LIFE HISTORY CHARACTERISTICS OF ALLIGATOR GAR *ATRACTOSTEUS SPATULA* IN THE BAYOU DULARGE AREA OF SOUTHCENTRAL LOUISIANA

A Thesis

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Kayla C. DiBenedetto
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ABSTRACT

The alligator gar *Atractosteus spatula* is a large, long-lived, physostomous fish that inhabits aquatic habitats throughout the central U.S., ranging from Oklahoma southward to the Gulf of Mexico. Unfortunately, the alligator gar has declined significantly in abundance throughout much of its historic range and is now considered vulnerable to localized extirpation. The goal of this study was to provide basic data on the ecology and life history of a commercially-exploited alligator gar population in south Louisiana. This study also focused on age determination and alternate aging techniques such as sectioned otoliths and sectioned scales. From 10 April 2007 through 21 May 2008, alligator gar were collected with jug lines from Bayou DuLarge and surrounding areas with the aid of a local commercial fisher. A total of 203 male, 125 female and 1 unsexed alligator gar were collected. Sex ratio was approximately 1:1 for catch by month. Overall, female alligator gar were longer, heavier, and had larger girths than males. Alligator gar predominately fed on fishes (34%), although crustaceans (4%) and non-food items (5%) were also found. Based on gonadosomatic index values, spawning occurred from March through May. Gar ages ranged from 1 to 26 years with a mean age of 5 years for males based on sectioned otoliths (N = 194) and sectioned scales (N = 144). Mean age for females based on sectioned otoliths (N = 122) was 5.5 years, and 5.8 years based on sectioned scales (N = 71). In my sample, it appeared male and female alligator gar matured by age 5. The growth rate (k value from von Bertalanffy growth equation) was 0.323 ± 0.017, and annual survival from a catch curve was estimated to be 79.9% (Z = 0.225). Sectioned otoliths yielded the highest precision between readers (0.46, Average Percent Error) and presented fewer complications during age

determination as compared to sectioned scales. Life history and age information from this study will aid with understanding the complex and variable nature of the Bayou DuLarge alligator gar population and will be useful to agencies in the development of future management programs for this unique species.

INTRODUCTION

The alligator gar, *Atractosteus spatula*, is one of three *Atractosteus* species in the family Lepisosteidae. The family Lepisosteidae includes the alligator gar, Cuban gar *A. tristoechus*, tropical gar *A. tropicus*, spotted gar *Lepisosteus oculatus*, longnose gar *L. osseus*, shortnose gar *L. platostomus*, and Florida gar *L. platyrhincus* (Wiley 1976; Gilbert and Williams 2002). The Lepisosteidae is an ancient group of fishes that has existed since the Cretaceous period approximately 180 million years ago (Rayner 1941; Wiley 1976). Gars possess several characteristics that have been advantageous to their survival, including rapid juvenile growth (Toole 1971; Mendoza et al. 2002) and thick, interlocking ganoid scales that reduce predatory mortality (Gilbert and Williams 2002). They also have a physostomous and highly vascularized swim bladder that allows them to breathe air and live in hypoxic water that can be fatal to other fish species (Potter 1927; Eddy 1957; McCormack 1967; Hill et al. 1972). Interestingly, gars are the only freshwater fishes of North America that have been reported to have toxic eggs (Brooks 1851; Goodger and Burns 1980).

Historically, the alligator gar was the apex predator (O'Connell et al. 2007) in aquatic habitats throughout the central U.S., ranging from Ohio southward through the states of Alabama, Arkansas, Florida, Illinois, Indiana, Kentucky, Louisiana, Missouri, Mississippi, Ohio, Oklahoma, Tennessee, and Texas (Goodyear 1966; Lee et al. 1980; Robinson and Buchanan 1988; Gilbert 1992). Unfortunately, the alligator gar has declined significantly in abundance (Robinson and Buchanan 1988; Etnier and Starnes 1993; Pflieger 1997; Ferrara 2001; Figure 1) and is now considered vulnerable to extirpation throughout much of its native range (Warren at al. 2000; Jelks et al. 2008). Several authors have cited habitat alteration and overexploitation as the most important factors in the pervasive decline in alligator gar abundance (Robinson and Buchanan 1988; Simon and Wallus 1989; Etnier and Starnes 1993; Metee at al. 1996; Warren et al. 2000; Ferrara 2001; Jelks et al. 2008), but a thorough assessment of alligator gar status has been hindered by a lack of life history information and coordinated studies of population trends. The Conservation Committee of the American Society of Ichthyologists and Herpetologists and the Endangered Species Committee of the American Fisheries Society have requested that states conduct assessments of alligator gar populations and evaluate possible threats due to habitat loss and overfishing (Buckmeier 2008). Consequently, an alligator gar technical committee was formed in 2008 in conjunction with the Southern Division of the American Fisheries Society to provide a network for fisheries professionals to collaborate and exchange information on the management and conservation of this unique fish.

Recent concerns for the health of alligator gar populations is in distinct contrast to past management recommendations. Gar have traditionally been considered nuisance or trash fish that were destructive predators of sport fish populations (Caldwell 1913; Richardson 1914; Gowanloch 1939; Scarnecchia 1992), and many programs were implemented throughout the middle of the 20th century to reduce or totally eradicate gar populations (Burr 1931; Gowanloch 1940; Williamson 1951; Menees 1957; Johnston 1961; MacKay 1963; Seidensticker and Ott 1989). However, the majority of diet studies have shown that although they will ingest sportfishes, alligator gar are opportunistic piscivores that predominately forage on abundant non-sport species (Bonham 1941;

Garcia de Leon et al. 2001), as well as invertebrates, birds, fishing tackle, and even boat engine parts (Raney 1942; Goodyear 1967; Seidensticker 1987).

In recent years, the perception of alligator gar has changed from a vilified trash fish to a highly valued sport and food fish (Sutton 1998). Bowfishing and hook and line anglers consider large alligator gar to be trophy fish, and it is believed that angling activity specifically targeting gar has increased in recent years (Ferrara 2001; Buckmeier 2008). The mean commercial harvest of alligator gar in Louisiana from 1999 through 2006 was 523,617 pounds/year and the 2003 commercial fisheries landings for gars (alligator gar, longnose gar, shortnose gar, and spotted gar combined) was valued at greater than $515,000 (LDWF 2005, Shanks 2007). Cleaned alligator gar from the dock to the market sell for $1.25 – 2.00/ pound depending on the time of year (R. Verrett, Commercial Fisherman, personal communication). In Baton Rouge, at the local seafood market, gar filets sell for $2.99/ pound. According to the Louisiana Seafood Promotion and Marketing Board, alligator gar are in high demand where they are marketed in central and north Louisiana, but the highest commercial harvests occur in brackish-water bays along the coast. Gar flesh is also marketed in smoked form, patties, and fish balls (Hoese and Moore 1998; LSPMB 2004; A. Ferrara, Nicholls State University, personal communication), and the diamond shape ganoid scales, once used by Native Americans as arrowheads and to make jewelry (Scarnecchia 1992), can easily be found today for sale via the internet as a popular hobby craft item for about three dollars for fifty dyed scales.

Given the potential for increased exploitation of alligator gar in the near future, concerns have been raised about the need for restrictive harvest regulations. Effective 1

September 2009 Texas Parks and Wildlife Department will implement a one fish per day bag limit for alligator gar for both recreational and commercial fishers (TPWD 2009), and all states except Louisiana that have extant populations of alligator gar also have some type of restrictive harvest regulations: Alabama (1/day); Arkansas (2/day); Florida (harvest prohibited), Mississippi (2/day); and Oklahoma (1/day). The state of Louisiana has no bag limit, size limit, commercial license limitations or closed season regulations (Ferrara 2001; Layher et al. 2008; TPWD 2009; USFWS 2009), and although the population status of alligator gar in Louisiana is considered secure, a comprehensive status assessment is needed (NatureServe 2009; USFWS 2009).

In addition to increased fishing pressures, alligator gar spawning habitat has been significantly altered over the past century. Levee construction has disconnected rivers from floodplain and backwater spawning areas and has likely hindered reproductive success (Simmon and Wallus 1989; Etnier and Starnes 1993; Boschung and Mayden 2004). Alligator gar appear to spawn from April to June in Louisiana (Suttkus 1963; an unconfirmed report from fisherman of an observed fall spawning in October has been documented, USFWS 2009), but it has been suggested that alligator may not spawn successfully on an annual basis in some systems (Brinkman 2008), which could cause significant fluctuations in effective population size across years. The alligator gar is a long lived fish (>50 years is not uncommon) that exhibits late sexual maturity at total lengths of 950 mm for males and 1,400 mm for females and ages of 10-14 for females and 6 years of age for males (Ferrara 2001; Garcia de Leon et al. 2001). The limited knowledge of basic life history characteristics, coupled with habitat loss, and fishing pressure expose the alligator gar to continued population declines, potentially even in Louisiana, and raises several potential research issues.

Given the uncertainty concerning the status of alligator gar throughout its range, and the apparent health of Louisiana populations, I developed this study to provide basic data on the ecology and life history of a commercially-exploited alligator gar population in south Louisiana. Specifically, my objectives were to: 1) determine the age structure, growth rate, seasonal condition, and mortality rate of male and female alligator gar; 2) compare the precision of ages determined from non-lethal (sectioned scales) and lethal (sectioned otoliths) aging methods; 3) investigate time of spawning and age and length at maturation; and 4) document the frequency of occurrence of food items in alligator gar stomachs. It is anticipated that these data will provide basic life history information that will be an important part of future alligator gar management plans developed by Louisiana and surrounding states.

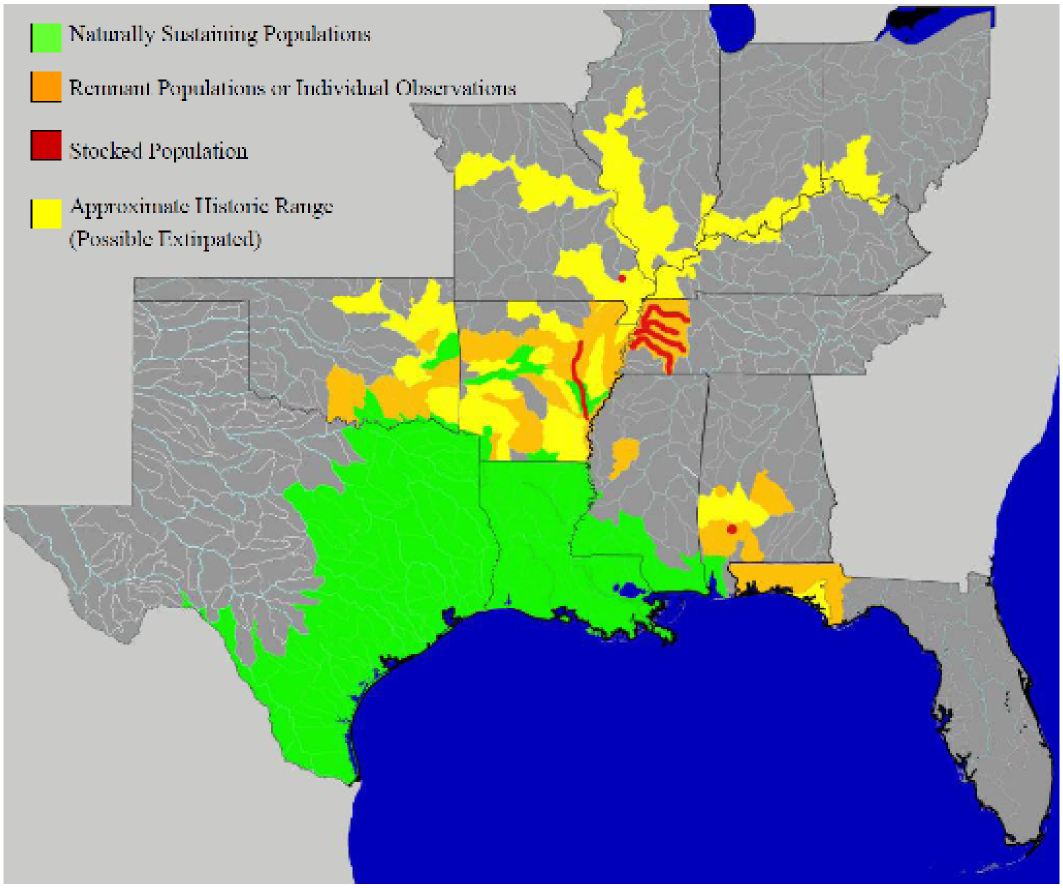

Figure 1. Historic and current distributions of alligator gar (USFWS 2009).

METHODS

Study Site

Alligator gar were collected from various sites within the lower Terrebonne estuary in southeastern Louisiana. The Terrebonne estuary includes several distinct aquatic habitat types, including lakes, swamps, marshes, and bayous, most of which have been altered structurally and hydrologically by canals, levees, pipelines, roads, navigation channels, and marsh management structures (Simon and Ensminger 1993). Alligator gar collected in this study were taken from Bayou DuLarge (N 29° 15’09.0” W -91° 00’07.3”, about 50 km south of Thibodaux, Louisiana) and surrounding areas of coastal brackish marsh in Terrebonne Parish (Figure 2). Salinities in this area ranged from 10 - 32 PSU. Most of the surrounding land was dominated by perennial grasses such as smooth cordgrass, *Spartina alterniflora,* and marsh hay cordgrass, *S. patens,* with some areas bordered by cypress, *Taxodium distichum*, swamp (Simon and Ensminger 1993; Michot et al. 2004). Bayou DuLarge was selected as a study site due to the abundance of alligator gar in the area and the availability of a local commercial alligator gar fisherman to help with fish collections.

