# The Lake Fork Trophy Largemouth Bass Survey: Benefits and Limitations of Using Volunteer Angler Data to Assess the Performance of a Trophy Fishery

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*Abstract:* Lake Fork Reservoir, in northeast Texas, supports a nationally-recognized trophy largemouth bass (*Micropterus salmoides, LMB*) fishery which the Texas Parks and Wildlife Department (TPWD) has managed using restrictive harvest regulations since it was opened to public fishing in 1980. Despite a long history of annual creel and electrofishing surveys conducted by TPWD, data on trophy fish is limited. Fisheries managers' inability to collect trophy-sized LMB using traditional sampling methods is probably the result of a combination of gear biases and low relative abundance of trophy-sized fish. We collected volunteer angler survey data on trophy-sized fish >3.18 kg, with interest in the sample above the upper bound of the protective slot-length limit (>609 mm TL), and evaluated the utility of this information to supplement creel and electrofishing survey data. From March 2003 through February 2013, the Lake Fork Trophy Bass Survey was used to collect data on 12,560 trophy LMB, 14% of which were larger than 4.54 kg. Anglers reported lengths on 93% of the entries: 31% of these were >609 mm TL. These combined observations affirm the quality of the trophy fishery, information which was unavailable from traditional sampling. Manpower investments for the volunteer survey were low, resulting in a cost-effective method of collecting supplemental data on trophy fisheries. However, although the volunteer survey provided valuable documentation on catches of trophy LMB, the eventual decline in angler participation and the increasing tendency to report only larger fish makes these types of surveys inappropriate for long-term monitoring.

*Key words*: Micropterus salmoides, gear bias, angler involvement, supplemental data

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Assessment of fisheries managed for trophy largemouth bass (*Micropterus salmoides*, LMB) can be difficult because typical fisheries-independent sampling using electrofishing (Bayley and Austen 2002) or fisheries-dependent sampling using creels (Bonds and Magnelia 2000, 2004; Storey and Myers 2002, 2004) are often ineffective at collecting large fish. When traditional sampling fails, fisheries managers have employed a range of alternate methods to collect supplemental information on these rare individuals. These include angling (Bonvechio and Rydell 2015), angler diaries (Ebbers 1987, Prentice et al. 1993, Wynne et al. 1993, MacLennan 1996, Bray and Schramm 2001), angler incentive programs (Ryan et al. 2002, Dutterer et al. 2014), various surveys (Gabelhouse and Willis 1986, Roach et al. 1999, Stanovick et al. 2002), tournament-supplied data (Ebbers 1987, Dolman 1991, Quertermus 1991, Pereira et al. 2002), taxidermist-supplied data (Horton and Gilliland 1993, Crawford et al. 2002), and angler-recognition programs (Forshage et al. 1989, Wilson and DiCenzo 2002).

Lake Fork Reservoir is an 11,033-ha impoundment located approximately 113 km east of Dallas, Texas, that supports a nationally-renowned trophy fishery for LMB. Since 1 September 2000, TPWD has managed the fishery using a 406- to 609-mm protective slot-length limit with a five-fish daily bag limit, of which only one fish >609 mm per day was permitted to be kept. Directed angler effort for LMB averaged over 620,000 h annually since 2006 (TPWD data), and Hunt and Parker (2016) estimated total annual fishing trip expenditures of US$18.8 million and a total economic value of the reservoir for fishing at $38.4 million.

Lake Fork Reservoir was sampled annually using nighttime electrofishing since 1990, and year-round access creel surveys were initiated in 1987. Lake Fork Reservoir has one of the Texas Parks and Wildlife Department's (TPWD) longest-term monitoring datasets of an LMB fishery with a sampling frequency beyond what occurs on other reservoirs sampled by management crews using TPWD's standard protocols. Despite the frequency of sampling, relatively few trophy fish were collected which made it difficult for managers to characterize the composition of the trophy fishery or to assess the performance of Lake Fork Reservoir's restrictive regulation on LMB. Increasing sampling intensity is labor-intensive and expensive. State agencies operate with finite budgets and resources, and alternate methods with the potential to provide complimentary data at reduced agency effort or cost should be investigated.

