Life History and Status of Alligator Gar *Atractosteus spatula,* with Recommendations for Management

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Alligator gar *Atractosteus spatula* is the largest freshwater fish in Texas and one of the largest species in North America, yet has received little attention from anglers or fisheries managers. Although gars (family Lepisosteidae) have long been considered a threat to sport fishes in the United States (summarized by Scarnecchia 1992), attitudes are changing. Recreational fisheries for alligator gar are increasing, and anglers from around the world now travel to Texas for the opportunity to catch a trophy. Because little data exist, it is unknown how current exploitation is affecting size structure and abundance of alligator gar in Texas. In many areas, alligator gar populations are declining (Robinson and Buchanan 1988; Etnier and Starnes 1993; Pflieger 1997; Ferrara 2001). Concerns by biologists and anglers about alligator gar populations in Texas have led the Texas Parks and Wildlife Department (TPWD) to consider management options for this species. In addition to this review, the TPWD has recently initiated several studies to learn more about Texas alligator gar populations. The purposes of this document are to 1) summarize alligator gar life history and ecology, 2) assess alligator gar status and management activities throughout their range, and 3) make recommendations for future alligator gar management in Texas.

Life History

In the United States, alligator gar spawn from April through June (Etnier and Starnes 1993; Ferrara 2001), coinciding with seasonal flooding of bottomland swamps (Suttkus 1963). Documented reports of alligator gar spawning are limited, though it is thought to occur in flooded backwater areas (Mendoza Alfaro et al. 2008). Spawning was recently observed in a shallow, vegetated-backwater area of Lake Texoma, Oklahoma. Snedden et al. (1999) found that lateral spawning migrations of spotted gar *Lepisosteus oculatus* onto floodplain areas were correlated with increased river stage and increased temperature. Because spawning is likely

linked to seasonal flooding, successful recruitment may be infrequent. Fecundity of alligator gar is highly variable, with means of 157,000 eggs per female and 4.1 eggs/g body weight (Ferrara 2001).

Juvenile alligator gar likely remain in backwater spawning areas as they develop. Sakaris et al. (2003) reported that tagged juvenile alligator gar demonstrated strong site fidelity to protected backwater areas and remained near their site of capture (thought to be a spawning area), whereas adults were more mobile. Robertson et al. (2008) also captured juvenile alligator gar from backwater oxbow habitats, whereas adults were collected in the river channel. Ferrara (2001) hypothesized that juvenile alligator gar utilize shallow embayments and tributaries, and suggested that identification and protection of such nursery areas may be critical to the recovery of alligator gar populations in areas with limited nursery habitats.

Young alligator gar apparently grow very fast; in Sam Rayburn Reservoir, Texas, fish thought to be young-of-year in 1965 averaged 1.1 kg by July 30 and 2.9 kg by October 6 (Toole 1971). Growth of older fish is much slower, taking about 10 years to attain a total length of 1 m and 30 or more years to reach a length of 2 m (Figure 1). Alligator gar mature between 950 and 1,400 mm total length (at age 10-14), with males maturing earlier than females (Ferrara 2001; Garcia de Leon et al. 2001). Although young fish grow fast, alligator gar are believed to be long-lived. Ferrara (2001) estimated annual survival of adult alligator gar exceeded 90% and found fish up to age 50 in an Alabama population receiving little harvest. However, maximum age of a heavily-exploited population in Lake Pontchartrain, Louisiana was only 28 years. Maximum age of alligator gar in Lake Texoma, Oklahoma, was recently estimated to be greater than 30 years (E. Brinkman, Oklahoma State University, personal communication). Length-

weight relationships for male and female alligator gar are similar ($\log_{10} W = 3.176 \log_{10} L - 2.540$; Garcia de Leon et al. 2001).

