted to ensure that the models met the requisite statistical assumptions (normality, linearity etc.), along with checks for outliers and influential values. Additionally, the ANCOVA results are presented first, followed by the Negative Binomial regression results.

Table 7. Represents the results of the multi-factorial ANCOVA. Only statistically significant results are presented. The results indicated significant price differences between Months $F(10, 1273)= 30.99$, $p = <.001$, 2=0.20 and between Sites $F(6, 1273) = 17.87$, $p = <.001$, 2=0.08. Follow-up post-hoc analyses identified the specific price gaps. The "Price Gap" represents the estimated mean difference in shark prices between Months (Site) A and B. A negative price gap indicates higher shark prices for Month (Site) B and vice versa. For example, on average, shark prices in January were $2.16TT lower than in March. Overall, the largest price-gap occurred between March-September ($3.34 TT) and the smallest price gap occurred between July-August ($0.97).

Table 7. Results of Multiple ANOVA of Shark Prices by Month

				95% CI for Price Gap	
Month (A)	Month (B)	Price Gap (A-B)	*SE*	Lower Bound	Upper Bound
January	March	-2.16	0.23	-2.93	-1.39
	April	-1.93	0.20	-2.58	-1.27
	September	1.18	0.24	0.38	1.97
February	March	-1.80	0.25	-2.62	-0.98
	April	-1.57	0.22	-2.28	-0.85
	September	1.54	0.25	0.70	2.38
March	May	1.51	0.28	0.59	2.43
	June	1.43	0.30	0.43	2.43
	July	1.55	0.26	0.68	2.43
	August	2.52	0.27	1.62	3.42
	September	3.34	0.26	2.47	4.21
	October	2.23	0.40	0.92	3.55
	November	2.00	0.45	0.51	3.50
April	May	1.27	0.24	0.47	2.08
	June	1.19	0.27	0.30	2.08
	July	1.32	0.24	0.53	2.11
	August	2.28	0.23	1.50	3.06
	September	3.10	0.24	2.32	3.89
	October	2.00	0.38	0.74	3.26
	November	1.77	0.43	0.33	3.21
May	August	1.01	0.27	0.11	1.91
	September	1.83	0.28	0.90	2.76
June	August	1.09	0.30	0.10	2.09
	September	1.91	0.30	0.91	2.91
July	August	0.97	0.27	0.06	1.87
	September	1.79	0.26	0.91	2.66

Table 8 presents the result of the price gap in sharks caught by Site. Only statistically significant results are presented. The Grand Riviere-Matelot price gap ($0.51TT) was lowest, while the Salybia-Toco price gap ($1.98TT) was the highest.

Table 8. Results of Multiple ANOVA of Shark Prices by Site

				95% CI	
Site (A)	**Site (B)**	**Price Gap**	**SE**	**Lower Bound**	**Upper Bound**
Salybia	Cumana	-0.99	0.30	-1.90	-.09
	Toco	-1.98	0.24	-2.70	-1.26
	Sans Souci	-1.07	0.21	-1.71	-0.42
	Grande Rivere	-1.10	0.22	-1.77	-0.44
	Matelot	-1.61	0.21	-2.24	-0.97
Balandra	Toco	-1.68	0.25	-2.45	-0.90
	Sans Souci	-0.76	0.23	-1.47	-0.06
	Grande Riviere	-0.80	0.24	-1.52	-.077
	Matelot	-1.30	0.23	-2.00	-0.61
Cumana	Toco	-0.98	0.29	-1.86	-0.11
Toco	Sans Souci	0.91	0.20	0.31	1.51
	Grande Rivere	0.88	0.21	0.25	1.50
Sans Souci	Matelot	-0.54	0.16	-1.04	-0.04
Grande Riviere	Matelot	-0.51	0.17	-1.03	0.02

The following tables present the results of the Negative Binomial regression model for the quantity of shark caught by Month, Site, Species and Fishing Method. The estimated coefficients in a negative binomial regression represent the effect of a unit change in the predictor variable on the *expected* count of the outcome variable when controlling for all other variables compared to the reference category. The results represent the percentage increase or decrease in the *expected count* relative to the "*Reference"* group controlling for the other variables. The sign of the beta coefficient (β)--2nd column, indicates whether the expected count is lower or higher (negative = lower expected catch, positive = higher expected catch). For example,

The month of February (Table 10) is used as an example of how to interpret the results – January is the reference group. In February fishers are expected to catch: Exp (β) – 1 = 0.60 - 1 = 0.40 x 100 = 40% less sharks than January controlling for the other variables. The expected number of sharks caught range from a low of 0.37 (37%) fewer (March and April) to as much as .85 (85%) fewer (June).

