

# A Social and Economic Characterization of the U.S. Gulf of Mexico Recreational Shark Fishery

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## Introduction

To protect sharks from overfishing, the National Marine Fisheries Service (NMFS) proposed a Fishery Manage-

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*ABSTRACT—A mail survey of tournament shark anglers and party boat shark anglers was completed to examine their fishing activity, attitudes, trip expenditures, and consumer surplus. A sample of 700 shark anglers was selected from tournaments in the Gulf of Mexico during 1990, and a sample of party boat shark anglers was drawn from Port Aransas, Tex., party boat anglers during the summer of 1991. A response rate of 58% (excluding nondeliverables) was obtained from tournament anglers. The sample of party boat shark anglers was too small to provide useful results. Tournament shark anglers reported fishing an average of 58 days per year and targeted sharks and other large marine species. Tournaments occupy a small portion of their fishing effort. If this group of anglers were not able to fish for sharks, one-third indicated no other species would be an acceptable substitute, while others were willing to substitute other large marine species. Shark trip expenditures averaged \$197 per trip with a consumer surplus of \$111 per trip. Based on MRFSS estimates of the number of shark fishing trips, we estimate a total of \$43,355,000 was spent by shark anglers in the Gulf of Mexico with a consumer surplus of \$23,865,000 for a total gross value of the shark fishery of \$66,220,000. MRFSS estimates of the number of sharks landed indicate an equivalent use value of \$183 per shark.*

ment Plan (FMP) for Sharks in the Atlantic Ocean<sup>1</sup>. The FMP was developed in light of several important issues: 1) Development of new shark fisheries in the 1980's that led to harvest levels exceeding maximum sustainable yield for large coastal sharks (Parrack, 1990), 2) foreign demand for shark fins that led to the controversial practice of "finning," 3) a general lack of management of shark fishing, and 4) the 1991 amendments to the Magnuson Fishery Conservation and Management Act (MFCMA) (16 USC 1801 et seq.) that gave the Secretary of Commerce authority over highly migratory species including oceanic sharks. In addition to placing 39 species of sharks in U.S. waters under Federal management, the proposed FMP<sup>1</sup> included the following management measures among others: 1) Reduced commercial harvest quotas for large coastal and pelagic sharks until stock abundance is increased, 2) a bag limit of four sharks/boat/trip for the combined large coastal and pelagic species groups and a daily bag limit of five small coastal sharks/person for the recreational fishery, 3) sharks taken beyond commercial quota or recreational bag limits must be released uninjured, 4) a ban on finning, and 5) institution of permit requirements and data reporting systems.

In their study of shark fishing club members, Graefe and Ditton (1976) reported that "there was little literature on shark fishing participation, less on participants, and none to explain shark fish-

<sup>1</sup>Fishery Management Plan for Sharks of the Atlantic Ocean. 1992. National Marine Fisheries Service, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

ing motivations." No work on shark anglers has emerged since then. From their paper, we would expect shark anglers to be highly motivated by the challenge or sport of the shark fishing experience. In particular, we would expect them to place high importance on the experience of the catch, i.e., the fight put up by the fish, but not on keeping and eating their catch. Likewise, we would expect them to be more avid than the general population of marine anglers.

If, as Graefe (1980) and Ditton et al. (1992) indicate, level of fishing frequency is a surrogate measure for recreation specialization, we would expect shark anglers to exhibit higher levels of self-reported skill, greater resource dependency, higher levels of expenditure associated with participation, more years of previous experience, and greater appreciation for catch and noncatch aspects of the fishing experience. Specialization is defined as "a continuum of behavior from the general to the particular reflected by equipment and skills used in the sport and activity/setting preferences" (Bryan, 1977). At one end of the continuum is the least specialized group of anglers with the most specialized group at the other. We would expect to find the shark fishery heavily skewed toward the most specialized group.

