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ARTICLE

Survey-Derived Angler Characteristics and Perspectives in the Shore-Based Shark Fishery in Florida

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Abstract

Shore-based shark fishing in Florida is rarely monitored as it largely occurs at night on remote beaches and has received a questionable reputation after recent exposure of illegal activity. While these events have led to calls for better management and enforcement, the characteristics of the fishery itself remain largely unknown. Our study, therefore, provides the first comprehensive profile of the Florida shore-based shark fishery to inform fisheries management and conservation. We distributed an online survey to all Florida Fish and Wildlife shore-based shark fishing permit holders to gather data on angler sociodemographics, fishing preferences, habits, motivations, and perceptions of shark conservation. We identified three angler typologies that differed primarily by shark fishing experience and frequency: (1) experienced infrequent anglers, (2) skilled frequent anglers, and (3) novice infrequent anglers. Our results revealed that the Florida recreational shore-based shark fishery itself has increased in participation fivefold since 2010 and generates approximately US$7.8 million (95% CI = $7.2– 8.5 million) annually in equipment expenditures and $34.3 million ($30.4–38.1 million) annually in fishing trips. Surveyed anglers caught a total of 9,617 sharks within a 12-month period, averaging 11 sharks/angler, and the most preferred target species was the Blacktip Shark *Carcharhinus limbatus*. Angler motivations for participating in this fishery were grouped into the following categories: leisure and well-being, experience of the catch, and consumption. Perceptions of shark conservation and management were generally positive; however, many anglers did not believe that recreational fishing negatively impacts shark populations. Most anglers expressed a desire to learn more about handling practices that benefited sharks, which may help managers implement more educational opportunities and communication efforts. Understanding the characteristics and perspectives of anglers from the shore-based shark fishery in Florida is crucial for highlighting potential management pathways and estimating angler acceptance of management.

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Populations of sharks (class Chondrichthyes) around the globe are currently under threat, primarily from overfishing (Roff et al. 2018; MacNeil et al. 2020). Resulting population declines have led to an increase in monitoring and research in the commercial shark fishing sector, addressing mortality from bycatch and live discards (Skomal 2007; Dulvy et al. 2014). In comparison, the recreational sector is believed to have minimal impact on shark populations and has thus received relatively little attention in both the research and management realms (Kilfoil et al. 2017). The negative impact of recreational angling, however, has been well documented in numerous fisheries globally. Recreational anglers can contribute to fisheries declines or collapse through overharvest (Coleman et al. 2004; Post 2013) or delayed postrelease mortality caused by handling stress, physical injuries, or postrelease predation (Arlinghaus et al. 2007; Coggins et al. 2007). Such fishing mortality, even if rather low, is of particular concern to species such as sharks with life history characteristics (e.g., long lived, late age of maturation, and low fecundity, all resulting in a low intrinsic rate of natural population increase) that make any incremental adult mortality problematic (Walker 1998; Booth et al. 2019). Yet, compared with other areas of research in shark conservation, there is relatively little research on the impacts of recreational fishing interactions on shark populations (e.g., Robbins et al. 2013; Gallagher et al. 2017; Kyne and Feutry 2017).

Recreational shark angling is a popular sport with participants from an array of socioeconomic backgrounds and occurs in nearshore waters (Lynch et al. 2010; Heard et al. 2016; Gallagher et al. 2017). In the USA, the popularity of recreational shark fishing has been variable over the past few decades (Babcock 2008; Gallagher et al. 2017); however, it appears to be increasing in the last 5 to 10 years, potentially due to media sharing on fishing forums, social media, and press coverage (personal observations in Kilfoil et al. 2017 and authors here). The U.S. Atlantic recreational shark fishery has nearly 13,000 members (12,912 "shark-endorsed" of the total 22,833 Highly Migratory Species Permit holders), compared with 11,740 in 2019 and 10,769 in 2018 (NOAA Atlantic Highly Migratory Species Management Division 2018, 2019, 2020). The U.S. Atlantic recreational shark fishery is managed by the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service's Highly Migratory Species division as well as regional fisheries commissions and state authorities. State and federal fisheries agencies employ a variety of strategies to manage recreational shark fisheries, including species-specific total allowable harvest quotas or complete retention restrictions, restricting various gear types, seasonal closures, and encouraging catch and release (Kilfoil et al. 2017; FWC 2020; NOAA Office of Sustainable Fisheries Atlantic Highly Migratory Species Management Division 2021). This fishery is monitored through the Marine Recreational Information Program, which previously used telephone-based creel surveys that now also includes mail-based (Fishing Effort Survey; NOAA 2019) and in-person surveys (Access Point Anglers Intercept Survey and Large Pelagic Survey; NOAA 2018).

While many anglers target sharks from private, charter, and/or headboat vessels (anglers pay a fee per person), there is also a large shore-based fishery with participants accessing water from beaches, piers, and bridges. This shore- or land-based shark fishing is a subsection of the recreational shark fishing sector and occurs around the globe, including in South Africa (Dicken et al. 2006), Australia (Griffiths 2012), Argentina (Cuevas 2015), and Europe (authors, personal observations). In the United States, active shore-based shark fishing has been observed in several states, including California, Texas, the Carolinas, and finally, Florida (e.g., Kilfoil et al. 2017; Shiffman et al. 2017; Gibson et al. 2019; Weber et al. 2020). Compared to boat-based fisheries, shore-based shark fishing has a low barrier for entry given the ease of access and low cost of fishing from shore. Consequently, there is potential that participants can begin fishing for sharks with little preparation and experience, which may in turn lead to practices that are unsafe for anglers or that reduce shark survival (Brownscombe et al. 2017). It has been acknowledged that the shore-based shark fishery is cryptic and has been largely excluded in the Marine Recreational Information Program and Fishing Effort Survey monitoring programs as it is transient, largely occurs at night on remote beaches, and has received a questionable reputation, leading anglers to avoid confrontation with the general public and enforcement agencies (personal communications with the Florida Fish and Wildlife Conservation Commission [FWC] and anglers).

In Florida, shore-based shark fishing was recently addressed by state managers after a recent publication highlighted illegal activity extracted from an online shore-based shark fishing forum (Shiffman et al. 2017) and the receipt of numerous complaints from the general public, scientists, and advocacy groups as a result of dead sharks along the Florida coastline (reviewed in Shiffman 2020). The shore-based shark fishery in Florida is thus highly polarized with differing opinions from various stakeholder groups regarding how the fishery should be managed or whether it should be banned outright. To address these concerns, the FWC hosted 10 information-gathering workshops around the state of Florida during 2018. An online forum was open for the public to submit their comments and proposed various new fishery-specific regulations. As a result, the FWC is now mandating anyone 16 years or older to take an online course on best practices for shark fishing (https://learningmyfwc.remote-learner.net/enrol/index.

php?id=40) in order to receive a free shark fishing permit to fish from the shore in Florida.

To more effectively manage this increasingly popular method of fishing, managers will require more information about the characteristics of the fishery. Social data on the anglers in this fishery could fill this knowledge gap, providing valuable information on angler composition and fishery economic value. While biological data are crucial to support evidence-based management decisions, social science data are very important for the implementation of fully informed, realistic, and effective management strategies (Skubel et al. 2019). Shark fisheries involve a substantial amount of human–shark interaction in a unique context, and information on angler specialization, motivations, behaviors, and preferences is essential in understanding the extent of those interactions and how they impact shark conservation (Gallagher et al. 2017). Shark fishing can offer opportunities for personal experiences that lead to attitudes and behaviors linked to positive conservation outcomes. Generally, anglers who are committed to fishing display greater interest in sustainability of a fishery and conservation of the species (e.g., Oh et al. 2004; Lynch et al. 2010; Garlock and Lorenzen 2017). These types of anglers also tend to be well informed on issues regarding shark conservation (Gallagher et al. 2015).

As the popularity of recreational shark fishing increases, so do the opportunities to work with anglers for sustainable management of the fishery and advocacy for shark conservation. For example, characterizing angler subgroups and collecting angler information over time may reveal trends in catch and participation rates, angler demographics, preferences, and support for shark fishery management and conservation strategies (Gallagher et al. 2017; Gibson et al. 2019; Skubel et al. 2019). Providing shark anglers with means to communicate their preferences and needs allows managers to understand angler values, while acknowledging and incorporating angler expertise when making decisions. Recreational anglers generally carry proconservation tendencies as the continuation of the sport depends on it, which may be leveraged to increase fishery management support (Cardona and Morales-Nin 2013; McClellan Press et al. 2016; Skubel et al. 2019). Building both positive relationships and trust between anglers, researchers, and managers will lead to angler support and cooperation and therefore more effective policies (Sullivan 2011; French et al. 2018).

