Diet Composition of Stunted Catfish Populations in Louisiana[1]

Jerome P. Zeringue, *School of Forestry, Wildlife, and Fisheries, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center, Baton Rouge, LA 70803*

William E. Kelso, *School of Forestry, Wildlife, and Fisheries, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center, Baton Rouge, LA 70803*

C. Fred Bryan, *Leader, Louisiana Cooperative Fish and Wildlife Research Unit, School of Forestry, Wildlife, and Fisheries, Louisiana State University, Baton Rouge, LA 70803*

Mark G. McElroy, *Fisheries Biologist, Louisiana Department of Wildlife and Fisheries, 2001 Quail Drive, Baton Rouge, LA 70808*

Abstract: Diet composition was investigated in 3 channel catfish (*Ictalurus punctatus*) populations in southeastern Louisiana, 2 of which were characterized by slow growth and reduced length at maturity. Multivariate analyses revealed that diets of catfish exhibiting slow growth were predominantly composed of marine prey, particularly engraulids, *Corophium* sp., and *Penaeus* sp., and were superior in quantity, diversity, and apparent nutritional value compared to diets of faster growing catfish from the Atchafalaya Basin. Slow growth and early maturity at reduced lengths did not appear to be forage-related, and may instead have reflected impacts of mesohaline conditions in coastal lakes.

Proc. Annu. Conf. Southeast Assoc. Fish and Wildl. Agencies 42:133–140

The channel catfish, *Ictalurus punctatus*, is one of the most important and abundant commercially-harvested species in the Mississippi River Valley (U.S. Dep. Commerce 1977). In 1985, Louisiana commercial fisherman landed 2,569,727 kg of catfish with a dockside value of $2,674,592 (U.S. Dep. Commerce, unpubl. data). Between 1972 and 1981, channel catfish harvested commercially in

[1] Approved for publication by the director of the Louisiana Agricultural Experiment Station as manuscript No. 88-22-2309.

Louisiana were subject to a minimum size limit of 28 cm total length (TL), which was based on average length at sexual maturity. The length limit was removed in 1981, and the potential impacts of length limit regulations on commercial channel catfish harvests were subsequently evaluated. In 1985, a statewide length limit of 28 cm TL was once again adopted, with the provision that the Louisiana Department of Wildlife and Fisheries (LDWF) could suspend length limits in selected waters if it could be demonstrated that resident channel catfish stocks would not be adversely affected. The impetus for this provision was data indicating that length at maturity varied considerably among Louisiana channel catfish populations.

Channel catfish in Lake Maurepas and Lac Des Allemands in southeastern Louisiana are characterized by slow growth, with 50% of the populations being sexually mature at 20–22 cm TL and 25.4–28 cm TL, respectively (LDWF, unpubl. data). Because of this slow growth and reduced length at maturity, a controversy has developed among commercial fishermen who wish to harvest catfish smaller than the legal limit. Commercial fishermen regard harvesting of Lake Maurepas and Lac Des Allemands catfish that are sexually mature, but 28 cm TL, as conforming to the intent of the law, i.e. providing potential for reproduction prior to harvest.

Differences in growth rates among channel catfish populations in similar geographic locations have been reported throughout the U.S. (Carlander 1969). Numerous catfish populations have exhibited slow growth (Condor and Hoffarth 1962), and intense inter- or intraspecific competition for available food has been reported to result in stunting (Bailey and Harrison 1948). If reduced growth rates and length at maturity are due to limitations in food quality or quantity, temporary suspension of commercial length limits could reduce catfish densities and increase growth rates, at which time length limits could be reinstated. In contrast, slow growth of catfish in southeastern Louisiana lakes could be a response to environmental conditions, hence the 28-cm TL limit would seem unwarranted and wasteful.

As part of a study to determine possible causes of slow growth and reduced length at maturity of channel catfish in southeastern Louisiana, diet composition of catfish populations in Lake Maurepas and Lac Des Allemands was determined. Results were compared to the diet of catfish from Flat Lake win the Atchafalaya Basin, which exhibit growth and maturity patterns typical of catfish in other parts of Louisiana. Results were evaluated to determine if a reduction in diet quality or quantity was evident in the slow-growing catfish populations.

