The Recreational Snag Fishery for Paddlefish in Cherokee Lake, Tennessee

Phillip W. Bettoli, *U.S. Geological Survey, Tennessee Cooperative Fishery Research Unit*[1]*, Box 5114, Tennessee Technological University, Cookeville, TN 38505*

Abstract: No information existed on the recreational snag fishery for paddlefish (*Polyodon spathula*) in Cherokee Lake in eastern Tennessee, purportedly the largest such fishery in the state. Therefore, a roving creel survey was conducted during the 15-day season in March 2008, 2009, and 2010. The fishery could be characterized as a a destination fishery in that 448 anglers in 239 parties drove an average of 80 km one-way (± 2.43 SE; range: 2–352) to participate. Most (67%) anglers were Tennesseans, followed by residents of Virginia (26%) and three other states. Most (80%) anglers had fished previously for paddlefish; they averaged 6.8 (± 0.3 SE) years of paddlefish snagging experience. Annual fishing pressure ranged from 1,674 to 1,838 h each year. Pooled harvest rates were low in 2008 (0.088 fish/h) and declined further in 2009 and 2010 (0.020 and 0.021 fish/h, respectively). Thus, fewer paddlefish were harvested in 2009 (41–42) and 2010 (39–60) than in 2008 (169–237). Harvested paddlefish ($n = 56$) ranged from 965 mm to 1,251 mm eye-fork length; the average length was 1,075 mm (SE = 9.6). Most (84%) anglers said they participated in the fishery primarily for its sporting aspects; 16% indicated that obtaining fish to eat was the most important reason. Only two anglers indicated that harvesting eggs was the principal reason they participated. The most common requests for changes to current regulations dealt with extending the season through the end of March, or starting the two-week season later (e.g., mid-March or early April).

Key words: paddlefish, snagging

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 65:125–130

A recreational snag fishery for paddlefish (*Polyodon spathula*) has existed in the headwaters of Cherokee Lake in eastern Tennessee for decades. Although snag fishing for paddlefish occurs sporadically in other locales throughout Tennessee, the Cherokee Lake fishery is probably the state's largest recreational snag fishery for paddlefish. Snag fisheries are popular throughout the Mississippi River basin, especially below dams on the Missouri River (Mestl and Sorenson 2009), Yellowstone River (Scarnecchia and Stewart 1997), in the Arkansas River watershed (Combs 1982), and the Grand River in Oklahoma (Gordon 2009). Much has been written about commercial paddlefish fisheries in Tennessee (e.g., Scholten and Bettoli 2005) and recreational paddlefish fisheries on the Missouri River and its tributaries (e.g., Scarnecchia et al. 1996). However, no information exists on the snag fishery for paddlefish in Cherokee Lake or anywhere else in Tennessee. The price of paddlefish roe has risen in recent years and was selling for more than $220/kg (wholesale) in Tennessee in 2008. Prosecutions of illegal commercial fishing activity targeting paddlefish for their roe have also risen in recent years (Bettoli et al. 2007). For instance, in U.S. v. Hale (113 Fed. Appx. 108, WL 2367994 [6th Cir. Oct 22, 2004]), two Tennessee wholesalers were convicted in Federal court for Lacey Act violations that included purchasing and selling eggs of paddlefish caught out of season and for falsifying records. In light of these trends, as well as the lack of targeted data on the Cherokee Lake paddlefish snag fishery, this project was undertaken.

The snag fishery for paddlefish in Cherokee Lake runs for 15 days each year (1–15 March) and there is a 762-mm eye-fork length (EFL) minimum size limit. Anglers must abide by a one-fish, no-cull regulation. An angler cannot release any legal-sized paddlefish landed (although snagged fish under the size limit must be released immediately), and the limit is only one fish per day; thus, an angler must stop fishing once a paddlefish longer than the minimum size limit is landed. Annual creel surveys on Cherokee Lake conducted by the Tennessee Wildlife Resources Agency (TWRA) do not specifically target paddlefish anglers and the fishery occurs only in a short, upstream reach of the reservoir. Thus, a traditional year-long, reservoir-wide creel survey design is unlikely to capture accurate information on fishing pressure or paddlefish harvest in Cherokee Lake. In fact, no paddlefish were observed in an annual creel survey when Cherokee Lake was surveyed by TWRA in 2008 (Pat Black, TWRA, personal communication.

