

An Estimation of the Total Number of Texas Fishermen, 1 September 1978-31 August 1979

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Abstract: The Texas Parks and Wildlife Department mailed 2 different survey questionnaires to 5,000 randomly selected households to estimate the number of residents fishing and the ways they fished in Texas from 1 September 1978 through 31 August 1979. The questionnaires in this survey were identical except one sub-group (1000) asked household members questions regarding their possession of a valid fishing license. Differences in responses to these 2 questionnaires were used to assess response biases. Estimates of total license sales (a known statistic) from survey data showed a strong positive bias (license sales were overestimated by 62%). The mean number of fishermen per household was significantly greater ($P < 0.05$) in the group which was not asked about the possession of fishing licenses. Return rates and responses to questions regarding all other fishing activities were identical for the different survey questionnaires. Consequently, the number of resident fishermen in Texas (2.47 ± 0.40 million) was estimated using data from questionnaires that had asked about license possession and adjusting the estimate downward by 62%, whereas estimates of other fishing activities were made using all questionnaires from persons claiming they had fished. Our study shows that loading a survey with a question that permits the estimation of a known statistic can be a useful device to evaluate the effect of response bias.

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The management of a fishery within the concepts of optimum yield requires economic considerations (Crutchfield 1975). This requires information on the numbers and activity of all fishermen within each user group. In Texas, the fish harvest and fishing pressure is obtained by on-site surveys and the number of commercial finfish fishermen fishing in saltwater only, freshwater only, or both is available directly from license sales published by the Texas Parks and Wildlife Department (TPWD). However, a complete accounting of recreational finfish fishermen is not currently available because only a part of the recreational fishing population in Texas is required to purchase a license. Texas residents <17 years old or >64 years old, residents fishing on private property, residents fishing in their county of residence with selected gear, residents having a Texas commercial fishing license, residents living in a hospital or state school, and Mexican residents licensed to fish in Mexico are not required to buy a recreational fishing license. All other persons fishing in Texas must buy a resident fishing license, a resident combination hunting and fishing license or an out-of-state license to legally sport fish in Texas.

The total number of Texas residents fishing in both fresh and salt water in Texas has not been previously determined. The purpose of this study was to estimate the total number of residents fishing in Texas in fiscal year 1979 (1 September 1978 to 31 August 1979), the number fishing in fresh and salt water, the number and proportion of residents using different access methods (piers, wade-bank, boats, etc.) and the number of resident recreational fishermen fishing illegally.

Methods

Five thousand survey questionnaires were mailed to Texas households during the last week in July 1979 using a random sample of names and addresses obtained from the Texas Department of Public Safety driver's license file. Survey questionnaires requested information on the total number of people in a household, the number of persons that participated in fishing activities at least once in the past year and general areas and methods used in those activities. No information on the number of trips was requested. A subsample ($N = 1000$) was asked how many persons in a household possessed a valid sport fishing or valid hunting-fishing combination license (long form); the remaining 4,000 questionnaires (short form) omitted these questions. The questionnaire sent to each household was determined by random selection using serial numbers. A stamped return envelope was provided, including a request that any questionnaire reaching a business instead of a private residence be returned uncompleted. In addition, each questionnaire asked if the residence was inside or outside a city limit.

Long-form questionnaires received within 30 days of mailing were used to make a preliminary estimate of the number of licensed resident fishermen and an associated variance. These estimates were made to calculate a sample size for a telephone follow-up survey. Independent sample size estimates were made for each of the 2 forms. Telephone numbers were obtained from current telephone directories and at least 3 attempts were made to contact each household. An adult (age >16) was interviewed at each household contacted, if possible. Telephone interviews differed depending on which form had originally been sent to that household. License questions were asked at the end of the interview when a short form had originally been sent to the household and at the beginning of the interview if the initial contact had been with a long form.

Response biases in the survey were checked several different ways. The estimated percent of households occurring in urban and rural areas (inside or outside the city limit) were compared to that reported by the U.S. Bureau of Census (1970). The estimated mean number of persons per household was compared to statistics reported by the U.S. Bureau of Census (1970) using a t-test. A test of independence (Sokal and Rohlf 1969) was performed using data from the 2 forms (both mail and telephone portions of the survey) to test whether the license question had caused a difference in the return rate. A 3-way analysis of variance (Overall and Spiegel 1969) was conducted on the mean number of persons per household to check for differences in responses between the 2 forms and to derive the 'best' way to compute subsequent estimates.

