Examination of Three State Records for Spotted Gar in Oklahoma

Richard A. Snow
Oklahoma Department of Wildlife Conservation, Oklahoma Fishery Research Laboratory, Norman, OK 73072

Michael J. Porta
Oklahoma Department of Wildlife Conservation, Oklahoma Fishery Research Laboratory, Norman, OK 73072

Abstract: Spotted Gar are found throughout Oklahoma and managed as a non-game species. This designation allows the species to be recreationally harvested using any legal methods. We examined three-state record (unrestricted division; harvested by bowfishing) Spotted Gars to estimate age, back calculate length-at-age (growth rates), and identify sex and stomach contents. Spotted Gars age estimates ranged from 32-43 years old. Back-calculated length-at-age displayed similar growth among the three specimens. All Spotted Gar examined were females, and contained no stomach contents. Although this study is limited in scope to the largest of Oklahoma specimens, it improves our knowledge of an understudied species in Oklahoma.

Introduction

The Spotted Gar (*Lepisosteus oculatus*) is one of four species of Lepisosteidae found in Oklahoma (Miller and Robison 2004, Frenette and Snow 2016). Lepisosteidae represents an ancient lineage of fishes that are widespread in central and eastern North America and throughout Central America (Echelle and Grande 2014, Snow et al. 2017, Davis et al. 2018). Gars are large-bodied, top-level piscivores that are important components of aquatic food webs (David et al. 2015). Historically, however, gars were viewed as nuisance species, so many aspects of their biology remain understudied (Scarnecchia 1992). Populations of several gar species have declined as a result of habitat loss or intentional removal efforts and are now in need of conservation (Scarnecchia 1992, Alfaro et al. 2008, Staton et al. 2012, NatureServe 2019). Spotted Gar, while globally secure, is a species of conservation concern at the northern edge of its range and is listed as critically imperiled in Canada (Glass et al. 2011, Staton et al. 2012, David et al. 2015, NatureServe 2019, Ontario Ministry of Natural Resources and Forestry 2016), several U.S. states (Kansas, Ohio, and Pennsylvania), and are thought to be extirpated in New Mexico (NatureServe 2019).

In Oklahoma, Spotted Gar are managed by the Oklahoma Department of Wildlife Conservation (ODWC) as a non-game fish (allowing harvest by any legal method) and currently no regulations protect this species (bag or size regulations), but populations are considered stable. The current state record Spotted Gar (and the four previous state records) was harvested via bowfishing, which is a method of take in the unrestricted division (bow and arrow, gig, spear, trotline, jug-line, limb-line) of the state record fish program (ODWC 2019). The objective of the state record fish program is to increase awareness of fishing opportunities for species that are regularly sought after and routinely found in reservoirs and rivers throughout Oklahoma.

Angler preference for gar fishing in Oklahoma has remained consistent across the last 35 years, ranking 16-20 of the most preferred species list (Jager 2016, Elizabeth York, ODWC personal communication). Although gar popularity

among anglers has stayed consistent, the state record Spotted Gar has been broken 4 times in the last 17 years (all via bowfishing), suggesting growing popularity within a specialized angling group (bow anglers). The most recent two state record Spotted Gars (held by Dustin Satton and Chasey Nease) were donated to ODWC in the last two years for research purposes. Additionally, a previous Spotted Gar state record holder (Brandon Taber) allowed examination of his taxidermy specimen and agreed to allow ODWC to remove a sagittal otolith from the mount. The objective of this paper is to examine these three-state record Spotted Gars to estimate age, back calculate length-at-age to understand growth rates, and to identify sex and stomach contents.

Methods

The most recently designated two state record Spotted Gars were donated to the Oklahoma Department of Wildlife Conservation for research purposes. These fish were brought to the Oklahoma Fishery Research Laboratory (OFRL) in Norman, Oklahoma where they were measured for total length (TL, mm) and weighed (nearest g). Sagittal otoliths were removed from each fish through the ventral side of the brain case. A third specimen (harvested by Brandon Taber in 2003) in the form of a taxidermy mount, was brought to the OFRL for otolith removal. A hole was drilled into the non-viewed side of the taxidermy mount and one sagittal otolith was removed. Otoliths were cleaned and dried before processing.

Otoliths were processed following methods in Buckmeier et al (2018), where otoliths were ground in a plane transverse to the nucleus using a rotary tool fixed with a grinding bit (#85422, Dremel, Racine WI). The rotary tool was attached to a table, and forceps coated in Tool Dip (Plasti Dip International, Blaine MN) were used to securely hold the posterior portion of the otolith during the grinding process. Sagittal otoliths were ground on a plane perpendicular to the anterior–posterior axis. Otoliths were then polished using wet 2000 grit sand paper. Prepared otoliths were stood polished-side up in a dish containing modeling clay, immersed in water, and viewed with a variable-power stereomicroscope (capable of 130× magnification) using a fiber-optic filament attached to an external light source.