Currently, managers have little understanding of the effects of new regulations on shark anglers. As constraints are imposed on the shark fishery, anglers have alternatives. They may: 1) Adapt to bag limits and subsequent catch and release requirements for shark fishing, 2) enter a substitute fishery with fewer constraints, 3) continue to fish at

current levels for other fresh and salt-water species they target but make no effort to seek substitutes for shark fishing, or 4) stop all fishing entirely.

There are implications for management if anglers select substitutes that exacerbate constraints on other scarce resources. If we define substitutability as the extent to which one species can effectively replace another in terms of its ability to produce particular social benefits, i.e., recreation satisfaction (after Hendee and Burdge, 1974), then species perceived as meeting these criteria are considered substitutable. Whereas individuals participate in recreation experiences to fulfill specific needs, they seek alternatives which provide similar benefits when their initial activities are constrained (Vaske, 1980). While it is not necessary for substitutes to share similar biological characteristics, we would expect substitutes for shark fishing to have similar experience attributes and access costs (Shelby and Vaske, 1991).

While the proposed Shark FMP<sup>1</sup> contains information on commercial fishery landings and ex-vessel prices, a lack of data precluded calculation of the economic value of the recreational fishery. Valuation of recreational fisheries is difficult because sport fishing is not a marketed good. The absence of a market precludes the opportunity to directly observe the value anglers place on a fishery resource and its use. Angler expenditures, which are essential for understanding local and regional economic impacts, i.e., jobs, income, and tax receipts, are generally recognized as not being a valid measure of a fishing trip's true economic value (Huppert, 1983). A shark fishing trip has much greater social value than the cost associated with participation; anglers are willing to pay more for the use of the resources than the actual amount they pay for market goods and services. Measures of willingness to pay in excess of trip expenditures (Huppert, 1983) can be used to estimate the value of these additional benefits (consumer surplus) to anglers. Consumer surplus is the difference between price of a good (i.e., a shark fishing trip) and the gross use value of the trip (Bell et al., 1982).

This is an important concept because it represents an increase in the welfare of the nation as a result of the opportunity to fish for sharks.

The proposed FMP<sup>1</sup> recognized the general lack of social and economic information on recreational fisheries. While data on recreational landings were estimated by the Marine Recreational Fishery Statistics Survey (MRFSS) (NMFS, 1991), no data were included on shark anglers and their fishing activity. Consequently, we completed a mail survey of shark anglers in the U.S. Gulf of Mexico. This research had three objectives: 1) To profile shark anglers according to their social and economic characteristics, fishing activity, attitudes, trip expenditures, and consumer surplus, 2) to estimate total trip expenditures and consumer surplus for shark anglers in the U.S. Gulf of Mexico region, and 3) to discuss the implications of results for proposed management measures. This information is prerequisite to increasing the benefits from shark resources, one of the stated objectives of the proposed Shark FMP<sup>1</sup>.

#### Methods

Since no special license provides a sampling frame for shark anglers, we sought an alternative means of accessing this angler group. We sampled from a list of anglers who had participated in shark tournaments along the Gulf of Mexico during 1990 and those who had participated in a party boat fishery based in Port Aransas, Tex., during the summer of 1991. Party boats in Port Aransas were reported to account for most of the total Gulf party boat shark landings by weight<sup>1</sup>. These proxy angler groups were identifiable and provided a cost effective means of obtaining information from shark anglers. We recognized from the outset these were segments of the recreational shark fishery and evaluated results in light of other data on shark anglers and other groups of anglers.