The specific objectives of this study were to (1) characterize paddlefish anglers at Cherokee Lake, and (2) estimate fishing pressure and harvest.

1. The Unit is jointly supported by the U.S. Geological Survey, the Tennessee Wildlife Resources Agency, and Tennessee Technological University.

Study Area

Cherokee Lake is a Tennessee Valley Authority impoundment on the Holston River at river km 84 in east Tennessee and covers about 12,250 ha at full pool. The dam was closed in 1941 and paddlefish once occurred in high enough numbers to attract substantial commercial fishing pressure when the prices for paddlefish roe rose in the 1980s (Peterson and Alexander 1984). Water levels in this tributary storage impoundment fluctuate about 15 m between summer and winter pools. The snag fishery is restricted to the headwaters of the reservoir near the town of Rogersville, and commercial exploitation is prohibited. Paddlefish undergo an upstream spawning migration each winter and those movements render them susceptible to snagging when they congregate in the headwaters, particularly in the Horseshoe Bend reach (Figure 1). Although paddlefish can move several km upstream past Horseshoe Bend and reach the tailrace of the low-head dam at the John Sevier steam plant, the tailrace is shallow at winter pool elevations, and bank access is restricted in that uppermost reach of Cherokee Lake. Most snag fishing activity was thought to take place between access points 1 and 4 (Figure 1).

The paddlefish stock in Cherokee Lake is a closed population because there is no lock on Cherokee Dam (i.e., there is no immigration from downstream stocks) and there are no recent records of paddlefish occurring upstream of the John Sevier Dam. Peterson and Alexander (1984) concluded that the paddlefish population in Cherokee Lake suffered from chronic recruitment failure and was a remnant of the stock that once inhabited the upper Holston River system; they also called for a stocking program to maintain fishable stocks of paddlefish in the reservoir. A paddlefish stocking program subsequently commenced, and 37,250 paddlefish were stocked between 1986 and 2006. Although sizes varied, stocked paddlefish usually averaged between 250 and 300 mm EFL. The percent contribution of stocked fish is unknown but is likely quite high given the observations of Peterson and Alexander (1984). The stocking program recommenced in April 2011 when 525 advanced fingerling paddlefish were microtagged and stocked into Cherokee Lake.

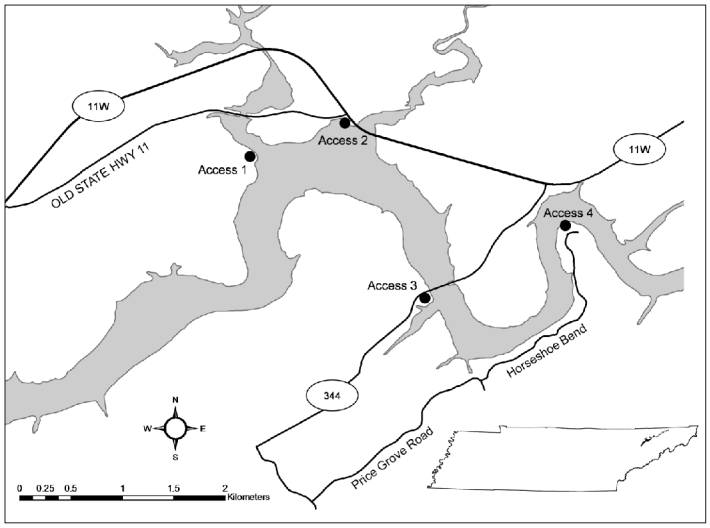

Figure 1. Map of the four access areas visited during the roving creel survey to assess the paddlefish snag fishery in the headwaters of Cherokee Lake. The Holston River flows from right to left in the figure.

Methods

Creel clerks surveyed anglers on all weekend days and 4 of the 10 weekdays during each 15-day season in 2008–2010. In 2008, two TWRA biologists participating in the snag fishery counted anglers on two other weekdays; thus, instantaneous counts were available for 6 of 10 weekdays that occurred during the 2008 season. Sampling days were divided into equal work periods based on sunrise and sunset times with equal probabilities of sampling the AM or PM work shifts. The clerk counted anglers twice each work shift. Counts were made from the road in 2008 and from a boat in 2009 and 2010. Start times for each count were randomly selected using a deck of cards from a list of possible start times for each shift, beginning at daylight (or midday) and every 30 minutes thereafter until 1 h before the end of the shift. During the instantaneous counts, the clerks would drive by road or boat to each of the four access points (Figure 1) and separately tally anglers as to whether they were fishing for paddlefish or other species. Distinguishing between paddlefish snaggers and anglers targeting other species was easy because (1) there were few other anglers at that time of year in that reach of the reservoir, (2) snaggers tended to use long, heavy-action rods, and (3) most importantly, the jerking retrieval of the weighted hooks did not resemble the fishing techniques employed for any other species in Cherokee Lake. The clerks also recorded whether paddlefish snaggers were on the bank or in boats.