We acknowledge personnel of the LDWF for their support during field collections. Catfish analyzed from Lac Des Allemands and Lake Maurepas were obtained as part of an ongoing study conducted by the LDWF that is partially funded by Dingell-Johnson Project F-60. Additional support for the study was provided by the Louisiana Board of Regents, Project 86-LBR/022-B06. We also acknowledge Michael R. Meador and D. Allen Rutherford for their contributions to statistical analyses.

Methods

Lac Des Allemands is a 6,075-ha lake located 64 km west of New Orleans, Louisiana. Although predominantly a freshwater lake, Lac Des Allemands is affected by tidal fluctuation, and salinities in excess of 1 ‰ have been recorded (Chambers 1980). Lake Maurepas, a 23,580-ha lake located 48 km northwest of New Orleans, receives influxes of saltwater from adjacent Lake Ponchatrain, with seasonal salinities exceeding 6 ‰ (LDWF, unpubl. data). Flat Lake is a predominantly freshwater 1,270-ha lake (C. F. Bryan, unpubl. rep., La. Coop. Fish and Wildl. Res. Unit, 1975) located in the lower portion of the Atchafalaya Basin 2 km north of Morgan City.

Periodic collections of channel catfish (using rotenone, gill nets, and a 4-m otter trawl) were conducted by LDWF personnel in Lac Des Allemmands and Lake Maurepas from January 1986 to July 1987. Monthly samples of catfish from Flat Lake were taken from July to October 1987 using gill nets and a 4-m otter trawl.

Upon collection, fish were immediately placed on ice and transferred to the laboratory on the Louisiana State University (LSU) campus. Stomachs of all fish were removed and preserved in 10% formalin. Stomach contents were identified and enumerated using a dissecting stereomicroscope. Food items were identified to the lowest taxon possible. The volume of each taxon in each stomach was determined by water displacement in a graduated cylinder. Total volume of stomach contents, mean total volume per fish, and percent volume of each prey taxon were determined for 40-mm size classes of catfish ranging from 100 mm TL to > 260 mm TL.

Analysis of variance (ANOVA), Tukey's HSD (2-way ANOVA), and Duncan's Multiple Range Test (1-way ANOVA) were used to test for differences in food quantity among lakes and catfish size classes (Steel and Torrie 1980), with significance expressed at the $P < 0.05$ level. Diets of the 3 catfish populations were analyzed using principal components analysis (PCA) from the correlation matrix of the percent of total volume of each prey taxon in each catfish length class, transformed by arc $\sin^{1/2}$. PCA was used to assess the relative contribution of various prey taxa in catfish diets as a basis for analyzing dietary differences among lakes. All calculations were performed using the Statistical Analysis System (SAS 1985).

Results

A total of 381 stomachs was examined during the study: 155 from Lac Des Allemands (24 empty, 15%); 148 from Lake Maurepas (20 empty, 13.5%); and 102 from Flat Lake (5 empty, 15%). Several catfish collected during rotenone operations had obviously ingested moribund clupeids, and therefore recently ingested clupeids were deleted from stomach content analysis.

Analysis of stomach content volumes indicated statistically significant differences among size classes for Lake Maurepas and Lac Des Allemands channel catfish, but not for Flat Lake fish, which exhibited uniformly low volumes of stomach contents for all size classes (Table 1). Further analysis indicated that stomach con-

Table 1. Mean volumes (cc) ± standard error of stomach contents by size class in channel catfish from 3 locations in Louisiana. The number of fish stomachs containing food items in each size class is shown in parentheses.

Catfish size class (mm)	Location		
	Lac Des Allemands	Lake Maurepas	Flat Lake
100–140	0.23 ± 0.05 (17)	0.26 ± 0.15 (4)	0.14 ± 0.02 (7)
141–180	1.00 ± 0.16 (37)	0.29 ± 0.04 (20)	0.19 ± 0.03 (6)
181–220	1.63 ± 0.35 (36)	0.79 ± 0.20 (22)	0.37 ± 0.07 (22)
221–260	2.39 ± 0.36 (25)	2.19 ± 0.47 (41)	0.43 ± 0.08 (27)
>261	6.97 ± 1.56 (18)	3.75 ± 0.86 (40)	0.48 ± 0.09 (10)

Table 2. Percent of total volume for each prey taxa identified in stomachs of channel catfish from Lac Des Allemands (LDA), Lake Maurepas (LM) and Flat Lake (FL), Louisiana. Loadings of prey taxa on PC1 and/or PC2 (≥0.20) are also listed.