#### Port Aransas Party Boat Fishery

Our original sampling plan was to select 20 days at random during the peak use season and conduct personal interviews of all shark anglers on party

boats operated from Dolphin Docks<sup>2</sup> in Port Aransas. One of their boats was the *Shark Hunter*. We identified shark anglers as those who 1) said they were specifically targeting sharks that day and 2) had  $\geq 1$  year of previous shark fishing experience. Since we intercepted few anglers who met our criteria as shark anglers during our first sampling period, we abandoned the plan. As an alternative, we sampled every day and intercepted party boat anglers at the same party boat operation before they departed. From 1 July to 2 September 1991, we collected names and addresses from those who met the criteria as shark anglers for follow-up contact with a mail survey. The alternative sampling plan yielded 31 shark anglers, 19 of whom responded to the mail survey. This sample size was too small to provide useful results. Based on the results of daily intercepts, the original plan would have yielded only five anglers who indicated they were targeting sharks.

#### Tournament Shark Anglers

We identified 18 shark tournaments held in the Gulf of Mexico during 1990; officials from ten tournaments agreed to provide names and addresses of participants. To determine the threshold level of willingness to pay ( $P=0.5$ ) with an accuracy of  $\pm 5\%$  at the 95% level of confidence, a sample of 400 anglers is needed (Cochran, 1977). However, based on our previous experience with mailed surveys, we anticipated a response rate of about 60%. Therefore, we selected a systematic random sample of 700 shark anglers in order to receive 400 completed surveys.

A 10-page questionnaire was developed to collect information from anglers. First, anglers were asked about their fishing experience: Number of years fishing, number of years fishing for sharks, number of days fishing in the previous 12 months by setting, and an evaluation of their fishing ability compared with other anglers. Second, they were asked to identify their top three target species and to indicate

<sup>2</sup> Mention of trade names or commercial firms or facilities does not imply endorsement by the National Marine Fisheries Service, NOAA.

whether any one species commanded most of their effort. Third, anglers were asked a series of questions about their orientation toward catching fish. Anglers were asked to indicate the extent to which they agreed with each attitudinal statement on a Likert-type scale developed by Graefe (1980) to understand four subdimensions of consumption: Number of fish caught, type of fish caught, disposition of catch, and general orientation towards catching "something." Fourth, anglers were asked to indicate the importance of 17 motive statements or reasons for fishing using a Likert-type scale. Eleven were drawn from previous work by Driver<sup>3</sup>. Six motive statements dealt with experience elements associated only with sport fishing (activity-specific). Fifth, we asked anglers a series of questions about their participation in the shark fishery: Number of shark tournaments fished in the previous 12 months, location of shark fishing, most sharks kept/caught per day, gear size, and other fish commonly caught while shark fishing. Sixth, anglers were asked to indicate which species groups they would be willing to substitute if they were unable to fish for shark and, if not, to choose among selected reasons why. Finally, we asked anglers to report how much they spent for each of 11 expense items on their most recent shark fishing trip.

We used a close-ended contingent valuation (CV) question to ascertain the amount anglers were willing to pay for an increase in the cost of a shark fishing trip (Bishop and Heberlein, 1979). Each angler was presented with one random offer from ten bid values which ranged from \$20 to \$200 in increments of \$20. Consumer surplus was evaluated using logistic regression. Logistic regression is appropriate when the dependent variable is a binary indicator variable (e.g., "yes" or "no"), and can be used to determine the probability of a "yes" response and thus the threshold level ( $P[\text{yes}] = P[\text{no}] = 0.5$ ) of an angler's willingness to pay (Agresti, 1990). An-

<sup>3</sup>Driver, B. 1977. Item pool for scales designed to quantify the psychological outcomes desired and expected from recreation participation. U.S. Dep. Agric., For. Serv., Rocky Mountain For. Range Exper. Sta., Fort Collins, Colo. Unpubl. rep.

gler characteristics expected to affect willingness to pay included 1) annual number of shark fishing trips, 2) years of shark fishing experience, 3) expenditures per shark trip, and 4) annual household income. Using an open-ended format, anglers were also asked how much more they were willing to pay rather than stop fishing for sharks.