Given the current lack in information regarding shore-based shark fishing participants and recent management changes associated with the shore-based shark fishery in Florida, the objective of this study was to evaluate who makes up the shore-based shark fishery, describe the characteristics of the fishery and its economic value, and investigate the angler motivations for participating in shore-based shark fishing. We identified different types of anglers based on their fishing characteristics and specialization and followed a grounded theory approach to understand how these factors link to shark management perceptions and preferences. From these data, we outlined how these perceptions might inform decision making and highlight potential management pathways to meet the needs of the fishery.

METHODS

Data collection: survey.—An online survey was distributed to recreational anglers who held a shore-based shark fishing permit with the FWC (see the Supplement available separately online for the full questionnaire). To address specific research questions regarding the shore-based shark fishery in Florida, survey data regarding socioeconomic and demographic factors describing the angling community and information related to shark fishing specialization, preferences, behaviors, motivations, and attitudes towards shark conservation and management were collected. The total survey consisted of 40 questions and was sent to members of the FWC and NOAA National Marine Fisheries Service Highly Migratory Species division for review and then piloted with several shark anglers to ensure our questions remained relevant and reduced personal bias (Moon et al. 2019). We distributed the survey via email on March 13, 2020, to 11,277 shore-based shark fishing permit holders (as of December 2019), followed by a prompting email on April 2, 2020, to increase responses before closing the survey on April 17, 2020. From this list, 271 emails bounced back and 16 emails were duplicates, resulting in 10,990 individuals receiving the survey. All components of the survey and research methods were approved and conducted in adherence to the Carleton University Research Ethics Board (CUREB-B Clearance #112118).

Our survey questions were built on similar studies of shark-based recreational fisheries in other regions, which included a mixture of multiple choice, 5-point Likert scales, and open-ended questions (e.g., NMFS 2014 [2011 National Marine Recreational Fishing Expenditure Survey]; Gallagher et al. 2015; McClellan Press et al. 2016; Lovell et al. 2016 [NOAA 2014 Marine Recreational Fishing Expenditure Survey]; Drymon and Scyphers 2017; Johnson 2018; French et al. 2019). Consistency in questions across similar studies is important for the relevancy of comparative analyses and builds upon research conducted on this fishery, allowing for enhanced understanding of global trends observed in this fishery. Since the focus of this study was to describe the anglers within the shore-based shark fishery in Florida, we included 18 questions addressing fishing habits and specialization, three of which were filtering questions (i.e., they had to select "yes" for all three of these to proceed), including whether or not they target sharks, hold an FWC shore-based shark fishing permit, and fish for sharks

from shore. The remaining relevant fishing profile and specialization variables will be described in the sections below. We also included four additional questions to obtain information on shark fishing motivations, preferences, behaviors, and attitudes towards shark conservation and management (described in the sections below). Finally, we included five questions to characterize sociodemographic variables, such as gender, age, state of residence, education, and employment. The anglers were given the option to remain on our mailing list to receive information on the results of the study once complete.

Data analysis: economic evaluation.— We included two economic variables in our survey: the total dollars (U.S. dollars) spent on shore-based shark fishing equipment (including rod gear, tackle, marine fishing clothing, and other) within a 12-month period and total dollars spent on their last shore-based shark fishing trip (including number of days fishing, fuel, transportation, accommodation, meals, fishing gear and bait, and other). We obtained the average dollars spent per angler for both variables after removing blank responses, values over US$10,000, trips longer than 21 d, and outlier values (three standard deviations from the mean). We excluded these values to reflect an accurate depiction of typical equipment purchases or shore-based shark fishing trips and to prevent major purchases or extended trips from skewing the results.

To get an approximate economic value of the entire fishery, we extrapolated the two variables to the estimated proportion of anglers who actively participated in shore-based shark fishing from the full FWC shore-based shark fishing permit list using the proportion obtained from our survey (full permit list in December 2020 = 18,000 anglers; FWC, personal communication). We calculated this by multiplying the mean ($\bar{x}$) of dollars spent on shore-based shark fishing equipment by the estimated number of active shore-based shark fishing anglers generated from the full permit list. For the shore-based shark fishing trip variable, we calculated the average daily expenditures of the trips (total dollars spent divided by total days of fishing trips), as well as the mean number of days spent shark fishing in 1 year from our sample. Next, we multiplied these two values by the estimated number of active shore-based shark fishing anglers from the full permit list to get an approximate dollar sum of all shark fishing days from the fishery in 1 year.

Data analysis: angler segmentation.— Anglers who responded that they both target sharks and fish from shore were included in the following analyses. Fishing specialization describes the degree of generalized and specialized anglers within a fishery, which in turn may predict their behaviors, motivations, and preferences based on specialization (Bryan 1977). The use of specialization to identify different types of anglers has been widely applied in the literature to describe the homogeneity of attitudes and behaviors within an angler type and differentiate them from other angler types for management purposes (Oh et al. 2004; Nguyen et al. 2013; Ward et al. 2013; Garlock and Lorenzen 2017; TenHarmsel et al. 2019). We selected nine fishing specialization variables to represent characteristics relevant for angler typologies. These variables have been used in previous studies with similar objectives and methods, including fishing experience (number of years fishing or shark fishing, number of days fishing or shark fishing in a year), self-assessed skill level, centrality to lifestyle variables (hours watching fishing videos, fishing club memberships), shark fishing equipment expenses in the last 12 months, and number of shark catches in the last 12 months (Gallagher et al. 2015; McClellan Press et al. 2016; Drymon and Scyphers 2017; Johnson 2018; French et al. 2019).

To group the respondents based on specialization, we conducted a two-step cluster analysis with log-likelihood distance measure and Akaike information criterion (AIC) in IBM SPSS Statistics Software version 26. Variables with a predictor importance value, a measure of contribution for each variable in the division of the cluster in SPSS, of over 0.8 were retained to characterize each cluster. Cluster analysis has been commonly used across similar studies to segment respondents into homogenous groups using a distance measure between data points, grouping anglers with similar response patterns together (Fisher 1997; Oh et al. 2004; Nguyen et al. 2013; Ward et al. 2013; Garlock and Lorenzen 2017; TenHarmsel et al. 2019). The two-step cluster analysis used a combination of both hierarchical and nonhierarchical clustering methods in that it ran a preclustering first, followed by a hierarchical method to determine an optimal number of clusters. This method was preferred over the more traditional methods, such as *K*-means or hierarchical cluster analysis, due to having a large dataset and no predetermined number of clusters prior to analyses.

Data analysis: differences among angler types.— Following the clustering of respondents based on "fishing specialization," we sought to understand whether these angler profiles differed in sociodemographics, species preference, fishing motivations, behaviors, and attitudes toward shark conservation and management. To achieve this goal, sociodemographic variables such as gender, age, residency (Florida), education, and employment status were used to construct contingency tables by angler profile to identify major associations. Cells within each contingency table with expected counts less than five were merged with appropriate variables to conduct chi-square tests on each table. We used a chi-square-type post hoc test using adjusted residuals to determine which exact cells within the tables were statistically significant, therefore revealing significant correlations between sociodemographic variables and each angler profile. Since the contingency tables were larger than 2×2, a Fisher's exact post hoc test could not be used, and multiple comparisons had to be accounted

for. We used adjusted standardized residuals (as per Beasley and Schumacker 1995; Garcia-Perez and Nunez-Anton 2003) to calculate chi-square and *P*-values for each cell, which were subsequently compared with the adjusted Bonferroni correction value to determine significance. Similar analyses were repeated for variables including species preference, fishing behaviors, and attitudes towards shark conservation and management. Species preference was measured by asking the respondents to rank seven species of shark in order of target preference (1 = most preferred, 7 = least preferred). Fishing behavior was measured in a 5-point Likert scale question "*How do you prefer to fish for sharks from shore*?" We asked the respondents to rate their level of agreement for six statements ("Don't know/does not apply," "Disagree," "Somewhat disagree," Somewhat agree," and "Agree"). Finally, attitudes towards shark conservation and management were measured in two Likert scale questions, eight Likert items to understand their attitudes towards shark conservation and five Likert items to understand their opinions on shore-based shark fishing management. We asked the respondents to rate each statement using the agreement scale listed above.

We captured angler motivation in a 4-point Likert scale question "*Why do you fish for sharks*?" We asked the respondents to rate nine statements by "Important," "Somewhat important," "Not important," and "Not sure." The nine Likert items were subjected to a multiple correspondence analysis (MCA) to identify latent dimensions within the Likert scale with the highest percentage of explained variance. Questions with a high proportion of nonresponse and/or >90% consistency in response were excluded from analysis. Scree plots were used to visually assess dimensions that summarized the greatest proportion of variation of the input data and thus were meaningful for subsequent analysis. Eigenvalues summarizing contributions from input factors (motivations) to each vector were used to describe each dimension, with values above 0.40 considered maximal contribution. The latent dimensions retained from the analysis were then compared with the cluster assignment variable to assess differences among angler types in what motivates them to fish for sharks using Kruskal–Wallis tests for nonparametric data. Dimensions with significant association with angler profiles were then investigated using the Dunn test for nonparametric pairwise comparisons to determine significant differences among the angler profiles. These analyses were conducted in RStudio (version 1.2.5001) using the FactoMineR and factoextra packages (Lê et al. 2008).