Field Methods

I sampled alligator gar that were collected from 10 April 2007 to 21 May 2008 by Rickey Verrett, a commercial fisherman in the Bayou DuLarge area. Gar were collected with jug lines, which consisted of flotation jugs fitted with string and metal lead line attached to a hook (Seidensticker and Ott 1989; Figure 3). Jug lines were baited with whole striped mullet *Mugil cephalus* about 20 cm in length or larger, set in the afternoon, and retrieved starting at 0600 the next morning. For each collected alligator gar, I

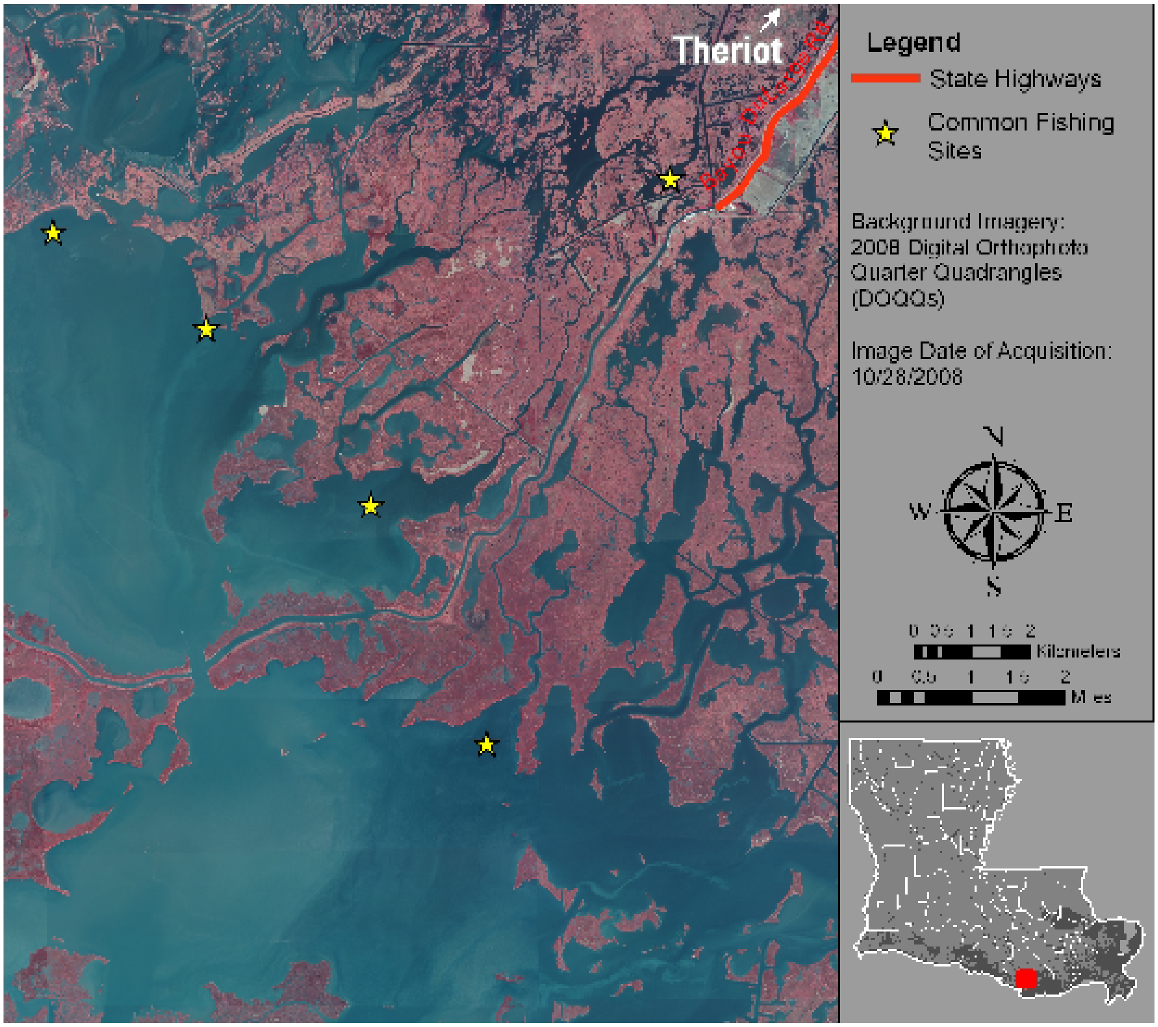

Figure 2. Location of Bayou DuLarge and surrounding area in southeastern Louisiana. Bayou DuLarge road is shown in red and potential fishing sites are represented by yellow stars.

measured total length (mm) and pre-pelvic girth (above pelvic fins; mm) with a flexible quilters tape. Weight was determined with a mechanical hanging dial scale and was recorded to the nearest kilogram due to the large size of some of the adult fish. After taking the measurements and weight of each fish, I removed the stomach, gonads, head, and several scales (nonspecific location on body), labeled each sample, preserved them on ice, and transported them to the laboratory where they were processed immediately.

Figure 3. Alligator gar captured with a floater used by commercial fisherman Rickey Verrett on 29 April 2008.

Laboratory Methods

Fish Metrics and Tissue Collection. Sex of all specimens was determined by inspection of the gonads (Ferrara and Irwin 2001), which were then weighed to the nearest gram to determine the gonadosomatic index (GSI; Snyder 1983):

GSI = (gonad weight) / (total body weight) x 100.

Sagittal otoliths were removed from the otic capsules at the base of the skull (DeVries and Frie 1996), cleaned, dried, and placed in dry labeled vials for future sectioning. Scales were cleaned, returned to the labeled field collection bag, and frozen. Prior to sectioning, scales (~ 5 per fish) were defrosted and placed in a small nylon mesh bag along with an etched metal tag (identification number), with the bag securely closed with a twist tie. Scales were then boiled in water for approximately 15-30 minutes to loosen the hard epidermis and organic material, the latter of which was removed by hand to expose the white enamel of the scale. Scales were returned to a dry, labeled bag for storage prior to sectioning, with unprocessed scales refrozen for future use.

Food items in gar stomachs were removed, identified to family, and grouped as fish, crustaceans, other, and empty (Echelle 1968; May and Echelle 1968). It was also noted if parasites such as nematodes (roundworm) or cestodes (tapeworm) were present or absent. Although not part of this study, I also removed fin clips from the majority of alligator gar collected during the study, which were subsequently labeled and sent for genetic analysis (University of Southern Mississippi, Brian Kreiser; TPWD, Bill Karel). Also, brains of several gar were removed, labeled and sent to Mexico for pituitary gland research (Universidad Autónoma de Nuevo León, Roberto Mendoza). Histology samples of gonads were also collected and frozen for preliminary investigation of alligator gar gonad development (Nicholls State University, Allyse Ferrara).

<u>Age Determination.</u> Whole otoliths have been used to age alligator gar (Ferrara 2001), but comparison studies with other species (Ihde and Chittenden 2002, Sipe and Chittenden 2002, Buckmeier and Howells 2003) indicate that otolith sections produce higher and more accurate age estimates than surface views. I sectioned otoliths and

scales with a Hillquist Model 800 thin-sectioning saw equipped with a diamond embedded wafering blade and a precision grinder following the protocol used by Cowan et al. (1995). Otolith (316) and scale (215) sections of individual alligator gar were examined for annuli independently by two different readers without knowledge of fish length, weight, or sex, and were assigned an age (DeVries and Frie 1996). A dissecting microscope with transmitted light and polarized light filter was used to examine otolith and scale sections (Fischer et al. 2002) at 20x to 64x magnification (Fischer et al. 2004). All sectioned otoliths and scales were examined a second time by both readers blindly and assigned a second age. Sectioned otolith and scale ages that were not consistent were inspected a third time by both readers until an agreed-upon (final) age was assigned. If both readers could not come to an agreement, an age was not assigned to that fish. Precision of otolith and scale section age determinations were based on Beamish and Fournier's (1981) 'average percent error' (APE) index. Precision only describes the reproducibility of, or consistency among, age determinations, not the accuracy of the age estimates. Accuracy can not be determined at this point because age validation is not yet possible due to the lack of known age fish. Average percent error is an index that represents greater precision as APE is minimized (Beamish and Fournier 1981). The initial APE was calculated for individual readers (KCD or AJF) for single structures (sectioned otolith or sectioned scale) based on the first and second readings. The second reading compared to the final or agreed-upon reading was used to determine the final APE. I also calculated APE to compare readers (KCD and AJF) for each structure (sectioned otoliths or sectioned scales) for the first, second, and final reads independently. Lastly, APE was calculated to compare structure (sectioned otoliths and sectioned scales) age estimates by individual readers (KCD or AJF) for first and second readings and then a final APE calculated for the agreed-upon age estimates of sectioned otoliths compared to the agreed-upon age estimates for sectioned scales. I calculated instantaneous mortality (Z) for alligator gar over age 4 (sexes combined) with a catch curve, regressing the $\log_e$ of the total number of individuals at each age (dependent variable) against age (independent variable).

Statistical Analyses. Means, medians and standard errors (SE) of total length (TL), girth, weight, gonad weight, and age from sectioned otoliths and scales were calculated for males and females. Sex-specific differences in age frequency were examined with a Chi-square test (PROC FREQ, SAS vers. 9.2, SAS Institute, Cary, NC). Length frequency plots ($\log_{10}$-transformed) were generated for males and females separately, and length-weight regressions ($\log_{10}$-transformed) were generated for males and females separately, as well as for both species combined because there were no significant differences in the length-weight relationship by sex. I calculated Le Cren's (1951) relative condition factor, K_n = (W/Ws) X 100, where W is observed weight and Ws is the standard weight determined from the length-weight regression for all individuals. I then used an analysis of covariance (sex as the covariate) to determine if fish condition varied by sex and season [spring (February through June) or fall (July through November)] (PROC MIXED, SAS vers. 9.2, SAS Institute, Cary, NC). Separate analyses of variance (ANOVA) followed by Tukey's *post hoc* comparisons were used to determine sex-related differences in TL, girth, and weight (PROC MIXED, SAS vers. 9.2, SAS Institute, Cary, NC). I plotted mean length-at-age for both sexes and used a two-way analysis of covariance (ANCOVA) followed by a Tukey-Kramer adjusted *post-*

hoc test to determine if growth rates differed by sex (PROC MIXED, SAS vers. 9.2, SAS Institute, Cary, NC). I also constructed a von Bertalanffy growth curve for female alligator gar (PROC NLIN, SAS vers. 9.2, SAS Institute, Cary, NC). Model outputs included the maximum theoretical length (L_∞), growth coefficient (K), and the curve-fitting constant t_o.

Mean GSI was plotted separately for males and females by each month to identify the spawning season. GSI was transformed by the natural log to better approximate normally distributed error, and ages were grouped into three categories; juvenile (1-3), intermediate (4-9), and old (>10). I used an analysis of covariance (ANCOVA) followed by Tukey-Kramer *post hoc* tests (PROC MIXED, SAS vers. 9.2, SAS Institute, Cary, NC) to determine if there was a difference in GSI by sex, month, and age group.

RESULTS

Length and Weight

I collected data from 329 alligator gar caught in the commercial harvest from the Bayou DuLarge area from April 2007 to May 2008. I took a total of 23 sampling trips, with fish collected in all months except December, January, and June. Overall, I collected more males (N = 203) than females (N = 125), with the sex of one individual undetermined (Table 1). Females were generally larger and heavier than males, although mean pelvic girth was similar between the two sexes (Table 1). Mean gonad weight was also similar between males and females, but as expected, maximum gonad size of gravid females was almost seven times that found for males collected during the spawning period. There was a trend of more males in the collections during February, March, April, and May, with the reverse from July through November, although these sex ratios were not were not significantly different from 1:1 (X^2, $_{7\text{d.f.}}$ = 22.15, $P = 0.09$; Figure 4).

Gar total lengths ranged from 665 to 2120 mm, with females exhibiting a larger range of lengths than males; all fish over 1500 mm were female (Figure 5). For age classes in which both sexes were collected, the mean size of females was consistently longer than males, with significant between-sex length differences for age classes 5, 6, 8, and 9 (ANOVA, $F_{1,312} = 22.79$, $P < 0.01$; Table 2). Similar to the length data, female girth and weight was consistently greater than same-age males, with significantly greater female girth in age classes 5, 6, and 8 (ANOVA, $F_{11,287} = 5.25$, $P < 0.01$; Table 3) and significantly greater female weight in age class 5, 6, 8, 9, 10, and 11 (ANOVA, $F_{11,287} = 11.37$, $P < 0.01$; Table 4).

The length-weight relationships for male and female alligator gar were $\log_{10} W = -5.3823 + 3.0435 \log_{10} L$ (N=203, r^2 =0.89) and $\log_{10} W = -5.606 + 3.1104 \log_{10} L$ (N=125, r^2 =0.96). However, ANCOVA revealed that the slopes of the length-weight relationships for males and females were not significantly different, and the data were combined to determine a single length-weight relationship for this population (Figure 6). Although there were no significant differences in K_n between male and female alligator gar (P = 0.29), gar were significantly heavier for a given length during the spring spawning season (P = 0.0001).

Food Habits

A total of 100 (41%) alligator gar had food items in their stomachs, whereas 144 (57%) were empty (Figure 7). Most of the alligator gar that contained food had consumed fish (34%; Figure 8), primarily mullet (Table 5), although crustaceans were also found in nine stomachs. A total of 12 (5%) fish had other items in their stomach, which included vegetation, bones, stones, plastic objects, hooks, and fishing line (Table 5). During investigation of gut contents, I found tapeworms and roundworms in 46 (18.4%) and 3 (1.2%) alligator gar, respectively.