Table 9. Results of Negative Binomial Regression by Month

Month	β	SE	Sig.	Exp(β)	% Increase-Decrease	95% Wald CI for Exp(β) Lower	Upper
February	-0.51	0.20	0.01	0.60	40	0.41	0.89
March	-0.46	0.15	0.002	0.63	37	0.47	0.85
April	-0.46	0.21	0.026	0.63	37	0.42	0.95
May	-0.56	0.23	0.013	0.57	43	0.37	0.89
June	-1.91	0.17	<.001	0.15	85	0.11	0.21
July	-1.04	0.20	<.001	0.36	64	0.24	0.52
August	-1.58	0.14	<.001	0.21	79	0.16	0.27
September	-1.68	0.17	<.001	0.19	81	0.14	0.26
October	-1.30	0.14	<.001	0.27	73	0.21	0.36
November	-0.60	0.15	<.001	0.55	45	0.41	0.74
January (Reference)	-	-	-	1	-	-	-

Table 10 presents the results for the expected number of sharks caught by Site, relative to Matelot (the most remote Site) controlling for the other predictors. Fishers in Sans Souci (372%) were expected to catch a significantly larger number of sharks compared to Salybia *i.e.* Exp (β) – 1 = 4.72 - 1 = 3.72 x 100 = 372 % controlling for the other predictors. Similarly, for fishers in Matelot (231%).

Table 10. Results of Negative Binomial Regression by Site

	β	SE	Sig.	Exp(β)	% Incr-Decr	95% Wald CI for Exp(β) Lower	Upper
Matelot	1.20	0.11	<.001	3.31	231	2.69	4.08
Grande Riviere	-0.52	0.13	.696	0.95	5	0.73	1.23
Sans Souci	1.55	0.25	<.001	4.72	372	2.89	7.71
Toco	0.53	0.11	<.001	1.70	70	1.36	2.13
Cumana	0.13	0.10	.195	1.14	14	0.94	1.39
Balandra	0.22	0.12	.068	1.24	24	0.98	1.57
Salybia				1			

Table 11 presents the results for the expected number of sharks caught by Fishing Methods with reference to "White Net" fishing methods controlling for the other predictors. Fishers using fishing methods other than nets are expected to catch significantly fewer sharks compared to fishers who use "White Net" as a fishing method i.e. Exp (β) – 1 = 0.44 - 1 = 0.56 x 100 = 56%. Similarly, fishers are expected to catch significantly fewer "endangered" sharks compared to sharks of "least concern" i.e., Exp (β) – 1 = 0.35 - 1 = 0.65 x 100 = 65%.

Table 11. Results of Negative Binomial Regression by Fishing Methods

	β	SE	Sig.	Exp(β)	% Incr-Decr	95% Wald CI for Exp(β) Lower	Upper
Other Fishing Methods	-0.83	0.12	<.001	0.44	56	0.34	0.56
Green Net	-0.05	0.10	0.609	0.95	5	0.78	1.16
White Net (Reference)				1			

Table 12 presents the results for the expected number of sharks caught by Shark Species with reference to "Sharpnose/Waterbelly Shark" (largest quantity of shark species caught) fishing methods controlling for the other predictors. Fishers are expected to catch significantly fewer shark species, ***except for*** Smalltail Shark, compared to the Sharpnose/Waterbelly Shark. Fishers are expected to catch 63% fewer (Puppy/Julius Shark) to as much as 87% fewer sharks (Nurse Shark). In contrast, fishers are expected to catch significantly more Small Tail Sharks (97%) compared to the Sharpnose/Waterbell Sharks.

