

Fisheries Technical Articles

Description of Bowfishing Tournaments in the Trinity River, Texas, with Emphasis on Harvest of Alligator Gar

Daniel L. Bennett, Texas Parks and Wildlife Department, Inland Fisheries Division, 11810 FM 848, Tyler, TX 75707

C. Craig Bonds, Texas Parks and Wildlife Department, Inland Fisheries Division, 11810 FM 848, Tyler, TX 75707

Abstract: Bowfishing may represent a substantial portion of the recreational harvest of alligator gar, but little is known about the relative efficiency of the angling method. To better understand angler effort and harvest rates, we collected data from three Trinity River bowfishing tournaments each year during 2009, 2010, and 2011 ($n=9$). Harvest ranged from 2 to 30 alligator gar per tournament with 641 anglers harvesting a total of 134 fish for all years. Mean (\pm SE) harvest rate (fish h^{-1}) of alligator gar for tournament participants was similar among years at 0.023 ± 0.095 in 2009, 0.018 ± 0.008 in 2010, and 0.016 ± 0.004 in 2011 ($F=0.24$, $df=8$, $P=0.79$). Harvested alligator gar ranged from 229 to 2210 mm in total length, indicating a wide range of vulnerability to bowfishing.

Key words: *Atractosteus spatula*, angler CPUE, trophy fishery

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 66:1–5

Alligator gar are distributed primarily in Gulf coastal rivers in the southeastern United States (Sutton 1998, Sakaris et al. 2003). This species has experienced declines throughout much of its range, mainly due to habitat degradation (Robison and Buchanan 1988, Simon and Wallus 1989, Etnier and Starnes 1993, Sakaris et al. 2003) and, to a lesser extent, from commercial and sport fisheries (Mendoza et al. 2000, as cited in Aguilera et al. 2002). However, populations in Texas appear stable. As the largest freshwater fish in Texas, interest in this species has increased among recreational anglers, especially those targeting the Trinity River for large fish. As a result, Texas Parks and Wildlife Department (TPWD) implemented a daily bag limit of one fish, imposed on 1 September 2009, as a proactive measure to protect alligator gar from overharvest and to allow time to collect more data on the species and fishery. Despite the observed increase in interest, directed angler effort and harvest of alligator gar in Texas is not well understood.

Although bowfishing is suspected to represent a large portion of the recreational harvest of alligator gar, current creel procedures do not adequately capture this information. Traditional creel surveys on large river systems are often inefficient and present many logistical problems (Deuel 1980, Malvestuto 1983). Bowfishing often occurs during nighttime hours, rendering traditional creel survey techniques ineffective. Many fisheries agencies use biological and fishery assessment data obtained from angling tourna-

ments to supplement agency-collected data (Schramm and Hunt 2007). These supplemental data describing the recreational fishery may provide valuable information about catch rates and size distribution of harvested fish, and also facilitate the collection of data for other studies. Because little was known regarding the operation and angling efficiency at competitive bowfishing tournaments in Texas, these tournaments allowed biologists an opportunity to describe and quantify an integral portion of the recreational fishery for alligator gar. Our specific objective was to describe tournament operation and estimate angler effort, harvest rate, and size distribution of alligator gar from bowfishing tournaments on the Trinity River, Texas.

Methods

Study Area

The Trinity River forms at the confluence of Elm Fork and West Fork just south of Dallas and Fort Worth, Texas, and flows 681 km south to the Gulf of Mexico, making it the longest river entirely contained within the state of Texas (Gard 2011). The river contains only one reservoir, Lake Livingston, a mainstream impoundment created in 1968 approximately 193 river km upstream of its confluence with Trinity Bay and the Gulf of Mexico (Gard 2011). The river upstream of Lake Livingston is referred to as the upper Trinity River, and the lower Trinity River is that por-

tion downstream of Lake Livingston Dam (Figure 1). The river is highly turbid with substrate composed primarily of shifting sand and clay amidst steep banks, bordered by hardwoods, conifers, and grasses. Land along the Trinity River is primarily private property, and public access to the river is restricted to a limited number of public boat ramps at road crossings and marinas. Two public boat access points currently exist north of Lake Livingston, and one is restricted to small boats (<5 m).