A total of 342 individuals responded to the mail survey for an overall response rate of 58% (when nondeliverables were excluded). Response rates varied from 73% in Texas to 55% in Florida. Mailings were initiated on 9 April 1991 following the procedures of Dillman (1978). A reminder postcard was mailed on 15 April, with second and third mailings on 30 April and 28 May, respectively.

A telephone survey of nonrespondents was completed to identify characteristics of nonrespondents for comparison with respondents. This was done to test the assumption the two groups were alike in order to check for nonresponse bias in the survey results (Bethlehem and Kersten, 1985). Questions were used regarding years of saltwater experience, species preference, years of shark fishing experience, and annual fishing frequency. Telephone calling resulted in 34 completed surveys from a sample of 40 nonrespondents. Using the Mann-Whitney U or chi-square test, as appropriate, we found significant differences between respondents and nonrespondents at the 0.05 level of significance for years of experience and annual fishing frequency. Respondents had more years of fishing experience and a higher annual frequency of fishing. Weighting procedures were implemented to reduce the effect of nonresponse (Kalton, 1983). Respondents were stratified by tournament and weighted by the inverse of the response rate within each tournament. Response rates by tournament varied from 39% to 94%.

## Results

### Port Aransas Party Boat Fishery

It would be unwise to make specific inferences about a population from only

19 respondents. Confidence intervals constructed about parameters were too wide to allow precise conclusions from the data.

### Tournament Shark Angler Characteristics

Tournament shark anglers were 38 years of age on average and male (95%). Anglers reported fishing an average of 58 days during the previous 12 months, with 75% fishing at least 20 days. Days fishing in freshwater accounted for 9 days of the overall mean, with 25% fishing >6 days. Days fishing in saltwater from a boat and from shore averaged 38 and 12 days, respectively, indicating these anglers spent most of their time fishing in saltwater from a boat. About 42% rated themselves as "more skilled" than other anglers. Almost 91% rated themselves as "equally or more skilled" with the remainder "less skilled."

Sharks were the most preferred species by 25% of the respondents. Grouper was second most preferred (22%), followed by snook (16%). Less than 5% listed offshore pelagic species, with the remainder reporting inshore or coastal pelagic species. About 37% indicated they devoted most of their effort to one species. Of this group, shark was targeted by 30%, grouper 30%, and snook 12%.

Eleven motivational items were rated very to extremely important by most respondents (Table 1). Only three of these items were specific to saltwater fishing ("For the challenge or sport," "To be close to the sea," and "For the experience of the catch"). The two motive items that were most often rated as not at all important were "To obtain a trophy fish" and "To win a trophy or prize."

About 60% of the respondents agreed with the statement "I would rather catch one or two big fish than ten smaller fish" and 64% agreed with "I usually eat the fish I catch" (Table 2). Most agreed with the statements "I'm just as happy if I release the fish I catch," "a fishing trip can be successful if no fish are caught," "the bigger fish I catch, the better the fishing trip," and "the more fish I catch, the happier I am."

## Participation in the Shark Fishery

Anglers reported an average of 9 years experience fishing for sharks. Compared to the mean for saltwater fishing experience ( $\bar{x}$  = 19 years), most probably began fishing for sharks after several years of saltwater experience. In the previous 12 months, this group of anglers participated in an average of two saltwater fishing tournaments with only one being a shark fishing tournament. This is probably due to the relatively low number of shark tournaments in the Gulf and their wide geographic dispersion.

Respondents reported they usually fish for sharks from shore (6%), in bays from a boat (12%), or in the Gulf from a boat  $\leq$  10 miles from shore (48%), with the remainder fishing  $\geq$  10 miles from shore. When asked to list the most sharks they caught in one day and the

most kept in one day during the past 12 months, anglers reported an average of 4 sharks caught and 1 shark kept. About 75% reported at least 5 sharks caught in one day, and 75% reported at least 2 sharks kept in one day. This agrees with the finding that most shark anglers release the fish they catch (Table 2). Heavy tackle is favored by this group of anglers for shark fishing, as most listed hook sizes between 6/0 and 12/0 and line test between 50 and 80 pounds for a typical shark fishing trip. Other species of fish commonly caught while fishing for sharks included grouper (26%), tarpon (20%), sea catfish (18%), stingrays (14%), cobia (14%), snapper (8%), and bonita (5%). A total of 50 fish species were listed as bycatch, but no other species were mentioned by  $>$ 5% of the respondents.