RESULTS

Survey Response Rate

A total of 1,895 surveys were completed, resulting in a 17.2% response rate and a 98% response quality rating issued by Qualtrics XM (Qualtrics, Provo, Utah). The response quality rating in Qualtrics assessed the validity of the completed surveys by detecting potential bots, duplicate and ambiguous responses, or respondents speeding through the survey with dishonest answers. After removing invalid and incomplete surveys (387 surveys with <90% of survey completed) and filtering respondents for shark anglers who fish from shore, a total of 856 surveys were included in the analysis.

Description of Sample Population and the Fishery

Demographics and fishing specialization.— The respondents were predominantly male and residing in Florida. Age amongst anglers had a relatively even distribution, with the exception of anglers under the age of 20 representing only a small percentage of respondents (anglers must be over 16 years to obtain the shore-based shark fishing permit and must be over 18 years to respond to our survey; Table 1). We compared the gender, age, and residence demographics from our sample to those of the entire fishery (14,809 anglers who hold an FWC shore-based shark fishing permit as of May 2020, obtained from

TABLE 1. Summary of sociodemographic variables of anglers who target sharks and fish from shore. Abbreviations are as follows: *N* = the number of respondents.

Sociodemographic variables	*N*	Percentage (%)
Gender (*N* = 848)		
Man	797	94.0
Woman	49	5.8
Other	2	0.2
Age (*N* = 846)		
<20 years	46	5.4
21–30 years	165	19.5
31–40 years	166	19.6
41–50 years	168	19.9
51–60 years	158	18.7
60+ years	143	16.9
Residency (*N* = 843)		
Florida	553	65.1
Outside of Florida	296	34.9
Education (*N* = 842)		
Less than high school	14	1.7
High school or equivalent	215	25.5
Trade or apprenticeship	131	15.6
Bachelor's or college degree	347	41.2
Postgraduate degree	135	16.0
Employment status (*N* = 843)		
Unemployed or student	55	6.5
Casual, part-time, or contract	51	6.0
Full-time or self-employed	593	70.3
Retired or pensioner	144	17.1

the FWC) and found relatively similar patterns in which the fishery is male dominated (89.6% of $N = 14{,}809$) and most reside in Florida (65.9% of $N = 14{,}809$). The distribution of age for the entire fishery was similar to our sample but not identical: 8.2% of anglers under the age of 20, 22.7% between the ages 21 and 30, 23.8% between the ages of 31 and 40, 19.2% between the ages of 41 and 50, 14.5% between the ages of 51 and 60, and 11.5% over the age of 60. After comparing these demographic characteristics to the total number of anglers who held an FWC shore-based shark fishing permit, this sample appeared to provide a reasonable approximation of the fishery.

The majority of respondents were employed in full-time work with a postsecondary education. Over half of our sample also fished for other species; however, most respondents had only been targeting sharks for 1 to 5 years out of their last 20 years participating in fishing activities (Table 1). An interesting observation was the increase in anglers joining the fishery over the years, with a spike after 2010. From our sample alone, 6 anglers joined the fishery each year between the years 1990 to 1999, 12 anglers joined each year between 2000 and 2009, and 58 anglers joined each year between 2010 and 2019. The sample of respondents were equally divided into frequent and infrequent anglers (where frequent was fishing biweekly or more and infrequent was fishing once a month or less) when fishing for any species. However, there was a clear imbalance of respondent distribution across the frequency of shark fishing variables, with most respondents classified as infrequent shark anglers (i.e., targeting sharks only once a month or less). Shore-based shark fishing among our sample most often occurred in the evening (48% of $N = 834$) and to a lesser extent in the early morning (18.6% of $N = 834$). Anglers tended to fish between 4 to 7 h at a time (68.8% of $N = 824$). Nearly all respondents self-classified their fishing skills as either intermediate or advanced. Most anglers watched less than 5 h of fishing videos per week, and over half of our sample were members of fishing clubs.

Within our sample of 856 shore-based shark anglers, a total of 9,617 sharks were caught within a 12-month period, averaging at 11 sharks/angler (SD = 13). The shark species listed included Tiger Shark *Galeocerdo cuvier* (262 caught), Blacktip Shark *Carcharhinus limbatus* (3,652 caught), Bull Shark *Carcharhinus leucas* (1,405 caught), Lemon Shark *Negaprion brevirostris* (784 caught), Great Hammerhead *Sphyrna mokarran* (309 caught), and Nurse Shark *Ginglymostoma cirratum* (954 caught), and there was an option for other (2,251 caught). The species caught most often was the Blacktip Shark, with a total of 3,652 catches among 607 respondents, and the species caught the least often was the Tiger Shark, with only 262 catches among 99 respondents.

Economic evaluation.— Our sample respondents spent a total of $523,706.50 on shark-specific fishing equipment within 12 months (rod and tackle gear, fishing clothing, other; $N = 683$), averaging $766.77/angler (SD = $873.48) (Table 2). On their last shore-based shark fishing trip of 21 d or less, respondents spent a total of $305,391.75 (included fuel, transport, meals and accommodation, gear and other; $N = 615$), averaging $496.57/angler (SD = $832.31) over an average of 3.21 d/fishing trip (SD = 3.61).

Using the proportion of respondents who actively participated in shore-based shark fishing (56.7% of $N = 1{,}508$ completed surveys), we estimated that 10,206 of the 18,000 FWC shore-based shark fishing permit holders are active shore-based shark fishing anglers and would generate approximately $7.8 million (95% CI = $7.2–8.5 million) in yearly revenue from shore-based shark fishing equipment purchases and $34.4 million (95% CI = $30.4–38.1 million) in yearly revenue from shore-based shark fishing trips.

Motivations, behaviors, and preferences.— We asked the respondents to rate the level of importance for nine Likert items capturing motivation. The majority of our sample (over 82.4% of $N = 852$) deemed "*Excitement/Thrill of the catch*," "*To relax and get away from it all*," and "*To be outside and by water*" to be important, whereas "*Fishing competitions*" and "*To eat for food*" were deemed unimportant by 89.0% of $N = 849$ and 67.1% of $N = 853$, respectively.

Next, we asked the respondents to rate their level of agreement for five Likert items capturing behavior. Most respondents agreed with the statement "*I will call out another angler if they are handling a shark poorly*" (70.6% of $N = 841$ selecting "Agree" and 18.7% selecting "Somewhat agree"), and most disagreed with the statement "*Longer fight times increase the survival of the shark after release*" (75.4% of $N = 841$ selecting "Disagree" and 12.4% selecting "Somewhat disagree").

We asked the respondents to rank seven species of shark in order of target preference, with a rank of 1 as their most preferred species and a rank of 7 as their least preferred. The species were ranked in the following order of preference: Blacktip Shark ($\bar{x} = 2.01$), Bull Shark ($\bar{x} = 2.58$), Tiger Shark ($\bar{x} = 3.73$), Lemon Shark ($\bar{x} = 4.07$), Great Hammerhead ($\bar{x} = 4.84$), Shortfin Mako *Isurus oxyrinchus* ($\bar{x} = 5$), and Dusky Shark *Carcharhinus obscurus* ($\bar{x} = 5.76$).

Attitudes towards shark conservation and management.— We asked the respondents to rank their level of agreement for nine statements on shark conservation and impacts. There were six statements with high levels of agreement and two statements with high levels of disagreement (Table 3). The six most agreed-upon statements included the following: "*Sharks need to be better protected*," "*I am knowledgeable about shark conservation related issues*," "*Commercial fishing has a negative impact*

TABLE 2. Summary of specialization variables of anglers who target sharks and fish from shore. Abbreviations are as follows: N = the number of respondents.