Relative to other gar species, alligator gar have the greatest capacity to overcome complete or partial year-class failures because they mature at the oldest age, are the most fecund, and have the highest adult survival (Ferrara 2001). However, low intrinsic rates of population increase indicate alligator gar are vulnerable to over-exploitation. Marine researchers have recommended setting the target levels of exploitation at < 10% for species similar to alligator gar that are long-lived and have very low rates of natural mortality (Walters and Pearse 1996; Codling et al. 2005). Ferrara (2001) postulated that mid-size adult alligator gar had the greatest influence on population growth rate and should be protected; limited harvest of older fish (> 25 years) did not cause population growth rates to decline substantially. Occupation of shallow spawning areas makes alligator gar highly vulnerable to sight fishing techniques such as bow fishing during spring and early summer. Male alligator gar may be especially vulnerable, because it is thought that they remain in the spawning area for extended periods (Suttkus 1963; Garcia de Leon et al. 2001).

Little is known about alligator gar movement and habitat use. Sakaris et al. (2003) conducted the first published telemetry study of alligator gar in the Mobile-Tensaw Delta, Alabama, and found the home ranges of alligator gar were 2.7-12.3 km. However, they observed individuals moving as much as 2.1 km in 1.25 hours, suggesting substantial movements can occur. It is likely that many coastal river populations of alligator gar use both freshwater and saltwater habitats (Goodyear 1967). In Texas, alligator gar are routinely captured in estuarine habitats, especially from salinities ≤ 20 ppt (unpublished data, TPWD Coastal Fisheries).

Sakaris et al. (2003) also reported that movement may increase with fish size, and possibly be linked to spawning migrations.

Historically, most alligator gar research has focused on diet due to concerns about their possible consumption of sport fishes. Alligator gar are considered opportunists and scavengers; in most studies, food items have been predominately forage fishes, although sport fish species are represented where abundant (Bonham 1941; Goodyear 1967; Toole 1971; Seidensticker 1987; Garcia de Leon et al. 2001). Additionally, items such as invertebrates, birds, and fishing tackle frequently have been found in the stomachs of alligator gar (Goodyear 1967; Seidensticker 1987). Food items in adult alligator gar tend to be large (> 20 cm; Goodyear 1967; Seidensticker 1987). Primary forage of young-of-year alligator gar in Sam Rayburn was young gizzard shad (Toole 1971).

Population Status and Management

Alligator gar populations are believed to be declining throughout much of their historical range (Robinson and Buchanan 1988; Etnier and Starnes 1993; Pflieger 1997), which included the Mississippi River system, as well as coastal rivers of the Gulf of Mexico from Florida to northern Mexico (Lee et al. 1980). Although the severity of these declines is unknown, habitat alteration and over-exploitation are thought to be partially responsible (Ferrara 2001). Because information about alligator gar life history and population status is very limited, the Conservation Committee of the American Society of Ichthyologists and Herpetologists and the Endangered Species Committee of the American Fisheries Society have asked states to assess remaining populations and evaluate potential threats from habitat loss and overfishing. Similarly the Southern Division of the American Fisheries Society recently formed a technical committee to facilitate information exchange about alligator gar.

Of the 14 states once inhabited by alligator gar, six consider them to be extremely rare or extirpated (Table 1). In most of these states, alligator gar are not managed; however, Tennessee is now restocking fish and does not allow harvest. Five additional states (i.e., Alabama, Arkansas, Florida, Mississippi, and Oklahoma) have enacted daily creel regulations from 0-2 fish/day (Table 1). In addition to daily creel regulations, Oklahoma has also closed a known spawning area to alligator gar fishing during the spawning season. Several states have stocked or are considering stocking alligator gar. Currently three fish hatcheries (Private John Allen National Fish Hatchery, Tupelo, Mississippi; Tishomingo National Fish Hatchery, Tishomingo, Oklahoma; and Aquaculture Center 'Tancol', Tampico, Tamaulipas, Mexico) are producing young alligator gar to supplement wild populations.