The total number of fishermen and total license sales were estimated using

$$\gamma = H \sum_{i=1}^2 \sum_{j=1}^2 \bar{P}_i R_j \bar{X}_{ij}$$

where H was the total number of households in Texas in 1979 (3,952,000; Texas Water Resources Department—pers. commun.), \bar{P}_i was the proportion of residents responding or not responding to the survey, R_j was the proportion of residents in urban or rural areas and \bar{X}_{ij} was the mean number of persons in a household that had fished or had a fishing license during the past year belonging to a specific stratum (i.e., respondents-nonrespondents and short form-long form). Variances for the estimates (γ) were estimated using Goodman's (1960) approximation for variance of a product.

A discriminant analysis (Cooley and Lohnes 1971) was used to determine if responses made by fishing households differed among the strata. This

was done to evaluate whether strata could be pooled to estimate the proportion of fishermen engaged in a specific activity.

The number of unlicensed legal fishermen was estimated by summing estimates for persons <17 and >64 years old, for persons fishing with pole and line in their county of residence, and for persons fishing on their private property exclusive of duplication in other categories. The number of unlicensed illegal fishermen was determined by subtracting the total of these categories from the total estimated number of persons fishing in Texas during the past fiscal year. Double counting in each category was held to a minimum by carefully examining each questionnaire when responses included more than one of these categories and assigning it to the one that was most inclusive.

Results

Over 23% of the questionnaires (943 short and 213 long) were returned (Table 1). However 19% of the forms returned (192 short and 37 long) had logic errors and were not used in the analyses or estimations. Approximately 1% of the forms were returned from business addresses or returned as undeliverable and 75% of the questionnaires were not returned (nonrespondents). There were no differences between the return rates for the 2 forms ($G_s = 3.859$, $df = 4$, $P > 0.05$).

An attempt was made to contact by phone 363 nonrespondents to the short form and 222 nonrespondents to the long form (Table 2). Approximately 31% of the households were successfully contacted, 5% declined to answer any questions, 8% were not at home (at least 3 times) and 56% either had unlisted numbers or phone listings were not available. There were no significant differences among the frequencies in each response category and the type of form that was originally sent to the household ($G_s = 3.859$, $df = 4$, $P > 0.05$).

Table 1. Summary of Responses to the Mail Portion of the Fishing Survey Conducted during July and August 1979 to Estimate the Number of Fishermen Residing in Texas

Category	Short Form		Long Form		Total	
	Number	Percent	Number	Percent	Number	Percent
Returned undeliverable	22	0.6	4	0.4	26	0.5
Returned from businesses	14	0.4	4	0.4	18	0.4
Returned with errors	192	4.8	37	3.7	229	4.6
Returned without errors	751	18.8	176	17.6	927	18.5
Not returned	3,051	75.5	779	77.9	3,800	76.0

Table 2. Response to the Telephone Follow-Up of the Texas Mail Fishing Survey, August 1979

Category	Short Form		Long Form		Total	
	Number	Percent	Number	Percent	Number	Percent
Declined survey	21	5.8	10	4.5	31	5.3
Unable to contact	27	7.4	18	8.1	45	7.7
Unlisted	210	57.9	116	52.2	326	55.7
Completed survey	105	28.9	78	35.2	183	31.3
Total	363	100.0	222	100.0	585	100.0

Seventy-six percent of all households were located in urban areas (Table 3). There were no significant differences in the proportion of urban or rural responses found between the 2 form types or between the respondents and nonrespondents ($G_s = 1.161$, $df = 3$, $P > 0.05$). The mean number of persons per household (Table 4) did not differ significantly among household types or form types but the means did differ between the respondents and nonrespondents $F_s = 4.748$, $df = 1$, 1102 , $P < 0.05$. The overall mean number of persons per household was estimated by weighting the means from respondents (24%) and nonrespondents (76%) within each form type. The short form estimate was 3.3 ± 0.02 and the long form estimate was 3.1 ± 0.2 persons per household. These estimates were not significantly different from each other or from the 3.2 persons per household reported in the 1970 U.S. census.