Specialization variables	N	Percentage (%), mean ± SD, or number of sharks
How long have you been fishing for any species?		
<1 year	13	1.5%
1–5 years	79	9.2%
5–10 years	65	7.6%
10–20 years	149	17.4%
>20 years	550	64.3%
How often do you fish for any species?		
Almost everyday	59	6.9%
2–3 times a week	201	23.5%
Once a week	172	20.1%
Every 2 weeks	149	17.4%
Once a month	148	17.3%
<5 times per year	127	14.8%
How long have you been fishing for sharks?		
<1 year	102	11.9%
1–5 years	346	40.4%
5–10 years	189	22.1%
10–20 years	117	13.7%
>20 years	102	11.9%
How often do you fish for sharks?		
Almost everyday	6	0.8%
2–3 times a week	54	6.8%
Once a week	16	2.0%
Every 2 weeks	83	10.5%
Once a month	141	17.9%
<5 times per year	493	62.5%
Self-assessed fishing skill level		
Beginner	82	9.6%
Intermediate	331	38.7%
Advanced	416	48.6%
Professional	27	3.2%
Hours per week watching fishing videos		
<5 h	537	63.4%
5–10 h	188	22.2%
10–15 h	59	7.0%
15–20 h	42	5.0%
>20 h	27	3.2%
Member of a fishing club?		
No	386	45.5%
Yes, 1	261	30.8%
Yes, 2+	207	24.4%
Expenses in the last year (mean ± SD)		
Rod gear	683	$451.93 ± 588.34
Tackle and gear	683	$168.50 ± 188.16
Marine fishing clothing	683	$76.41 ± 125.77
Other equipment	683	$69.94 ± 136.86
Sharks caught in the last year (number of sharks)		
Tiger Shark	99	262
Blacktip Shark	607	3,652
Bull Shark	337	1,405
Lemon Shark	234	784
Great Hammerhead	119	309
Nurse Shark	267	954
Other	349	2,251

on shark populations," "*I want to learn more about how to make sure my shark survives after I release it*," and "*I would change how and where I fish if it helped shark survival*." The two most disagreed-upon statements included "*When shore-based shark fishing, Great Hammerhead sharks always survive after being caught*" and "*Recreational fishing has a negative impact on shark populations*." Two statements testing shark conservation knowledge received high ranks of "I don't know/does not apply": "*When shore-based shark fishing, Great Hammerhead sharks always survive after being caught*" and "*Populations of Great Hammerhead sharks are not at risk of extinction*."

Next, we asked the respondents to rank their level of agreement for five statements on shark fishery management. The most agreed upon statements were "*Current management measures and restrictions help shark conservation*" (53.7% of $N = 849$ selecting "Agree" and 34.0% selecting "Somewhat agree") followed by "*There needs to be more education and training for shore-based shark fishing*" (36.1% of $N = 851$ selecting "Agree" and 36.9% selecting "Somewhat agree"). The most disagreed upon statements were "*Current management restrictions are too strict or interfere with my fishing*" (41.7% of $N = 850$ selecting "Disagree" and 27.2% selecting "Somewhat disagree"), followed by "*More regulations are required for recreational shark fishing*" (31.0% of $N = 849$ selecting "Disagree" and 29.3% selecting "Somewhat disagree"). The last statement "*Most shore-based shark anglers know what they are doing and will release sharks unharmed*" was relatively even across the options but weighed heaviest at "Somewhat agree" (35.3% of $N = 850$).

TABLE 3. Response summary to Likert items assessing attitudes and knowledge on shark conservation and management from anglers who target sharks and fish from shore. Abbreviations are as follows: SBSF = shore-based shark fishing and GHHSs = Great Hammerhead sharks.

Survey questions	Don't know/does not apply	Disagree (1)	Somewhat disagree (2)	Somewhat agree (3)	Agree (4)	Mean	Standard deviation	Total respondents
Shark conservation								
I want to learn more about how to make sure my shark survives after I release it	31	27	34	156	602	3.63	0.72	850
Commercial fishing has a negative impact on shark populations	42	37	53	185	535	3.50	0.81	852
Sharks need to be better protected	26	29	81	239	477	3.41	0.81	852
I am knowledgeable about shark conservation related issues	10	8	51	331	452	3.46	0.65	852
I would not fish for sharks if I thought it could kill them	17	99	191	226	317	2.91	1.04	850
When SBSF, GHHSs always survive after being caught	173	428	145	76	28	1.56	0.85	850
Recreational fishing has a negative impact on shark populations	53	343	247	173	36	1.88	0.90	852
Populations of GHHSs are not at risk of extinction	254	293	193	76	35	1.75	0.89	851
I would change how and where I fish if it helped shark survival	22	36	47	253	491	3.45	0.79	849
Shark management								
Current management measures and restrictions help shark conservation	37	23	44	289	456	3.45	0.73	849
More regulations are required for recreational shark fishing	59	263	249	171	107	2.15	1.03	849
Current management restrictions are too strict or interfere with my fishing	38	355	231	146	78	1.93	1.00	850
Most shore-based shark anglers know what they are doing and will release sharks unharmed	42	136	189	300	183	2.66	1.01	850
There needs to be more education and training for SBSF	25	70	135	314	307	3.04	0.93	851

Angler Typology

From the initial 856 responses, 75 responses were excluded from the cluster analysis due to missing data in at least one of the variables used, resulting in a total of 781 responses used. The cluster analysis revealed three separate groups among our sample of Florida shore-based shark anglers. The cluster analysis in SPSS generated a low Silhouette measure (0.1), illustrating that clusters were less distinct based on the proximity of one angler to its own cluster relative to the other clusters (H. Řezanková, paper presented at the Applications of Mathematics and Statistics in Economics 21st international scientific conference, 2018). The predictor importance values generated in SPSS revealed that the division of the three clusters was mostly driven by four variables (>0.87 predictor importance): fishing frequency, shark fishing frequency, self-assessed fishing skill, and number of years spent shark fishing.

We labelled the first cluster as "experienced infrequent angler" (EIA) consisting of 271 respondents (34.7% of $N = 781$; Figures 1–4). We used the word "experienced" in the label to reflect that this angler type had been targeting sharks and other fish for many years (between 5 to over 20 years, majority over 10 or 20 years) and mostly rated their fishing skills to be intermediate or advanced. Next, the word "infrequent" was used because these anglers did not fish for sharks frequently (once a month or less). In the last 12 months, these anglers had spent an average of \$452.38 (SD = \$647.23) on shark-specific fishing equipment and had caught approximately 7 sharks (SD = 8) each. The standard deviation values for these last two variables were high due to the fact that the responses still varied widely within these two variables (Figure 4).

We labelled the second cluster as "skilled frequent angler" (SFA) consisting of 312 respondents (39.9% of $N = 781$; Figures 1–4). We used the term "skilled" to specify that these anglers self-assessed as the highest skill level, predominantly as advanced or professional anglers. Further, we did not use the term "experienced" to define this cluster as there was no significant difference in the number of years the anglers within the cluster had been shark fishing (varied relatively evenly between less than 1 year to more than 20 years). Next, we used the label "frequent" to represent that these anglers fished for sharks frequently (mostly weekly to daily), most of which also fished for other fish species frequently. They spent more hours online watching fishing videos (5 to over 20 h weekly) and were more likely to be involved in one or more fishing clubs. In the last 12 months, these anglers spent an average of \$1,305.24 (SD = \$1,643.34) on shark-specific fishing equipment and had caught approximately 18 sharks (SD = 16) each.

Finally, we labelled the third cluster as "novice infrequent angler" (NIA) consisting of 198 respondents (25.4% of $N = 781$; Figures 1–4). Similar to the "experienced infrequent angler" profile, the "novice infrequent angler" did not fish for sharks or other fish species very frequently (once a month or less) but differentiated by the lower number of years they had been fishing for sharks (less than 5 years) and described their skills as beginner or intermediate to the sport. Anglers in this profile were typically not a member of fishing clubs and did not spend many hours online watching fishing videos (mostly less than 5 h/week). In the last year, these anglers spent an average of \$405.29 (SD = \$565.03) on shark-specific fishing equipment and had caught approximately 4 sharks (SD = 5) each.

Demographic Distribution across Angler Types

We compared sociodemographic variables (e.g., gender, age, residency, education, employment) among the different angler types. Gender was excluded from analyses due to the sample being male biased and therefore there was not much difference to observe with this variable. The distribution of age did not differ significantly across the three angler types, with the exception of a few correlations with the EIA and the SFA groups at the Bonferroni-corrected significance level of 0.0028. Most anglers over the age of 50 (49.8% of $N = 273$; $P < 0.001$) were found in the EIA group, while most anglers under the age of 30 (64.4% of $N = 191$; $P < 0.001$) were found in the SFA group (Table 4). There were no significant correlations between any age group and the NIA group. Secondly, we found that residency was significant at the Bonferroni significance of 0.0083. Most of the non-Florida-resident anglers (43.0% of 284 non-Floridians; $P < 0.001$) were found in the EIA group, and most of the Florida-resident anglers (49.80% of 490 Floridians; $P < 0.001$) were found in the SFA group.

Finally, the post hoc tests reveal that the angler types do not differ significantly in education or employment variables, with the exception of three significant correlations at the Bonferroni significance of 0.0042. When exploring educational trends, we found a significant relationship between anglers with highest education as high school or less and being clustered into the SFA group (49.5% of $N = 202$; P-value = 0.0013). When exploring employment trends, two significant relationships were found among anglers who were either students or unemployed; the majority of them were found in the SFA group (60.4% of $N = 48$; P-value = 0.0033), and very few were found in the EIA group (2.1% of $N = 48$; P-value < 0.001).