Otolith annuli were defined as the distal edge of the opaque zones, because these margins appear as very bright fractures when illuminated with intense light from a fiber-optic filament (Buckmeier et al. 2012, Buckmeier et al 2018). Age estimates were performed independently by two readers experienced with gar otoliths and who had no knowledge of the other's age estimates or specific information about the fish (length or weight) being examined. If the two readers did not agree on an age estimate, the readers viewed the otolith together and determined a final consensus age. Once age estimates were finalized, the Dahl-Lea method was used to back-calculate length-at-ages (mm) for each fish (Quist et al 2012).

To determine sex, pruning shears were used to cut the ventral side of the fish from the vent to the isthmus exposing the internal organs. Once exposed, sex was determined by examining the gamete release pathways following a standardized procedure for determining sex in Lepisosteids (Ferrara and Irwin 2001). After sex was determined, the stomach was extracted, and stomach contents removed. On the third specimen that was mounted a stomach sample was not taken during harvest or observed.

Results & Discussion

Ages estimated from the Spotted Gars in this evaluation ranged from 32-43 years old (sagittal otoliths; Table 1, Figure 1), considerably higher longevity than what has been reported in the literature. Buckmeier et al. (2018) reported Spotted Gars up to age 27 (sagittal otoliths) from two Texas reservoirs. Similarly, King et al. (2018) found Spotted Gar that reach age 24 (sagittal otoliths) from twelve Illinois water bodies. Prior to these studies, the previous maximum known age of Spotted Gar was 18 years (COSEWIC 2005). Similarly, Redmond (1964) estimate ages of Spotted

Table 1. Information from state record Spotted Gar harvested in Oklahoma.

Angler	Lake Harvested	Date	Age (yrs)	Weight (g)	TL (mm)	Girth (mm)	Sex	Method of Take
Dale Starry	Lake Arbuckle	4/28/2002	N/A	3,230	946	298	N/A	Bow and Arrow
Brandon Taber	Lake Arbuckle	3/15/2003	39	4,136	972	349	F	Bow and Arrow
Jimmy Nelson	Lake Arbuckle	4/19/2008	N/A	4,141	946	394	N/A	Bow and Arrow
Chasey Nease	Lake Texoma	4/21/2016	32	4,595	968	394	F	Bow and Arrow
Dustin Satton	Lake Arbuckle	5/11/2018	43	5,171	1029	349	F	Bow and Arrow

Gar to 18 years old using brachiostegal ray. Using three structures (otoliths, pectoral ray, and branchiostegal rays), Glass et al. (2011) estimated the maximum age of Spotted Gar to be 14 years old. Frenette and Snow (2016) found Spotted Gar in Lake Thunderbird, Oklahoma up to age 12 (sagittal otoliths), but this population may have recently become established. The longevity of Spotted Gars from estuarine populations appears shorter (6-10 years) than those from reservoir populations (branchiostegal rays; Love 2004, Smith 2006). Differences in maximum age estimates in these studies may be due to the aging structure (otoliths, spines, fin rays, and branchiostegal rays) that was used or the aging technique, which can result in varying age estimation precision.

Figure 1. Photograph of a sectioned sagittal otolith from the current state record Spotted Gar (age 43) harvested on 11 May 2018. Age reference points indicate years.

Spotted Gars have been found to grow rapidly during their first year of life (Matthews et al. 2012, David et al. 2015, Frenette and Snow 2016). Back-calculated Spotted Gar lengths were similar for the three Spotted Gars evaluated in this study. Back-calculated lengths-at-age suggest that the three Spotted Gar in this study grew to 38% of their TL in the first year and 81% of their TL by age 6, although growth plateaued after age 16 (Figure 2). Similarly, Frenette and Snow (2016) found Spotted Gar grew to half of their maximum TL in the first year and approached maximum TL by age 4.