The Lake Fork Trophy Bass Survey (LFTBS) was initiated to enable local fisheries-related businesses to promote the reservoir's fishery and to provide supplemental data on catches of trophy LMB to fisheries managers. The volunteer reporting program was

designed to collect data on catches of trophy-sized LMB. It is a cooperative program of TPWD, the Lake Fork Area Chamber of Commerce, the Lake Fork Sportsman's Association, and participating businesses and marinas. We examined the benefits and limitations of using the angler-supplied catch data to augment data collected using typical fisheries management techniques in evaluating the status of Lake Fork Reservoir's trophy fishery. The objectives of our study were (1) to quantify catches of trophy LMB by using angler-supplied data and (2) to document catches of LMB above the upper limit of the restrictive slot-length limit by using angler-supplied data to supplement fisheries monitoring surveys.

## Methods

During the period concurrent with the LFTBS, we completed nighttime electrofishing and access point creel surveys to collect catch data on trophy LMB for comparison with the LFTBS. We conducted electrofishing surveys in spring and fall at 24 5-min randomly-selected sites in accordance with standard TPWD fishery assessment procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2015). All observed LMB were collected and measured. Annual access-point creel surveys were conducted on 5 weekend days and 4 weekdays per quarter selected from seven boat ramps in accordance with standard TPWD fishery assessment procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2015). We used creel survey data to estimate angler effort, numbers of fish caught, harvested, and released. For each party, we recorded data on number of anglers, home zip code, species sought, trip time, species and sizes of released fish, and individual lengths of harvested fish. Weight information generally was not recorded in creel surveys but for the purposes of assessing angler reporting rates, any fish caught ≥3.18 kg were recorded along with the time caught. During creel surveys, anglers were not asked about the LFTBS so as not to influence their willingness to participate.

The LFTBS started in March 2003 and extended through February 2013, and 13 private marinas at the reservoir agreed to participate. Based on prior trailer counts, boat launches at participating marinas represented an estimated 59% of total fishing pressure on Lake Fork Reservoir. We used private businesses as reporting stations to reduce project costs and to engage business owners in the survey. We promoted the LFTBS by posting laminated signs at public boat ramps and participating marinas, and through monthly results summaries provided to marinas and outdoor writers, along with periodic press releases. Marina owners prominently displayed survey ledgers and encouraged anglers to record their catches of trophy LMB.

We requested anglers catching fish ≥3.18 kg and/or >609 mm in total length (TL) to record weight and TL of fish, the date and time of catch, and angler home zip code. The weight criterion was chosen to match an earlier, short-lived trophy bass survey, and the length criterion was selected to document catches of fish above the upper limit of the protective slot-length limit. Anglers catching fish >609 mm had the option of bringing them to a marina to weigh on certified scales, or fish could be weighed using personal scales and immediately released. All fish in the protective slot-length limit had to be weighed on personal scales and released. Anglers could submit entries using measured or estimated fish weights and/or lengths, which they were asked to record. During the first week of each month, TPWD staff collected survey ledgers from marinas and recorded all catches of trophy LMB. Monthly summaries of entries were sent electronically to participating businesses, media outlets, and other interested parties.

We calculated angler reporting rate for the LFTBS to estimate total catch of trophy LMB by cross-referencing creel survey interviews with the LFTBS data set. For each creel interview where anglers reported catching a trophy fish we attempted to verify the catch in the LFTBS database by matching details such as date, boat ramp, time of catch, fish weight, and angler zip code. We defined the reporting rate as the number of verified trophy entries divided by the total number of trophies reported in the creel, expressed as a percentage. We calculated reporting rate for three time periods; the first two years of LFTBS, the following four years, and the final four years.

We investigated the incidence of larger fish in the LFTBS over time to determine the survey's suitability for longer-term monitoring. We compared the percentages of fish >609 mm, the upper limit of the slot-length limit, and fish ≥4.54 kg, a notable achievement for bass anglers, by program year through regression analysis using the R software environment (Venables et al. 2015) with arcsine-square-root transformed percentage data ($P \leq 0.05$).

## Results

We completed electrofishing surveys in spring (April) and fall (October) from 2003–2010 and in 2012 for a combined total sampling effort of 36 h. A fall sample was collected in 2011 but since there was no corresponding spring sample that year, the data were excluded. During combined electrofishing surveys, we collected a total of 3686 LMB including 658 fish within the protective slot (406–609 mm TL) and only three fish >609 mm TL (Figure 1). Fourteen fish collected in electrofishing samples were ≥3.18 kg.