Spawning and GSI

Mean GSI by month for male alligator gar exhibited a peak in April, a decline through August, and an increase through fall (Figure 8). Although females showed substantially more variability in GSI than males, they followed a similar annual pattern (Figure 9). Based on these data, it appears that spawning occurred from March through May.

Table 1. Number (N), mean (± SD), range, and median of total length, pre-pelvic girth, weight, total gonad weight, and age from sectioned otoliths and scales for male and female alligator gar collected from 10 April 2007 to 21 May 2008, in the Bayou DuLarge area.

Variable	N	Mean ± SD	Range	Median
Males				
Total length (mm)	203	1,106 ± 152	665 - 1,495	1,095
Pre-pelvic girth (mm)	203	451 ± 66	245 - 590	410
Weight (kg)	203	8 ± 4	2 - 20	7
Gonad weight (g)	201	305 ± 225	2 - 1,511	267
Otolith age (years)	194	5 ± 2.6	1 - 16	4.5
Scale age (years)	144	5 ± 2.4	2 - 15	5
Females				
Total length (mm)	125	1,247 ± 277	785 - 2,120	1,200
Pre-pelvic girth (mm)	125	467 ± 118	265 - 950	450
Weight (kg)	125	12 ± 9	2 - 68	9
Gonad weight (g)	122	505 ± 1,226	3 - 10,250	44
Otolith age (years)	122	5.5 ± 3.6	2 - 26	4
Scale age (years)	71	5.8 ± 3.2	2 - 23	5

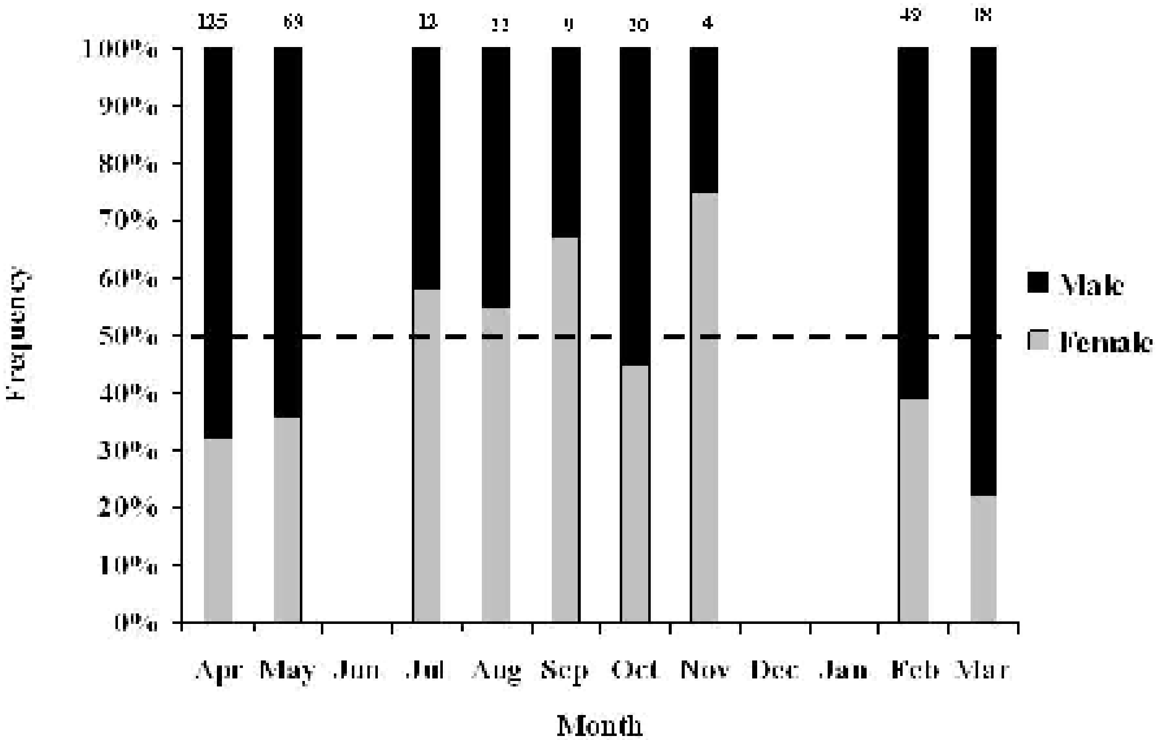

Figure 4. Percent of monthly catch of male (N =203) and female (N =125) alligator gar collected from 10 April 2007 to 21 May 2008, in the Bayou DuLarge area. No fish were collected in June, December, or January. Numbers above columns indicate the number of fish collected each month.

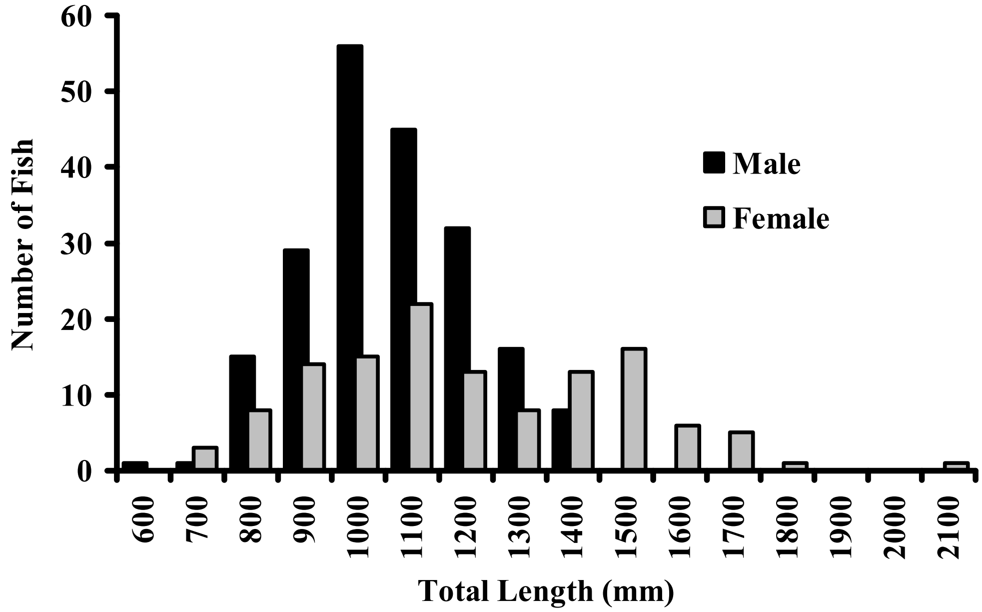

Figure 5. Total length frequency distributions of male (N = 203) and female (N = 125) alligator gar collected from 10 April 2007 to 21 May 2008, in the Bayou DuLarge area.

Table 2. Mean (± SD) and range (below mean) for length (mm) of male (N = 189) and female (N = 118) alligator gar for each age class in which both sexes were collected from 10 April 2007 to 21 May 2008, in the Bayou DuLarge area. Statistically significant differences between the sexes are marked with an asterisk and are in bold.

Age (Years)	Male N	Male Mean ± SE (Range)	Female N	Female Mean ± SE (Range)
2	16	941 ± 82 (810 - 1,100)	11	1,005 ± 78 (835 - 1,125)
3	54	1033 ± 100 (665 - 1,190)	35	1,044 ± 159 (785 - 1,370)
4	26	1028 ± 111 (815 - 1,200)	22	1,107 ± 153 (785 - 1,420)
5*	**38**	**1133 ± 117 (840 - 1,340)**	**8**	**1,349 ± 140 (1,110 - 1,510)**
6*	**13**	**1103 ± 132 (895 - 1,320)**	**11**	**1,323 ± 143 (1,100 - 1,500)**
7	17	1183 ± 108 (990 - 1,360)	5	1,286 ± 154 (1,125 - 1,500)
8*	**9**	**1217 ± 137 (975 - 1,360)**	**9**	**1,532 ± 104 (1,365 - 1,755)**
9*	**9**	**1323 ± 78 (1,210 - 1,450)**	**8**	**1,587 ± 121 (1,405 - 1,750)**
10	3	1,300 ± 38 (1,265 - 1,340)	3	1,582 ± 43 (1,550 - 1,630)
11	2	1,350 ± 78 (1,295 - 1,405)	2	1,723 ± 60 (1,680 - 1,765)
12	1	1,260	3	1,557 ± 25 (1,530 - 1,580)
15	1	1,475	1	1,790

Table 3. Mean (± SD) and range (below mean) for pre-pelvic girth (mm) of male (N = 189) and female (N = 118) alligator gar for each age class in which both sexes were collected from 10 April 2007 to 21 May 2008, in the Bayou DuLarge area. Statistically significant differences between the sexes are marked with an asterisk and are in bold.

Age (Years)	Male N	Male Mean ± SE (Range)	Female N	Female Mean ± SE (Range)
2	16	340 ± 41 (275 - 415)	11	363 ± 37 (300 - 410)
3	54	378 ± 38 (245 - 450)	35	381 ± 63 (265 - 510)
4	26	383 ± 45 (300 - 455)	22	403 ± 59 (285 - 510)
5*	**38**	**431 ± 56 (290 - 560)**	**8**	**522 ± 54 (440 - 610)**
6*	**13**	**422 ± 41 (355 - 485)**	**11**	**497 ± 49 (420 - 575)**
7	17	463 ± 40 (370 - 520)	5	494 ± 38 (455 - 555)
8*	**9**	**453 ± 44 (390 - 530)**	**9**	**597 ± 48 (520 - 700)**
9	9	505 ± 46 (450 - 580)	8	591 ± 43 (535 - 640)
10	3	513 ± 42 (480 - 560)	3	608 ± 18 (590 - 625)
11	2	533 ± 32 (510 - 555)	2	657 ± 66 (610 - 704)
12	1	490	3	615 ± 18 (600 - 635)
15	1	555	1	670

Table 4. Mean (± SD) and range (below mean) for weight (kg) of male (N = 189) and female (N = 118) alligator gar for each age class in which both sexes were collected from 10 April 2007 to 21 May 2008, in the Bayou DuLarge area. Statistically significant differences between the sexes are marked with an asterisk and are in bold.

Age (Years)	Male N	Male Mean ± SE (Range)	Female N	Female Mean ± SE (Range)
2	16	5 ± 1 (3 - 8)	11	5 ± 1 (3 - 7)
3	54	6 ± 2 (2 - 11)	35	6 ± 3 (2 - 14)
4	26	6 ± 2 (3 - 10)	22	8 ± 3 (2 - 15)
5*	**38**	**9 ± 3 (2 - 14)**	**8**	**14 ± 4 (8 - 22)**
6*	**13**	**8 ± 3 (4 - 11)**	**11**	**13 ± 4 (8 - 19)**
7	17	10 ± 2 (6 - 14)	5	12 ± 3 (8 - 16)
8*	**9**	**10 ± 3 (7 - 14)**	**9**	**21 ± 5 (15 - 33)**
9*	**9**	**14 ± 3 (10 - 19)**	**8**	**22 ± 5 (14 - 28)**
10*	**3**	**11 ± 1 (13 - 15)**	**3**	**23 ± 2 (20 - 24)**
11*	**2**	**15 ± 2 (14 - 17)**	**2**	**28 ± 4 (25 - 31)**
12	1	11	3	23 ± 1 (22 - 24)
15	1	19	1	31

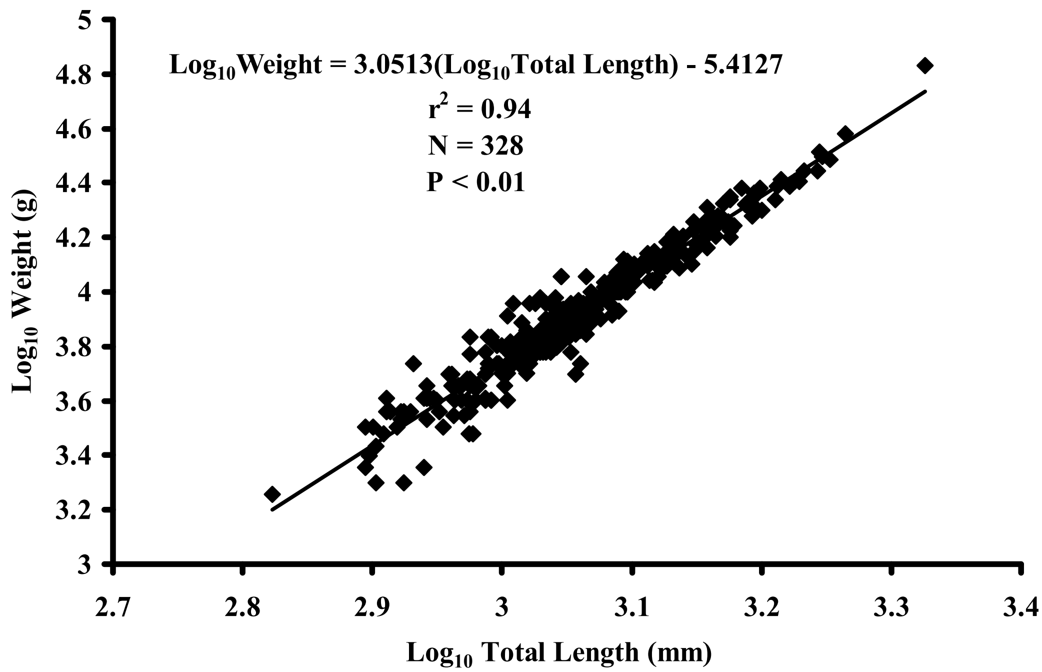

Figure 6. Relationship between $\log_{10}$ weight and $\log_{10}$ total length for male and female alligator gar collected from 10 April 2007 to 21 May 2008, in the Bayou DuLarge area.