When the clerks were not counting anglers, they conducted interviews. If anglers agreed to be interviewed, they were asked how long they had been fishing and whether or not they had harvested a paddlefish. Start and end times were separately recorded for individual anglers in each party. The no-cull, one-fish-per-day regulation meant that complete-trip anglers had caught either none or one paddlefish. Similarly, interviewed anglers could only offer one of two responses (and still be legal): they either caught one paddlefish (and were done fishing for the day) or they had not yet caught a paddlefish and were still in the process of fishing. Parties were also asked several questions pertaining to how far they traveled (one-way), their years of experience at snagging paddlefish, and their primary motivation for participating in the fishery. Finally,

anglers were given an opportunity to provide any comments they wished to share with TWRA managers.

Mean daily counts of all paddlefish snaggers (boat and bank anglers combined) were expanded to estimate effort in each stratum (i.e., weekday versus weekend) and then pooled to estimate effort over the entire season following the methods of Pollock et al. (1994). The mean-of-individual-ratios method was used to calculate harvest rates, which is recommended by Hoenig et al. (1997) and others for roving creel surveys. The statistical shortcomings of various catch rate estimators have been thoroughly addressed in the literature (e.g., Pollock et al. 1997), but only for "typical" fisheries. No-cull, one-fish-creel-limit fisheries (and creel surveys) are rare and it is not known whether the mean-of-ratios estimator is still the best approach to estimating harvest rates in such fisheries. Therefore, harvest rates were also calculated using the ratio-of-means approach (i.e., total hours of effort expended each day divided by total harvest that day) and separate estimates of yield were calculated and presented herein. Harvest rates were calculated for all parties that had been fishing for at least 30 minutes before being interviewed. Data from all interviews (complete and incomplete trips) were used to calculate harvest rates because too few complete-trip interviews were obtained. To estimate daily harvest on the two days in 2008 when counts were made but interviews were not collected, the harvest rate pooled over the entire season was used to estimate the numbers of paddlefish harvested those two days. Standard errors of harvest and effort each month and 90% confidence intervals were calculated according to Pollock et al. (1994). Differences among years were considered significant at $P \leq 0.10$ if 90% confidence intervals did not overlap. A one-way ANOVA model and Tukey's test ($P = 0.10$) compared the average time it took successful anglers each year to harvest a paddlefish.

Results

Angler Characteristics

Anglers targeting paddlefish were willing to travel to participate in the fishery. Four hundred and forty-eight anglers in 239 parties (mean party size = 1.87; SE = 0.07) interviewed in the three surveys drove an average of 80 km one-way (SE = 2.4; range: 2–352). Most (66.8%) anglers were from Tennessee, followed by residents of Virginia (25.8%), Kentucky (4.0%), North Carolina (1.8%), and West Virginia (1.6%). The fishery resides entirely within Hawkins County, but most of the Tennessee anglers interviewed lived in adjacent Greene (45%) and Sullivan (28%) counties. Only 17% of Tennessee residents that were interviewed lived in Hawkins County. Residents of four other east Tennessee counties (Carter, Hamblen, Unicoi, and Washington) represented the other 10% of Tennessee residents interviewed over the three fishing seasons. Most (80%) anglers had fished previously for paddlefish; those anglers averaged 6.8 (± 0.3 SE) years of paddlefish snagging experience (range: 1 to 30 years).

Table 1. Responses offered by paddlefish snaggers when asked during the creel surveys in 2008, 2009, and 2010 if they had anything they wanted to share with TWRA managers regarding the management of the paddlefish fishery in Cherokee Lake. Responses were recorded for parties (not individual anglers) and not all parties commented; some parties offered two suggestions.