From March 2003 through February 2013, we conducted 531 access-point creel surveys with a total sampling effort of 2790.8 h. Creel surveys were conducted from June through May, so creel results were offset by three months from the program years of the

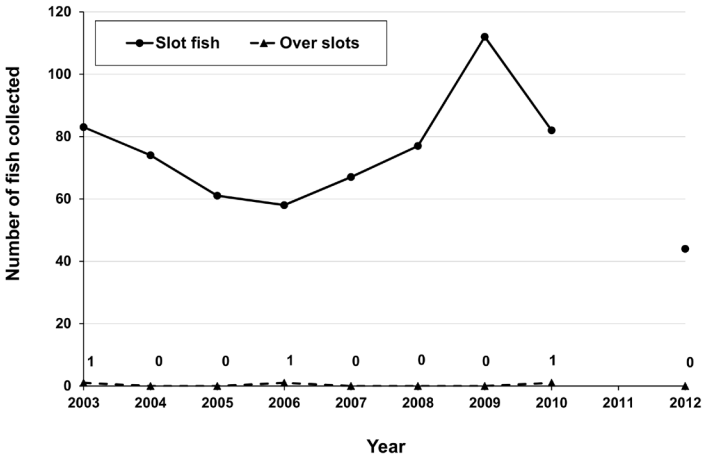


**Figure 1.** Catches of LMB within the 406–609 mm protective slot and fish over the protective slot (>609 mm) from combined samples of spring (April) and fall (October) electrofishing, Lake Fork Reservoir, Texas, 2003 through 2010 and 2012. Numbers above horizontal axis represent number of fish >609 mm caught.

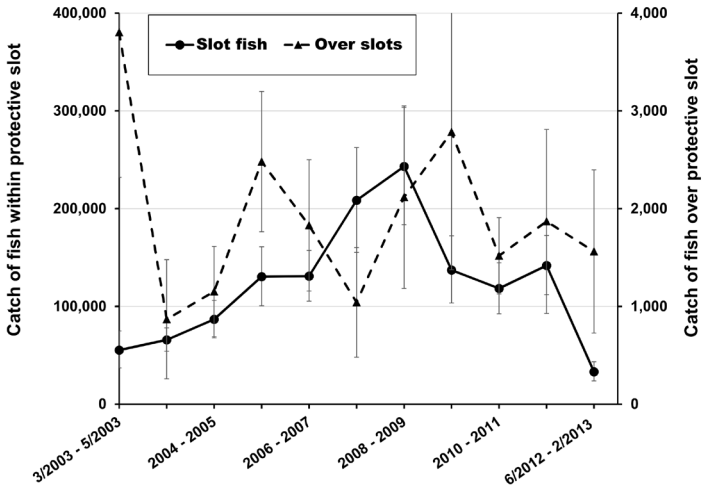


**Figure 2.** Catches of LMB within 406–609 mm protective slot (primary vertical axis), and catches of LMB over the protective slot (>609 mm) (secondary vertical axis), from access creel surveys, Lake Fork Reservoir, Texas, March 2003–February 2013. Creel survey sample years run from June 1 through May 31. Vertical bars represent ± standard error.

**Table 1.** Summary table of number of entries (combined measured and estimated weights) by weight classes by program year in the Lake Fork Trophy Bass Survey, Lake Fork Reservoir, Texas, March 2003 through February 2013.

| Weight class lb (kg; lower bound) | Program year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Weight class totals |
| 3.18 kg (7 lb) | 759 | 628 | 679 | 615 | 699 | 567 | 318 | 353 | 297 | 143 | 5058 |
| 3.63 kg (8 lb) | 589 | 463 | 486 | 397 | 487 | 395 | 227 | 309 | 218 | 146 | 3717 |
| 4.08 kg (9 lb) | 278 | 281 | 289 | 227 | 226 | 199 | 110 | 162 | 136 | 76 | 1984 |
| 4.54 kg (10 lb) | 172 | 155 | 157 | 129 | 145 | 116 | 60 | 89 | 62 | 51 | 1136 |
| 4.99 kg (11 lb) | 55 | 63 | 65 | 46 | 49 | 38 | 23 | 28 | 22 | 17 | 406 |
| 5.44 kg (12 lb) | 25 | 22 | 30 | 28 | 24 | 17 | 11 | 17 | 8 | 7 | 189 |
| 5.90 kg (13 lb) | 11 | 7 | 6 | 8 | 6 | 3 | 2 | 1 | 2 | 2 | 48 |
| 6.35 kg (14 lb) | 2 | | 1 | 5 | 2 | | 1 | 1 | 1 | 1 | 14 |
| 6.80 kg (15 lb) | | 2 | 1 | | | | 1 | 1 | | 1 | 6 |
| 7.26 kg (16 lb) | 1 | | | | | | | | | 1 | 2 |
| Totals | 1892 | 1621 | 1714 | 1455 | 1638 | 1335 | 753 | 961 | 746 | 445 | 12,560 |

LFTBS. Total directed fishing effort for LMB at Lake Fork Reservoir was high. During the LFTBS, anglers fished 6,004,679 h (SE = 961,918) for LMB and caught 3,798,738 (SE = 818,131) fish. A total of 1,351,759 (SE = 315,592) fish within the protective slot was caught and a further 21,030 (SE = 9013) above the protective slot (Figure 2). Fish >609 mm included 2933 (SE = 958) harvested or retained for live-release tournament weigh-ins and 18,096 (SE = 8055) released.