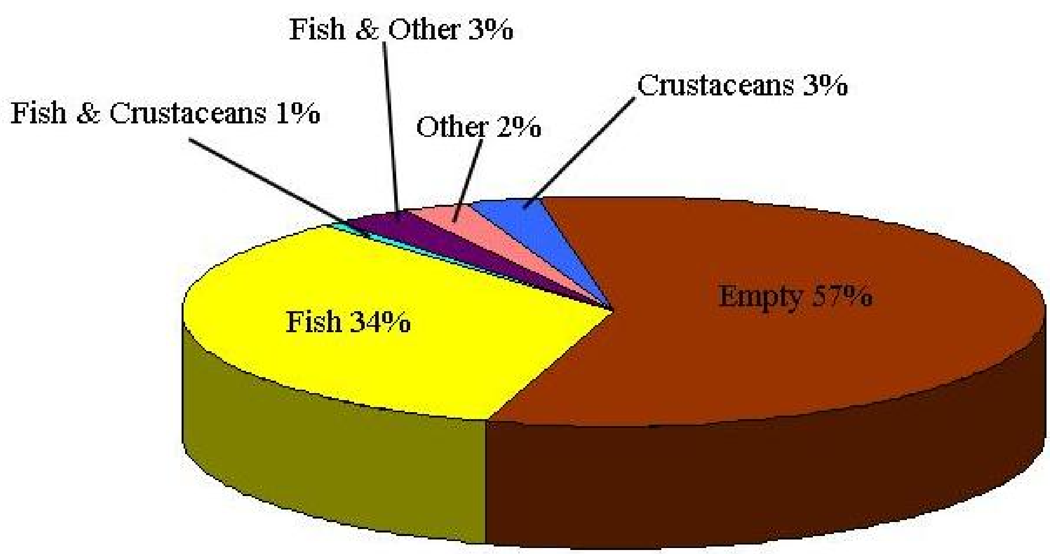

Figure 7. Stomach contents of alligator gar collected from 11 July 2007 to 21 May 2008, in the Bayou DuLarge area.

Table 5. Alligator gar stomach contents of fish, crustaceans, other, and unidentifiable (Unid) collected with floaters from 11 July 2007 to 21 May 2008 in the Bayou DuLarge area.

Category	N	% Total
Crustaceans		
Penaeidae	1	0.4
Portunidae	5	2
Unid	1	0.4
Fish		
Mugilidae	30	12
Centrarchidae	3	1.2
Sciaenidae	4	1.6
Ictaluridae	2	0.8
Sparidae	1	0.4
Mugilidae & Clupeidae	1	0.4
Mugilidae & Sciaenidae	1	0.4
Unid	42	16.8
Other		
Stone	1	0.4
Bone	1	0.4
Vegetation	2	0.8
Foreign Object	1	0.4
Unid	1	0.4
Fish & Crustaceans		
Portunidae & Ariidae	1	0.4
Portunidae & Mugilidae	1	0.4
Fish & Other		
Centrarchidae & Vegetation & Unid	1	0.4
Mugilidae & Vegetation & Unid	1	0.4
Mugilidae & Vegetation & Nail	1	0.4
Mugilidae & Sciaenidae & Hook & Line	1	0.4
Unid & Hook	1	0.4
Unid & Foreign body	1	0.4
Unid & Vegetation	1	0.4
Empty	144	57.6

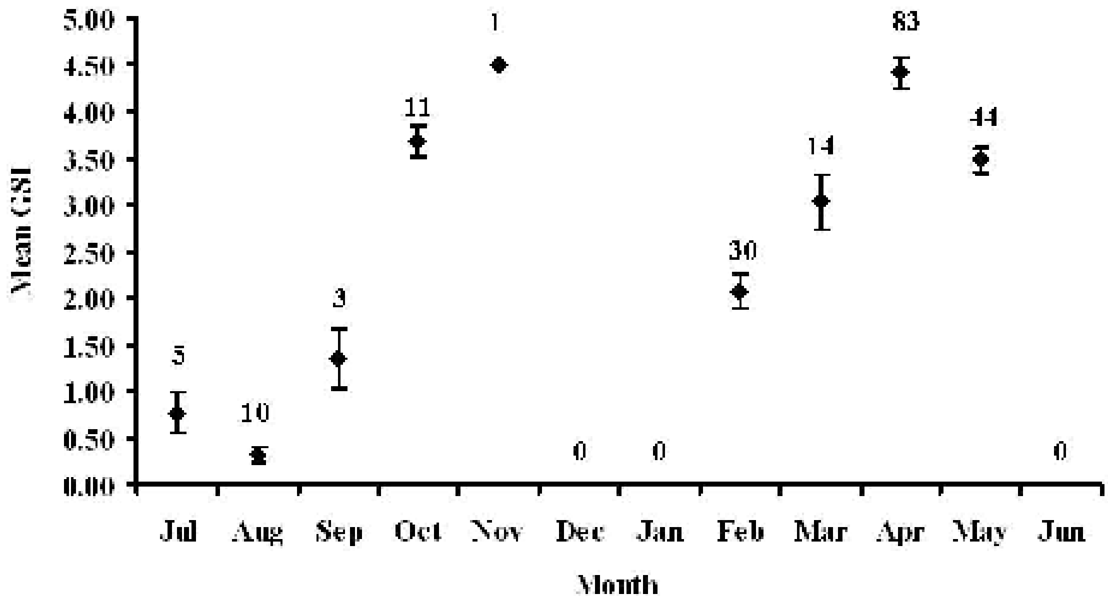

Figure 8. Mean (± SE) gonadosomatic index (GSI) by month sampled for male alligator gar (N = 201) collected from 11 July 2007 to 21 May 2008, in the Bayou DuLarge area. No fish were collected in January, June and December.

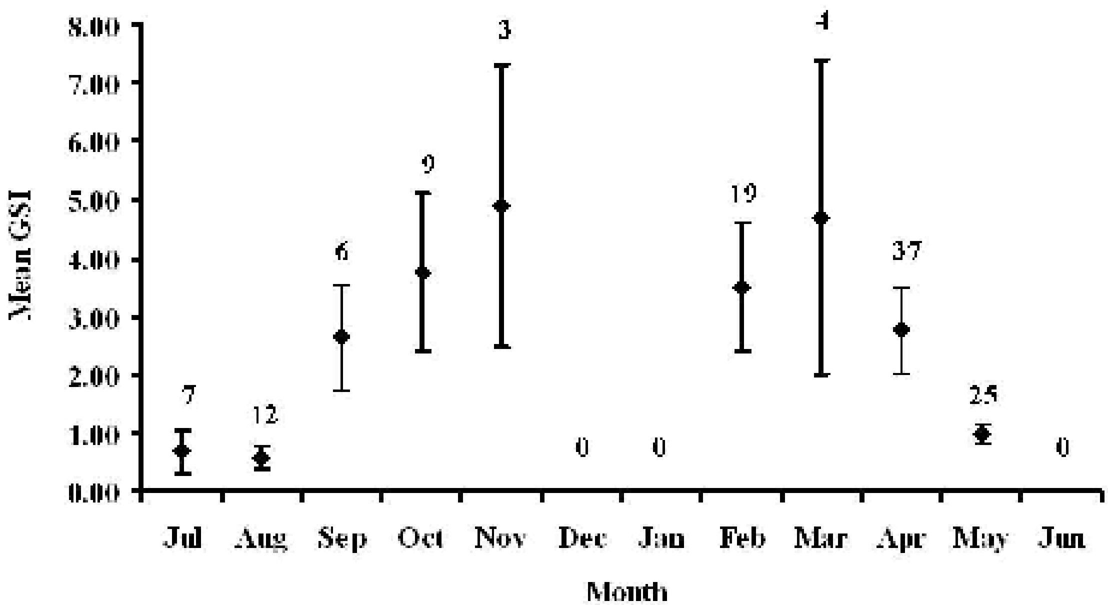

Figure 9. Mean (± SE) gonadosomatic index (GSI) by month sampled for female alligator gar (N = 122) collected from 11 July 2007 to 21 May 2008, in the Bayou DuLarge area. No fish were collected in January, June and December.

GSI by Age Group. Although analyses of GSI were complicated because the number of fish captured varied by age, it appeared that female GSI patterns varied by age / size of the fish, so I grouped gar into juvenile (ages 1-3), intermediate (ages 4-9), and old (ages 10 and above) age classes for further analysis of GSI patterns. Overall, GSI differed among months (ANCOVA, $F_{27,73} = 4.13$, $P < 0.01$), but not for all age groups. Tukey-Kramer *post hoc* tests revealed in October old and juvenile age groups showed significant differences, in February and May old individuals exhibited significantly higher GSIs than intermediate and juvenile ages, and in April all three age groups showed significant differences in GSI ($P < 0.5$; Figure 10).

Age

Alligator gar ages determined from 317 sectioned otoliths and 215 sectioned scales indicated that collected individuals ranged from 1 to 26 years of age, with the majority of individuals between ages 3 and 6 (Figure 11). Age frequency distributions were significantly different for males and females (X^2, $_{16\ d.f.} = 26.63$, $P = 0.4706$), but were similar for sectioned otoliths and sectioned scales (Figure 11; Figure 12). Age 3-5 males and females dominated the collections (Figure 11), with the oldest individual being a 26-year old (otolith) female.

Ages determined from scale and otolith sections ranged from 2 to 23 and 1 to 26, respectively. The two readers agreed on age estimates for 92.3% of the otoliths and 85.54% of the scales after the initial reading. Re-examination of the otolith and scale sections for which annulus counts differed produced agreement for 97.6% and 93.7% of otoliths and scales, respectively. Average percent error (APE) for single readers and single structures revealed sectioned otoliths to be most precise, with reader Andrew J.

Fischer being the most consistent (Table 6). The APE was lowest for sectioned otoliths (7.7% first read, 2.4% second read, 0.46% final read) compared to sectioned scales (14.5% first read, 6.3% second read, 0.83 final read), indicating this structure yielded the highest precision when comparing age estimates from the two readers (Table 7). Precision was lowest when comparing final ages between structures, with an APE of 11.5% (Table 8). Relative to otoliths, scale age determinations tended to be overestimates at younger ages and underestimates at older ages (Figure 13). The catch curve for the Bayou DuLarge population resulted in an estimated Z of 0.225, which corresponds to an annual survival of 0.799 (Z = -ln survival).

Mean length at age was significantly greater for female alligator gar relative to males for the DuLarge population (ANCOVA, $P = < 0.001$; Figure 14; Figure 15). The von Bertalanffy growth curve for female alligator gar exhibited a typically declining growth rate with age. Estimates of L_4, K, and t_o were 3025.4 mm (± 933.7 SE), 0.0323 (± 0.017 SE), and -9.92 (± 2.19 SE), respectively (Figure 16).

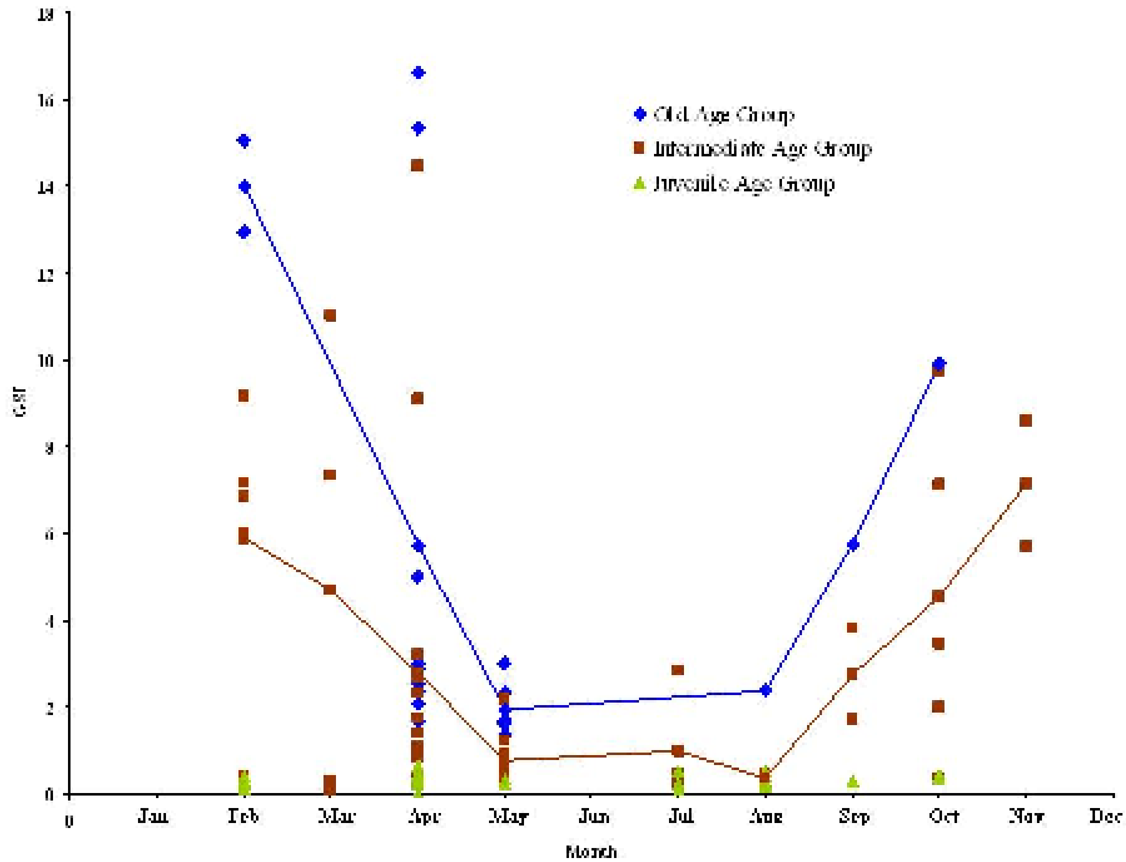

Figure 10. Gonadosomatic index (GSI) by month sampled and grouped ages by juvenile (1-3); (N = 45), intermediate (4-9); (N = 55), old (>10); (N = 20) for female alligator gar collected from 11 July 2007 to 21 May 2008, in the Bayou DuLarge area. Lines indicate mean GSI for old and intermediate age groups. No fish were collected in January, June and December.