Comment or suggestion	*n* Parties
Longer season	78
Delay the season (i.e., start in April)	66
Raise the creel limit	9
Stock more paddlefish	8
Remove the "no cull" regulation	6
Increase or decrease the size limit	6
More enforcement	2
Start season earlier	2
Raise out-of-state license fee	1
Lower fishing license fee	1
Total	179

When parties were asked to specify the most important motivation for them to participate in the snag fishery (given the options "for sport, meat, or eggs"), their responses were overwhelmingly (84%) in favor of the sporting aspect of the fishery. The question as posed did not allow for distinguishing between anglers wanting to catch the biggest fish of their lives (a common theme expressed during the interview), and those who were participating because of the camaraderie (another common theme) or the desire to go fishing for the sake of fishing. Anglers motivated to catch a fish to eat represented 16% of respondents, and only two anglers indicated that harvesting eggs was why they fished for paddlefish in Cherokee Lake. Conversations with anglers during the interview process revealed that motivations for fishing for paddlefish were more nuanced than simply "fishing for sport."

Angling parties provided a range of responses when asked if there was anything they wanted to share with TWRA managers (Table 1). The most common requests for changes to current regulations dealt with extending the season through the end of March or starting the two-week season in mid-March or April, ostensibly to allow snagging when the water was warmer and more fish would be upriver attempting to spawn.

Pressure and Harvest

Most paddlefish anglers were encountered at the Horseshoe Bend access area. All but six of the paddlefish anglers observed

during the 22 instantaneous counts in 2008 were fishing at Horseshoe Bend. In 2009 and 2010 only 5 and 7 paddlefish anglers, respectively, were observed fishing somewhere other than the Horseshoe Bend access area. The lack of much snagging activity at access points 1, 2, and 3 (Figure 1) in all years was apparently (according to some anglers) because snagging is not productive at those sites unless the water level is low (i.e., during a severe drought).

The clerks intercepted and interviewed 12 boat anglers (6% of all interviewed anglers) in four parties in 2008. Anglers in boats represented about 10% of all snaggers observed during the instantaneous counts in 2008 and several boat anglers indicated that they had been fishing upstream of Horseshoe Bend and out of sight of the clerks. The fact that some boat anglers were unobserved during the instantaneous counts in 2008 indicates that fishing pressure may have been underestimated. All counts were made from a boat in 2009 and 2010 to improve the accuracy of the counts and in 2009 and 2010 the clerks interviewed 23 and 17 anglers, respectively, who were fishing from boats and they represented 16% and 15%, respectively, of all anglers interviewed in those years. Most (75%) of the 239 parties interviewed over the three surveys were still engaged in fishing when intercepted (i.e., incomplete trips); only 59 parties had completed fishing when interviewed.

Fishing pressure over the three-year survey was remarkably consistent and 90% confidence intervals overlapped broadly (Table 2). Fishing pressure totaled 1,838 h in 2008 (90% confidence interval: 1,192–2,483 hours), 1,674 h in 2009 (1,017–2,332 h) and 1,705 h in 2010 (1,044–2,366 h). The time it took successful anglers to catch and harvest a paddlefish varied significantly among years (ANOVA; $P = 0.0591$) and was lowest in 2008 and 2009 (2.4 and 1.7 h, respectively) and highest in 2010 (4.0 h; Table 2). The harvest rate pooled over all anglers each season varied four-fold among years and ranged from 0.020–0.021 fish per h in 2009 and 2010 to 0.088 fish per h in 2008. Given the similarity in fishing pressure each year, the expanded estimates for the number of paddlefish harvested each year tracked harvest rates. The estimated yield was highest in 2008 (169–237 fish) and declined to fewer than 60 fish in 2009 and 2010 (Table 2). Over the three seasons, fishing pressure averaged just over 1,700 h annually and yield averaged only 83 to 113 fish (depending on which harvest rate estimator was used).