During the LFTBS, anglers reported weights on 12,560 LMB ≥3.18 kg, involving a combination of measured ($n$ = 10,523) and estimated ($n$ = 2037) data. Fish ≥4.54 kg represented 16% of total entries ($n$ = 1801; Table 1). We logged the highest number of entries in the first year of the survey (1892). Total annual entries for the first six years remained relatively consistent, but decreased for the final four years of the survey (Table 1).

Participants recorded TL data on 11,669 trophies (Figure 3) and 7574 of these recorded measured lengths. Fish >609 mm TL represented 31% ($n$ = 3655) of entries with associated length data. Total annual reports of entries with TL data declined rapidly over the course of the survey, although entries >609 mm TL were relatively stable for the first five years before they followed a similar declining trend (Figure 3).

Over the course of the LFTBS, fish >609 mm TL represented between 27%–39% of annual entries (Figure 4). The relative contri-

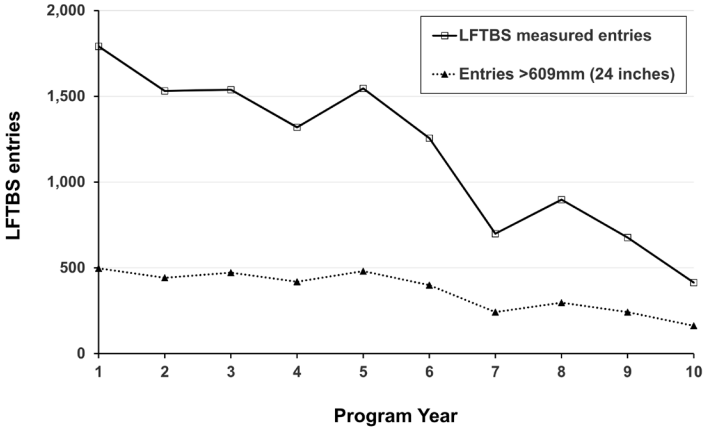


**Figure 3.** Entries in the Lake Fork Trophy Bass Survey with associated total length measurements (fish with measured lengths and fish with estimated lengths) by program year, Lake Fork Reservoir, Texas, March 2003–February 2013.

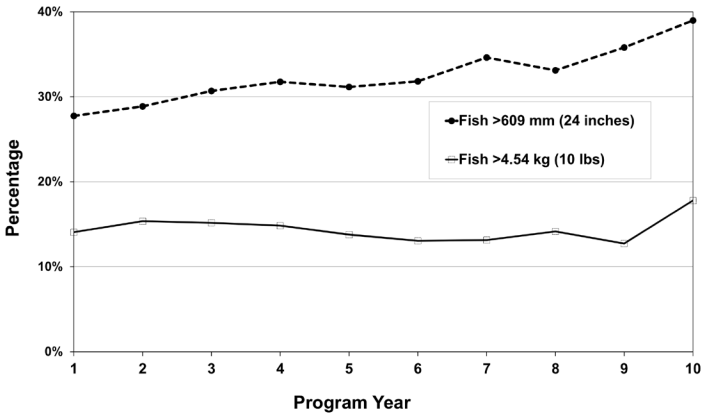


**Figure 4.** Percentage of fish >609 mm and percentage of fish >4.54 kg by program year, in the Lake Fork Trophy Bass Survey, Lake Fork Reservoir, Texas, March 2003–February 2013.

bution of fish above the slot-length limit showed a positive increase over time ($P < 0.001$, $R^2 = 0.89$) as entries declined (Figure 2). Fish ≥4.54 kg represented between 13–18% of annual entries and, although there was an apparent increasing trend in the relative contribution of these large fish, it was not significant ($P = 0.89$).