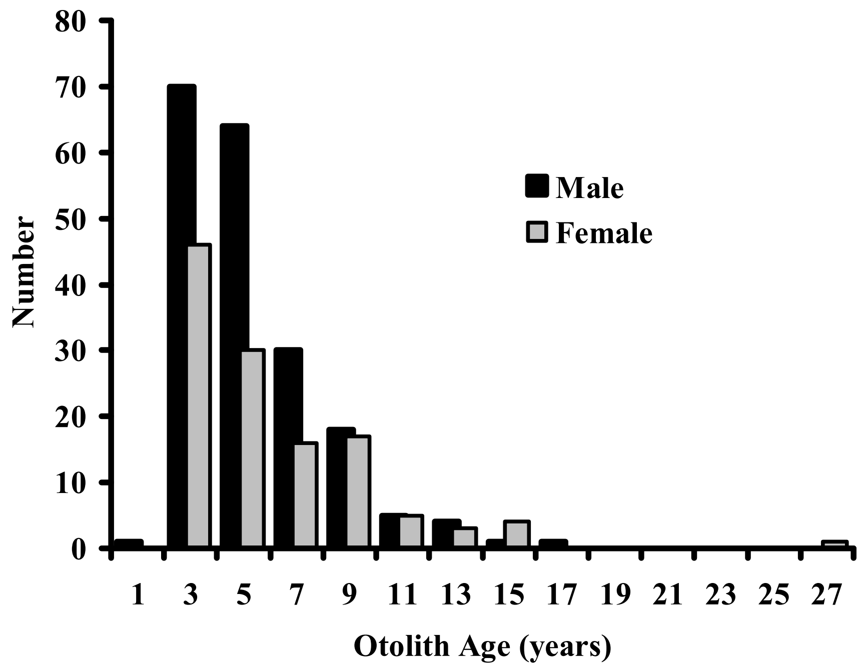

Figure 11. Sectioned otolith age frequency distributions of male (N = 194) and female (N = 123) alligator gar collected from 10 April 2007 to 21 May 2008, in the Bayou DuLarge area indicates a few older males but many young males.

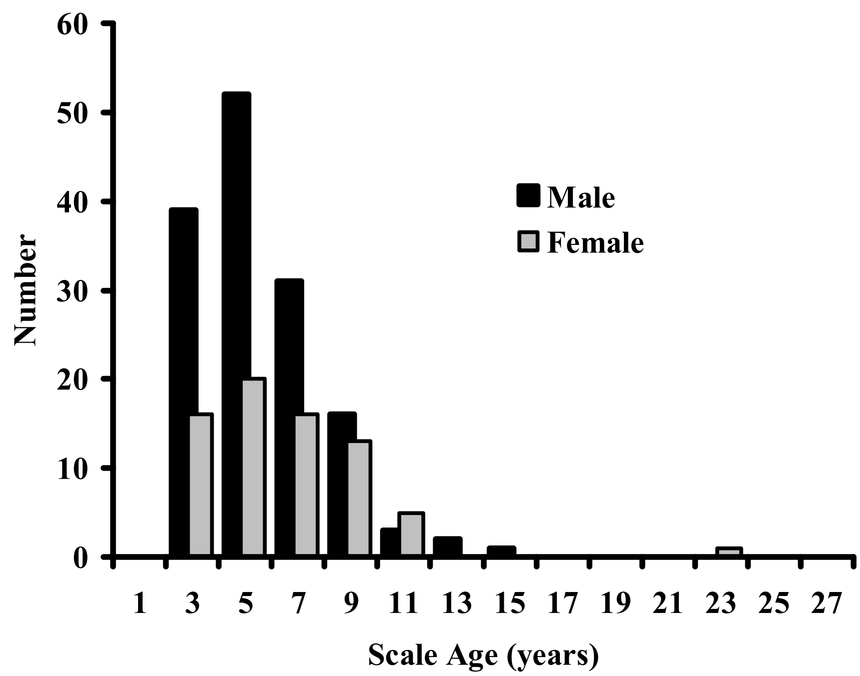

Figure 12. Sectioned scale age frequency distributions of male (N = 146) and female (N = 71) alligator gar collected from 02 February 2008 to 21 May 2008, in the Bayou DuLarge also indicates many young males.

Table 6. Average percent error (APE) between the first and second reads (Initial) and the second and final reads (Final) of a single alligator gar structure (sectioned otoliths or sectioned scales) for a single reader (KCD or AJF).

		APE	
Structure	**Reader**	**Initial**	**Final**
Otoliths	KCD	5.58	1.71
Scales	KCD	9.99	3.54
Otoliths	AJF	2.83	0.41
Scales	AJF	8.59	2.34

Table 7. Average percent error (APE) of ages assigned by two readers (KCD and AJF) for sectioned otoliths or scales of alligator gar after first, second, and final readings.

		APE	
Structure	**1st Read**	**2nd Read**	**Final Read**
Otoliths	7.74	2.36	0.46
Scales	14.46	6.3	0.83

Table 8. Average percent error (APE) between alligator gar structures (sectioned otoliths and sectioned scales) for individual readers. Calculated APE for the final read were based on differences in ages between structures, after the two readers had agreed on ages for each structure.

			APE	
Structure	**Reader**	**1st Read**	**2nd Read**	**Final Read**
Scales vs. Otoliths	KCD	14.99	12.84	
Scales vs. Otoliths	AJF	14.24	12.96	
Scales vs. Otoliths	KCD & AJF			11.52

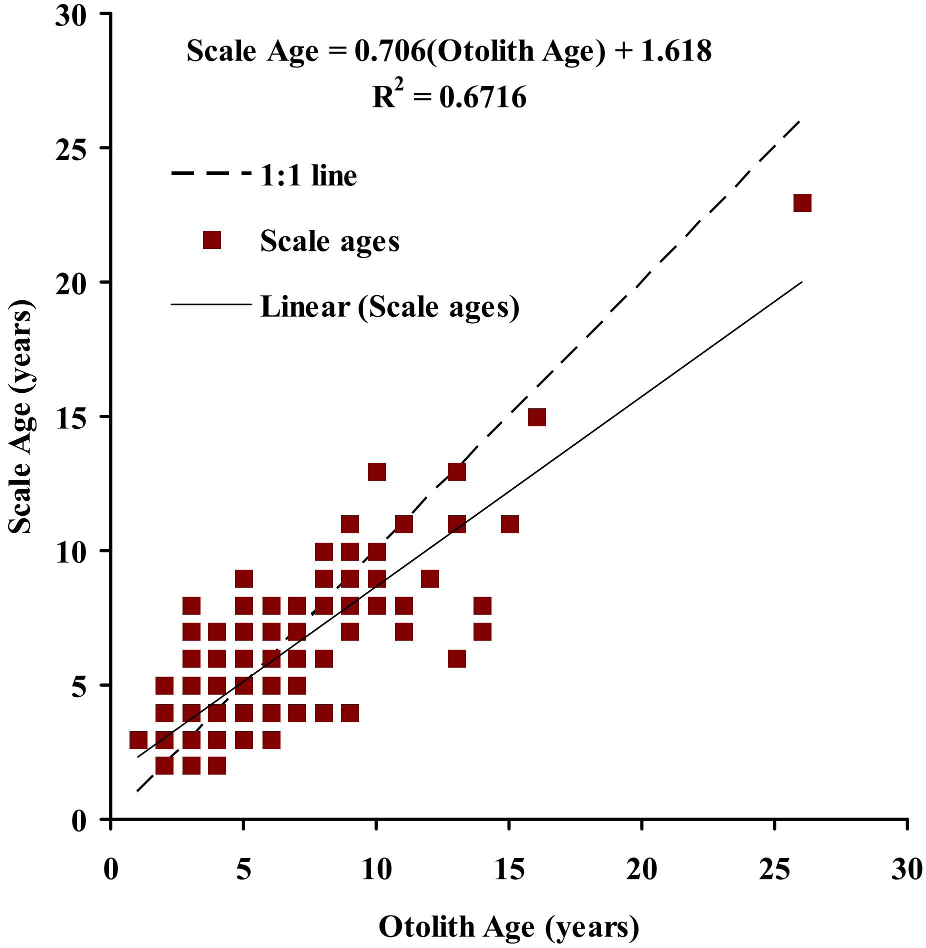

Figure 13. Comparison of otolith ages and scale ages for alligator gar collected from the Bayou DuLarge area, 2007-2008, as a measure of bias of scale age determinations.

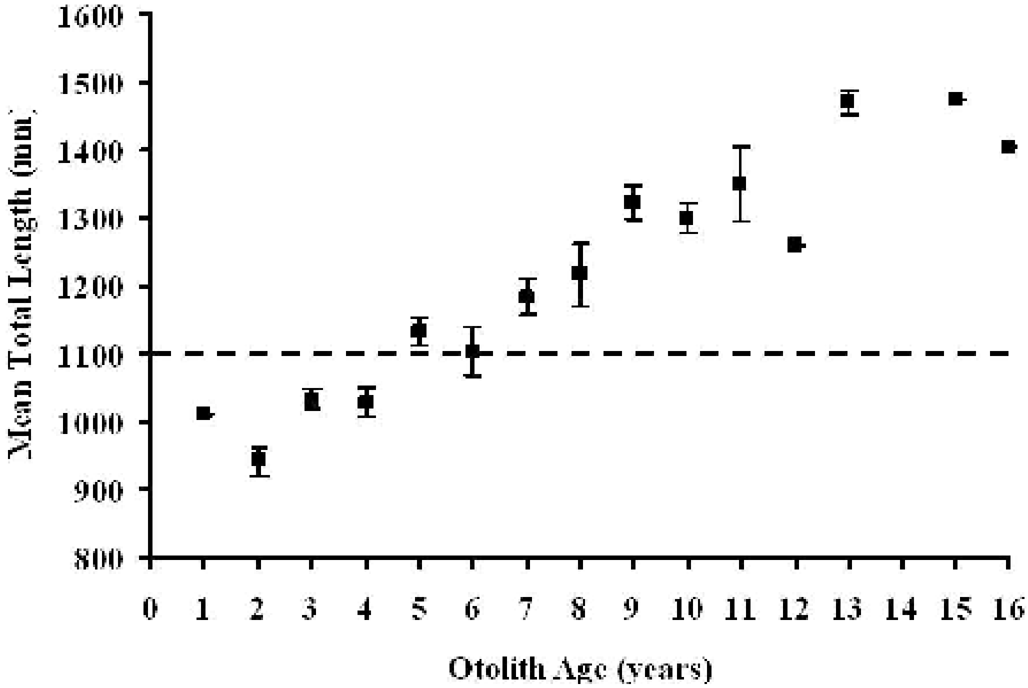

Figure 14. The relationship between age and mean total length (± SE) for male alligator captured in the Bayou DuLarge area during 2007 and 2008. Dotted line indicates reproductive lengths determined by Ferrara (2001).

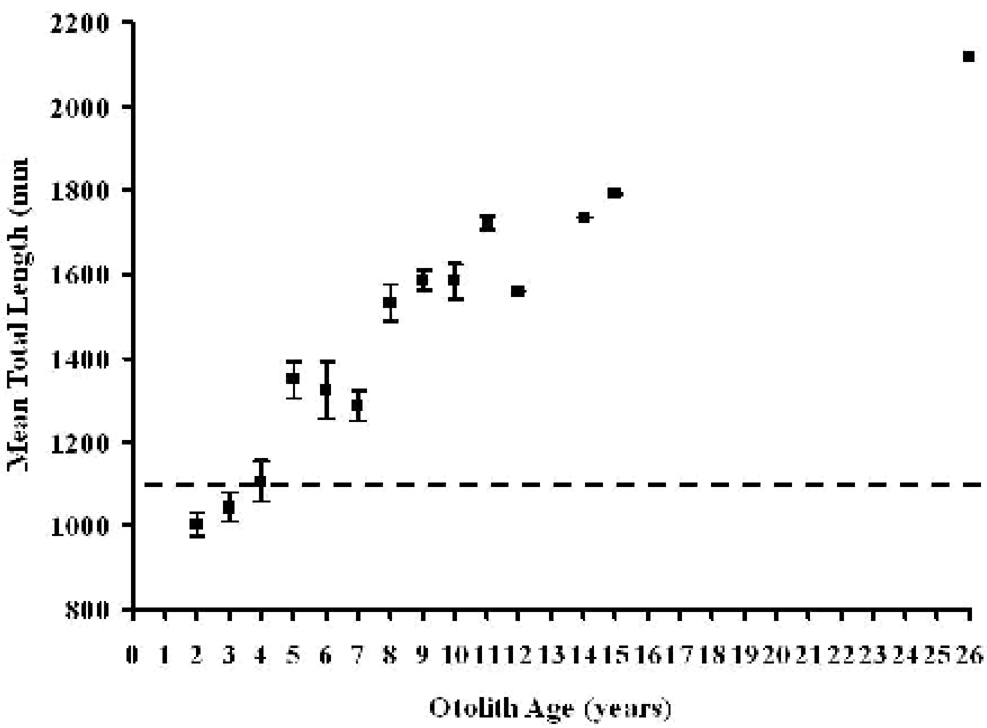

Figure 15. The relationship between age and mean total length (± SE) for female alligator captured in the Bayou DuLarge area during 2007 and 2008. Dotted line indicates reproductive lengths determined by Ferrara (2001).