Gars are known to be sexually dimorphic in body size, with females being larger, on average, than males (Love 2002, McGrath and Hilton 2012, McDonald et al. 2013). Frenette and Snow (2016) found female Spotted Gars were larger than males in Thunderbird Reservoir, Oklahoma. The three Spotted Gars in this study were determined to be female. However, only the 2016 and 2018 state record fish were dissected to visually examine sex. The gar harvested in 2003 was not dissected, but the angler described grayish, egg-like objects falling from the fish through the exit wound of the arrow on the ventral side of the fish. This account accurately describes the gametes in mature female Spotted Gar. Based on their size, it is likely that the two Spotted Gar records that were not examined (Table 1) are also female, as this species is sexually dimorphic (Love 2002, McGrath and Hilton 2012, McDonald et al. 2013). Of the two Spotted Gars observed for diet, both had empty stomachs. However, this is not surprising as

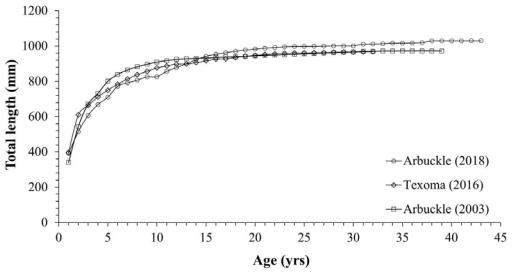

Figure 2. Back-calculated total length-at-age (mm) for three state record Spotted Gar harvested in Oklahoma.

both fish were harvested during the expected spawning time of Spotted Gar (April-June in Oklahoma; Tyler and Granger 1984, Miller and Robinson 2004, Frenette and Snow 2016). Tyler and Granger (1984) found that 82% (of 172 Spotted Gar evaluated for diets) were empty, suggesting that foraging slows or ceases during the spawning period.

Spotted Gars in this study were all large, mature females that may be very important to these populations. In general, older and larger females are more fecund, and produce larger, higher quality eggs and larvae that have a greater potential to survive compared to those that smaller females produce (Daugherty et al. 2019), which could be important for population sustainability. On the whole, little is known about Spotted Gar populations in Oklahoma, however evaluations like this improve our knowledge of this species, and provide ODWC with data and results to better manage the species. Further, increased efforts to understand population dynamics of this species in Oklahoma waters are underway.

Although this study is limited in nature, it does document considerably higher longevity than previously described for Spotted Gars. Additionally, observation of the largest recorded specimens in Oklahoma is rare. Biologists with ODWC were privileged that anglers enabled us to examine these specimens for further evaluation. Findings reported in this study demonstrate the ability of Spotted Gar to grow rapidly and live up to 43 years old. Furthermore, they provided information to develop a better understanding of Spotted Gar natural history and assist with conservation and management of this species.

Acknowledgments

The authors thank Chasy Nease and Dustin Satton for their willingness to donate their Spotted Gar state records to ODWC. The authors also thank Brandon Taber for allowing otolith removal from his mounted Spotted Gar. A special thanks to Cliff Sager from the southcentral region office for collection of information and storage of the Spotted Gar donated by Chasey Nease. We thank Kurt Kuklinski (ODWC) and Dr. James Long (OSU) for reviewing an earlier draft of this manuscript. Additionally, comments provided by Dr. Mostafa Elshahed and anonymous reviewers greatly improved this manuscript. Financial support was provided by the U.S. Fish and Wildlife Service Sportfish Restoration grant F-86-D-1and F-66-D-8 to the Oklahoma Department of Wildlife Conservation.

References

Alfaro, R., C. Aguilera, and A. Ferrara. 2008. Gar biology and culture: status and prospects. Aquac. Res. 39:748-763.

Buckmeier, D. L., N. G. Smith, and K. S. Reeves. 2012. Utility of Alligator Gar age estimates from otoliths, pectoral fin rays, and scales. T. Am. Fish. Soc. 141:1510–1519.

Buckmeier, D. L., R. Snow, N. G. Smith, and C. Porter. 2018. Are age estimates for Longnose Gar and Spotted Gar accurate? An evaluation of sagittal otoliths, pectoral fin rays, and branchiostegal rays. T. Am. Fish. Soc. 147:639–648.

COSEWIC 2005. COSEWIC assessment and update status report on the spotted gar *Lepisosteus oculatus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. www.sararegistry.gc.ca/status/status_e.cfm

Daugherty, D. J., D. L. Buckmeier, and N. G. Smith. 2019. Sex-specific dynamic rates in the Alligator Gar: Implications for stock assessment and management. N. Am. J. Fish. Manage. 39:535-542.

David, S. R., R. S. Kik IV, J. S. Diana, E. S. Rutherford, and M. J. Wiley. 2015. Evidence of counter gradient variation in growth of Spotted Gars from core and peripheral populations. T. Am. Fish. Soc. 144:837-850.

David, S. R., S. M. King, and J. A. Stein. 2018. Introduction to a special section: angling for dinosaurs—status and future study of the ecology, conservation, and management of ancient fishes. T. Am. Fish. Soc. 147:623–625.