Prey taxa	LDA	LM	FL	PC1	PC2
Gastropoda	0.001	0.001			
Oligochaeta		0.009			
Pelecypoda		0.015		0.270	
Insecta					
Diptera	0.005	0.012	0.029		−0.264
Hemiptera					
Veliidae			0.008		−0.208
Odonata	T[a]	T			
Corixidae	0.030		T		0.315
Crustacea					
Amphipoda					
Corophium	0.043	0.005	T		0.386
Gammaridae	0.004	T	0.002		
Isopoda		0.024		0.397	
Decapoda	0.079	0.162	0.271		−0.295
Penaeus		0.066		0.365	
Paleomonetes			0.008		−0.295
Taphromysis	0.001	T	T		0.267
Procambarus			0.038		
Osteichthyes					
Atherinidae	0.056				0.200
Menidia		0.011		0.365	
Catostomidae		0.015		0.386	
Clupeidae	0.039				0.288
Engraulidae	0.571	0.388			0.412
Gobiidae		0.016		0.299	
Vegetation	0.040	0.048	0.510		−0.316
UID digested matter	0.131	0.228	0.134		

[a]T = trace (< 0.001).

tent volumes of Flat Lake catfish were significantly lower than Lac Des Allemands and Lake Maurepas fish; the latter 2 populations were not significantly different.

Thirty-one taxa of prey organisms identified in catfish stomachs were grouped into 22 taxonomic categories for analyzing similarity of diet among lakes and size classes (Table 2). Principal components analysis indicated that 42.1% of the variation in stomach contents data among size classes and lakes was accounted for by the first 2 principal components (Table 2). Positive loadings for pelecypods, isopods, decapods, catostomids, gobeides, *Menidia* spp., and *Paneus* spp. contributed most to the characterization of the first principal component (PC1), which accounted for 22.5% of the variation. PC2 (19.6% of the variation) was characterized by positive loadings for corixids, *Corophium* spp., *Taphromysis* sp., atherinids, clupeids, and engraulids, and a negative loading for dipterans, veliids, *Paleomonetes* spp., and vegetation.

A plot of PC2 on PC1 revealed differences in catfish diet composition among all 3 lakes (Fig. 1). Channel catfish from Lac Des Allemands loaded highly on PC2, which was primarily related to the dietary importance of fish, *Corophium*, and corixids. Flat Lake catfish exhibited low loadings on both PC1 and PC2 due to predominance of algae in stomach contents. Lake Maurepas catfish showed intermediate loadings on PC1 and PC2, reflecting the dietary importance of several invertebrate and vertebrate taxa. Catfish from Lac Des Allemands and Flat Lake exhibited few dietary differences among size classes, as evidenced by similar loadings among size classes within lakes (Fig. 1). In contrast, Lake Maurepas catfish showed a consistent progression along PC1 with increasing size, which was related to an increase in the dietary proportion of fish in larger size classes and exploitation of *Panaeus* by catfish over 261 mm TL. Little seasonal variation in the dietary proportions of major prey groups were evident within channel catfish populations in the 3 lakes (Table 3).

Discussion

Differences in channel catfish collection periods could have contributed to dietary differences between catfish from the 3 lakes. However, differences in the taxonomic composition of channel catfish diets were evident during summer and fall when all 3 lakes were sampled. Benthic foraging by catfish from Flat Lake, indicated by the high proportion of ingested algae, has been previously reported for channel catfish populations in a wide variety of habitats (Perry 1969, Jearld 1970, Mathur 1972). Benthic prey also comprised between 17% and 30% of the diet of catfish from Lac Des Allemands and Lake Maurepas, but dietary proportions of algae were low.