Tournament Operation

Tournaments were identified through bowfishing associations and bowfishing websites (Bowfishing Association of America (BAA) 2010; Texas Bowfishing Association (TBA) 2010). We obtained a complete census of Trinity River bowfishing tournaments that were sanctioned and advertised by the BAA and TBA during the study period (R. Peeples, TBA, personal communication). We did not find evidence about additional bowfishing tournaments held on the Trinity River during the study period through either online or personal inquiries. Specific locations of tournament registrations and weigh-ins were recorded. We determined the number of teams and anglers from records collected at registration during each event. We attempted to obtain a complete census of names and addresses of tournament participants.

Harvest Characteristics

Due to the volume of fish presented at tournament weigh-ins, and to expedite the collection of alligator gar, individual data describing harvest rates of other species were not collected. Some tournaments gave prizes to teams catching the most fish (all species combined). Tournament directors recorded the total number of fish (all species) caught by bowfishing teams competing for these prizes. These data were obtained from tournament directors and are presented along with alligator gar data for comparison.

We collected all but 11 alligator gar presented at the weigh-ins following each tournament. Each fish was measured (Total Length, TL) to the nearest 25.4-mm length group to expedite data collection (Quinn 2010). Catch-per-unit-effort (CPUE) and standard error (SE) were estimated as the number of alligator gar harvested divided by total angler hours at each event. Shapiro-Wilk tests *W* were performed on CPUE data to determine if data were normally distributed; CPUE was compared among years using a one-way Analysis of Variance for independent groups. CPUE of alligator gar was not recorded for individual teams. Median length of alligator gar was compared between years using a Kruskal-Wallis test, and a Kolmogorov-Smirnov two-sample test for comparison between the upper and lower river.

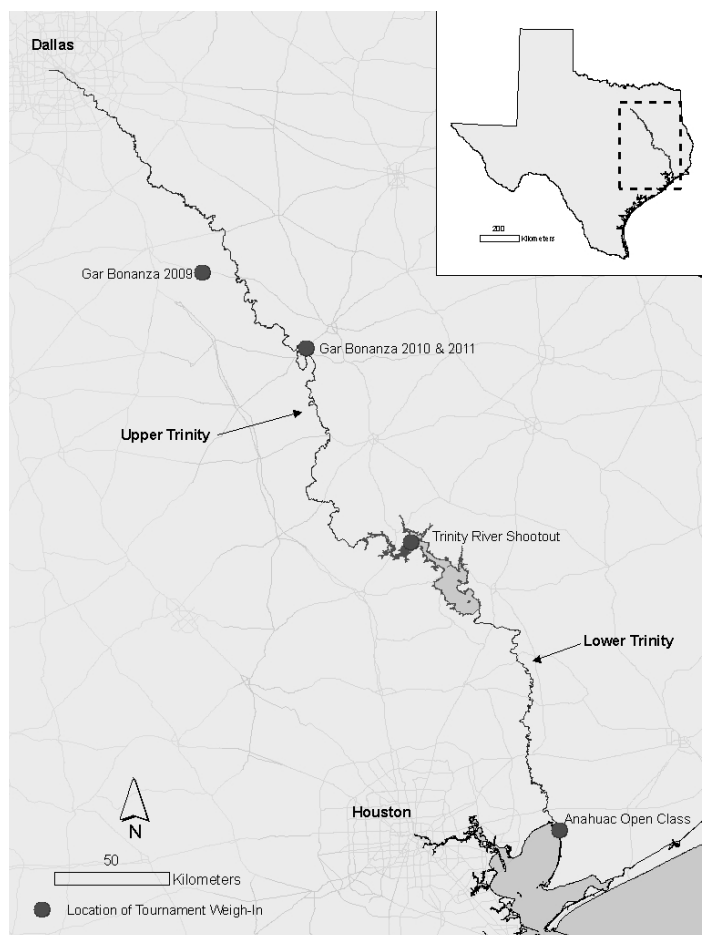


Figure 1. Location of annual bowfishing tournament weigh-ins on the Trinity River, Texas, in 2009–2011.

Results

Tournament Operation

Tournaments included the Gar Bonanza and the Trinity River Shootout in the upper Trinity River and the Anahuac Open Class Championship in the lower Trinity River (Figure 1). In each event, anglers were required to check in with tournament directors at the site of the weigh-in, but were permitted to travel by vehicle to any launch site along the river at the start of the event. Individual teams registered using only a team name and the number of participants per team. Prize categories and formats differed for each tournament and depended on such classifications as boat class type (i.e., airboat [fixed propeller], fanboat [movable-trolling propeller], and troller [trolling motor]), total number of fish, and heaviest individual fish or various groups of fishes.