Exploring Shark Fishing Motivations among Angler Types

Three factors were excluded from the MCA due to missing and/or heavily weighted responses, including "*For physical exercise*" (28% nonresponse of $N = 856$), "*To be outdoors and by water*" (92% very important of $N = 852$), and "*Fishing competitions*" (89% not important of $N = 849$). The following MCA on the nine variables exploring

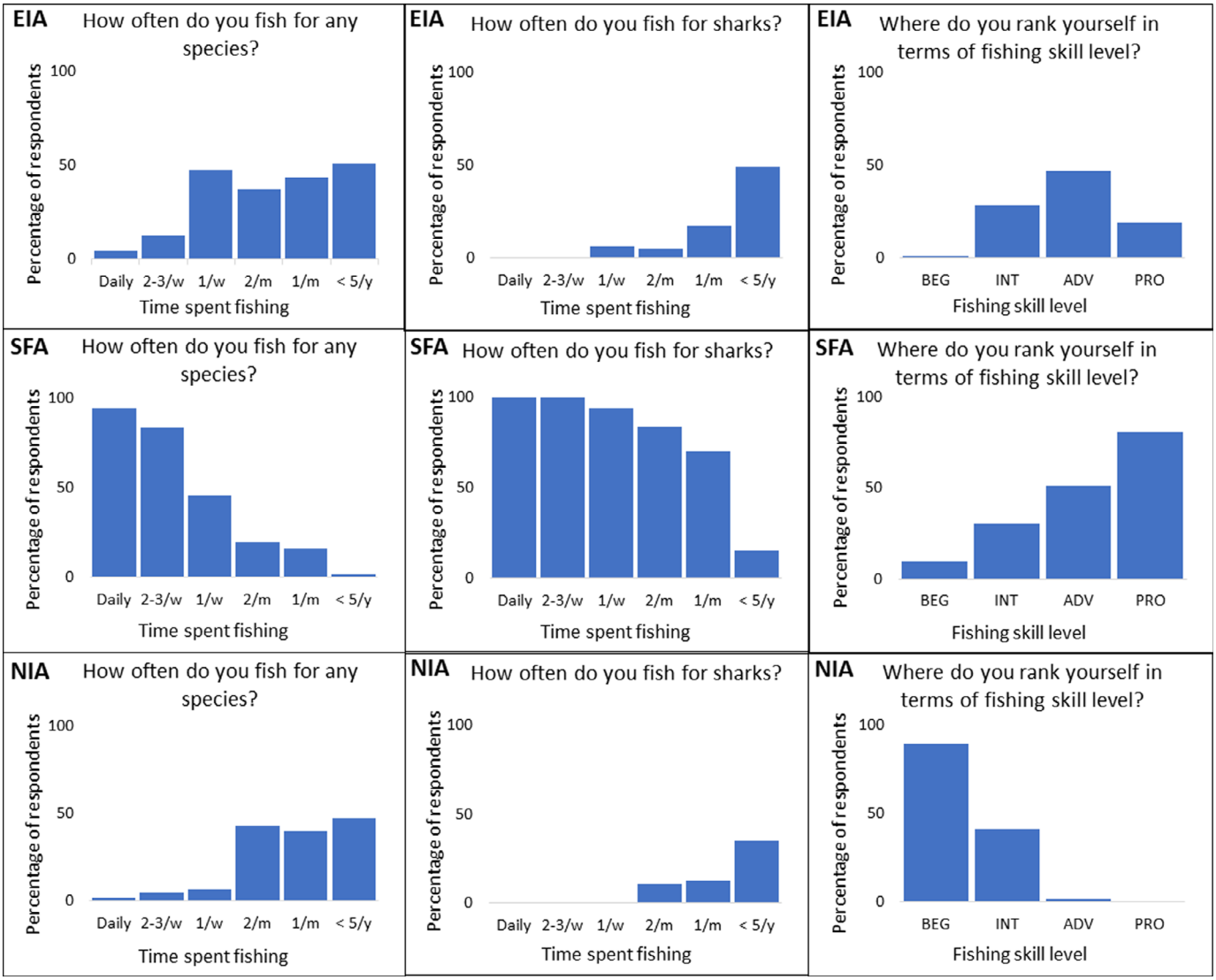

FIGURE 1. Distribution and response summary of the variables used in the two-step cluster analysis on shore-based shark anglers across the three angler types (EIA = experienced infrequent angler, SFA = skilled frequent angler, and NIA = novice infrequent angler). Abbreviations are as follows: w = week, m = month, y = year, BEG = beginner, INT = intermediate, ADV = advanced, and PRO = professional.

shark fishing motivations revealed three latent dimensions summarizing 37.2% of the variation in the input data. Based on eigenvalues, dimensions were assigned as follows: dimension 1 was considered "Leisure and well-being," which explained 15.2% of the variance, had an eigenvalue of 0.512, and grouped variables "*Opportunity to hang out with my friends or family*" and "*To relax and get away from it all*"; dimension 2 was considered "Experience of catching a shark," which explained 11.4% of the variance, had an eigenvalue of 0.454, and grouped variables "*Excitement/ thrill of the catch*," "*Satisfaction of catching the largest fish*," and "*To develop and improve my skills*"; dimension 3 was considered "Consumption" and explained 10.6% of the variance, had an eigenvalue of 0.452, and best summarized the "*To eat for food*" variable (Table 5).

Comparison of the cluster analysis variable to the MCA results revealed "Experience of catching a shark" to be the central motivation differentiating angler types, driving differences among angler profiles 1 (EIA) and 2 (SFA), and 2 (SFA) and 3 (NIA). The SFA group had allocated higher importance values to two of the three variables grouped within this dimension: "*Satisfaction of catching the largest fish*" (EIA = 45.2% of $N = 270$, SFA = 52.7% of $N = 311$, NIA = 42.1% of $N = 196$) and "*To develop and improve my skills*" (EIA = 40.8% of $N = 270$, SFA = 71.8% of $N = 311$, NIA = 54.7% of $N = 196$).

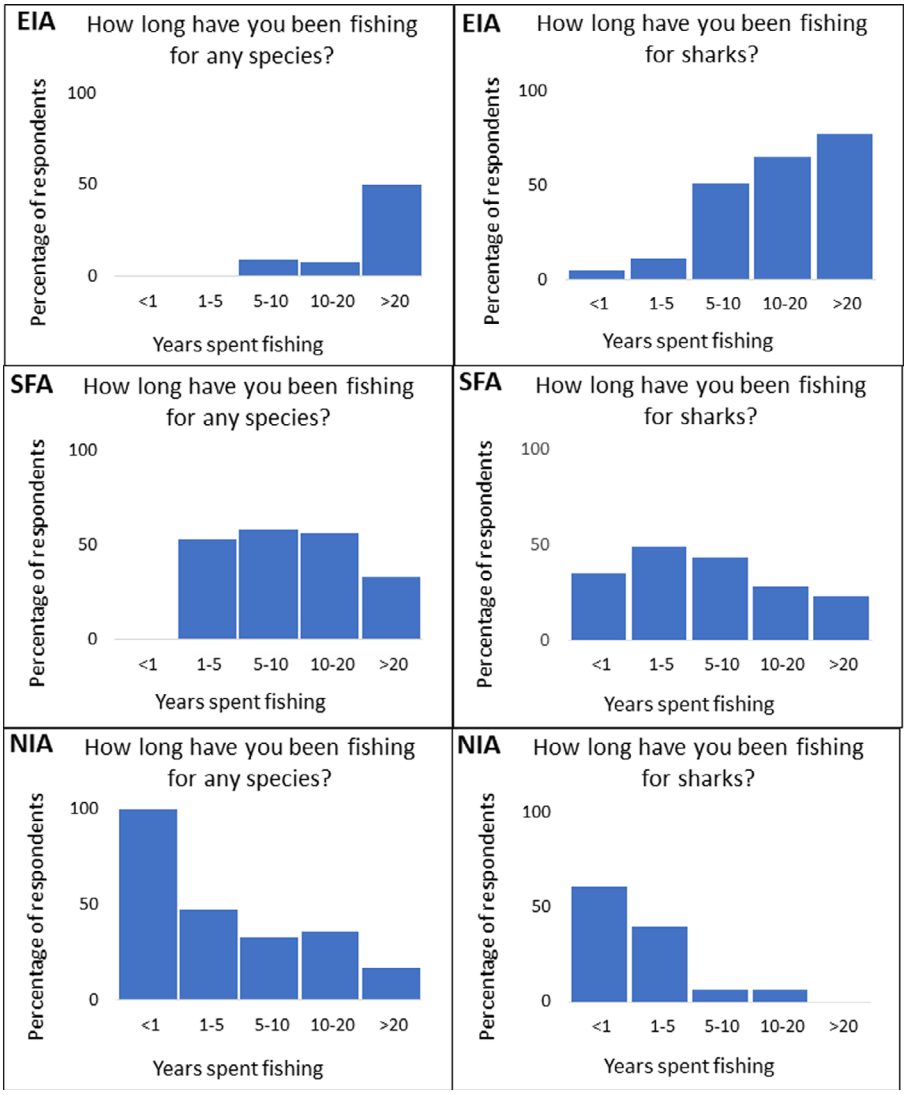

FIGURE 2. Distribution and response summary of the variables used in the two-step cluster analysis on shore-based shark anglers across the three angler types (EIA = experienced infrequent angler, SFA = skilled frequent angler, and NIA = novice infrequent angler).