Prey taxa found in stomachs of Flat Lake channel catfish were less diverse than those found in fish from the other 2 lakes. In particular, fish comprised 43% and 67% of the diet by volume in catfish from Lake Maurepas and Lac Des Allemands respectively, and the absence of fish in stomachs of Flat Lake catfish accounted for much of the separation in diet among lakes (PC2). Fish have been found to be a

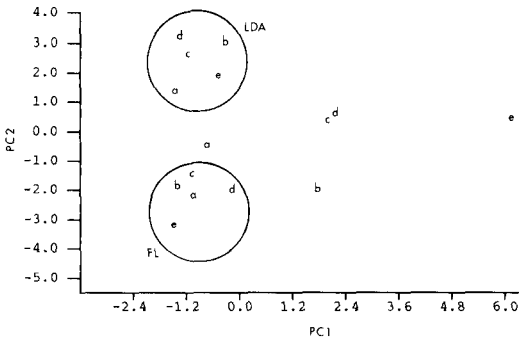

Figure 1. Plot of Principal Component 2 (PC2) on Principal Component 1 (PC1) for 5 size classes (a, 100–140 mm TAL; b, 141–180 mm TL; c, 181–220 mm TL; d, 221–260 mm TL; e, > 261 mm TL) of channel catfish from Lac Des Allelmands (LDA), Flat Lake (FL) and Lake Maurepas (uncircled), Louisiana. Circles are for identification only.

major component of channel catfish diets, particularly in larger size classes (Baily and Harrison 1948, Ware 1967, Mathur 1972, Cannamela et al. 1980, Robinette and Knight 1983). Diets of channel catfish from Lac Des Allemands and Lake Maurepas were similar to those previously reported for channel catfish in southwestern Louisiana (Perry 1969), where piscivory was noted in size classes > 100 mm TL.

Results of diet composition analyses were puzzling in view of growth patterns exhibited by Lake Maurepas, Lac Des Allemands, and Flat Lake channel catfish. Morphometric analyses (Lutz et al. 1987) and preliminary growth data indicated that catfish in Lake Maurepas and Lac Des Allemands were similar in body form and grew < 150 mm TL at age I (M. G. McElroy, unpubl. data) compared to 200 mm TL for age-I catfish in Flat Lake, which was similar to that reported for channel

Table 3. Percent of total volume of major prey groups in stomachs of Lac Des Allemands (LDA), Lake Maurepas (LM), and Flat Lake (FL), Louisiana, channel catfish during spring (March-May), summer (June-August), fall (October-November), and winter (December-February). Blanks denote no collections during that season.

		Season			
Prey group	Lake	Spring	Summer	Fall	Winter
Pelecypoda	LDA	0.00	0.00	0.00	0.00
	LM	0.01	0.02	0.01	
	FL		0.00	0.00	
Insecta	LDA	0.10	0.01	0.00	0.00
	LM	0.04	0.01	0.01	
	FL		0.07	0.05	
Crustacea	LDA	0.02	0.21	0.20	1.00
	LM	0.47	0.19	0.32	
	FL		0.36	0.01	
Osteichthyes	LDA	0.88	0.68	0.79	0.00
	LM	0.48	0.78	0.49	
	FL		0.01	0.01	
Vegetation	LDA	0.00	0.10	0.01	0.00
	LM	0.01	0.01	0.17	
	FL		0.55	0.93	

catfish in other Mississippi River habitats (Lee 1983). Results of diet analyses, however, did not correlate with observed growth patterns and did not support the hypothesis that a lack of forage quantity or quality was responsible for reduced growth of catfish in southeastern Louisiana lakes. In fact, stomach contents indicated that slow growing channel catfish in Lac Des Allemands and Lake Maurepas were exploiting a more diverse and presumably nutritionally adequate vertebrate and invertebrate forage base than catfish in the lower Atchafalaya Basin, at least during summer and fall.

Reduced growth rates of catfish in Lac Des Allemands and Lake Maurepas may be a function of overcrowding, yet overcrowding was not evidenced by low stomach content volumes. In addition, these catfish have been harvested extensively for many years (Schafer et al. 1967), and growth has not improved. However, catfish diet composition in these lakes suggests an alternative explanation for observed growth and maturity patterns. Marine prey organisms, particularly engraulids (primarily *Anchoa mitchilli*), *Penaeus* spp. and the amphipod *Corophium* spp.) accounted for 61.4% and 45.9% of the diets of channel catfish in Lac Des Allemands and Lake Maurepas, respectively. Previous research has demonstrated negative impacts of salinity (9 ‰) on catfish growth in experimental ponds (Allen and Avault 1969), although results have been conflicting (Lewis 1973). Reduced growth of largemouth bass (*Micropterus salmoides*) inhabiting brackish Louisiana marshes has been reported (Meador 1988), and such a growth strategy may be a common physiological response of freshwater fishes that are chronically exposed to low salinity.