Alligator gar are found in rivers, reservoirs, and estuaries throughout Texas. Little is known of population status since investigations have been limited to food habit studies (Bonham 1941; Toole 1971; Seidensticker 1987). Gutreuter (1988) attempted to estimate abundance and biomass of alligator gar in Sam Rayburn Reservoir, but was unsuccessful. Recently, several new alligator gar research projects have been initiated in Texas. These projects include: 1) a mark-recapture study of alligator gar in Lake Livingston and the upper Trinity River, 2) an investigation of seasonal movement and habitat use by alligator gar in the lower Trinity River, and 3) an evaluation of genetic variability of alligator gar collected from coastal bays and inland rivers of the state.

Although no data exist, angling activity for alligator gar in Texas, especially by bow anglers, is believed to have increased in recent years. In 2007, commercial angling for alligator gar was limited to 13 permitted fishermen; most reported harvesting 1,000 lbs or less. It is unknown how many alligator gar are taken by non-permitted or recreational anglers. Locally,

gar flesh is popular and valuable. In a recent article, "Gar in the Pan" by Keith Sutton, the author notes that alligator gar sold for $3 per pound and was more popular than catfish in a local fish market in Arkansas. In northern Mexico, alligator gar are highly valued as a food fish (Garcia de Leon et al. 2001). Many anglers are concerned about potential increases in exploitation, and some have requested that the TPWD enact restrictive harvest regulations for alligator gar (www.petitiononline.com/texasgar/petition.html).

Alligator gar habitats in Texas have been significantly altered in the past century. Although effects are unknown, factors such as fragmentation of river-floodplain corridors, impoundments, channelization, wetland loss, and urbanization have likely impacted alligator gar populations. Remaining alligator gar populations will likely be threatened as the population of Texas expands and water demands increase. Increasing demands for land and water will further reduce wetlands and river flows, thus reducing connectivity of river channels to backwater spawning and nursery areas. Reduced river flows will also affect estuarine habitats by increasing salinities. Additionally, many remaining alligator gar populations are at risk because they are located near large metropolitan areas where impacts will be greatest (e.g. populations of the Trinity River).

Recommendations

In Texas, increased fishing pressure for alligator gar and future degradation of river and estuarine habitats potentially threaten existing alligator gar populations. Observed declines in other states and vulnerability to overfishing indicate a conservative approach is warranted until populations and potential threats can be fully assessed. It is recommended that the TPWD join other states in managing alligator gar populations by significantly reducing harvest and protecting spawning and nursery areas. A management strategy that emphasizes protection of

adult fish, while allowing some harvest of juvenile with more limited harvest of trophy fish seems most appropriate for the goal of ensuring population stability while allowing utilization of the resource. Because alligator gar inhabit, and likely migrate between inland and coastal waters, management needs to span both environments. The TPWD should also work to prevent further habitat degradation. Specifically, it will be necessary to maintain the periodicity of flood pulses that connect river channel habitats to backwater areas to ensure alligator gar recruitment. Maintenance of river flows will also be critical to the preservation of estuarine habitats used by alligator gar. The TPWD will need to assess alligator gar populations and evaluate potential threats as soon as is feasible. Data describing basic population rates (i.e., growth, recruitment, and mortality) will be critical to population assessments, as will the identification of critical habitat needs and information about seasonal movements. Data describing the commercial and recreational fishery, as well as data projecting future river flows will be needed to assess potential threats to alligator gar populations.

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Table 1. Regulations and status of alligator gar by state from a 2008 survey of state fisheries agencies (R. Neumann and A. Ferrara, unpublished data.

