Potential Caviar Fishery Impacts on Louisiana Bowfin Populations

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Abstract: In recent years, a small scale bowfin (*Amia calva*) roe fishery in Louisiana has increased in both volume and value. To initiate an evaluation on the impacts of this fishery on bowfin populations, 3 study areas were selected to represent various ecosystems inhabited by bowfin. It was not possible to relate growth, size, and sexual maturity with age based on otolith samples. Length-frequency data suggested that 9-month-old fish ranged from 225–400 mm and 21-month-old bowfin may grow to 525 mm. Gonadosomatic indices showed a constant increase through February, and all females observed had spawned by early March. Gonadal development and length-frequency data support the conclusion that most bowfin in Louisiana mature during their second winter. It appears that at least some bowfin mature before they become vulnerable to legal mesh (76 mm) gill nets. Other legal gears such as trotlines and hoopnets are capable of capturing bowfin before they mature, but their impact on the population has not been evaluated.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 45:385–391.

The bowfin is widely distributed throughout Louisiana. It is typically found in weedy shallow lakes, sluggish muddy streams, ditches, turbid canals, borrow pits, and backwater areas of rivers (Douglas 1974). Until recently, bowfin attracted little commercial or recreational interest in Louisiana. Some recreational fishermen target this species, but most people consider it a 'trashfish.' In recent years, however, commercial interest in bowfin has increased dramatically in Louisiana. An existing

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bowfin roe fishery within the state has increased in both volume and value, due, in part, to the decline of paddlefish and sturgeon populations and subsequent emergency closure of commercial and recreational fisheries for these species. In the opinion of many people, the size, color, and quality of maturing bowfin eggs make them a suitable substitute for traditional sources of caviar.

Commercial bowfin fishermen use several harvest methods, depending primarily on location and water depth. Most of the commercial harvest in Louisiana comes from the Atchafalaya Basin; however, some bowfin are captured in private ponds. Sinking gill nets are the gear of choice, but during high-water periods hoop nets with leads are often used in flooded areas. Trotlines and gill nets are commonly used where boats must be hand loaded into isolated areas. Currently, the minimum legal mesh for freshwater gill nets in the state is 76 mm bar mesh. Harvesting generally begins in December and continues until late January or early February, or until enough roe is harvested to satisfy the market demand for caviar.

As of February 1991, only 1 legal caviar cannery was processing bowfin roe within the state. The company purchased roe from several fishermen and processed the caviar in the vicinity of Charenton. Numerous claims have recently alleged that out-of-state interests purchase bowfin roe to be shipped to processors outside of Louisiana without proper permits and that much of this roe is obtained through the use of illegal mesh sizes. These claims have not been substantiated.

Due to limited recreational and commercial interest prior to the late 1980s, few studies have investigated the bowfin's life history. Most studies have concentrated on food habits (Hildebrand and Towers 1927, Breeder 1928, Schneberger 1937, Lagler and Hubbs 1940, Lagler and Applegate 1942, Penn 1950, Berry 1955, Toole 1971, Dugas 1976). Green (1966) studied the feasibility of raising bowfin for experimental use. Effects of increased commercial harvests on bowfin populations have not been widely studied. The objectives of this study were to estimate selected parameters of bowfin populations in Louisiana and to investigate potential impacts of an increase in commercial fishing due to the developing roe fishery.

Methods

Three study areas were selected to represent various ecosystems inhabited by bowfin in Louisiana. The Atchafalaya Basin (in the vicinity of Charenton, St. Mary Parish) was chosen to represent a riverine habitat, white Spring Bayou Wildlife Management Area (Avoyelles Parish) and Chicot Lake (Evangeline Parish) represented backwater and lacustrine habitats, respectively. Sample stations in each area were selected based on suitability as potential commercial harvest sites.

From October 1990 through March 1991, population samples were collected using electrofishers and gill nets with 64 mm, 70 mm, and 76 mm bar mesh. Additional samples were obtained from a commercial fisherman in the Charenton area who allowed Department of Wildlife and Fisheries personnel to accompany him while he harvested bowfin with various mesh gill nets. A random sample of

commercially-harvested bowfin was obtained at the caviar processing facility. These fish were caught using assorted, unspecified gears.

Total weight and total length were obtained from each bowfin. Sex and state of maturity (Lagler 1956) were determined among randomly-sampled fish during collection. Ovary weights were obtained from a subsample of mature females. Gonadosomatic indices (GSI) were calculated as the percentage of total weight contributed by the ovaries. Average fecundity was estimated by counting all eggs in subsamples randomly selected from ripe ovaries.

Louisiana State University was contracted to determine if analysis of scales or other calcified structures could be used for aging bowfin. Saggital otoliths, lagenar otoliths, and scales were removed from random samples in each study area. A small number of gular plates were obtained from bowfin in the Atchafalaya Basin. Opercules and gular plates were anterio-posteriorly sectioned and examined for presumed annuli.