Gar Bonanza—The Gar Bonanza is an annual tournament with prize categories specific to alligator gar and longnose gar (*Lepis-*

teus osseus). Categories included three heaviest alligator gar, heaviest individual alligator gar, 10 heaviest longnose gar, and heaviest individual longnose gar. Alligator gar prize categories received priority and paid more prize money than did categories for longnose gar. In 2009, the tournament weigh-in took place at Oak Cove Marina in Corsicana, (31.9925°, -96.2119°), Texas. In 2010 and 2011, the weigh-in was held at Tucker's Store in Palestine, (31.6804°, -95.7437°), Texas.

Trinity River Shootout—The Trinity River Shootout consisted of two divisions of prize categories and included multiple non-game species. One division included monies divided between teams with the five heaviest fish and the greatest number of fish. The second division included a prize for the heaviest group of fish consisting of one gar (of any species), one buffalo (*Ictiobus* spp.), one common carp (*Cyprinus carpio*), and one bowfin (*Amia calva*). The tournament weigh-in took place at the Outback Campground and Marina in Trinity, (30.9053°, -95.3033°), Texas.

Anahuac Open Class—The Anahuac Open Class Tournament consisted of three prize categories distinguished by boat or “class” type. The first prize was given to the team with the greatest number of fish in any boat type, and a second category was open only to teams harvesting the greatest number of fish using a boat not classified as an airboat (i.e., a boat propelled by a fixed-mounted aerial propeller). The third category was open to all boat types and a prize was awarded to the team with the 10 heaviest fish of any non-game species. The Anahuac tournament weigh-in was held at Fort Anahuac Park in Anahuac, (29.7555° -94.6917°) Texas.

Tournament Angler Participation and Harvest Characteristics

Participation declined through time at all three annual tournaments sanctioned by bowfishing associations from 2009 to 2011 (Table 1). At the Gar Bonanza, participation declined 17% from 34 teams (105 anglers) in 2009 to 26 teams (87 anglers) in 2011. At the Trinity River Shootout participation declined 29% from 26 teams (91 anglers) in 2009 to 21 teams (65 anglers) in 2011. At the Anahuac Open, 21 teams (60 anglers) participated in 2009 but

Table 1. Alligator gar harvest results and statistics for Trinity River, Texas, bowfishing tournaments.

Year	Gar Bonanza			Trinity River Shootout			Anahuac Open		
	2009	2010	2011	2009	2010	2011	2009	2010	2011
Hours	13	13	13	7.5	7.5	7.5	12	12	12
Anglers	105	102	87	91	65	68	60	45	18
Teams	34	27	26	26	21	21	21	16	6
A. Gar Harvested	16	23	25	10	2	8	30	18	2
CPUE ^a	0.012	0.017	0.022	0.015	0.004	0.016	0.042	0.033	0.009
Mean(SE) CPUE	0.017(0.003)			0.012(0.004)			0.028(0.01)		

a. Catch-per-unit-effort defined as alligator gar harvested per total angler tournament hours.

only 6 teams (18 anglers) attended the event in 2011, a 70% decline in participation.

Harvest Characteristics

A total of 134 alligator gar were harvested in the tournaments held on the Trinity River during the study period (Figure 2). Similar to angler participation, the total number of alligator gar harvested declined each year (56 in 2009, 43 in 2010, and 35 in 2011). Mean harvest rate of alligator gar from tournaments was 0.023 h⁻¹ (SE=0.095), 0.018 h⁻¹ (SE=0.008), and 0.016 h⁻¹ (SE=0.004) in 2009, 2010, and 2011, respectively, and was similar among years ($F=0.24$, $df=8$, $P=0.79$). The mean harvest rate for all nine tournaments was 0.018 h⁻¹ (SE=0.004) and was normally distributed ($W=0.92$, $P=0.83$). Mean harvest rate of alligator gar within tournaments across years ranged from 0.012 to 0.028, but was similar among tournaments ($F=1.7$, $df=8$, $P=0.26$). We only recorded the total number of species harvested for teams in the various numbers divisions; however, the number of alligator gar harvested in tournaments was only 0.1% to 1.7% of the total number of fish recorded at the Trinity River Shootout and Anahuac Open, respectively.