In summary, diet analyses did not reflect reduced forage quantity or quality in catfish populations exhibiting slow growth and reduced length at maturity. Taxonomic composition of the diet indicated a more mesohaline environment in Lac Des Allemands and Lake Maurepas relative to Flat Lake, and slow growth and reduced length at maturity of channel catfish in southeastern Louisiana lakes may be a response to physiochemical conditions rather than forage limitation.

Literature Cited

Allen, K. O. and J. W. Avault. 1969. Effects of salinity on growth and survival of channel catfish, *Ictalurus punctatus*. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 23:319–323.

Bailey, R. M. and H. M. Harrison. 1948. Food habits of the southern channel catfish (*Ictalurus lacustris punctatus*) in the Des Moines River, Iowa. Trans. Am. Fish. Soc. 75:110–138.

Cannamela, D. A., J. D. Brader, and D. W. Johnson. 1980. Feeding habits of catfishes in Barkley and Kentucky Lakes. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 32:686–691.

Carlander, K. D. 1969. Handbook of freshwater fishery biology. Volume 1. Iowa State Univ. Press, Ames, 752pp.

Chambers, D. G. 1980. An analysis of nekton communities in the upper Barataria Basin, Louisiana. M.S. Thesis, La. State Univ., Baton Rouge. 286pp.

Condor, J. B., and R. Hoffarth. 1962. Growth of channel catfish, *Ictalurus punctatus,* and blue catfish, *Ictalurus furcatus,* in the Kentucky Lake portion of the Tennessee River in Tennessee. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 16:349–359.

Jearld, A. 1970. Fecundity, food habits, age and growth, length-weight relationships and condition of channel catfish, *Ictalurus punctatus* (Rafinesque) in a 3300-acre turbid Oklahoma reservoir. M.S. Thesis, Okla. State Univ., Stillwater. 78pp.

Lee, D. C. 1983. Growth of blue, channel, and flathead catfish in selected habitats of the lower Mississippi River. M.S. Thesis, Univ. of Tenn., Knoxville. 58pp.

Lewis, S. D. 1973. Effect of selected concentrations of sodium chloride on the growth of channel catfish. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 25:459–466.

Lutz, C. G., W. R. Wolters, A. J. Joubert, C. F. Bryan, and W. E. Kelso. 1987. Multivariate morphological variation in channel catfish, *Ictalurus punctatus,* from three southeast Louisiana lakes. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 41:136–144.

Mathur, D. 1972. Food habits and feeding chronology of channel catfish, *Ictalurus punctatus* (Rafinesque), in Conowingo Reservoir. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 24:377–386.

Meador, M. R. 1988. Behavioral and physiological adaptation of largemouth bass (*Micropterus salmoides*) to low-salinity environments. Ph.D. Diss., La. State Univ., Baton Rouge. 109pp.

Perry, W. G. 1969. Food habits of blue and channel catfish collected from a brackish-water habitat. Prog. Fish-Cult. 31:476–50.

Robinette, H. R. and S. S. Knight. 1983. Foods of channel catfish during flooding of the Tombigbee River, Mississippi. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 35:598–606.

SAS. 1985. SAS user's guide: Statistics, Version 5. SAS Inst. Inc., Cary, N.C. 957pp.

Schafer, H., L. Posey, and G. Davidson. 1967. The use of cans in harvesting catfish. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 19:210–216.

Steele, R. G. D. and J. H. Torrie. 1980. Principles and procedures of statistics. McGraw-Hill Book Co., New York. 633pp.

U.S. Dep. Commerce. 1977. Fisheries statistics of the United States. NOAA, Nat. Mar. Fish. Serv., Washington, D.C. 458pp.

Ware, F. J. 1967. The food habits of channel catfish in south Florida. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 20:283–287.