Table 2. Annual fishing pressure, yield (number of fish) calculated using two approaches to estimate harvest rates, and average time to catch and harvest a fish by successful anglers during the 15-day paddlefish snag fishery in the headwaters of Cherokee Lake, Tennessee. Ninety-percent confidence intervals or standard errors [and sample size] are in parentheses. Times not sharing a superscript letter were dissimilar (Tukey's test; $P \leq 0.10$)

Variable	2008	2009	2010
Effort (h)	1,838 (1,192–2,483)	1,674 (1,017–2,332)	1,705 (1,044–2,366)
Yield (ratio-of- means estimator)	169 (105–233)	42 (17–68)	39 (1–77)
Yield (mean-of-ratios estimator)	237 (73–400)	41 (17–64)	60 (7–113)
Average time required to harvest a fish (h)	2.4^{AB} (0.4 [30])	1.7^{A} (0.4 [10])	4.0^{B} (0.7 [10])

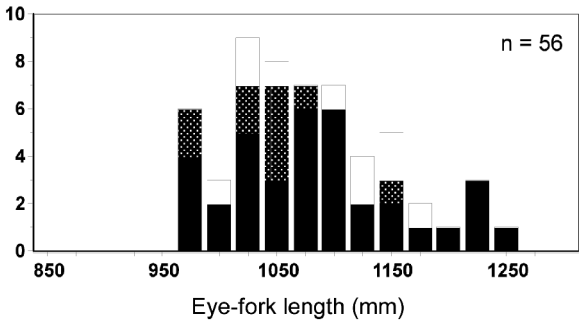

Figure 2. Frequency distribution for the lengths of paddlefish harvested by snaggers in the headwaters of Cherokee Lake, Tennessee, in 2008 (black bars), 2009 (shaded bars), and 2010 (open bars).

One party of anglers in 2008 admitted to catching and releasing "several" paddlefish of indeterminate size, which was a violation of the no-cull regulation. No anglers reported catching and releasing undersized (<762 mm EFL) paddlefish and every paddlefish observed by the clerks was a legal fish. The 56 paddlefish that clerks measured over all three surveys ranged from 965 mm to 1,251 mm EFL (Figure 2); the average harvested fish measured 1,075 mm EFL (±9.6 SE). The longest paddlefish was subsequently weighed at a local bait shop and registered 32.2 kg. The average weight of 24 paddlefish weighed by snaggers at a local bait shop (as part of a contest) in 2008 was 22.2 kg (±0.9 SE). Two mature females (i.e., "egg fish") were observed by the clerk in 2009 and they measured 1,079 and 1,156 mm EFL; the sex and reproductive state of harvested paddlefish was not recorded in 2008. In 2010 the clerks observed four mature females (of 10 fish creeled) that ranged in size from 1,111 to 1,156 mm EFL.

The headwater elevation of Cherokee Lake (where snagging occurred) was at or just above the guide curve during the 2009 and 2010 snagging seasons (average: 318 m MSL both years), but it was higher during the 2008 survey (320 m MSL) when the harvest rate and number of paddlefish harvested were the highest observed. Thus, the purported relationship between low water levels and high harvest was not observed over this three-year study. However, high harvest in 2008 coincided with the lowest flow observed in the headwaters over the three years (26 $m^3 \cdot sec^{-1}$ daily average between 1 January and 28 February measured upstream of Cherokee Lake at Fort Patrick Henry Dam). Conversely, the low harvest rates

and harvests in 2009 and 2010 coincide with high flows averaging 43 and 125 $m^3 \cdot sec^{-1}$, respectively.

Discussion

The fact that all nearly all (97%) anglers counted were observed at the Horseshoe Bend access site argues strongly for employing an access-point design in future surveys and using the ratio-of-means approach to estimate the catch rate and total harvest (Pollock et al. 1997). An access-point design will provide complete-trip interviews only (and potentially more of them), which will avoid biases often associated with incomplete-trip data (Pollock et al. 1994).

The absence of paddlefish between 762 mm EFL (the minimum size limit) and 965 mm EFL (the smallest fish observed) in the creel has several possible explanations. First, the spawning run in Cherokee Lake may be dominated by larger, mature fish. In Kentucky Lake on the lower Tennessee River, most of the mature male paddlefish made a spawning run into the riverine reach of that reservoir, as did nearly all of the mature females (Scholten and Bettoli 2005). Although immature paddlefish (especially females) may have been present in the headwaters of Cherokee Lake during the snagging season, they may have been outnumbered by larger, mature fish. This scenario was not observed in the Missouri River snag fishery below Gavins Point Dam, Iowa/Nebraska, where a large percentage (40% or more) of harvested paddlefish were age-5 or less (Mestl and Sorensen 2009). However, that system is a large, run-of-the-river impoundment and young, immature paddlefish in Cherokee Lake, a much smaller tributary reservoir, may not behave in the same way as immature paddlefish in the impounded reaches of the Missouri River. Poor recruitment to the fishable stock by age-0 paddlefish stocked up through 2006 might also account for the lack of small fish in the snag fishery, but there are no data to evaluate this possibility. Finally, no fish were stocked between 2007 and 2010, which might explain the lack of small fish in the creel in 2009 and 2010.