Overall, the average angler hours required to harvest one alligator gar of any size during a Trinity River bowfishing tournament was 53 hours. The highest catch rate of alligator gar was observed at the Anahuac tournament in 2009, where it took 24 angler tournament hours to harvest one alligator gar. Median length of alliga-

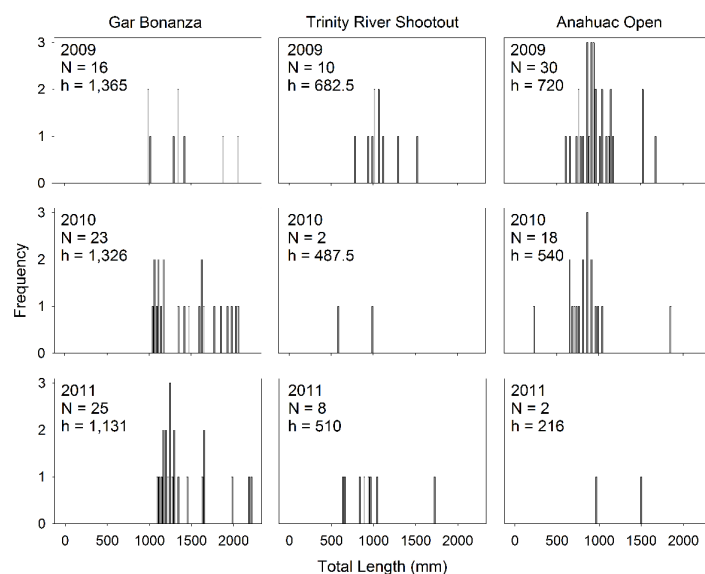


Figure 2. Length frequency histogram of alligator gar harvested from three bowfishing tournaments on the Trinity River, Texas, in 2009–2011 (n = number of alligator gar harvested; h = angler tournament hours). Lengths were not recorded for seven fish in 2009, one fish in 2010, and three fish in 2011.

tor gar harvested from bowfishing tournaments was 1,016 mm TL (range = 610 to 2,057), 1,067 mm TL (range = 229 to 2,057), and 1,219 mm TL (range = 635 to 2,210 in 2009, 2010, and 2011, respectively, and was greatest in 2011 ($H=7.7$, $df=2$, $P=0.02$). Median length of alligator gar harvested in the upper Trinity River (1,219 mm TL, range = 591 to 2,210) was greater ($D=0.58$, $P<0.0001$) than median length of alligator gar harvested in the lower Trinity River (914 mm TL, range = 229 to 1,867) across all years. Median length of alligator gar harvested at the Gar Bonanza tournament over all years was 1,295 mm TL (range = 991 to 2,210), which was greater ($H=56.6$, $df=2$, $P<0.0001$) than median lengths of alligator gar harvested at Anahuac (914 mm TL; range = 229 to 1,854) and the Trinity River Shootout (991 mm TL; range = 584 to 1,727).

Discussion

Reasons for declining participation from 2009 through 2011 are unknown. Poor weather conditions may have attributed to lower participation at the Trinity River Shootout in 2010, and tournament scheduling conflicts were attributed to low turnout at the Anahuac tournament in 2011 (T. Fuller, TBA, personal communication). Based on increased media attention and strong angler interest in alligator gar, a decrease in participation over time was unexpected. In fact, TPWD biologists expected angler harvest to increase through time, which, along with the perception of high vulnerability to overharvest and sensitivity to habitat degradation, led to the implementation of the daily bag limit on alligator gar. However, because we only collected one year of bowfishing-tournament data prior to the regulation change, we were unable to fully evaluate its effect on participation and angler harvest statistics.

Our study suggested that bow anglers participating in competitive fishing events on the Trinity River required over 50 hours of effort on average to harvest each alligator gar. Previous studies indicate jug lines and gill nets used by commercial anglers (Garcia de Leon et al. 2001, Ferrara 2001) were more successful at catching alligator gar in reservoirs. In order to evaluate potential by-catch of non-target species by commercial fisherman, Seidensticker and Ott (1988) quantified harvest per hour of effort for alligator gar using gill nets and jug lines in Sam Rayburn Reservoir, Texas. They defined one hour of effort as the amount of effort required to fish 10 jug lines or one gill net overnight, and reported a CPUE of 0.96/h using jug lines and 0.04/h using gill nets. In a separate study by Gutreuter (1988), jug line catch rates of alligator gar in Sam Rayburn Reservoir ranged from 0.02–0.34 fish per 100 line-nights or 0.002–0.034/h, assuming one hour of effort was required to fish 10 jug lines overnight.