The effect of different size meshes on total length and weight of harvested bowfin were analyzed using multiple *t*-tests. Linear regression of log10-transformed lengths and weights was used to calculate length-weight relationships (Anderson and Gutreuter 1983) according to sex, study area, and for all study areas combined, using the GLM procedure of SAS (SAS Inst., Inc. 1988).

Results

Age and Growth

Bowfin scales showed no evident markings. Inconsistent numbers and orientation of presumed annuli on bony structures and from bowfin of similar sizes suggested that marks on the cross-sections of these structures may not be annual marks. Further estimates of age determination from scales or bony parts from bowfin would only be possible after verification of the chronological origin of these marks.

Length-frequency data were used to estimate age and growth. To minimize the effect of gear selectivity, changes in habitat preference and growth during the study, only fish collected at Spring Bayou over a 2-day period with the electrofisher were used. Length modes for this sample were not clearly distinguishable, but appeared to separate into only 2 groups. The first mode ranged from 225–400 mm and the second from 425–600 mm (Fig. 1). Length-weight data (Table 1) indicate that the growth pattern for males is isometric but is allometric for females. Sampling during the spawning season may be partly responsible for this difference.

Gonadosomatic Index

Each area, except Chicot Lake where too few specimens were obtained, showed a constant increase in GSI from October through February (Fig. 2). Only 1 spent female was observed prior to March in any study area (January 1991 at Spring Bayou). During the first half of March all females observed had spawned and were in various stages of resorption.

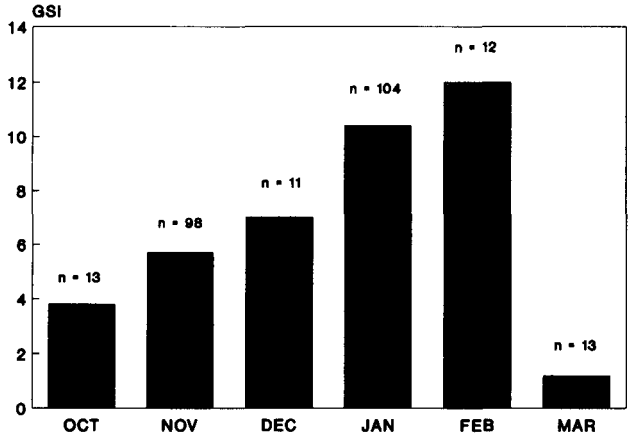

Figure 1. Length frequencies of bowfin collected using electrofishing at Spring Bayou, 19 and 20 November 1990.

Table 1. Regression parameters based on log10 transformed length (mm; independent variable) and weight (g) data from 3 Louisiana study areas (Oct 1990–Feb 1991).

Study Area	Sex	*N*	Slope	Intercept	r^2
Atchafalaya Basin	All[a]	315	3.22	−5.60	0.95
	Females	174	3.28	−5.75	0.94
	Males	60	3.08	−5.22	0.93
Spring Bayou W.M.A.	All[a]	145	2.96	−4.93	0.91
	Females	82	3.34	−5.94	0.96
	Males	63	2.51	−3.73	0.84
Chicot Lake	All[a]	18	3.40	−6.08	0.98
	Females	13	3.54	−6.46	0.97
	Males	5	3.67	−6.79	0.98
All Areas Combined	All[a]	476	3.27	−5.75	0.95
	Females	269	3.39	−6.07	0.96
	Males	128	3.00	−5.01	0.90

[a]Includes fish of unknown sex.

Fecundity

Fecundity was estimated from ovarian samples of 29 ripe females captured during January and February. Bowfinn fecundity estimates averaged 30,814 ova per female in January samples and 43,780 ova per female in February samples. These eggs made up about 12% of the total fish weight. In many fishes, a portion of the mature ova remain in the ovary and are resorbed (Snyder 1983). This appears to be true for bowfin.

Sexual Maturity

From October 1990 through February 1991 only 2 bowfin were classified as immature based on visual observation of gonads. Only the November sample con-

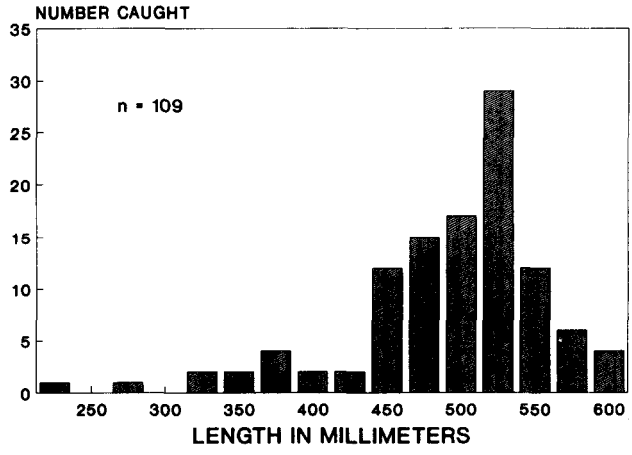

Figure 2. Average monthly gonadosomatic indexes of bowfin collected from 3 Louisiana water bodies, 1990–91.