If this group of anglers were not able to fish for sharks, 32% indicated no

other species would be an acceptable substitute. Seatrout/red drum, flounder, and pompano/permit were deemed unacceptable substitutes for sharks by most anglers, with king mackerel/dolphin/cobia listed as the most acceptable substitutes (Table 3). This agrees with the finding that most of this angler group prefers to catch big fish (Table 2) and would probably substitute other large fish species for shark. Billfish were unacceptable substitutes because this group of anglers had no access to that fishery (too expensive, too far offshore, etc.) (Table 4). Seatrout/red drum, flounder, and pompano/permit were unacceptable because they were perceived as not challenging enough.

On their most recent fishing trip for sharks, anglers reported an average expenditure of \$197 (excluding tournament fees) (Table 5). The trip averaged 1.8 days in length, with an average expenditure of \$109/day. Boat operation (fuel, oil, etc.) was the largest individual expense category, followed by food, drinks, ice, and bait and tackle (Table 5). When combined, these items accounted for 67% of total expenditures.

Table 6 reports the results of the logistic regression model of willingness to pay responses and consumer surplus estimates. Annual number of trips and household income were not statistically significant ( $P > 0.10$ ) and were not included in the final model. These two variables were not significant because the sample was homogeneous with respect to income and number of trips. The parameter estimates indicate the probability of a "yes" response decreases as the bid value increases and increases as years of shark fishing experience and total trip expenditures increase. When they were asked the open-ended question about the highest additional trip costs they would pay rather than stop fishing for sharks, the mean response was \$105, indicating good agreement with the logit model.

Results from the most recent MRFSS (NMFS, 1991) indicate 1.13% of all intercepted anglers in the Gulf of Mexico were fishing primarily for sharks in 1989. During the same time, an estimated total of 19,064,000 fishing trips were taken in the Gulf, sug-

Table 1.—Distribution of anglers by the importance they attribute to various reasons why people fish in saltwater ranked by mean score.

Statement	Percent by category <sup>1</sup>					n	Mean
	1	2	3	4	5		
For the experience of the catch	2.3	1.4	15.5	35.6	45.3	339	4.2
For relaxation	2.5	3.5	13.7	35.0	45.4	337	4.2
To experience adventure and excitement	2.3	4.7	16.5	37.5	39.1	339	4.1
For the challenge or sport	2.7	3.1	18.6	35.6	40.1	340	4.1
To experience unpolluted natural surroundings	2.9	4.6	19.7	30.8	42.0	333	4.0
To get away from the regular routine	2.6	5.6	23.0	36.3	32.6	336	3.9
To be outdoors	1.8	5.5	18.1	42.1	32.5	340	3.9
To be close to the sea	4.0	9.8	22.0	32.9	31.2	338	3.8
To get away from the demands of other people	11.8	11.6	19.9	20.7	35.9	338	3.6
To experience new and different things	8.8	10.7	28.7	28.3	23.5	339	3.5
To be with friends	7.1	10.0	30.4	37.6	14.9	339	3.4
To develop my skills	9.3	12.2	34.1	25.8	18.6	338	3.3
For family recreation	16.0	18.9	26.0	27.9	11.3	337	3.0
To obtain fish for eating	16.1	23.2	33.8	15.8	11.2	338	2.8
To obtain a "trophy" fish	31.9	16.4	24.8	11.3	15.6	338	2.6
To test my equipment	24.2	24.9	30.5	12.4	8.0	339	2.6
To win a trophy or prize	40.9	22.7	18.3	7.2	10.9	339	2.2

<sup>1</sup> =Not at all important, 2=slightly important, 3=moderately important, 4=very important, 5=extremely important.