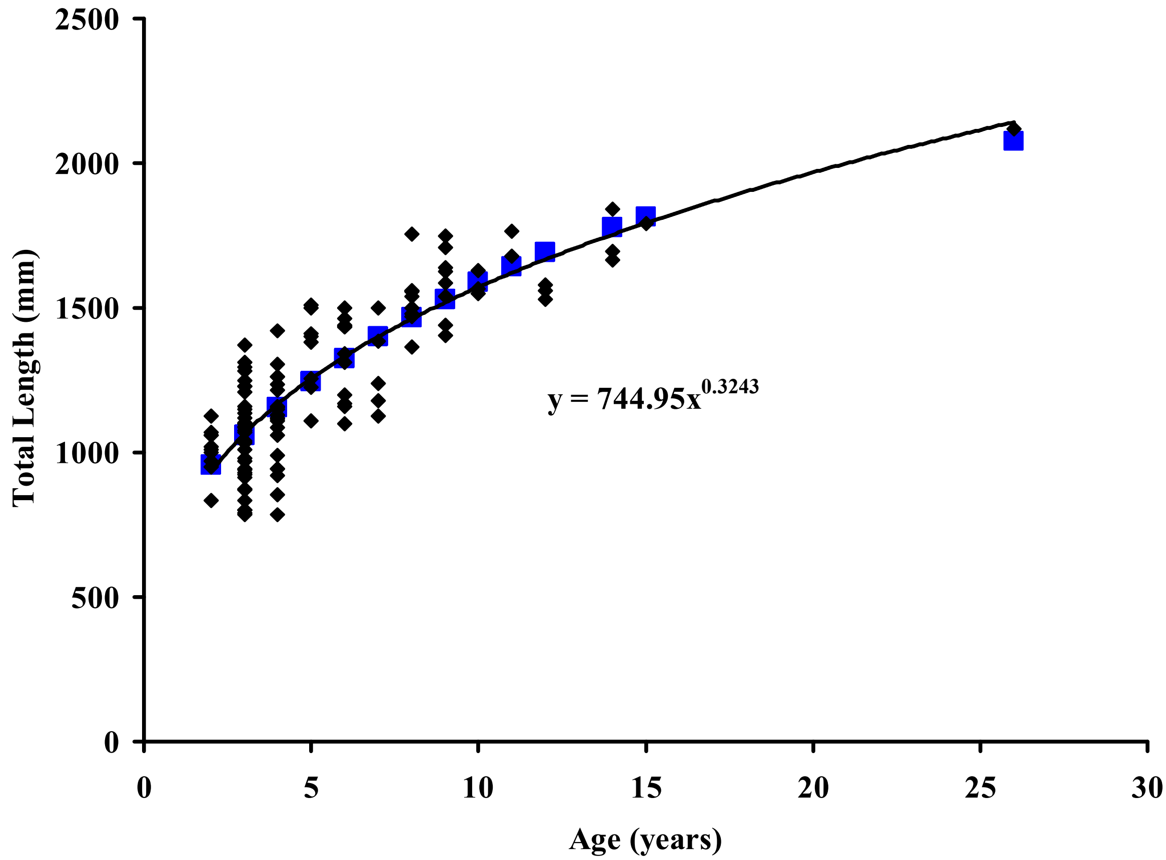

Figure 16. von Bertalanffy fitted growth curve for female alligator gar collected from 10 April 2007 to 21 May 2008, in the Bayou DuLarge area.

DISCUSSION

Summary of Length and Weight

Alligator gar was the most abundant species collected during this study, although the gear also caught red drum *Sciaenops ocellatus*, channel catfish *Ictalurus punctatus,* gafftopsail catfish *Bagre marinus,* hardhead catfish *Ariopsis felis,* bull and blacktip sharks *Carcharhinus leucas* and *C. limbatus*, southern stingray *Dasyatis americana,* and American alligator *Alligator mississippiensis*. I could not collect alligator gar in December or January because of cessation of commercial fishing from cold water temperatures or possible fish movements (Garcia de Leon et al. 2001), which reduced alligator gar densities in the Bayou DuLarge area.

Overall, female alligator gar grew longer and were heavier than same-age males, which is typical of most fishes. In age class 5, 6, and 8, females exhibited significantly greater total lengths, weights, and girths than males. In addition, females were significantly longer in age class 9, and significantly heavier in age classes 9, 10, and 11. It is likely that my sample of age-7 fish was not representative of actual mean sizes for this age group, likely due to random variation related to sample size. It appears that in this population, growth of female alligator gar deviates significantly from that exhibited by males around age 5 and this trend continues through life. Although growth of age-5+ individuals appeared to be gender-specific, the length-weight relationships for males and females were not significantly different, indicating consistent allometry for same-sized individuals. The significant increase in standard relative weight in the spring season indicates development of gonads and provides further evidence of spring spawning, at least for a portion of the population.

Food Habits

Alligator gar feed more intensely at night (Echelle 1968; May and Echelle 1968); therefore, our floaters were set late in the evening. We baited the hooks with mullet, which was subsequently the dominant food item found in alligator gar stomachs in this sample. In most cases the baitfish could be determined from other fishes in the stomach by stage of digestion and size. The fact that non-bait mullet dominated the stomach contents suggests that alligator gar are foraging on abundant nongame fishes, similar to the findings of other diet studies (Bonham 1941; Raney 1942; Seidensticker 1987). They also fed on crabs, which is typical foraging behavior in areas where these prey are available (Darnell 1958, 1961; Lambou 1961; Suttkus 1963). The presence of several non-forage items in alligator gar stomachs supports previous reports that alligator gar are relatively voracious scavengers that will opportunistically feed on anything perceived to be a prey item (Goodyear 1967).

Spawning and GSI

Ferrara (2001) found that when compared to longnose and spotted gar, alligator gar had the smallest investment in each egg (greatest number of eggs per gram of body weight) and were the most fecund. I found gonad weight in females to range widely from 3 – 10,250 grams, depending on the age and reproductive state of each individual. Interestingly, however, there was considerable variation in gonad size among same-age females collected at the same time throughout my study, particularly during the spring. Whether these variations indicate collection of both pre-spawn and post-spawn individuals, or non-annual spawning by individual females is not known.

Determination of spawning period solely from monthly GSI values was difficult. The highest mean GSI for female and male occurred in November, decreased in the early spring, and then peaked again in March for females and April for males. Females showed more variability than males, yet they followed a similar annual pattern. Alligator gar mean monthly GSI values of the Bayou DuLarge population followed similar patterns described by Ferrara (2001) in populations pooled from Mobile-Tensaw Delta (SW Alabama), Lake Pontchartrain (SE Louisiana), and Sabine National Wildlife Refuge (SW Louisiana). Data indicated that these populations spawned in May and June, whereas my data indicates that the Bayou DuLarge population spawned from March through May. Although the GSI suggests the possibility of fall and spring spawnings, it has been consistently documented that spawning of alligator gar and other gar species occurs in spring and early summer (Agassiz 1878; Suttkus 1963; Simon and Tyberghein 1991; Etnier and Starnes 1993; Johnson and Noltie 1997; Ferrara 2001). There are unconfirmed reports of fisherman observing alligator gar spawning in October in years with high fall water levels. Histological examination of alligator gar ovaries would likely provide more conclusive evidence of the seasonal spawning cycle (Brown-Peterson et al. 2007; Smith 2008).

GSI by Age Group. To determine the influence of age on monthly GSI values for females, I grouped the ages into juvenile (1-3 years), intermediate (4-9 years), and old (greater than 10 years) age categories. Because the GSI of fish 1-3 years of age did not fluctuate and were close to zero throughout the year, I do not consider them part of the spawning population. Intermediate and old alligator gar exhibited higher mean GSI values that fluctuated by month, and both groups appeared to contribute to the reproductive effort for this population. Significantly greater GSIs in February, April, and May for older females suggests a significant contribution of these large individuals to the spawning population in Bayou DuLarge. Additional questions that need to be answered include: 1) whether the low-GSI values exhibited by old females during the peak of the spawning season indicated post-spawn or non-spawning individuals; and 2) the relative importance of the spawning contribution of intermediate age classes to the recruitment of individuals to the Bayou DuLarge population.

Age

In order to effectively manage any species of fish, especially one that is considered vulnerable to overexploitation and population declines, managers must consider several important life history characteristics, particularly how long the fish lives and when it reaches maturity (Lackey and Nielson 1980; Musick 1999; Musick et al. 2000a). To be able to address these questions we must be able to accurately assign an age to the fish. Branchiostegal rays have been traditionally used to age other gar species (Netsch and Witt 1962; Klaassen and Morgan 1974; Johnson and Noltie 1997; Love 2001, 2004), however, in alligator gar these structures were found to be opaque (Ferrara 2001) and pitted (Brinkman 2008), which resulted in loss of visually-discernable annuli. Ferrara (2001) determined ages of 225 alligator gar by examining the surface of whole otoliths. Although this method is recognized as accurate, I chose to use sectioned otoliths and scales to determine the feasibility of an alternative non-lethal aging technique that could clearly distinguish annual marks. Otoliths are considered more accurate and reliable than other structures in other species (Ihde and Chittenden 2002; Sipe et al. 2002;

Buckmeier at al. 2002), yet an accurate, non-lethal method for determining age would be particularly useful for this species.

Otoliths of Lepisosteidae grow in several different planes, which makes the nucleus hard to isolate and easy to miss while sectioning, resulting in missed and or obscured outer annuli (Ferrara 2001). Based on this knowledge and recommendations by an experienced researcher in age and growth techniques (Andy J. Fischer, Dept. of Oceanography and Coastal Sciences, Louisiana state University, personal communication), I altered the method of longitudinally sectioning alligator gar otoliths (E. Shanks, LDWF personal communication; E. Brinkman, Oklahoma State University, personal communication) to follow the protocol established for red snapper *Lutjanus campechanus* (Cowan et al. 1995). This method allowed otoliths to be hand held and visually adjusted while being ground along the transverse plane with a precision grinder, which is not possible with a straight longitudinal cut. This was a useful technique with alligator gar otoliths because just enough otolith could be taken off near the core to view the thick, opaque structure without obscuring the most recent annuli at the otolith's outer edge. This method also greatly reduced the time required to prepare otoliths with the traditional Hillquist thin-sectioning saw.

Sectioned otoliths appeared to be clear and straightforward to read, therefore I applied a similar technique to alligator gar scales. Scales were initially sectioned through the widest point with the diamond cut-off saw, which resulted in two sections (one for otoliths) that were glued to a microscope slide and further processed like otoliths.

Precision was best between readers with sectioned otoliths. Although precision of sectioned scales was acceptable after multiple reads, confidence levels were low and annual marks were often difficult to determine. Scale clarity, false annuli (check marks), double marks, and incomplete annuli resulted in much greater difficulty in age assignment for scale sections relative to sectioned otoliths. Sectioned scale age estimates were typically higher than those based on sectioned otoliths for younger fish (up to about age 7), whereas scale-based age estimates tended to be lower than otolith-based ages for older fish.

Even though sectioned otoliths precisely aged alligator gar, it is not possible to determine whether my age determinations were accurate. Age validation, either by aging known-age fish or by mark-recapture of chemically marked individuals is needed and will help verify annual marks (Beamish and McFarlane 1983). One difficulty associated with aging alligator gar and other fishes with sectioned otoliths is determination of the first annuli. To maintain consistency, I counted the first opaque mark after what I considered to be the nucleus as the first annulus, although it did not always appear to represent a full year of growth (Figure 17). I also encountered some false annuli with sectioned otoliths, but considerably fewer than with sectioned scales. Figure 18 illustrates the difference between a sectioned otolith and a sectioned scale from the same fish.

Based on sectioned otoliths, alligator gar from Bayou DuLarge ranged in age from 2 – 26 with a mean age of 5.2 years, which is significantly lower than the mean ages determined by Ferrara (2001) from Alabama, Sabine National Wildlife Refuge, and Lake Pontchartrain of 17, 12.3, and 12 years, respectively. Some of these differences could have been due to gear selectivity [i.e., jug lines in the current study, jug lines and gill nets in Ferrara (2001)], but given the size of the hooks and bait used in the current study, I would have predicted a bias towards larger, not smaller gar. Gar from the Bayou DuLarge population appear to be growing substantially faster than other alligator gar populations (Ferrara 2001), and also appear to be reproducing at ages as early as 4 for males and 5 for females, which is substantially younger than the mean age at spawning reported by Ferrara (2001). Although the estimated Z (0.225) and corresponding survival (80%) indicate the Bayou DuLarge population is experiencing relatively high survival, these values are lower than those reported by Ferrara (2001; Z = 0.097, Survival = 90.7%), suggesting that the commercial fishery may be influencing the mortality rate of fully-recruited individuals in this population.

Louisiana coastal marsh productivity exceeds that of other regions and provides a high abundance of food items (Zimmerman et al. 2000) for alligator gar. The availability of food coupled with commercial fishing pressure may have influenced the age and size structure of this alligator gar population. Ferrara (2001) found that populations presumably affected by exploitation had a truncated age structure and were potentially more susceptible to population decline, but there was no indication of reduced length at maturity. Maturing at younger ages is a typical response to diminishing numbers within a population of fishes, e.g., red snapper and Atlantic cod *Gadus morhua* (Woods 2003; Fudge and Rose 2008), but these stocks would seem to have been subjected to much higher exploitation rates than Bayou DuLarge alligator gar.