Species Preferences, Fishing Behaviors, and Conservation Attitudes across Angler Types

No significant correlations were found among species preferences, fishing behaviors, and angler attitudes towards shark conservation and management in Florida and the three angler groups.

DISCUSSION

Our study explored the human dimensions of a shore-based shark fishery in Florida through an online survey of licensed shark anglers that investigated shark fishing specialization, motivations, preferences, behaviors, and attitudes on shark conservation and management. We acknowledge that our study presents some limitations as our survey captured only a sample of the entire fishery. We aimed to reduce sampling bias by sending our survey to the full shore-based shark fishing permit-holder list; however, lack of participation may have been a result of skepticism among anglers from this fishery towards researchers (Shiffman et al. 2017). Nonetheless, sociodemographic trends from the FWC permit-holder database illustrated that our sample was relatively representative and was an alternative to other studies dealing with human dimensions of shark recreational fisheries that have relied on snowball sampling (e.g., Gallagher et al. 2015; McClellan Press et al. 2016; French et al. 2018). Our response rate (17.4%) was typical (if not high) for targeted online email surveys (Sheehan 2001; Nulty 2008; Shih 2009). Further, due to the diversity in shore-based shark

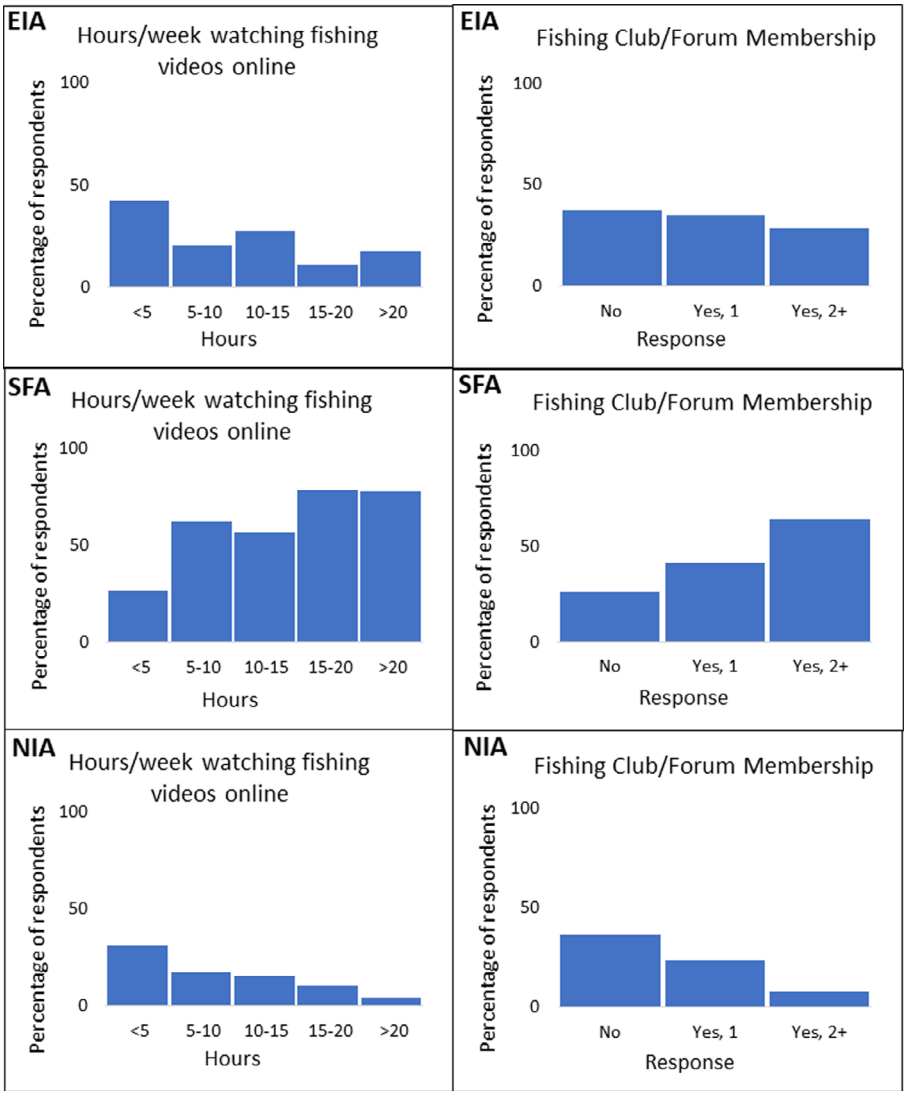

FIGURE 3. Distribution and response summary of the variables used in the two-step cluster analysis on shore-based shark anglers across the three angler types (EIA = experienced infrequent angler, SFA = skilled frequent angler, and NIA = novice infrequent angler).

fishing habits and specialization among anglers, the distinction of the three types of anglers was less robust than we had desired but was still highly informative. Responses of the nine specialization variables varied widely, resulting in some overlap of cluster boundaries. Survey instruments were inherently biased due to self-reporting by participants and may have been limited due to a prescribed set of responses (e.g., multiple choice rather than open-ended questions). It is important to note potential recall bias, which may have resulted in inaccurate (i.e., higher) reports of catch rates, fishing expenses, or fishing trip frequency. Social desirability bias may have also added inaccuracies in the form of overreported socially favorable behavior when asked about attitudes on conservation. Nonetheless, our findings present the first descriptions of an increasingly popular fishery, the shore-based shark fishery in Florida.

Anglers of the Florida Shore-Based Shark Fishery

Our survey revealed that the majority of anglers participating in the shore-based shark fishery in Florida were males of various ages and had more experience fishing for other species than for sharks. Further, although most anglers were Florida residents, we found that about a third of anglers traveled to Florida to engage in shore-based shark fishing.

Our analyses revealed three angler types based on fishing specialization variables: EIA, SFA (the largest group), and NIA (the smallest group). The three angler types fit along the continuum of recreational specialization defined

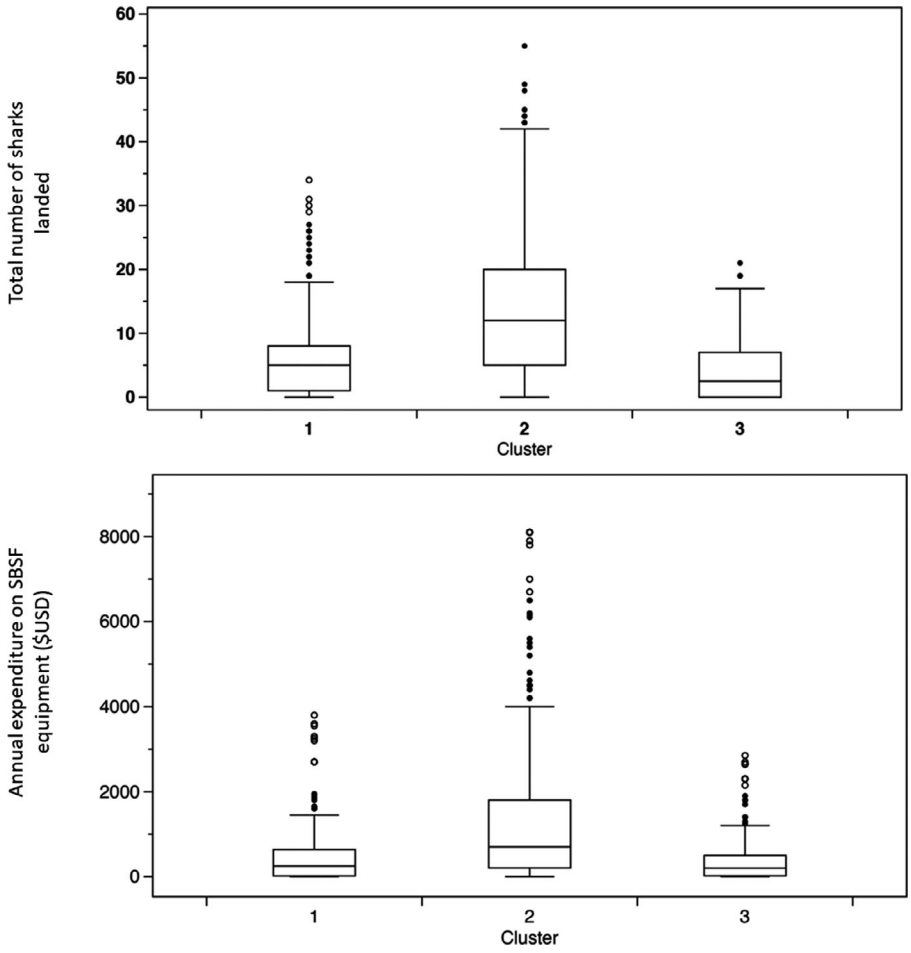

FIGURE 4. Distribution and response summary of the variables used in the two-step cluster analysis on shore-based shark anglers across the three angler types (continuous variables). Clusters are as follows: cluster 1 = experienced infrequent anglers, cluster 2 = skilled frequent anglers, and cluster 3 = novice infrequent anglers. For the box plot, the horizontal line in each box indicates the median, the box dimensions represent the 25th to 75th percentile range, whiskers show the 10th to 90th percentile range, and the dots are outliers. Abbreviations are as follows: SBSF = shore-based shark fishing.