Echelle, A. A., and L. Grande. 2014. Lepisosteidae: Gars, Pages 243-278 in: North American Freshwater Fishes: Natural History, Ecology, and Conservation. M. L. Warren, Jr. and B. M. Burr, editors. Johns Hopkins University Press, Baltimore, Maryland.

Frenette, B. D., and R. A. Snow. 2016. Natural habitat conditions in captive environment lead to spawning of Spotted Gar. T. Am. Fish. Soc. 145:835-838.

Frenette, B. D., and R. A. Snow. 2016. Age and size of Spotted Gar (*Lepisosteus oculatus*) from Lake Thunderbird Reservoir in Central Oklahoma. Proc. Okla. Acad. Sci. 96:46-52.

Ferrara, A. M., and Irwin E. R. 2001. A standardized procedure for internal sex identification in Lepisosteidae. N. Am. J. Fish. Manage. 21:956-961.

Glass, W. R., L. D. Corkum, and N. E. Mandrak. 2011. Pectoral fin ray aging: an evaluation of a nonlethal method for aging and its application to a population of the threatened Spotted Gar. Environ. Biol. Fish. 90:235-242.

Jager, C. A. 2015. 2014 angler opinion survey. Oklahoma Department of Wildlife Conservation, Oklahoma City, OK. Page 17-18.

King, S. M., S. R. David, and J. A. Stein. 2018. Relative bias and precision of age estimates among calcified structures of Spotted Gar, Shortnose Gar, and Longnose Gar. T. Am. Fish. Soc. 147:626-638.

Love, J. W. 2002. Sexual dimorphism in spotted gar *Lepisosteus oculatus* from southeastern Louisiana. Am. Mid. Nat. 147: 393- 399.

Love, J. W. 2004. Age, growth, and reproduction of spotted gar, *Lepisosteus oculatus* (Lepisosteidae), from the Lake Pontchartrain Estuary, Louisiana. Southwest. Nat. 49:18-23.

Matthews WJ, Shelton WL, Marsh-Matthews E. 2012. First-year growth of Longnose Gar (*Lepisosteus osseus*) from zygote to autumn juvenile. Southwest. Nat. 57:335-337.

McDonald DL, Anderson JD, Hurley C, Bumguardner BW, Robertson CR. 2013. Sexual dimorphism in Alligator Gar. N. Am. J. Fish. Manage. 33:811-816.

McGrath PE, Hilton EJ. 2012. Sexual dimorphism in Longnose Gar *Lepisosteus osseus*. J Fish Biol 80:335-345.

Merrit, R. W., K. W. Cummins, and M. B. Berg. 2008. An introduction to the aquatic insects of North America. Kendall Hunt Publishing Company, Dubuque, IA.

Miller, R. J. and H. W. Robison. 2004. Fishes of Oklahoma. University of Oklahoma Press, Norman, Oklahoma.

NatureServe. 2019. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: September 10, 2019)

Oklahoma Department of Wildlife Conservation (ODWC). 2019. Oklahoma fishing 2019 – 2020 official regulation guide.

Ontario Ministry of Natural Resources and Forestry. 2016. Recovery strategy for the Spotted Gar *Lepisosteus oculatus* in Ontario. Pages 11-14. Ontario recovery strategy series. Ontario Ministry of Natural Resources and Forestry, Peterborough, Ontario.

Quist, M. C., M. A. Pegg, and D. R. Devries. 2012. Age and growth. pp. 677-731 in Zale, A.V., Parrish, D.L. and Sutton, T.M. (eds.), Fisheries Techniques, third edition. American Fisheries Society, Bethesda, Maryland.

Scarnecchia, D. L. 1992. A reappraisal of gars and bowfins in fishery management. Fisheries 17:6–12.

Smith, O. A. 2006. Reproductive potential and life history of spotted gar, *Lepisosteus oculatus*, in the upper Barataria Estuary, Louisiana. Master's thesis, Nicholls State University, Thibodaux, LA.

Snow, R. A., J. M. Long, and B. D. Frenette. 2017. Validation of daily increments periodicity in otoliths of Spotted Gar. J. Annu. Southeast. Assoc. Fish. Wildl. Agencies 4:60-65.

Staton, S.K, A. L. Boyko, S. E. Dunn, and M. Burridge. 2012. Recovery strategy for the Spotted Gar (*Lepsisosteus oculatus*) in Canada (Proposed). Fisheries and Oceans Canada, Species at Risk Act Recovery Strategy Series, Ottawa.

Tyler, J. D., and M. N. Granger. 1984. Notes on food habits, size and spawning behavior of Spotted Gar in Lake Lawtonka, Oklahoma. Proc. Okla. Acad. Sci. 64:8-10.

Submitted October 11, 2019 Accepted November 3, 2019