Table 2.—Distribution of anglers by the extent they agree or disagree with the following statements about saltwater sport fishing ranked by mean score.

Statement	Percent by category <sup>1</sup>					n	Mean
	1	2	3	4	5		
I'm just as happy if I release the fish I catch I would rather catch one or two big fish than ten smaller fish	1.9	8.9	19.1	32.5	37.6	337	3.95
I usually eat the fish I catch	3.6	12.8	23.3	29.7	30.7	337	3.71
A fishing trip can be successful even if no fish are caught	4.4	13.8	17.0	39.0	25.4	335	3.66
The bigger the fish I catch, the better the fishing trip	6.8	13.8	11.9	50.4	17.1	338	3.57
The more fish I catch, the happier I am	4.1	17.7	27.4	31.9	18.9	337	3.44
A successful fishing trip is one in which many fish are caught	6.2	17.6	24.7	36.9	14.5	337	3.36
It doesn't matter to me what type of fish I catch	8.8	30.8	26.5	25.4	7.9	333	2.91
When I go fishing, I'm just as happy if I don't catch a fish	12.8	34.7	16.2	28.4	7.9	336	2.84
	16.2	28.2	22.5	24.6	8.5	338	2.81

<sup>1</sup>1=Strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree.



**Table 3.—Distribution of anglers by whether selected species groups were a substitute for shark.**

Species	Percent response <sup>1</sup>	
	No	Yes
Seatrout/red drum	62.4	37.6
King mackerel/dolphin/cobia	34.2	65.8
Snapper/grouper	35.3	64.7
Sailfish/marlin	50.0	50.0
Flounder	68.8	31.2
Tarpon/bonefish	40.1	59.9
Amberjack	47.0	53.0
Pompano/permit	63.7	36.3

<sup>1</sup> 32.1% of respondents agreed with the statement that there was no substitute for shark.

**Table 4.—Percent distribution of reasons why selected species groups were not acceptable substitutes for shark.**

Reason	Percent distribution							
	Seatrout, red drum	King mackerel, dolphin, cobia	Snapper, grouper	Sailfish, marlin	Flounder	Tarpon, bonefish	Amberjack	Pompano, permit
I don't have the right tackle	2.2	3.8	2.0	14.4	0.9	7.1	2.7	3.3
No access to that type of fishing	3.1	13.8	3.3	59.1	7.4	12.4	8.9	16.1
Not challenging enough	51.9	24.3	35.7	4.6	51.2	7.0	17.2	29.2
I don't know how to catch that type	4.8	3.9	0.0	8.6	2.8	12.7	4.7	13.4
My partners don't fish for it	7.3	7.0	2.8	9.0	9.2	10.8	14.2	13.8
It is overfished	13.3	9.6	22.2	4.6	4.1	4.3	6.3	2.6
Too many regulations	15.8	21.4	18.3	3.4	0.7	5.3	5.5	2.9
Not good to eat	5.1	4.8	1.8	6.8	1.0	25.9	13.1	1.5

**Table 5.—Mean expenditures from most recent shark fishing trip.**

Expenditure item	Mean spent per angler (n=340)	Percent of anglers who purchased each item	Mean expense to anglers who purchased each item
Automobile transportation	\$12.42	71.5	\$17.38
Other transportation (airplane, taxi, etc.)	\$4.62	1.8	\$261.87
Boat rental	\$14.79	4.4	\$335.16
Boat operation	\$63.94	82.1	\$77.92
Boat launch/hoist fees	\$1.18	17.9	\$6.58
Entrance/parking fees	\$2.09	7.9	\$26.34
Lodging	\$10.62	9.7	\$109.38
Food, drinks, ice	\$36.53	88.5	\$41.26
Bait, tackle	\$30.90	77.6	\$39.79
Captain and/or charter fees	\$14.68	5.6	\$262.61
Other	\$6.37	13.5	\$74.16
Total	\$197.13 ± 20.53 <sup>1</sup>		

<sup>1</sup> 95% confidence interval.