State	Recreational and Commercial Regulations	Status	Activities
AL	1 fish/day; no commercial fishery	Unknown	Drafting management plan
AR	2 fish/day; no commercial fishery	Unknown	Recently stocked, drafting management plan
FL	No harvest allowed	Declining	
GA	Not mentioned in regulations	Unknown, likely very rare	
IL	No regulations	Likely extirpated	May reintroduce in future
IN	No regulations	Likely extirpated	
KY	No regulations	"Species of concern", likely extirpated	
LA	No regulations, although gill nets restricted to < 3-inch mesh in some areas; Sabine NWR restricts gear and season	Unknown, not uncommon	Considering regulation, initiating research
MO	50 fish/day; no commercial regulations other than restricted area	Unknown	Recently stocked and currently evaluating
MS	2 fish/day recreational or commercial; some areas closed to commercial harvest	Unknown	
OH	No regulations	Rare, possibly extirpated	
OK	1 fish/day, upper Lake Texoma closed during spawning (01/2009); no commercial fishery	Unknown, not uncommon	Drafting management plan, on-going research
TN	No harvest allowed	"In need of management", possibly was extirpated	Recently reintroduced, completed management plan, initiating research
TX	No regulations, commercial harvest limited to set lines	Unknown, not uncommon	On-going research

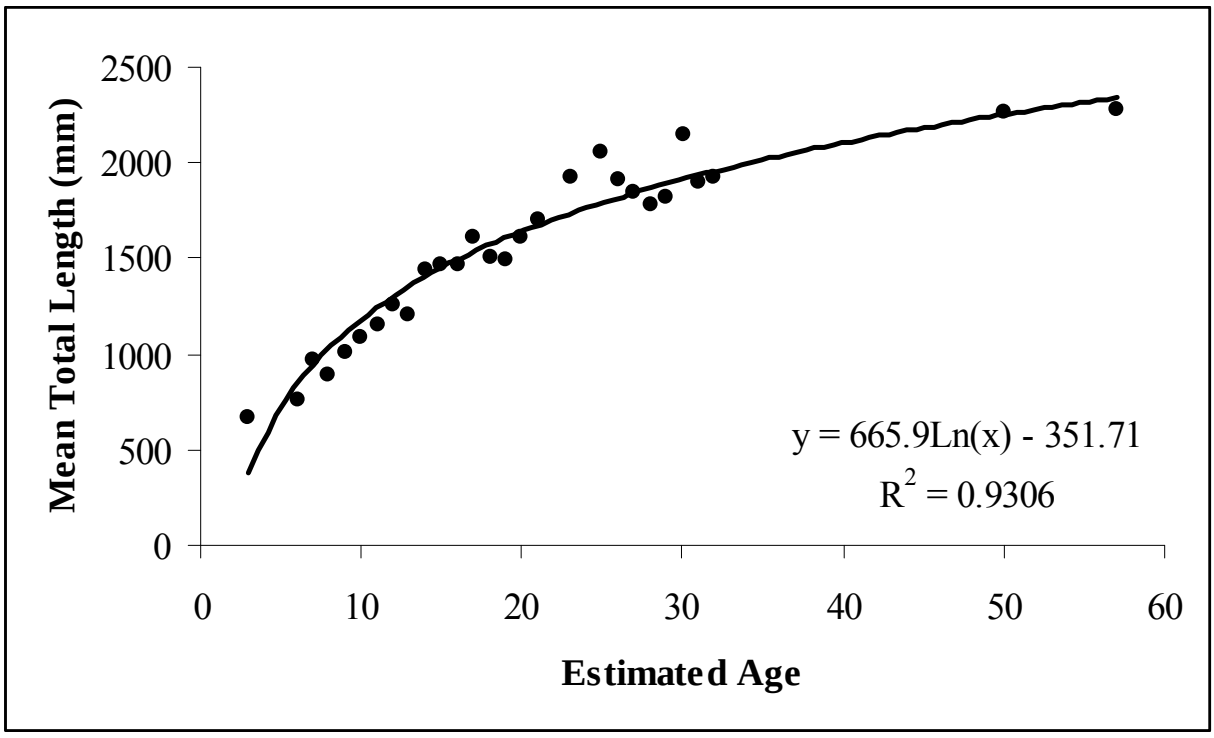

Figure 1. Estimated mean total length (mm) at age of alligator gar (collected from Alabama, Louisiana, Mississippi, and Texas; A. Ferrara, unpublished data).