During creel surveys anglers reported catching 389 trophy fish (≥3.18 kg). These data represent observed counts. Angler reporting rate was 15.1% for the first two years of the LFTBS, 7.0% for the next four years, and 1.5% for the final four years. Applying these reporting rates to the total entries in each period conferred a total estimated catch of 309,570 trophy fish over the course of the study.

## Discussion

Based on TPWD semi-annual electrofishing surveys, there was no evidence of decline in the LMB population in Lake Fork Reservoir during the LFTBS. Four years prior to the start of the LFTBS, Lake Fork Reservoir experienced a largemouth bass virus-induced fish kill, and although electrofishing CPUE decreased, no differences in mean angling catch rates were detected (Bister et al 2006). During the LFTBS the lake was exposed to periods of drought and consequent reduced reservoir elevation from 2005–2007 and 2010–2013 (Storey and Bennett 2014). Electrofishing CPUE tended to decrease during drought conditions because of the lack of available aquatic habitat but catches increased as reservoir elevation improved (Storey and Bennett 2014). There was no evidence of any sustained trends in population abundance during the LFTBS.

Unfortunately, electrofishing surveys yielded insufficient data to help characterize the trophy segment of the LMB fishery or to assess changes in the population that may have resulted due to implementation of the protective slot-length limit. This issue has been previously documented on Lake Fork Reservoir (Poarch 1988; Storey and Myers 2000, 2002, 2004) as well as other trophy LMB reservoirs in Texas (Bonds and Magnelia 2000, 2004; Ryan et al. 2002; Ashe and Driscoll 2016). Bayley and Austen (2002) hypothesized that large LMB were less vulnerable to electrofishing due to a behavioral shift in habitat use, especially in occupied depths. They also suggested big LMB were repelled by the peripheral electrical field due to a fright response and their faster inherent swimming speeds would tend to reduce their relative abundance in electrofishing sampling as they were able to overcome the galvanotactic response. Beamesderfer and Rieman (1988) reported a similar decreased vulnerability to capture with increasing fish size in smallmouth bass. Conversely, other researchers have demonstrated higher capture efficiencies as LMB size increases (Reynolds and Simpson 1978). Dolan and Miranda (2003) used power transfer theory to demonstrate that larger fish were easier to immobilize with electrofishing because absolute total power transferred into their bodies increases as they grew, making them more vulnerable to capture. Regardless, electrofishing was ineffective at collecting trophy LMB at Lake Fork Reservoir. Increasing electrofishing sampling effort may allow a better chance of collecting more trophy-sized LMB, but it is expensive, and given the low catches of trophy-sized fish observed during our study, increasing effort even an order of magnitude would be unlikely to provide any meaningful data that would enable fisheries managers to describe the trophy fishery or assess the impact of the slot-length limit.

Historically, few catches of LMB >609 mm are reported in creel surveys at Lake Fork Reservoir (Storey and Myers 2002, 2004), although analysis of creel data yielded a higher estimated catch of fish >609 mm than the LFTBS but it was associated with a relatively high relative standard error. Angler creel surveys are the stan-

dard method for assessment of effort, harvest, and released catch in recreational fisheries (Jones and Pollock 2012), but they are ineffective at sampling catch of trophy-sized fish, due to their scarcity in populations (Hanson et al. 1986). Since weight data were not recorded in creel surveys at Lake Fork Reservoir, this method could not be used to quantify catches of trophies by weight, but it was able to provide an estimate of catch of LMB above the upper limit of the slot-limit.

Volunteer-reported survey data has the potential to reduce agency costs and supplement standard fisheries data used to formulate fisheries management decisions. However, these data are challenging or impossible to validate which leaves them open to criticism (Pollock et al. 1994, McCluskey and Lewison 2008). Some studies have demonstrated anglers can supply accurate data on LMB (Ebbers 1987, Mallison and Cichra 2004, De Jesus et al. 2009). In most cases, anglers in the LFTBS reported only one trophy LMB per day. We believed the memorable nature of these large fish might have increased anglers' motivation to record that information.

We asked participants in LFTBS to indicate the quality of their data by recording if they measured or estimated their entries. We initially assumed that measured data might be accurate enough that we could potentially use it to refine the length to weight relationship of trophy LMB or to investigate attributes such as fish condition. De Jesus et al. (2009) found no significant difference between lengths of trophy LMB reported by volunteers and comparable data collected by fisheries professionals in a creel survey. In our study, we observed some inconsistencies between the recorded values and the anglers' claim of data quality, and in some cases it was difficult to interpret whether anglers recorded weights in pounds and ounces or in decimal pounds. Bryant and Jones (1991) and Page et al. (2004) observed anglers rounding fish lengths to the nearest half or whole inch and Jones and Pollock (2012) concluded this bias could have a significant impact on data collected in self-reported surveys. Most entries in the LFTBS were from fish in the protected slot-length limit so anglers used personal equipment in their boats to record length and weight data. Boat movements from wind and wave action can impair this process, and it was impractical to attempt to verify the accuracy of personal devices and impossible to validate data quality.