Harvest rates of alligator gar by bowfishing were low when compared with overall harvest rate of other species weighed-in

by anglers in the numbers divisions of bowfishing tournaments. Tournament harvest rates (for all species) were similar to those observed during a study of Arkansas bowfishing tournaments which ranged from 2.1 to 5.3/h among tournaments (Quinn 2010). This suggested that alligator gar were either less vulnerable to bowfishing than other species or lower in abundance than other species. While alligator gar may be less abundant than other target species, their movements and habits likely make them less vulnerable to bowfishing. Studies on movement and habitat use of these fish (Ferrara 2001, Sakaris et al. 2003) and anecdotal accounts by anglers suggest that vulnerability to bowfishing may be highest during the spawning period in the spring, when surfacing activity by alligator gar is more common. We believe tournament dates adequately represented times when alligator gar were the most vulnerable to bowfishing.

Length of alligator gar harvested in all years ranged from 229–2,210 mm TL, indicating a broad size range of vulnerability to bowfishing. An Arkansas study conducted in 1999 and 2000 found that tournament bowfishers typically harvested fish of all species that were ≥ 400 mm in length (Quinn 2010). With the exception of one 229-mm alligator gar, Texas bowfishers generally harvested alligator gar ≥ 550 mm (Figure 2). However, this may have been because of low abundance of small fish due to the rapid growth of young ($< \text{age } 1$) alligator gar (Ferrara 2001) rather than angler preference.

Anglers favored bowfishing the upper river during daylight hours for larger alligator gar, and targeted fish while surfacing for aerial breaths (B. Suggs, TBA, BAA, personal communication). The median length of harvested fish was greater in the upper river, although it is unknown if this was related to differences in length frequencies of the populations or greater vulnerability of large gar in the upper river. Gar Bonanza tournaments also took place during the day, which suggested an increased vulnerability of large gar during daylight hours. Anglers fishing the Gar Bonanza may have been more inclined to target large fish because the award categories are based on weight. In contrast, anglers entering numbers divisions at tournaments, such as the Anahuac tournament and the Trinity River Shootout, are likely less motivated by fish size or species.

Although the number of comprehensive bowfishing studies is currently limited, data indicate overall bowfishing harvest rates for all species may be higher than typical sport fisheries (Quinn 2010). However, harvest rates of alligator gar from Trinity River bowfishing tournaments were significantly lower than other species, and may be representative of a relatively inefficient angling method for this species. Harvest rates were also likely influenced by diverse species and size-specific targeting by anglers, tournament struc-

ture and incentives, as well as seasonal variation in the vulnerability of alligator gar to bow angling. Gears such as jug-lines and gill-nets may have a larger potential to impact alligator gar populations than those observed during organized, competitive bowfishing, at least at the level of effort documented in this study. We observed no significant difference in harvest rates of alligator gar one year prior to and two years after implementing the one-fish-per-day bag limit. It will be important to continue monitoring harvest rates and length frequencies of future bowfishing tournaments to monitor temporal trends in harvest rates and length frequencies of alligator gar.

Although we quantified bowfishing angler effort and harvest practices during organized tournaments, greater attention needs to be given to obtaining information on fishing effort and harvest practices by non-competitive bow and rod-and-reel anglers. Identifying and sampling anglers who target alligator gar outside of organized tournaments will be challenging and will require alternative survey methods to reach this fragmented and highly specialized constituency.

Attending the tournaments allowed biologists to develop relationships with constituents, as well as supplement agency-collected tissues and data in a cost effective manner. Data collected from angler-harvested fish can greatly reduce agency costs of sampling equipment, manpower, and the need to collect and sacrifice additional fish for scientific purposes (Driscoll et al. 2012).

Acknowledgments

This research was partially funded by the U.S. Fish and Wildlife Service through Federal Aid in Sport Fish Restoration grants F-30-R and F-221-M to the Texas Parks and Wildlife Department, Inland Fisheries Division. We thank Michael Baird, Bob Betsill, David Buckmeier, Richard Ott, and Warren Schlechte for their helpful comments, which improved the quality of this paper. We also thank the members of the Bowfishing Association of America and Texas Bowfishing Association, as well as Steve Barclay, Walter Blackburn, Sam Lovell, Tommy Fuller, Robert Peeples, Bubba “Hoopty” Suggs, and the staff of Sportsman’s Memory Shop in Grapeland, Texas, who helped make this research possible.