The mean number of fishermen/household (Table 5) was greater in 1) rural households than in urban households ($F_s = 21.087$, $df = 1$, 1102 ,

Table 3. Number and Percent of Usable Mail and Telephone Responses Received from Urban and Rural Households

Survey	Form	Urban		Rural		Total
		Number	Percent	Number	Percent	Number
Mail	Short	556	75.4	185	24.6	751
	Long	137	77.8	39	22.2	176
	Total	703	75.8	224	24.2	927
Telephone	Short	83	79.0	22	21.0	105
	Long	141	77.0	20	25.6	78
	Total	649	75.8	42	23.0	183
Total	Short	649	75.8	207	24.2	856
	Long	195	76.8	59	23.2	254
	Total	844	76.0	266	24.0	1,110

Table 4. Mean Number of Persons Per Household \pm S.E. for Households in Urban and Rural Areas as Estimated from the Mail and Telephone Surveys and the Long and Short Forms

Questionnaire Type (form)	Residence	Survey Type	
		Mail	Telephone
Short	Urban	2.99 \pm 0.06 (566) ^a	3.35 \pm 0.18 (83)
	Rural	3.18 \pm 0.10 (185)	3.46 \pm 0.28 (22)
Long	Urban	3.00 \pm 0.13 (137)	3.05 \pm 0.18 (58)
	Rural	2.77 \pm 0.16 (39)	3.20 \pm 0.30 (20)

^a Numbers in parentheses indicate sample sizes.

$P < 0.01$), 2) households responding to mail questionnaires compared to those phoned ($F_s = 3.747$, $df = 1, 1102$, $P < 0.05$), and 3) households that were sent the short form compared to those receiving the long form ($F_s = 6.684$, $df = 1, 1102$, $P < 0.01$).

The estimated 2.47 \pm 0.40 million licensed fishermen in the state was significantly greater than the 1.53 million reported by the License Division of TPWD ($t_s = 2.15$, $P < 0.05$) showing license sales had been overestimated (Table 6) by 62% (combination licenses were overestimated by 112% and the sport fishing licenses by 37%).

Consequently, the total resident fishermen in Texas was estimated using responses from parties receiving the long form only because short form re-

Table 5. Mean Number of Fishermen Per Household \pm S.E. for Households in Urban and Rural Areas as Estimated from the Mail and Telephone Surveys and the Long and Short Forms

Questionnaire Type (form)	Residence	Survey Type	
		Mail	Telephone
Short	Urban	1.34 \pm 0.06 (566) ^a	1.16 \pm 0.16 (83)
	Rural	1.69 \pm 0.11 (185)	1.73 \pm 0.29 (22)
Long	Urban	1.12 \pm 0.12 (137)	0.76 \pm 0.15 (58)
	Rural	1.54 \pm 0.02 (39)	1.25 \pm 0.42 (20)

^a Numbers in parentheses indicate sample sizes.

Table 6. Fishing License Sales in Texas (September 1978–August 1979) and Estimated Number of Licenses Sold Based on Mail and Telephone Surveys, Long Form Only

Type of License	Number Sold ^a	Number Estimated
Resident combination hunting and fishing	518,404	1,100,000
Resident fishing ^b	1,011,530	1,380,000
Total	1,529,934	2,470,000

^a Reported by the Texas Parks and Wildlife License Division.
^b This did not include ~73,000 3-day saltwater fishing licenses.