**Table 6.—Logistic regression model of willingness to pay for an increase in shark trip expenses<sup>1</sup>.**

Variable description	Parameter estimate and standard error	Wald chi-square value	Prob. > chi-square	Standardized estimate
Intercept	0.6796 (0.2303)	8.71	0.0032	
Bid value	-0.0208 (0.00155)	48.70	0.0001	-0.482
Total \$/trip	0.00143 (0.000408)	12.28	0.0005	0.287
Years fishing for shark	0.0244 (0.0119)	4.22	0.0400	0.139

<sup>1</sup> Key: N=311, model chi-square=76.44, percent concordance=69.2, consumer surplus=\$110.85 (calculated using a mean trip expenditure of \$197.13 and 9.7 years shark fishing experience).

gesting 215,000 trips were taken in 1989 specifically for shark fishing. Alternatively, an average of 657,000 sharks/year were caught in the Gulf of Mexico from 1979 to 1989, with an average catch of 2.4 sharks per trip (when sharks were caught)<sup>1</sup>, suggesting an average of 274,000 shark fishing trips per year for 1979-89, indicating good agreement with the 1989 estimates. When combined with our results

for shark trip expenditures and consumer surplus, we estimate a total of \$42,355,000 was spent in the Gulf of Mexico region during 1989 with a consumer surplus of \$23,865,000 for a total use value of \$66,220,000. The MRFSS also estimates 418,000 sharks were caught in the Gulf in 1989 (this represents sharks caught by all anglers, and not just those targeting sharks specifically), suggesting an equivalent value of \$101/shark caught with a consumer surplus of \$57 for a total use value of \$158/shark caught. An estimated 362,000 sharks were landed by recreational anglers during 1989, suggesting \$117/shark landed and \$66 consumer surplus for a total use value of \$183/shark landed. We cannot provide estimates for 1979-89, as mean expenditures and consumer surplus are unknown.

## Discussion

When angler studies are completed on a species basis, there are often questions regarding the suitability of the sampling frame used and extent to which results can be generalized to the population level of anglers targeting that species. In this paper, there is support for using tournament shark anglers as a proxy for shark anglers. Our sample of shark anglers participate in tournaments but their shark fishing is not limited exclusively to tournaments. Furthermore, tournament shark anglers were similar in many ways to the shark club anglers studied previously by Graefe and Ditton (1976) (e.g., both groups had annual mean fishing frequencies >50 days). Finally, there may be no alternative to using the sampling frame of tournament shark anglers. While it may be possible to expand sampling coverage under the MRFSS to intercept more anglers targeting sharks, the costs involved may far outweigh the biases associated with sampling tournament anglers. Perhaps the estimated gross economic value of the shark fishery will provide support for using a more representative and costly approach to sampling shark anglers in support of fisheries management.

When the motivations and attitudes of this group of shark anglers are com-

pared to those of members of the Corpus Christi Shark Association (Graefe and Ditton, 1976), there are similarities and differences. Both groups placed great importance on the nonconsumptive aspects of fishing, notably challenge and the experience of the catch, and much less importance on fishing as a means to obtain fish for eating or to obtain a "trophy" fish. Neither group was highly motivated to participate in fishing as family recreation.