by Bryan (1977), ranging from least specialized (NIA) to moderately specialized (EIA) to most specialized (SFA). However, Bryan (1977) argued that recreational specialization progressed in a linear fashion, where one's invested time, behaviors, attitudes, and preferences advance towards the desire to manage and protect the environment, which would in turn preserve the activity. Our results did not show such a linear path, much like the results in Fisher's work (1997). The EIA group generally had many years of experience in shark fishing (mostly more than 10 or 20 years) but did not invest much time shark fishing (less than once a month) or engaging with the shore-based shark fishing community (most were in either none or one fishing club). Conversely, the SFA group were very engaged with the shore-based shark fishing community (mostly targeted sharks weekly to daily, most were in two or more fishing clubs) but generally did not have as many years of experience as the EIA profile (mostly between 1 to 10 years). This nonlinearity could potentially be explained by the recent increase in anglers joining the fishery, resulting in most anglers having been relatively new to the sport but with varying degrees of interest, training, and time investment. Differing angler values with respect to their relationship with nature or shore-based shark fishing and the importance of the activity in contributing to their livelihoods or well-being may have also contributed to the nonlinearity observed (Chan et al. 2016).

These three profiles differed in their fishing habits and skills, certain sociodemographic characteristics, and certain motivators for targeting sharks. They did not differ widely in their preferred target species, shark fishing behaviors, and overall attitudes or feelings towards shark-related conservation matters and management of shore-based shark fishing. While the range of specialization among anglers in our study were parallel to similar

TABLE 4. Results from the post hoc test on the contingency table between age and angler type. Significant values are marked with an asterisk (Bonferroni correction for significance = 0.0028). Abbreviations are as follows: EIA = experienced infrequent angler, NIA = novice infrequent angler, and SFA = skilled frequent angler.

Angler type, age, and total	Count	Percent of age group across clusters (%)	*z*-scores	Chi-square value	*P*-value
EIA: <20 years	0	0	–4.59	21.0681	<0.0001*
EIA: 21–30 years	16	10.5	–6.99	48.8601	<0.0001*
EIA: 31–40 years	43	29.7	–1.36	1.8496	0.1738
EIA: 41–50 years	71	43.8	2.81	7.8961	0.0050
EIA: 51–60 years	75	52.1	4.92	24.2064	<0.0001*
EIA: 61+ years	61	47.3	3.35	11.2225	0.0008*
SFA: <20 years	24	63.2	2.98	8.8804	0.0029*
SFA: 21–30 years	99	64.7	6.94	48.1636	<0.0001*
SFA: 31–40 years	59	40.7	0.17	0.0289	0.8650
SFA: 41–50 years	50	30.9	–2.69	7.2361	0.0071
SFA: 51–60 years	43	29.9	2.77	7.6729	0.0056
SFA: 61+ years	34	26.4	–3.48	12.1104	0.0005*
NIA: <20 years	14	36.8	1.66	2.7556	0.0969
NIA: 21–30 years	38	24.8	–0.19	0.0361	0.8493
NIA: 31–40 years	43	29.7	1.3	1.69	0.1936
NIA: 41–50 years	41	25.3	–0.04	0.0016	0.9681
NIA: 51–60 years	26	18.1	–2.25	5.0625	0.0244
NIA: 61+ years	34	26.4	0.27	0.0729	0.7872
Total	771				

TABLE 5. Distribution of the eigenvalues across the three dimensions in the multiple component analysis. The values highlighted in bold indicate maximal contributors to the retained dimensions (>0.40).

Variables	Dimension 1	Dimension 2	Dimension 3
Explained variation (%)	15.2	11.4	10.6
Consume	0.071	0.021	***0.452***
Thrill	***0.454***	0.151	0.066
Largest shark	0.365	0.228	0.244
Improve	0.302	0.076	0.04
Relax	0.381	0.383	0.224
Social	0.25	***0.512***	0.25

recreational fishing studies, the differences between each angler profile and other variables (preferences, behaviors, attitudes) were contradictory to the literature (Oh et al. 2004; Garlock and Lorenzen 2017; TenHarmsel et al. 2019). For instance, similar studies found that more specialized and invested anglers tended to show more support for the management of the fishery with intentions of safeguarding the stock for prolonged access and availability. Our results demonstrated no such difference in attitudes towards shark management and conservation based on specialization. Rather, all three angler profiles reported relatively positive management attitudes despite their level of specialization or years of experience in the fishery. This observation could be explained by the high levels of importance allocated to non-consumptive-oriented motivations for shark fishing. Hence, all angler profiles demonstrated appreciation for the experience of the catch and nature rather than harvesting sharks, which may help with their willingness to comply with management actions or voluntarily change their behavior.

Furthermore, understanding angler preferences within a fishery can support effective management of social-ecological systems (e.g., shore-based shark fishing) as policies may gain higher acceptance rates should they align with angler interests (Fisher 1997; Connelly et al. 2001; Solomon et al. 2020). Among our sample population, the similarity of the three angler types relative to preferences, behaviors, and attitudes could present both positive and negative outcomes for the management of the fishery should this finding be reflective of the entire shore-based shark fishery. A positive outcome may be the ability of applying overarching management strategies that would appease the majority of the shore-based shark fishing population. Conversely, a potential negative outcome may be that such strategies are less tailored to highly specific anglers, therefore resulting in lower management acceptance from these anglers. The homogeneity of these profiles regarding their preferences and attitudes may reduce the complexity of managing the fishery; however,

managers could be faced with further community complexities that may not have been identified in our survey.

Description of the Florida Shore-Based Shark Fishery

From the results obtained in our survey, the shore-based shark fishery in Florida holds an estimated economic value of $7.8 million (95% CI = $7.2–8.5 million) in annual shore-based shark fishing equipment purchases and $34.3 million (95% CI = $30.4–38.1 million) in annual shore-based shark fishing trips (extrapolated to the estimated 10,206 active shore-based shark fishing anglers of 18,000 permit holders in December 2020). This value is less than the $46.6 million (2016) in total trip expenditures reported from the Atlantic Highly Migratory Species recreational angler expenditure survey (NOAA Atlantic Highly Migratory Species Management Division 2019), which is to be expected considering that shore-based shark fishing does not require purchasing or renting a charter or headboat vessel and is accessible by beaches, piers, or bridges. It is important to note that our value was an approximation, and anglers may not have been purchasing equipment or taking shore-based shark fishing trips in the state of Florida. Thus, our values may not accurately reflect the true economic value of the fishery.

Furthermore, our survey revealed a surge in angler recruitment to this fishery since 2010, continuously increasing each year. The number of anglers holding shore-based shark fishing permits with the FWC as of December 2020 was over 18,000, up by more than 6,700 anglers from the 11,277 permit holders in December 2019. Compared with the 12,912 (2020) shark-endorsed Atlantic Highly Migratory Species permit holders with NOAA, more anglers were permitted to fish for sharks from Florida's shores than could in the federal bounds of the Atlantic Ocean. Although the number of permits reflect the vast shorelines and thus easier access to shore-based shark fishing within the state of Florida compared with the rest of the USA, the sharks inhabiting these waters nonetheless appear to experience heavy fishing pressure. Conversely, because the shore-based shark fishing permit is free to obtain, many permit holders may not actively practice shore-based shark fishing, hence reflecting a false volume of participating anglers. Nevertheless, increased popularity and participation of recreational shark fishing has been observed in other studies (e.g., Drymon and Scyphers 2017; Kilfoil et al. 2017), which could increase the economic values of these fisheries but may also heighten fishing pressure on shark populations. An estimate of over 9,617 sharks had been caught within a period of 12 months from our sample of 856 anglers, averaging about 11 sharks/angler, most of which were Blacktip Sharks and Bull Sharks, the two most preferred target species. Both species of sharks are harvestable and regulated recreationally and commercially, with a maximum bag limit of one shark per person per day recreationally and with specific weight and catch limits commercially (NOAA Office of Sustainable Fisheries Atlantic Highly Migratory Species Management Division 2019, 2021; Florida Administrative Code and Register 2020; FWC 2020). The two species listed on our survey with the lowest number of reported catches were Tiger Sharks and Great Hammerhead sharks; however, they were not among the least preferred species. Since the two species are listed as prohibited sharks by the FWC, it is possible that anglers did not provide honest reports of sharks caught for the prohibited species listed on our survey.