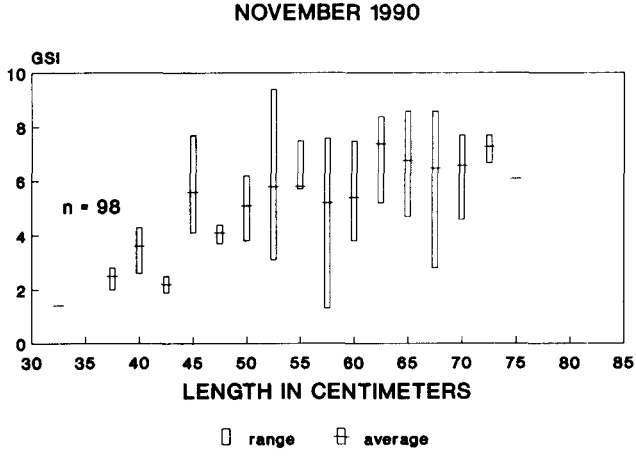

Figure 3. Range and average gonadosomatic indexes for bowfin collected from 3 Louisiana water bodies, November 1990.

tained sufficient numbers of bowfin under 450 mm to draw inferences comparing GSI and length. This sample suggested that ovarian maturation occurs in most bowfin >450 mm total length (Fig. 3). GSI values were <5 for individuals below this size.

Gill Net Selectivity

No bowfin were captured with 76-mm mesh gill nets at Spring Bayou or Chicot Lake. In the Atchafalaya Basin study area, bowfin captured with 76-mm mesh gill nets averaged 705 mm in length and 3,918 g in weight. These values were significantly longer ($P < 0.05$) and heavier than for bowfin captured with 70 mm and 64 mm mesh gill nets (Table 2). Sizes of bowfin sampled with the 70 mm and 64 mm mesh nets did not differ significantly.

Table 2. Comparative lengths and weights of bowfin (*Amia calva*) sampled in 63.5-mm, 70-mm, and 76-mm bar mesh gillnets.

Mesh	*N*	Minimum	Maximum	Mean	SE
63.5 mm					
Length (mm)	26	455	704	636	10.5
Weight (g)	26	900	4100	2879	140.3
70 mm					
Length (mm)	38	512	760	643	7.4
Weight (g)	38	1225	4800	2842	98.3
76 mm					
Length (mm)	172	570	800	705	3.0
Weight (g)	172	1750	5700	3918	50.4

Discussion

Bowfin sampled in this study ranged in size from 248 mm to 800 mm total length. Length-frequency distributions suggested that by their first winter bowfin attained a length of 248-400 mm (Fig. 1) corresponding to 120–573 g based on length-weight equations. This rate of growth is consistent with results of Mayeux (1966) where 8-week-old fish reached 114 mm and with Green (1966) where young-of-the-year bowfin in August averaged 406 mm. The second length mode in this study probably consisted of all age classes over 1. The presence of only 2 length modes may indicate that growth rates substantially declined in or slightly after the second year, or it may indicate that mortality rates were greatly increased. Data suggest that 1+ bowfin range from 400–525 mm. Length and weight data from all study areas indicate that males, on average, were smaller than females.

Mayeux (1966) indicated that bowfin of approximately 1,300 g (weight estimate based on observed length-weight relation obtained in this study) could be expected to produce approximately 11,000 eggs per kilogram body weight. Nikol'skii (1961) reported that bowfin fecundity ranges between 20,000 and 70,000 eggs per female. Based on the observed patterns of increasing GSI and the fact that only 1 spent female was observed through February, the 12 samples from February with average fecundity of nearly 44,000 ova per female probably provide the best estimate of spawning potential.

The smallest individual retained in 76-mm mesh gill nets was 560 mm total length, with individuals exceeding 610 mm comprising the bulk of these samples. Most female bowfin >450 mm are mature. This indicates that most bowfin have matured, and probably had an opportunity at least once, before they become vulnerable to legal mesh (76 mm) gill nets. Smaller mesh gill nets will capture individuals prior to their first spawning season. Commercial fishermen indicated that some bowfin are captured using trotlines and hoopnets with 1-inch mesh. These gears are capable of catching bowfin that have not matured.

It appears that young-of-the-year bowfin were not as vulnerable to our sampling techniques as older fish. Future sampling strategies will be designed to better

represent this age class. Research will also continue to develop a reliable aging methodology.

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