When tournament shark anglers are compared to the general population of saltwater anglers in Texas (Ditton et al., 1991), for example, there is good evidence to suggest that high specialization anglers are overrepresented in the shark angler group. First, shark anglers have a three times higher annual fishing frequency and are three times more likely to rate themselves as more skilled than saltwater anglers in general. Second, although younger on average, shark anglers have roughly the same average number of years of saltwater fishing experience. Third, as an indicator of their greater resource dependency, shark anglers are more interested in catching big fish than the general population of saltwater anglers. Also, approximately one-third of the former group were sufficiently committed to shark fishing that they were unwilling to substitute another big fish species. Finally, shark anglers attribute more importance to the challenge aspects of catching fish than saltwater anglers in general; likewise, shark anglers have less interest in numbers of fish caught or their retention for food or other purposes. Shark anglers are intimately involved in fishing for big fish, and for many it is probably a central life interest. Furthermore, we found shark anglers to be similar to billfish anglers in the U.S. Atlantic (Fisher and Ditton, 1992). Results suggest both angler groups share the need for challenging, big-fish fishing experiences, but shark anglers who are unwilling to substitute billfish for sharks lack the financial means to pursue billfishes.

Proposed regulations should have minimal impact on the recreational shark fishery. Most shark trips occur in state waters and probably target both

small and large coastal sharks; proposed regulations would allow a maximum catch of 5 sharks/person/day and 4 sharks/boat/trip, respectively. Historically, the Gulf of Mexico recreational shark fishery releases most of its catch<sup>1</sup>, and our results suggest most anglers do not reach the bag limit. Sharks represent the last of the big fish species to be regulated; all other large species that were acceptable substitutes for sharks are subject to bag limits or annual quotas. Closure of one fishery, e.g., king mackerel, may cause anglers to devote more effort to sharks in order to satisfy their motivation for the challenge of catching a big fish. If shark regulations become more restrictive in the future, big fish anglers may curtail their fishing activity or stop altogether.

We found no evidence of a major directed party boat shark fishery in Port Aransas, Tex., as reported in the proposed shark FMP<sup>1</sup>. Our sampling effort revealed few anglers targeting sharks. We found sharks to be a by-catch fishery for party boat anglers hoping to catch "something." Furthermore, we have reservations about data that show the Port Aransas party boat fishery landing an average of 92 metric tons of sharks per year from 1987 to 1989<sup>1</sup>. Each shark weighed an average of 5.7 kg for an average of over 16,000 sharks landed per year, or 44 sharks per day. Approximately half of these sharks were Atlantic sharpnose, *Rhizoprionodon terraenovae*. From 50 to 75% were landed between June and August, necessitating an average of 88-132 sharks landed per day in Port Aransas during this period<sup>1</sup>. These figures do not agree with our observations, those of the party boat operators, or McEachron (1984). McEachron's estimates of party boat shark landings from the Port Aransas area (Aransas Bay to Upper Laguna Madre) during 1979-83 were an order of magnitude less than the estimates for Port Aransas<sup>1</sup>. One Port Aransas party boat operator keeps a photographic record of his daily catches; species and numbers are easily identifiable, and his 1991 landings do not reflect the magnitude of the landings or species composition reported in the proposed shark FMP<sup>1</sup>. Other Port Aransas party boat

operators report they primarily target king mackerel, snapper, and grouper during June-August and land sharks as bycatch.

Our estimate of the gross value of the recreational fishery should be considered a conservative estimate. We calculated our results using trips specifically targeting sharks as estimated by the MRFSS. Trips not targeting sharks but resulting in sharks being caught were not included in our estimate. While we extrapolate the value of all directed shark trips in the Gulf of Mexico, we have no estimate of the value of a trip where sharks are caught incidentally. Thus, our results are an underestimate of the total value of the recreational shark fishery. Nevertheless, the gross use value of the Gulf of Mexico recreational shark fishery would appear to justify the \$500,000 annual cost of enforcement of the commercial and recreational shark regulations<sup>1</sup>. Also, it is reasonable to expect the value of the recreational fishery to increase as stocks rebuild, creating an increase in net benefits to the nation when management costs are subtracted. Finally, we would recommend further research to clarify the various issues on data needs mentioned in the preceding paragraph.

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