Sharks that are not harvested may still be negatively impacted by fishing through behavioral or physiological disturbances as well as by postrelease mortality of catch-and-release fishing or bycatch (Frick et al. 2010; Herberer et al. 2010; Danylchuck et al. 2014; Kilfoil et al. 2017; Weber et al. 2020). Survival rates of released sharks vary widely and are based on several factors, including species, gear, fight time, or hooking location (e.g., 74% survival in Common Thresher Sharks *Alopias vulpinus* [Herberer et al. 2010], 86% survival in Sand Tiger Sharks *Carcharias taurus* [Kilfoil et al. 2017], 83% survival in Blacktip Sharks [Weber et al. 2020]). While anglers are mandated to release prohibited shark species (e.g., Great Hammerhead sharks or Dusky Sharks), catch and release is a popular mode of shore-based shark fishing that anglers practice predominantly even with harvestable sharks (FWC 2020). Currently, there are no regulations on the number of sharks an angler may catch as long as they are released, as anglers have minimal control over which species takes their baited hook. There are gear restrictions, however, and prohibited sharks must remain submerged in the water and released immediately (Florida Administrative Code and Register 2020; FWC 2020). Furthermore, all anglers who apply for a shore-based shark fishing permit with the FWC must pass an online educational course on safe handling practices (FACR 2020; FWC 2020). These measures can greatly enhance shark survival postrelease but may be ineffective if not enforced properly. Shore-based shark fishing (like all hook-and-line-based fisheries) can be physiologically stressful to sharks (Gallagher et al. 2014) and can leave them energy-depleted or injured once released, rendering them vulnerable to death or predation (Danylchuk et al. 2014; Weber et al. 2020). With an average of 11 sharks/angler and the number of permitted anglers able to fish in Florida, extrapolated catch rates are in the hundreds of thousands. This could result in adverse impacts to coastal shark populations of Florida, and further research incorporating angler expertise is recommended to minimize these impacts.

Motivations of Shore-Based Shark Anglers

Understanding angler motivations can provide valuable insights on the relationships and interactions between anglers and sharks (Fedler and Ditton 1994; French et al. 2018). Motivations for recreational fishing may vary widely

(e.g., Fedler and Ditton 1994; Arlinghaus 2006), and thus it is important to study them to apprehend all types of angler–shark relationships. While motivations can provide explanations for angler behaviors that may help shift those behaviors towards conservation objectives (e.g., Gallagher et al. 2015, 2017; French et al. 2018), behavior change is a complex issue to address and would depend on underlying values, intentions, beliefs, and lifestyle (St John et al. 2018).

Our study demonstrated high importance for both catch- and non-catch-related motivations for shark fishing, including the experience of the thrill of catching a shark, as well as the experience of being outdoors and the opportunity to relax. Our findings are similar to other recreational fishing studies in which consumptive-oriented motivations are relatively less important than activity- and experience-based motivations (Cardona and Morales-Nin 2013 [bony fishes]; Shiffman and Hammerschlag 2014 [sharks]; French et al. 2018 [sharks]). Non-consumptive-oriented motivations may indicate increased likelihood of release of harvestable sharks by the angler (such as Blacktip Sharks). French et al. (2018) observed that anglers who preferred to release harvestable sharks were more interested in conservation, which is analogous to our results of positive attitudes towards shark conservation.

Furthermore, our variables related to fishing motivations segmented into three components: the social aspects of shark fishing, the thrill of shark fishing, and for consumption reasons. The thrill of shark fishing distinguished three angler profiles, with more specialized anglers (SFA) allocating higher importance to this motivation. This finding is common across recreational angling studies as more specialized anglers are more invested in the sport and may travel further or spend more money to experience the challenge of catching a big fish, such as a shark (Ditton et al. 1992; Voyer et al. 2013; Shiffman and Hammerschlag 2014). Since the thrill and excitement of catching a shark is valued by anglers, educational programs on safe and best handling practices could potentially be very useful and effective at minimizing shark mortality postrelease.

Management and Conservation Implications: Now What?

The widespread adoption of voluntary guidelines or compliance with regulations is highly reliant on public knowledge and concern of respective conservation issues, which thus feeds into positive attitudes in favor of conservation (O'Bryhim and Parsons 2015; Gallagher et al. 2017). For instance, Gallagher et al. (2015) and French et al. (2019) found that anglers who were more knowledgeable about shark-related conservation issues held more proconservation attitudes and were more likely to embrace handling techniques that reduce shark mortality. Our survey documented similar results. Most anglers agreed that they were knowledgeable of shark conservation issues and that sharks need to be better protected. Participants showed some awareness of possible negative impacts to sharks imposed by recreational fishing, such as long fight times decreasing the chance of survival and that sharks do not always survive after being caught. Interestingly, anglers felt commercial fisheries were harmful to shark populations but disagreed that recreational fisheries had a negative impact, implying that their actions were not very harmful to sharks. The belief that recreational angling poses minimal impacts to sharks is common across recreational shark anglers, which may discourage anglers from following regulations set by managers (Gallagher et al. 2015; French et al. 2019). Angler compliancy, however, is very situational and relies on several factors not captured in our survey, such as worldviews, cultural norms, and economic status (Carman and Carman 2018).

From our results, anglers seemed to believe that current management measures in Florida protect shark populations without interfering with their fishing habits. Anglers agreed that no further regulations are required for recreational shark fishing, which may present challenges for managers should they wish to more strictly manage the fishery. Little data exists on the potential harm recreational shark fishing can pose on individuals and populations, but there is an assumption that because the majority of sharks are released from the recreational sector, this results in fewer sharks killed when compared to the commercial sector (NOAA 2014). However, with limitations to monitoring the absolute numbers caught, and the varying rates of postrelease mortality, this assumption requires further investigation. Nevertheless, most respondents expressed a willingness to learn more about best handling practices to reduce shark mortality and a willingness to alter their fishing habits to apply such practices. There was some controversy in the responses to our survey about whether other shore-based shark fishing anglers are comprehensive of their actions and will release sharks unharmed, but there was a general agreement with that statement. Regardless, the majority of respondents agreed that more education and training for shore-based shark fishing is needed. As mentioned above, safe and best handling practices are essential to ensure shark survival postrelease and has been strongly recommended by other studies (e.g., Gallagher et al. 2015; McClellan Press et al. 2016).

Marine recreational anglers are more likely to trust information that is shared through direct interactions and social channels such as friends, family, or bait and tackle shops than through online Web sites or forums (Ropicki and Carlton 2020). For example, over 70% of our participants opted to be included on our mailing list for updates on our research and for opportunities to help with future research. Should they search for information online, state and federal Web sites are used in favor of other forums (Cardona and Morales-Nin 2013; Ropicki and Carlton 2020). Efforts for communicating science, shark

conservation matters, or educational and research opportunities should be focused on direct communication, and managers should target avid anglers with large social networks.

Conclusions and Future Directions

Our survey characterized 856 anglers who participate in shore-based shark fishing from Florida and identified a continuum of specialization among the anglers in this fishery, ranging from least specialized to most specialized (NIA, EIA, SFA). This study presents the first description of the anglers of the Florida shore-based shark fishery, providing valuable data that, if collected over time, can bring forth trends in both social data (angler preferences, experiences, motivations, expenditures, conservation attitudes, demographics, etc.) and biological data (i.e., shark abundance and size) (Gallagher et al. 2017; Brownscombe et al. 2019; Skubel et al. 2019). Research on the human dimensions of social-ecological systems (such as shore-based shark fishing) is crucial for the management of such systems as it can reveal factors that may need addressing or present possible pathways for management strategies. For instance, our study highlighted that more education on best handling practices is in high demand to increase the chances of shark survival postrelease. Moreover, most respondents believed that recreational fishing has minimal negative impacts on shark populations. Since it has been argued that more knowledge on shark conservation leads to increased feelings of accountability and therefore greater awareness and caution of actions (French et al. 2019), the current lack of research on the impacts of recreational fishing on shark populations may perpetuate improper handling practices. Future research should focus on the direct impacts of recreational fishing on coastal shark populations, and managers should implement and promote comprehensive educational programs, including information on safe and best handling practices, shark conservation, and potential harm to sharks from catch-and-release fishing.

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SUPPORTING INFORMATION

Additional supplemental material may be found online in the Supporting Information section at the end of the article.