Out of 14 states surveyed in 2006 that managed snag fisheries for paddlefish, six allowed some catch-and-release snagging (Hansen and Paukert 2009). Paddlefish are hardy and capable of withstanding capture and handling without suffering high mortality (Kerns et al. 2010) at cool (<15 C) water temperatures, which is an important consideration if managers opt to promote more fishing pressure by allowing catch-and release. The generally cool water temperatures in eastern Tennessee in March also provide managers the opportunity to extend the season if the goal is to promote more fishing activity without risking high catch-and-release mortality. A catch-and-release approach is currently employed in the Yellowstone River (Montana), where Scarnecchia and Stewart (1997) observed low hooking mortality in that fishery which was catch-and-release during certain times and days over a six-week season. Snag fisheries for paddlefish in several rivers in Kansas are managed for catch-and-release fishing over a two-month season (15 March–15 May) with a two-fish daily creel and no size limit (KDWPT 2011). In certain waters of North Dakota, the paddlefish snagging season runs the entire month of May and anglers must follow a no-cull regulation Wednesday through Sunday each week; "snag-and-release-only" occurs on Mondays and Tuesdays (NDGFD 2010). Those North Dakota fisheries are managed with a quota and the season can end with only 36-h notice if the quota is reached; also of note, North Dakota snaggers can harvest (and tag) only one paddlefish each season.

The harvest of paddlefish in Cherokee Lake was low, averaging only 83 to 113 fish per year over the three seasons, and was likely due to the low adult density. By contrast, popular snag fisheries in some midwestern states yielded several thousand paddlefish each year (e.g., Purkett 1963, Mestl and Sorensen 2009) and catch rates can be much higher than those observed in Cherokee Lake (e.g., 0.2–0.5 fish/h in the Yellowstone River, Montana; Scarnecchia and Stewart 1997). In regulated rivers in the midwestern United States, the recreational harvest of paddlefish was often dependent on high flows during spring months (Carlson and Bonislawsky 1981). Paddlefish spawning migrations into the headwaters of a Oklahoma reservoir where they became vulnerable to snagging were linked to high river flows (Paukert and Fisher 2001); high flows also influenced the timing of paddlefish migration in the upper Missouri River (Braaten et al. 2009). Many anglers expressed the opinion that low water provided better snagging conditions given the characteristics of the habitat in upper Cherokee Lake, but as noted above, low flows may be the environmental factor that improves their success the most.

The Cherokee Lake snag fishery is the only snag fishery for paddlefish in eastern Tennessee and as such it provides a unique fishing opportunity for anglers in that region of the country, especially at a time of year when fishing for other species may be at a lull. Fishing pressure was low, as was harvest, and both will likely remain low given the short season, no-cull regulation, and the absence of a long-term stocking plan. A more detailed examination of the human dimensions of the Cherokee Lake snag fishery following the methods of Scarnecchia et al. (1996) might lend credence to the notion that simply getting outdoors with friends was a powerful motivator for participating in the fishery, which would argue for extending the season to maximize fishing opportunities. If concerns persisted that the stock might be overfished if the season is extended, a mandatory catch-and-release regulation such as the one in effect at certain times and locales on the Yellowstone River, Montana, is one approach to promoting fishing ac-

tivity while simultaneously protecting the stock from overfishing. Finally, the information presented herein may become particularly valuable if a tentative plan announced in September 2011 to allow commercial fishing for paddlefish in Cherokee Lake becomes a reality.

Acknowledgments

This work was supported in part by the Tennessee Cooperative Fishery Research Unit using funds provided by the Tennessee Wildlife Resources Agency (TWRA), the U.S. Geological Survey, and Tennessee Technological University. I thank Doug Peterson, Steve Henegar, and John Hammonds (TWRA Region IV) for their field and technical assistance during all three surveys. This report benefitted from comments made on an earlier draft by Mike Steuck, Iowa DNR, and Jeff Quinn, Arkansas Game and Fish Commission.

Literature Cited

Bettoli, P. W., G. D. Scholten, and W. C. Reeves. 2007. Protecting paddlefish from overfishing: A case history of the research and regulatory process. Fisheries 32:390–397.