Table 12. Results of Negative Binomial Regression by Shark Species

						95% Wald CI for Exp(β)	
	β	SE	Sig.	Exp(β)	% Incr-Decr	Lower	Upper
Blacknose Shark	-1.95	0.11	**<.001**	0.14	86	0.11	0.18
Blacktip Shark	-1.85	0.09	**<.001**	0.16	84	0.13	0.19
Caribbean Reef	-1.87	0.14	**<.001**	0.15	85	0.12	0.20
Dusky Shark	-1.67	0.18	**<.001**	0.19	81	0.13	0.27
Golden or Smalleye Hammerhead	-1.41	0.09	**<.001**	0.25	76	0.20	0.29
Great Hammerhead	-1.94	0.09	**<.001**	0.14	86	0.12	0.17
Nurse Shark	-2.07	0.10	**<.001**	0.13	87	0.10	0.15
Puppy/Julius Shark	-0.99	0.15	**<.001**	0.37	63	0.28	0.50
Scalloped Hammerhead	-1.39	0.10	**<.001**	0.25	75	0.21	0.30
Shark X HH	-1.65	0.14	**<.001**	0.19	81	0.15	0.25
Tiger Shark	-1.88	0.17	**<.001**	0.15	85	0.11	0.21
Silky Shark	-1.74	0.28	**<.001**	0.18	83	0.10	0.30
Small Tail Shark	0.68	0.12	**<.001**	1.97	97	1.54	2.51
Sharpnose-Waterbelly Shark (Reference)				1			

4. DISCUSSION

Price of Shark Landed by Month

The results show that there were statistically different prices in the pound of shark over the year (see Table 8). March and April enjoy the highest mean price of shark ($8.50TT and $8.07TT respectively, see Table 1). Of the two, April was the only month that recorded the least amount of shark , and so one can expect that the scarcity in the supply accounted for the higher price. However, upon closer inspection, there were other months with similarly lower and even lower landings of shark (June, July, and August), but these did not enjoy a similar high market price. March, with an intermediate quantity of shark landed as compared to April, enjoyed the first highest price for shark. This goes against the principle of high supply resulting in lower price and vice versa, low supply resulting in higher price. However, the higher prices in March and April are most likely as a result of an artificially high demand for seafood. Many nationals are from the Christian faith and they typically only consume seafood and abstain from other meats during the Lenten period. Lent was from March to mid-April in 2022. It is noteworthy that for September, October, and November, three of the four months with the higher mean shark weights, the mean price of shark is amongst the lowest received for shark. This is in keeping with the principle of lower price when supply is high. However, it is possible that there were better-quality fish being brought to the market at more competitive prices during this period such as Mackerels, Snappers and Salmons, hence the lower price given for the sharks.

Price of Shark Landed by Site

The results show that there were statistically different prices in the pound of shark across the landing sites (see Table 9). Toco was the site with the highest price per lb of shark ($7.72, see Table 2), and Matelot was the site with the lowest price per lb of shark ($5.72). Generally, it could be said that the price of shark decreases the further west one goes along the only access road into the study area. The section of road from Toco to Matelot in particular is of poor quality. Our pattern of generally decreasing price for fish follows that of Minten and Kyle (1999) where distance and road quality have been shown to affect margins. The exception however, would be Toco. This anomaly might be explained by the high number of vendors that service this landing site, such a situation causing them to be more competitive in the prices they offer to Fishers.

Type and Number of Shark Caught by Month, Landing Site, and Fishing Method

The fishing practices utilised by fishers in the study area are resulting in substantially more Small Tail and Sharpnose/Waterbelly Sharks being landed (see Table 7), with there expected to be almost twice as many Small Tails landed as there are Sharpnose/Waterbelly landed (see Table 13). For example, fishers are expected to catch In contrast, it is those practices that result in less of the other species being landed. January was the month when the largest number of sharks were caught (Tables 3), and fishers are expected to catch fewer numbers of sharks in all the other months of the year (Table 10). Fishers at Matelot, Sans Souci and Toco are expected to catch significantly more sharks relative to Salybia, expected to catch 2.3, 3.7, and 0.7 times more sharks than landed at Salyboa (see Table 11). Conversely, Fishers at Grande Riviere, Cumana, and Balandra are not expected to catch significantly more sharks than landed at Salybia. It is noteworthy that Sans Souci had a high number of sharks landed per shark capture trips (see Table 4). There is no significant difference between the number of sharks captured between green and white net use Green Net (see Table 12). However, there is a significant difference in the number of sharks caught using other methods relative to white net.

5. CONCLUSIONS

There are significant differences in the price of shark between months and between sites. There are also significant differences in the type and number of sharks caught by month, landing site, and fishing method. Investigations into the underlying factors for the difference in numbers and species of shark landed can provide insight into the habits of shark species, targeting the time, place and method of their respective susceptibility.

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