When we considered the inherent errors and observed limitations in the quality of the data in the LFTBS, we decided it was infeasible to use individual fish length and weight data for analyses. We pooled all observations to generate summary weight and length frequencies and for analysis purposes. We felt any inaccuracies in length and weight measurements likely had minimal impact on the overall trends we observed in the survey as we sought to quantify catches of trophies and document performance of the slot-limit because of the length of the survey and the number of entries recorded.

Participation in volunteer angler surveys typically declines over time (Dolman and Gutreuter 1991, Prentice et al. 1993, Wilde et al. 1998, De Jesus et al. 2009). An earlier trophy bass survey at Lake Fork Reservoir (unpublished data, Storey and Poarch 2000, Storey and Myers 2000) lasted for 18 months but was discontinued because of decreasing public interest and organizational challenges (Storey and Myers 2000). The LFTBS maintained high numbers of entries for the first six years of the survey. This longevity was likely the result of high angler effort at Lake Fork Reservoir, coordination and administration by TPWD, cooperation from marinas, and the reservoir's reputation as a preferred destination for trophy LMB fishing. Our ability to have recording stations at many marinas also provided a convenient situation for anglers to cooperate and record their information. This level of cooperation would not be expected at an unmanned, public boat ramp particularly in a remote rural area.

We wanted to estimate angler reporting rate, so we could approximate total catch of trophy LMB. We believed verifying trophy catches reported in creel surveys with the LFTBS data was the most appropriate approach. However, at three of the seven ramps where access creels were conducted, there were no LFTBS-participating marinas immediately adjacent to the ramp, so anglers wishing to record trophy catches had to travel to a participating marina. This inconvenience may have decreased entries, and any trophy catches recorded in creel surveys at these locations would have been less likely to have been verified. The inherent difficulty of matching individual trophy catches from creel interviews with values in the LFTBS database, combined with potential loss at remote ramps, reduced our confidence in estimates of reporting rate and the total estimated catch.

As angler interest in the survey decreased, the importance of larger fish apparently increased relative to smaller fish presumably as smaller fish became progressively less memorable and not worth reporting. This increased representation of larger fish in later years would tend to make volunteer surveys impractical for long-term monitoring of trophy fisheries. Over the short-term, however, these types of surveys can provide valuable information to characterize angler catch of trophy fish.

## Conclusions

In future surveys, we recommend that fisheries managers design forms that clearly state how data need to be recorded, specifying required units and whether each fish is measured or estimated. In systems with multiple access points it would be advantageous to locate recording stations at marinas or check stations to engage

anglers and businesses in collecting data that could be used to help manage the LMB fishery. Marina employees actively promoted the survey and encouraged customer participation at many locations on Lake Fork Reservoir. In systems where professional fishing guides operate, it is advantageous to get their cooperation, as they represent technically competent anglers who are likely to be proficient at catching trophy fish.

Smartphone apps (Gutowsky et al. 2013, Papenfuss et al. 2015) and SMS texts (Baker and Oeschger 2009) are being developed to provide alternative data recording methods for fishing trips that could prove popular with anglers. Digitally recorded entries could include photographs of catches, fishing effort, and required length and weight data. Technological advances such as these can provide alternative methods for fisheries surveys.

Neumann and Allen (2007) concluded that using a single gear type to sample all lengths of fish in a population is rarely effective and the use of alternative methods to specifically target larger individuals is a convenient sampling strategy where maintaining or increasing the abundance of large fish is a desired objective. The LFTBS was an effective tool for targeting trophy-sized LMB with limited required resources from TPWD and provided an alternative method for collecting data to evaluate the fishery. It also created an opportunity for anglers to be involved in contributing information that was important to management of the fishery. Furthermore, the survey provided an effective tool for gathering supplemental information on the trophy segment of the LMB population. Agency involvement was limited to survey promotion, record collection, data entry and analysis, and production of results summaries. The information we collected from the survey would otherwise have been unavailable using traditional sampling methods. The methods we used for our volunteer survey can be employed in any fishery, regardless of species or geographic location, but logistical and resource limitations should be considered.

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