Braaten, P. J., D. B. Fuller, and R. D. Lott. 2009. Spawning migrations and reproductive dynamics of paddlefish in the upper Missouri River basin, Montana and North Dakota. Pages 103–122 *in* C. P. Paukert and G. D. Scholten, editors. Paddlefish management, propagation, and conservation in the 21st Century. American Fisheries Society, Symposium 66, Bethesda, Maryland.

Carlson, D. M. and P. S. Bonislawsky. 1981. The paddlefish (*Polyodon spathula*) fisheries of the midwestern United States. Fisheries 6:17–27.

Combs, D. L. 1982. Angler exploitation of paddlefish in the Neosho River, Oklahoma. North American Journal of Fisheries Management 2:334–342.

Gordon, B. 2009. Paddlefish harvest in Oklahoma. Pages 223–233 *in* C. P. Paukert and G. D. Scholten, editors. Paddlefish management, propagation, and conservation in the 21st Century. American Fisheries Society, Symposium 66, Bethesda, Maryland.

Hansen, K. A. and C. P. Paukert. 2009. Current management of paddlefish sport fisheries. Pages 277–290 *in* C. P. Paukert and G. D. Scholten, editors. Paddlefish management, propagation, and conservation in the 21st century: building from 20 years of research and management. American Fisheries Society, Symposium 66, Bethesda, Maryland.

Hoenig, J. M., C. M. Jones, K. H. Pollock, D. S. Robson, and D. L. Wade. 1997. Calculation of catch rate and total catch in roving surveys of anglers. Biometrics 53:306–317.

KDWPT (Kansas Department of Wildlife, Parks, and Tourism) 2011. Kansas fishing regulations summary 2011. Kansas Department of Wildlife, Parks, and Tourism, Topeka.

Kerns, J. A., P. W. Bettoli, and G. D. Scholten. 2009. Mortality and movements of paddlefish released as bycatch in a commercial fishery in Kentucky Lake, Tennessee. Pages 329–343 *in* C. P. Paukert and G. D. Scholten, editors. Paddlefish management, propagation, and conservation in the 21st century: building from 20 years of research and management. American Fisheries Society, Symposium 66, Bethesda, Maryland.

Mestl, G. and J. Sorenson. 2009. Joint management of an interjurisdictional paddlefish snag fishery in the Missouri River below Gavins Point Dam, South Dakota and Nebraska. Pages 235–260 *in* C. P. Paukert and G. D. Scholten, editors. Paddlefish management, propagation, and conservation in the 21st Century. American Fisheries Society, Symposium 66, Bethesda, Maryland.

NDGFD (North Dakota Game and Fish Department) 2010. North Dakota fishing guide 2010–2012. North Dakota Game and Fish Department, Bismarck.

Paukert, C. P. and W. L. Fisher. 2001. Spring movements of paddlefish in a prairie reservoir system. Journal of Freshwater Ecology 16:113–124.

Peterson, D. C. and C. M. Alexander. 1984. An evaluation of the Cherokee Reservoir paddlefish population. Unpublished report, Tennessee Wildlife Resources Agency, Region IV, Morristown, Tennessee.

Pollock, K. H., J. M. Hoenig, C. M. Jones, D. S. Robson, and C. J. Greene. 1997. Catch rate estimation for roving and access point surveys. North American Journal of Fisheries Management 17:11–19.

———, C. M. Jones, and T. L. Brown. 1994. Angler survey methods and their applications in fisheries management. American Fisheries Society, Special Publication 25, Bethesda, Maryland.

Purkett, C. A., Jr. 1963. The paddlefish fishery of the Osage River and the Lake of the Ozarks, Missouri. Transactions of the American Fisheries Society 92:239–244.

Scarnecchia, D. L. and P. A. Stewart. 1997. Implementation and evaluation of a catch-and-release fishery for paddlefish. North American Journal of Fisheries Management 17:795–799.

———, ———, and Y. Lim. 1996. Profile of recreational paddlefish snaggers on the Lower Yellowstone River, Montana. North American Journal of Fisheries Management 16:872–879.

Scholten, G. D. and P. W. Bettoli. 2005. Population characteristics and assessment of overfishing for an exploited paddlefish population in the lower Tennessee River. Transactions of the American Fisheries Society 134:1285–1298.