Literature Cited

Aguilera, C., R. Mendoza, G. Rodriguez, and G. Marquez. 2002. Morphological description of alligator gar and tropical gar larvae, with an emphasis on growth indicators. *Transactions of the American Fisheries Society* 131:899–909.

Bowfishing Association of America (BAA). 2010. <www.bowfishingassociation.com/>. Accessed 10 December 2009.

Deuel, D. G. 1980. Special surveys related to data needs for recreational fisheries. Pages 77–81 in J. H. Grover, editor. *Allocation of fishery resources*. European Inland Fisheries Commission, Food and Agriculture Organization of the United Nations, Rome, Italy.

Driscoll, M. T., K. M. Hunt, and H. L. Schramm. 2012. Trends in fishery agency assessments of black bass tournaments in the Southeastern United States. *Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies* 66:25–32.

Etnier, D. A. and W. C. Starnes. 1993. *The Fishes of Tennessee*. University of Tennessee Press, Knoxville.

Ferrara, A. M. 2001. Life-history strategy of Lepisosteidae: implications for the conservation and management of alligator gar. Doctoral dissertation. Auburn University, Alabama.

Garcia de Leon, F. J., L. Gonzalez-Garcia, J. M. Herrera-Castillo, K. O. Wine-miller, A. Banda-Valdes. 2001. Ecology of the Alligator Gar, *Atractosteus spatula*, In the Vicente Guerrero Reservoir, Tamaulipas, Mexico. *The Southwestern Naturalist* 46(2):151–157.

Gard, W. 2011. Trinity River. *Handbook of Texas*. <<http://www.tshaonline.org/handbook/online/articles/rnt02/>>. Accessed 10 January 2011.

Gutreuter, S. 1988. Abundance and biomass of alligator gar in Sam Rayburn Reservoir, Texas. Texas Parks and Wildlife Department, Inland Fisheries Data Series Number 7, Austin.

Malvestuto, S. P. 1983. Sampling the recreational fishery. Pages 397–419 in L. A. Nielsen and D. L. Johnson, editors. *Fisheries Techniques*. American Fisheries Society, Bethesda, Maryland.

Mendoza, R., C. Aguilera, J. Montemayor, G. Rodriguez, and G. Marquez. 2000. Biología de los lepisosteidos y estudios orientados hacia la recuperación de las poblaciones naturales del catán (*Atractosteus spatula* Lacepede 1803). [Biology of lepisosteids and studies oriented toward the recovery of natural populations of the alligator gar *Atractosteus spatula* (Lacepede, 1803).] Pages 103–120 in P. Alvarez, M. Guzman, S. Contreras, and A. Silva, editors. *Redes nacionales de investigación en acuicultura, Memorias de la IV reunion*. [National networks for research in aquaculture, proceedings of the fourth meeting.] Secretaria de Medio Ambiente Recursos Naturales y Pesca (SEMARNAP), Instituto Nacional de la Pesca, Distrito Federal, Mexico.

Quinn, J. W. 2010. A Survey of Bowfishing Tournaments in Arkansas. *North American Journal of Fisheries Management*. 30(6):1376–1384.

Robison, H. W. and T. M. Buchanan. 1988. *Fishes of Arkansas*. University of Arkansas Press, Fayetteville, Arkansas.

Sakaris, P. C., A. M. Ferrara, K. J. Kleiner, and E. R. Irwin. 2003. Movements and home ranges of alligator gar in the Mobile-Tensaw Delta, Alabama. *Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies* 57:102–111.

Schramm Jr., H.L., and K. M. Hunt. 2007. Issues, Benefits, and Problems Associated with Fishing Tournaments in Inland Waters of the United States: A Survey of Fishery Agency Administrators. *Fisheries* 32(5):234–243.

Seidensticker, E. P. and R. A. Ott. 1988. Comparison of gill nets and jug lines for selectively harvesting large gar. *Proceedings of the Annual Conference of the Southeast Association of Fish and Wildlife Agencies* 42:229–233.

Simon, T. P. and R. Wallus. 1989. Contributions to the early life histories of gar (Actinopterygii: Lepisosteidae) in the Ohio and Tennessee River basins with emphasis on larval development. *Transactions of the Kentucky Academy of Science* 50:59–71.

Sutton, K. 1998. Gar wars: Lessons not learned. *In-Fisherman* 23:38–52.

Texas Bowfishing Association (TBA). 2010. <<http://texasbowfishingassociation.com/>>. Accessed 10 December 2010.