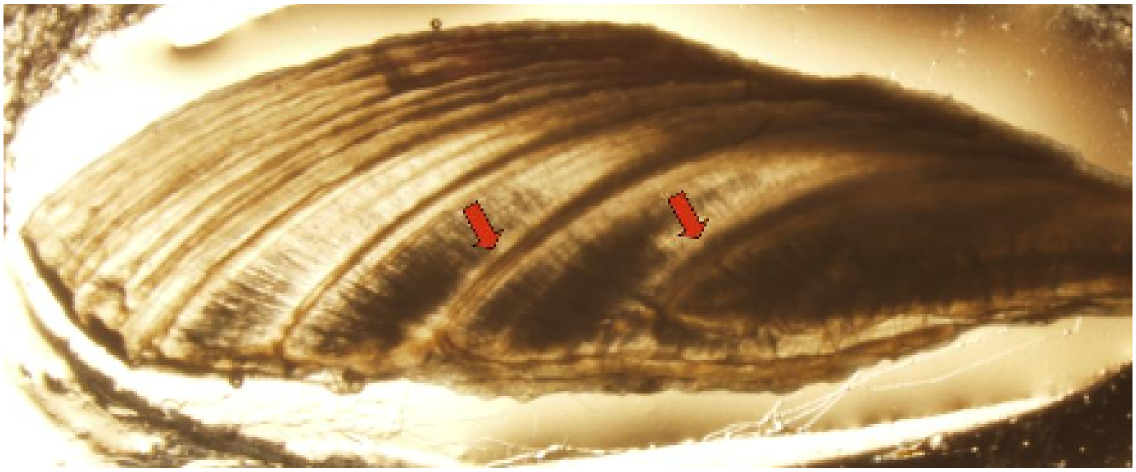

Figure 17. Sectioned otolith illustrating possible first annuli location in alligator gar collected from Bayou DuLarge on 16 February 2008.

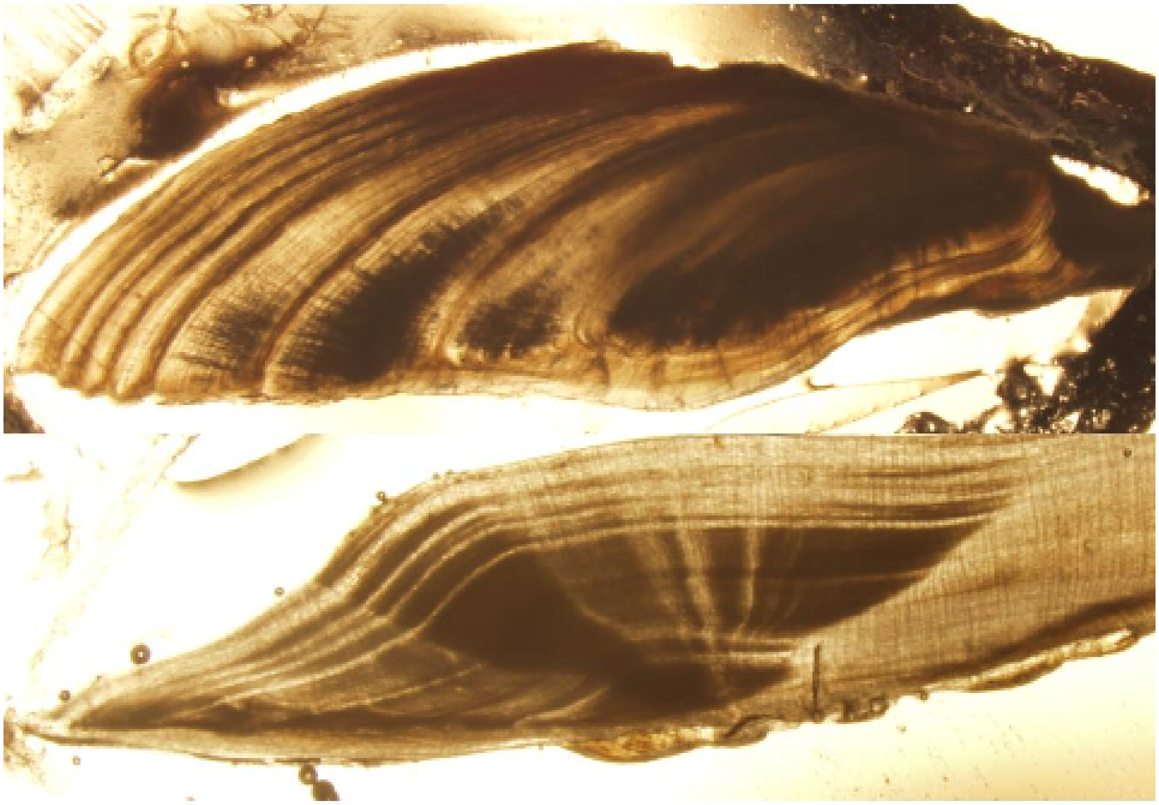

Figure 18. Sectioned otolith (above) and sectioned scale (below) of same alligator gar with different annuli counts. Sectioned otolith with agreed age of 9 years and sectioned scale with agreed age of 7 years collected from Bayou DuLarge on 21 May 2008.

MANAGEMENT RECCOMMENDATIONS

Data from the Bayou DuLarge population of alligator indicate fish spawn at younger ages than previous literature determined (Ferrara 2001). This finding could have positive or negative implications. There is a possibility that this population is being over-exploited, or at least exploited to the point where age at maturity has declined. It is also possible that errors in age assignment misrepresented the age structure of the Bayou DuLarge population, making it appear as though fish are reproducing at earlier or later ages. Several age classes spanned a large range in total length (e.g., age-5 gar ranged from 840 to 1510 mm TL), however; ages are not yet validated so we can only presume the rings we counted represent annual growth.

Age determination data and experience suggest sectioned otoliths are more consistent, clear-cut, and precise than sectioned scales. However, exchanging less precision for a non-lethal aging method may not have negative repercussions in such a long lived fish for management purposes. Basic management actions will often only need to know an age within a few years of the actual age (e.g., juvenile versus spawning ages), so exchanging the life of the fish for more precision in aging may not be necessary. Sectioned scales have potential to be a non-lethal aging structure, however; multiple reads, training, and possible adjustments to thickness of sections would be valuable to increase precision. Comparing structures to alligator gar of known age will be necessary to help verify annual marks and accuracy.

Louisiana's alligator gar population is considered apparently secure and naturally sustaining, whereas populations throughout its historic range are declining. Louisiana does not currently have any management regulations to help conserve or protect alligator gar, although every other state within the current alligator gar distribution has implemented harvest restrictions. Does Louisiana need regulations on a fishery that has apparently been self sustaining for hundreds of years? Are populations of alligator gar declining in Louisiana from habitat loss or over-exploitation? These are questions that need to be addressed to guarantee a sustainable future for this fish in Louisiana.

There are multiple management options that may protect alligator gar in Louisiana, however establishing population goals is key. Texas recently implemented a bag limit of one fish per day as a move to protect the trophy alligator gar fishery. Louisiana lacks the alligator gar trophy fishery, but does support a commercial fishery. A more tailored management action such as closed harvest during spawning periods, when gar are more vulnerable due to spawning characteristics like clustering of multiple males around mature females, may be beneficial. Also, fishery restrictions such as limited sales of commercial alligator gar licenses or effort restrictions (50 jug lines per license holder) could potentially help protect abundance of coastal Louisiana alligator gar populations. Lastly, the prohibition of harvest in refuge areas (Wildlife Management Areas and National Wildlife Refuges), similar to Marine Protected Areas, might help ensure a viable stock of Louisiana alligator gar.

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APPENDIX: LIFE HISTORY DATA OF BAYOU DULARGE ALLIGATOR GAR

Date	TL (mm)	Girth (mm)	Wt. (kg)	Sex	GSI	Scale Age	Otolith Age
20080520	1130	425	8.618255	F	0.37	.	4
20080520	915	330	4.535924	M	1.37	2	4
20080520	1055	380	6.350293	M	3.28	4	3
20080520	1050	380	5.896701	M	2.44	3	3
20080520	1320	470	11.33981	M	4.09	4	6
20080520	1155	410	9.071847	M	2.78	4	5
20080520	1200	440	10.43262	M	3.80	4	5
20080520	1260	470	11.33981	F	0.39	5	4
20080520	1280	490	12.24699	M	3.98	9	9
20080520	1070	375	6.803886	M	3.53	5	4
20080520	840	310	3.628739	M	2.20	3	4
20080520	835	310	3.401943	F	0.24	3	3
20080520	1405	540	18.14369	M	3.97	15	16
20080520	1255	480	11.56661	F	0.31	7	5
20080520	1550	590	20.41166	F	2.35	8	10
20080520	1235	425	9.979032	F	0.32	6	4
20080520	1500	555	15.87573	F	2.15	6	7
20080520	1495	540	18.14369	M	3.54	13	13
20080520	1165	415	8.391459	M	2.72	5	3
20080520	1260	460	10.88622	F	0.26	3	4
20080521	1480	550	18.14369	M	5.27	6	13
20080521	1465	575	19.05088	F	0.68	6	6
20080521	1440	555	16.55612	F	1.37	.	9
20080521	1365	520	15.42214	F	1.23	6	8
20080521	1355	530	16.32933	M	3.60	7	9
20080521	1115	430	8.391459	F	0.28	4	4
20080521	1035	370	6.577089	M	2.84	3	3
20080521	1210	420	9.52544	M	2.96	.	8
20080521	1695	610	25.40117	F	1.65	7	14
20080521	1385	495	13.60777	F	2.20	7	7
20080521	1625	570	21.77243	F	1.69	9	9
20080521	1140	400	4.989516	M	3.29	5	5
20080521	1085	405	6.803886	F	0.26	4	4
20080521	1630	625	24.49399	F	1.62	8	10
20080415	1150	400	7.257478	M	2.58	4	5
20080415	870	325	4.082331	M	3.74	3	3
20080415	1170	445	9.979032	M	3.79	5	5
20080415	1050	360	6.350293	M	5.03	3	3
20080408	1405	555	16.78292	M	3.63	7	11
20080408	1405	535	14.06136	F	2.91	8	9
20080408	1435	580	18.14369	M	8.33	11	13
20080408	1250	500	12.24699	M	4.71	7	7
20080408	1315	500	13.15418	M	5.03	6	5
20080408	1295	480	13.38097	M	3.85	13	10

20080408	1270	480	11.7934	M	5.91	8	8
20080408	1295	510	13.83457	M	6.02	8	11
20080408	950	340	4.535924	M	2.34	2	3
20080408	1180	455	9.52544	M	6.17	5	5
20080408	1107	395	6.803886	M	3.62	3	3
20080408	1015	415	6.577089	M	5.82	2	2
20080408	1160	440	11.33981	M	3.92	7	3
20080408	1020	390	6.350293	M	8.83	6	4
20080408	1210	430	9.071847	M	4.72	3	.
20080408	1240	450	10.43262	M	4.27	7	9
20080408	1115	440	8.618255	M	5.73	5	5
20080408	1175	435	9.52544	M	4.16	7	5
20080408	1235	490	10.43262	M	7.05	5	.
20080408	1150	410	5.443108	M	7.97	3	3
20080408	1025	385	5.896701	M	3.02	6	3
20080408	1170	415	7.71107	M	4.39	4	.
20080408	1095	390	7.257478	M	4.35	4	3
20080408	980	370	6.803886	M	2.60	4	3
20080408	1180	440	8.618255	M	4.50	5	4
20080408	1100	390	7.71107	M	3.39	4	2
20080408	1035	385	7.71107	M	3.48	5	5
20080408	1090	410	7.257478	F	0.42	3	3
20080408	1110	450	11.33981	M	3.44	4	3
20080408	1210	475	10.88622	M	7.95	5	7
20080402	800	285	2.721554	F	0.28	.	3
20080402	1030	385	5.443108	M	3.72	5	3
20080402	785	285	2.267962	F	0.38	6	4
20080402	1070	410	7.257478	M	4.01	.	8
20080402	1565	610	23.13321	F	15.35	10	10
20080402	1560	570	19.05088	F	2.67	8	8
20080401	1580	635	24.0404	F	16.64	9	12
20080401	1555	595	21.99923	F	9.09	6	8
20080401	1500	615	21.77243	F	14.47	10	8
20080401	1225	500	11.7934	M	4.77	8	7
20080401	1200	465	10.88622	M	5.87	8	5
20080401	1060	410	6.803886	M	5.76	3	3
20080401	1095	415	8.164663	M	4.68	3	5
20080401	835	300	3.628739	F	0.30	5	2
20080401	830	300	3.175147	M	3.80	3	4
20080401	665	245	1.814369	M	4.24	4	3
20080401	925	355	4.535924	M	4.96	7	6
20080401	795	300	3.175147	M	3.76	3	3
20080401	990	370	5.443108	F	0.37	3	4
20080401	945	395	6.803886	M	4.69	9	5
20080401	1100	420	8.618255	M	4.88	9	5
20080326	1240	560	13.15418	M	2.87	7	5
20080326	1130	430	9.071847	M	3.26	4	5
20080326	1050	455	9.071847	M	3.94	2	4
20080326	1070	430	9.52544	M	3.72	7	7