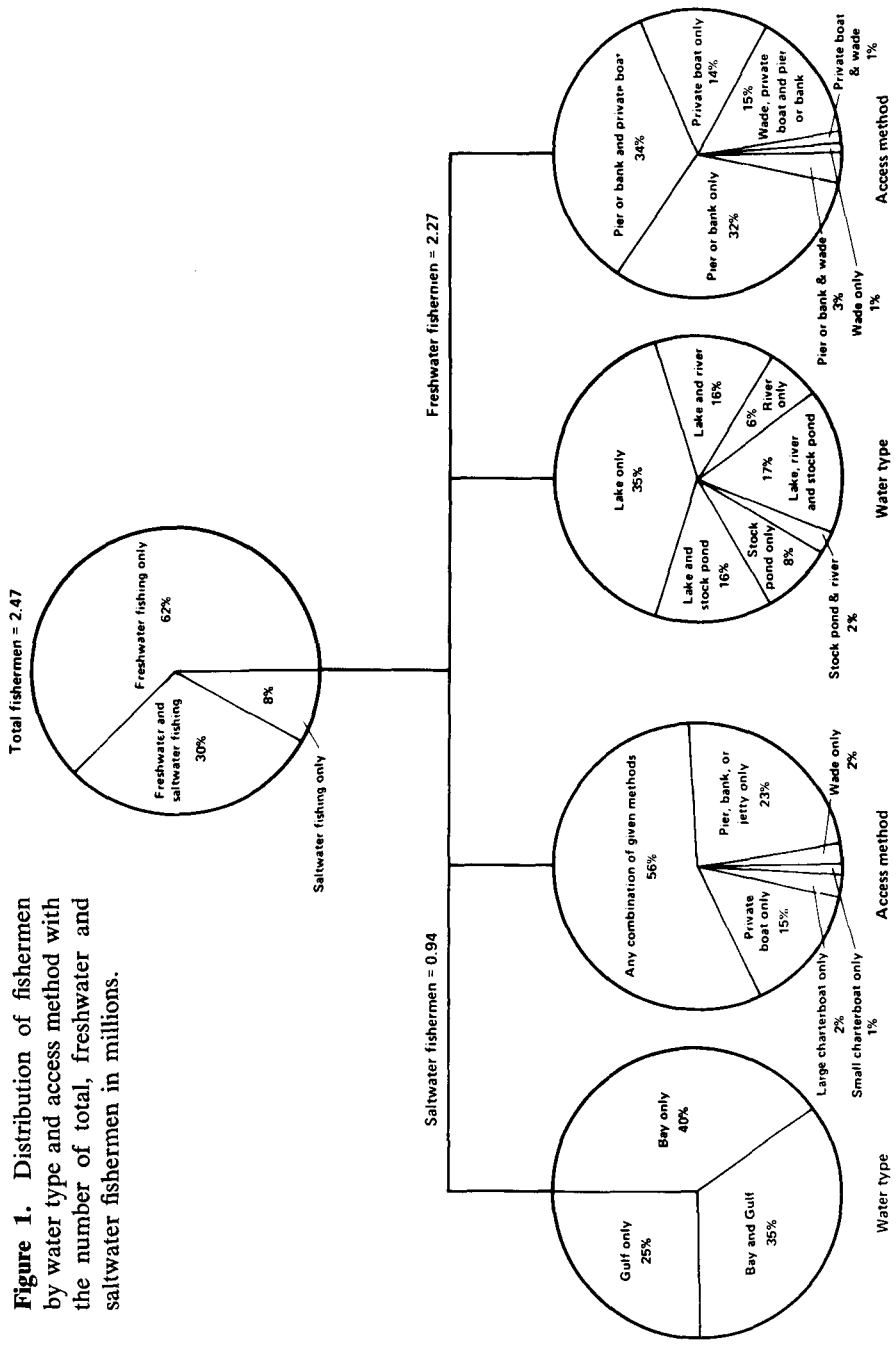
cipients had an even higher mean number of fishermen per household and the estimate was assumed to be more biased. This estimate was then adjusted downwards by 62%. The final estimate was 2.47 ± 0.40 million resident fishermen (licensed and unlicensed).

A discriminant analysis showed there were no significant differences among the strata regarding the way fishermen responded to questions about fishing activities and access methods. Estimates of fishing activities could be made using all questionnaires from fishermen. Approximately 92% (2.27 million) of the fishermen in Texas fished in freshwater while 38% (0.94 million) of the fishermen fished in saltwater (Fig. 1). Only 8% of all fishermen restricted their activities to saltwater and 62% of all fishermen restricted their activities to freshwater.

Most freshwater fishermen (84%) fished in reservoirs or lakes. The percentage of fishermen visiting stock ponds and rivers was about equal (approx. 39% each). The estimate of saltwater fishermen who fished in bays (75%) was greater than the estimate of the number who fished in the Gulf (60%). However, this difference was not significant. The percentage of fishermen fishing only from private boats was equal among saltwater and freshwater fishermen (15% and 14%, respectively). There was a large group of freshwater and saltwater fishermen that fished only from piers, banks or jetties (32% and 23%, respectively). Many fishermen fished from all platforms at one time or another during the year (saltwater, 56% and freshwater, 34%). Only 3% to 4% of the saltwater fishermen fished only from charter boats.

Nearly 67% of the fishermen possessed a valid resident sport fishing license or hunting-fishing combination license. Approximately 17% were either older than 64 or younger than 17, and could legally fish without a license. Over 8% of the fishermen fished only with a cane pole in their county of residence or only on private property, activities which didn't require a license. Approximately 8% of the unlicensed fishermen (0.19 million) fished illegally.

Figure 1. Distribution of fishermen by water type and access method with the number of total, freshwater and saltwater fishermen in millions.