20080326	1060	450	9.071847	M	3.27	6	5
20080326	910	335	4.989516	M	4.38	.	3
20080326	815	325	4.082331	M	1.32	.	4
20080311	1755	700	32.65865	F	7.35	4	8
20080311	1540	580	20.86525	F	11.02	6	8
20080311	1300	490	13.15418	M	3.31	6	7
20080311	1265	500	12.70059	M	3.30	9	10
20080311	945	375	5.896701	M	3.88	4	4
20080311	975	390	6.803886	M	2.31	9	8
20080311	930	315	4.535924	M	0.37	4	2
20080311	1020	425	9.071847	M	3.62	5	5
20080311	1110	470	11.33981	M	2.81	5	5
20080311	920	330	4.535924	F	0.31	5	4
20080311	855	310	5.443108	F	0.09	.	4
20080226	1240	495	11.33981	F	9.15	5	7
20080226	1340	500	13.60777	F	6.01	6	6
20080226	815	295	3.628739	F	0.28	4	.
20080226	950	325	4.535924	F	0.23	2	2
20080226	1000	360	6.350293	F	0.30	3	2
20080226	975	350	5.443108	M	2.59	6	.
20080226	880	320	4.082331	M	2.84	7	5
20080226	820	275	3.628739	M	0.66	2	2
20080226	875	315	4.535924	M	0.84	2	2
20080226	945	345	3.628739	F	0.31	8	3
20080226	875	320	4.082331	M	0.67	2	2
20080226	785	280	3.175147	F	0.14	6	3
20080226	870	290	2.267962	F	0.22	6	3
20080226	1100	430	9.52544	M	2.34	6	6
20080226	1015	380	5.896701	M	0.96	3	3
20080226	1160	420	8.618255	F	6.85	8	6
20080226	1020	380	5.896701	F	0.25	2	2
20080226	990	370	6.350293	M	1.64	6	7
20080226	1050	415	6.803886	M	2.76	6	6
20080226	970	380	4.082331	M	3.10	4	6
20080226	1060	415	5.896701	M	2.85	.	5
20080226	895	370	3.628739	M	1.30	8	6
20080226	1085	370	6.803886	F	0.27	2	3
20080514	1640	640	25.85477	F	2.99	9	9
20080514	1560	585	20.86525	F	1.23	8	8
20080514	1285	485	12.92738	M	3.78	6	5
20080514	1360	510	13.60777	M	4.07	8	7
20080514	1275	470	12.0202	M	4.12	4	7
20080514	1170	430	9.071847	M	3.10	3	3
20080514	1400	480	12.70059	F	0.92	5	5
20080514	1145	430	9.071847	M	3.86	7	7
20080514	1220	440	9.979032	M	2.55	4	5
20080514	1150	430	9.071847	M	3.94	5	5
20080514	955	325	4.535924	M	2.90	3	3
20080514	1035	390	6.803886	M	1.82	5	3

20080514	1080	400	7.030682	M	3.04	3	4
20080514	900	290	3.175147	M	2.98	4	5
20080514	1170	410	8.164663	M	3.10	4	3
20080514	1030	380	6.350293	M	5.23	5	3
20080514	1200	455	9.752236	M	3.78	5	4
20080514	1050	350	5.443108	M	3.73	4	4
20080514	950	330	4.535924	M	2.16	.	4
20080514	1200	450	9.979032	M	3.58	6	5
20080514	790	265	2.494758	F	0.25	3	3
20080514	1150	430	8.618255	F	0.41	4	4
20080514	1025	390	5.669905	M	3.59	7	3
20080514	1070	400	6.803886	M	4.19	4	3
20080514	1110	385	6.577089	M	2.68	2	3
20080514	1130	410	7.484274	M	2.86	2	3
20080514	1210	440	9.071847	M	5.64	5	7
20080514	1155	435	8.845051	F	0.59	4	4
20080514	1265	450	10.88622	M	4.04	4	9
20080514	1160	400	7.71107	M	2.82	8	5
20080514	1360	480	12.70059	M	4.59	.	9
20080514	1325	470	12.0202	M	4.48	8	8
20080514	915	355	4.989516	F	0.32	4	3
20080514	1130	410	7.71107	M	4.37	4	4
20080514	1160	435	8.164663	F	0.46	5	4
20080429	1750	640	27.66913	F	4.99	11	9
20080429	1310	510	13.60777	F	0.45	3	3
20080429	1340	480	12.47379	M	2.60	8	8
20080429	1145	460	9.298644	M	5.90	3	6
20080429	1245	460	9.979032	M	6.18	.	5
20080429	850	325	3.628739	M	1.89	4	3
20080429	945	335	4.535924	F	0.24	2	4
20080429	1060	385	5.896701	M	2.97	7	4
20080429	1090	390	6.803886	M	2.46	4	4
20080429	1060	370	6.350293	F	0.28	3	2
20080429	1110	440	8.391459	F	1.07	4	5
20080424	1540	580	20.86525	F	3.01	8	9
20080424	1710	640	27.66913	F	1.67	11	9
20080424	1500	610	22.22603	F	1.74	6	5
20080424	1440	500	14.51496	F	2.32	6	6
20080424	1230	470	9.979032	F	0.45	6	3
20080424	925	350	4.535924	F	0.31	3	3
20080424	1295	495	12.47379	F	0.65	5	3
20080424	1665	610	24.49399	F	2.55	8	14
20080424	1100	440	8.618255	F	0.83	3	6
20080424	1135	425	8.618255	F	0.50	4	3
20080424	1585	565	19.95806	F	2.08	9	9
20080416	1280	470	10.88622	.	0.00	.	3
20080416	1680	610	25.40117	F	2.34	11	11
20080416	1450	580	19.05088	M	4.93	10	9
20080416	1500	525	16.78292	F	1.39	5	6

20080416	1435	545	17.23651	F	0.88	4	6
20080416	1170	450	8.391459	M	4.41	3	3
20080416	1260	500	11.7934	M	5.50	5	5
20080416	885	330	4.082331	M	3.36	3	3
20080416	1010	360	5.443108	M	2.44	3	1
20080416	875	335	3.401943	M	1.01	5	2
20080416	875	330	4.082331	F	0.28	3	3
20080416	1070	400	6.350293	M	5.56	2	3
20080416	1005	345	4.535924	M	3.76	6	4
20080416	970	360	4.989516	M	4.80	3	3
20080416	1060	395	6.350293	F	0.38	2	2
20080416	1075	385	6.350293	M	4.80	3	3
20080416	1065	370	6.123497	M	3.27	6	3
20080416	1155	435	8.164663	M	4.95	4	5
20080416	930	355	4.535924	F	0.45	.	3
20080416	1110	410	7.030682	M	4.37	5	4
20080416	1210	460	9.979032	M	6.79	5	5
20080416	1035	370	5.443108	M	3.52	5	3
20080416	995	365	5.443108	M	5.36	3	3
20080415	1475	555	18.82408	M	5.04	11	15
20080415	1440	590	20.41166	M	3.69	8	.
20080415	1410	530	14.96855	F	3.21	5	5
20080415	1365	535	14.51496	M	5.25	9	9
20080415	1320	495	13.15418	M	3.32	7	7
20080415	1310	475	10.88622	M	4.79	6	6
20080415	960	360	4.535924	M	5.62	3	3
20080415	1110	410	7.030682	M	4.32	3	3
20080415	945	340	4.76272	M	3.59	3	5
20080415	1125	410	6.803886	F	0.25	.	2
20080415	940	350	4.76272	F	0.35	.	3
20080415	1110	415	7.484274	M	4.54	6	6
20080415	1060	375	6.350293	F	0.27	4	4
20080415	1070	370	6.350293	M	2.84	.	3
20080415	1020	380	5.443108	M	2.95	2	2
20080415	1095	415	7.484274	M	4.36	6	5
20080415	975	355	5.216312	M	3.58	3	2
20080415	1225	470	10.88622	M	4.06	5	7
20080415	1045	365	5.896701	M	2.65	2	.
20080415	1150	410	7.257478	M	3.77	4	4
20080415	1045	405	7.257478	M	5.00	5	6
20070410	1102	399	6.25	F	0.27	.	3
20070410	917	320	3.5	M	0.44	.	2
20070410	1140	420	7	M	4.33	.	.
20070410	970	345	4	F	0.30	.	3
20070410	1765	704	31.25	F	13.76	.	11
20070711	1070	387	6	F	0.24	.	2
20070711	1225	554	10	F	0.36	.	5
20070711	1030	390	6	M	1.20	.	3
20070711	1055	363	6	M	0.42	.	.

20070711	1033	385	6	F	0.52	.	3
20070711	1436	534	16	F	2.85	.	6
20070711	1184	440	9	M	0.53	.	4
20070711	1305	457	11	F	0.45	.	4
20070711	1160	405	7	M	1.37	.	6
20070711	943	302	3	F	0.23	.	4
20070711	950	315	3	F	0.10	.	2
20070711	1045	355	5	M	0.33	.	4
20071008	1070	400	6.25	M	4.10	.	2
20071008	1215	450	8.25	F	3.47	.	4
20071008	1070	405	6.5	M	4.03	.	3
20071008	1180	450	9	M	3.32	.	5
20071008	1250	450	10	F	0.43	.	3
20071008	1090	380	6	M	2.69	.	3
20071008	1340	535	14	M	3.80	.	5
20071008	1360	530	14	M	4.29	.	8
20071008	1480	610	21	F	9.76	.	8
20071008	1370	490	12.25	F	0.41	.	3
20071008	1300	465	11	M	4.48	.	8
20071008	1380	535	16	F	2.01	.	5
20071008	1380	550	16	M	3.58	.	9
20071008	1110	400	6.5	F	0.35	.	4
20071008	1030	390	6	M	3.07	.	3
20071008	1210	440	10	F	0.35	.	3
20071008	1510	550	17.5	F	7.14	.	5
20071008	1790	670	30.5	F	9.92	.	15
20071008	1230	485	11	M	3.69	.	6
20071008	1190	420	8	M	3.34	.	3
20071108	1125	455	8	F	5.71	.	7
20071108	1470	595	18	F	8.59	.	8
20071108	1340	560	15.25	M	4.49	.	10
20071108	1150	430	8	F	0.38	.	3
20080216	1100	430	8	M	4.44	.	7
20080216	1120	430	8	M	2.45	.	4
20080216	1260	490	11	M	3.46	.	12
20080216	1020	410	6	M	2.04	.	7
20080216	800	295	2	F	0.31	.	3
20080216	1080	460	8	M	2.41	.	7
20080216	840	310	2	M	0.55	.	5
20080216	920	355	4	M	0.66	.	4
20080216	1180	470	9	F	7.18	.	7
20080216	1080	425	6	M	2.14	.	6
20070918	1230	430	8.5	F	0.31	.	3
20070918	1210	485	10	M	0.75	.	
20070918	1310	520	14	F	3.81	.	6
20070918	1000	380	5	M	1.43	.	3
20070918	1250	510	13	M	1.85	.	5
20070918	1450	575	18	F	3.88	.	
20070918	1530	610	24	F	5.77	.	12

20070918	1100	410	8	F	0.28	.	3
20070928	1420	510	15	F	1.72	.	4
20070828	935	325	3.5	M	0.09	.	3
20070828	940	352	4	M	0.18	.	2
20070828	1160	410	7.5	M	0.46	.	3
20070828	1010	350	4	F	0.22	.	2
20070828	955	320	4	M	0.18	.	3
20070828	810	279	3	M	0.07	.	2
20070828	1100	402	7	F	0.38	.	3
20070828	1120	420	8.5	F	0.46	.	4
20070828	1210	477	10	M	0.64	.	9
20070828	1160	440	9	F	0.27	.	3
20070828	1040	375	6	M	0.18	.	3
20070828	1070	405	6	F	0.30	.	3
20070828	930	310	4	M	0.23	.	2
20070828	1010	345	5	F	0.20	.	3
20080216	1070	435	7	M	2.70	.	4
20080216	2120	950	68	F	15.07	23	26
20080216	1230	520	12	M	2.51	.	7
20080216	970	400	6	F	0.41	.	2
20080216	1200	460	10	F	5.87	.	6
20080216	1040	380	5.5	F	0.28	.	3
20080216	1100	430	8	M	2.87	.	8
20080216	970	335	4	M	1.04	.	2
20080216	1100	470	9	M	3.63	.	7
20080216	890	370	4	M	1.42	.	4
20080216	1170	450	8	F	0.41	.	6
20080216	1020	400	6	M	3.05	.	4
20080216	940	350	4	M	0.97	.	2
20080216	1840	740	38	F	12.96	.	14
20070803	1120	390	7	F	0.53	.	3
20070803	1130	405	6	M	0.32	.	5
20070803	1075	375	6	F	0.25	.	3
20070803	1460	520	16	F	1.39	.	.
20070803	1560	600	22	F	2.37	.	12
20070803	980	340	4	M	0.81	.	3
20070803	1130	410	7	F	0.27	.	4
20070803	980	345	4	F	0.24	.	3
20080220	1080	405	9.07	M	1.92	.	3
20080220	1010	365	8.16	M	1.28	.	3

VITA

Kayla Chereé DiBenedetto was born in Zachary, Louisiana, in October 1983. She attended Baker High School where she graduated as valedictorian of the 2001 class. Kayla began her college career at Louisiana State University the fall of 2001 with an interest in veterinary medicine. Her career path changed a few years into college when she changed majors to wildlife biology and graduated in 2006 from Louisiana State University with a Bachelor of Science degree. After working as a Research Associate for eight months in the fisheries lab at Louisiana State University she was accepted into the graduate school there and began working on an alligator gar research project. Kayla is currently a candidate for the Master of Science degree in fisheries.