Discussion

The total number of Texas resident fishermen was 2.47 ± 0.40 million. No other published estimates were available with which to compare this estimate. However, 3 other studies have estimated the total number of Texas saltwater fishermen. Belden Associates (1958, 1960) estimated the total number of saltwater fishermen during fiscal years 1958 and 1960 at 748,000 and 665,000 respectively. The National Marine Fisheries Service (1980) estimated the total number of saltwater fishermen in Texas for calendar year 1979 at $1,319,000 \pm 137,000$. Our study estimated there were $940,000 \pm 40,000$ resident saltwater sport fishermen during fiscal year 1979. This study did not include 70,000 residents that purchased a 3-day fishing license nor 79,000 non-resident fishermen. Conversely, the National Marine Fisheries Service (NMFS) estimate included 107,000 non-residents. It is possible the NMFS estimate may have been inflated due to double sampling since it sampled a calendar year instead of a fiscal year. The fact that NMFS's non-resident estimate was 26% greater than reported non-resident license sales (79,000) supports this conclusion. There were no legal exceptions for non-resident fishermen and license sales should have accurately reported total non-resident fishermen. Considering the different methodologies used and the different times surveyed, these 2 estimates are similar.

Although these estimates are similar (confidence intervals overlap), it does not mean the problems encountered in making estimates in this survey can be ignored. Fishing license sales in this survey showed a 62% over estimation from known figures even with an adjustment from a follow-up telephone survey. A large part of this discrepancy probably arose from the inaccessibility of 53% of the total population. Telephone numbers were unavailable for 56% of the follow-up sample and an additional 8% were never home during 3 different attempts to contact. Another 5% of the households contacted by phone declined to answer any questions. If this large proportion of inaccessible people did not include fishing in their life-styles then the failure to contact them and have the data represented in the survey could easily have resulted in the positive bias. Obviously a better method of obtaining accurate telephone information is needed. Positive biases could also have been caused by prestige and memory processes. Even though the percent of households in urban and rural areas and the mean number of persons per household in the short and long form questionnaires appeared to be representative of reported demographic statistics for Texas indicating the survey was unbiased, the data from the short form estimated a significantly greater number of fishermen per household than did data from the long form. Obviously, the license questions influenced the responses and estimating the total number of fishermen with data from the short form would have resulted in a much

higher estimate than the one made with data from the long forms. Atwood (1956) described a memory bias caused by the absence of written records. The timing of this survey was coordinated so that it took advantage of the license as a written record. Unfortunately, the license question may have caused persons fishing illegally to not report their fishing activities. Persons responding to the short form reporting fishing trips occurring greater than one year would inflate the estimate of fishermen and persons responding to the long form and not reporting fishing activity because they were illegal would deflate the estimate of fishermen. Unfortunately, it was impossible to tell which was greater with the current survey design.

Other reasons for the overestimation of license sales could have been caused by persons upgrading their responses to the license question while reporting truthfully to questions regarding fishing activity. Persons fishing illegally or not sure of whether they can fish legally without a license might have responded that they had a license just to be sure they were not found fishing illegally. There was no way to determine the extent of this type of activity or how much it might have affected the results. It is important to realize that a downward adjustment of the total fishermen based on license sales could have caused a serious negative bias in the estimate of total fishermen if upgrading was extensive.

The overestimation of combination licenses was much greater than for resident fishing licenses, probably due to people being confused by the question regarding the 2 license types. Many persons probably had a resident hunting and a resident fishing license and reported them as a combination license. There was no logical reason for a person to claim possession of one license more than the other.

Estimates of the percent of fishermen using various access methods or fishing in different ways were probably inflated by prestige biases. Atwood (1956) found hunters reported more trips and higher numbers of game taken than actually taken. He hypothesized that this contributed to their image of success and boosted their ego. Again, there was no way to evaluate the extent of this type of bias in this survey and estimates of participation from this survey should be viewed as maximum amounts of activity.

About 35% of the Texas fishermen fished without a license (8% illegally). This estimate is similar to one reported by Martin (1977) who stated that non-licensed anglers generally comprise about 40% of a state's angling population. Dunning and Hadley (1978) estimated that 67% of the fishing population of Erie County, New York was comprised of non-licensed fishermen. They concluded that "fishery management decision-making based solely on licensed anglers may exclude from consideration the majority of the angling population of an area." However, when the illegal fishermen are re-

moved Texas has only 27% of its resident fishermen legally fishing without a license.

One of the most difficult things to find out about a fishery is the total number of anglers using an area. The creation of an exempt fishing license (perhaps sold at a reduced price) for all persons over 64 years old or anyone fishing in one of the exempt categories (except private property and children <17 years old) would improve surveys by permitting all fishermen to be contacted directly using the license list as a sampling frame (most children <17 years would be contacted through a parent). In any case a better sampling frame than the driver's license file must be found if new surveys are to be more accurate and more efficient. Finally, we found the estimation of a known statistic a useful device for evaluating biases and may offer a way to adjust other estimates made with the survey.

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