LENGTH AT MATURITY AND TOTAL LENGTH-COLLARBONE LENGTH CONVERSIONS FOR CHANNEL CATFISH, *ICTALURUS PUNCTATUS*, AND BLUE CATFISH, *ICTALURUS FURCATUS*, COLLECTED FROM THE MARSHES OF SOUTHWEST LOUISIANA

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ABSTRACT

This paper describes the results of a length and weight at maturity study of channel catfish, *Ictalurus punctatus*, and blue catfish, *Ictalurus furcatus*. Total length-collarbone length and collarbone length-total length conversion factors were determined and are presented for future biological references. Data were collected from the marshes of Southwest Louisiana.

INTRODUCTION

Louisiana's marshes are well known for their high productivity of channel catfish, *Ictalurus punctatus*, and blue catfish, *I. furcatus*. The coastal commercial harvest of catfishes far surpasses the remainder of the state. The Bureau of Commercial Fisheries report for 1970 states that the commercial catfish harvest for Louisiana was 5,547,000 pounds, valued at $1,594,000.00. Of this, 4,227,000 pounds representing $1,212,000.00 came from the coastal portions of Louisiana. The same was true for 1971, 4,450,000 pounds for the state, 3,172,000 pounds for the coastal marshes (Arville Allen, Personal Communication).

Lantz (1970) in an ecological survey of factors affecting fish production in Lac Des Allemands suggested a need to determine size of channel catfish at maturity in coastal Louisiana. Lantz's data supported findings of Schafer *et al.* (1965) that channel catfish matured at smaller total lengths than reported elsewhere. Lantz postulated that channel catfish as well as some sunfish species under brackish water conditions do not obtain the lengths and weights experienced in more inland freshwaters. He reported high annual standing crops of catfish, yet only limited numbers were of harvestable size based on the present Louisiana size limit of 13 inches total length or 10 inches with collarbone off.

Commercial catfish are often marketed heads off. Louisiana has a minimum collarbone off length restriction for dressed catfish. No total length-collarbone length comparisons are given in the literature; therefore, it was deemed necessary to determine these factors as a management tool and for future comparisons with these data. Computations of total length-collarbone length conversion factors for both sexes of channel and blue catfish were included in the study along with length-weight and length frequency relationships.

This study was initiated to gather additional data to support Louisiana's commercial size regulations which are apparently based upon the age old theory that large numbers of immature fish must escape harvest to perpetuate the fishery. It is hoped these data prove useful in management design to better exploit the fishery of Louisiana's coastal waters when used with other population indices.

DESCRIPTION OF STUDY AREA

This study was conducted in the coastal prairie marshes of Southwest Louisiana. Samples were taken along the northern Property Line Canal and Superior Canal complex of Rockefeller Wildlife Refuge which extends beyond the eastern edge of Grand Chenier, Louisiana. Drainage of this water system is into the Gulf of Mexico and varying degrees of salinity are experienced. Salinities were 3.5 parts per thousand and below during this sampling period. Samples were also taken approximately 20 nautical miles north of the refuge in the Old Intracoastal Canal just west of White Lake. This lake is a large freshwater lake which supports a considerable commercial catfishery.

MATERIALS AND METHODS

During the spring and early summer of 1972, 693 channel catfish and 466 blue catfish were collected for the study. A 27 foot, ¾ inch square mesh, balloon type, otter trawl was towed approximately 20-30 minutes at each sample site. This gear tended to be selective in the harvest of many small catfish, the majority of which were not mature. Rotenone, when applied at a concentration of 2 ppm was less selective and furnished fish of all sizes. Four 5′ x 2′ single throated wire traps constructed of 1″ x 2″ weld wire were fished periodically throughout the study. When baited with cotton seed cake this gear was highly selective for channel catfish.

Total length and collarbone length (distance from the posterior end of the collarbone to the tip of the tail) was measured to the nearest millimeter and the weight recorded in grams for each fish. Gross examination of the catfish in the field determined sex and gonadal development. The basis for maturity classification was on criteria given by Davis and Posey (1958). Female catfish classed as mature included all fish in which the ovaries were fully swollen or developed, contained yellowish to creamy-yellow eggs or were spent for the present year. Mature males were those with enlarged or swollen testis, milkish in color. Others were classed as immature.

The fish were grouped in class intervals of 10 millimeters and average total lengths, average collarbone lengths and average weights were determined for each interval. Percent maturity was determined for each class interval. This average total length and percent maturity of channel catfish appeared to be a straight line when plotted on arithmetic grid. A linear regression was computed for the comparison. The data for the blue catfish did not require such a comparison as the scarcity of fish in the stages approaching maturity resulted in size classes that were either 100 percent immature or 100 percent mature. The 50 percent mature level was selected for calculated size at maturity. Other studies (Davis and Posey, 1958; DeRoth, 1965, Appleget and Smith, 1950) seemed to use this criterion and other biological determinations are often judged on a 50 percent level.

Length-frequency histograms and length-weight relationships were prepared as an indicator of age and weight at maturity. The length-frequency determinations were obtained from rotenone data since it was least selective to size. Length-weight relationships were calculated by sex based upon the average measurements expressed logarithmically. This relationship is $\text{Log } W = \text{Log } a + b \text{ Log } L$.

where W = weight in pounds
L = total length in inches.

Factors for converting total length to collarbone length and collarbone length to total length were calculated by dividing the average total length by the average collarbone length and vice versa. Conversion ratios were interpreted for each class interval to determine whether the factor changes with size and sex of

channel catfish and blue catfish. The following formulas were used to calculate total length and collarbone length from the ratios:

$$\text{Total length} = \text{collarbone length} \times \frac{\text{average total length}}{\text{average collarbone length}}$$

$$\text{Collarbone length} = \text{total length} \times \frac{\text{average collarbone length}}{\text{average total length}}$$

The collarbone length-total length data were compared by means of a linear regression for each sex of each species. An analysis of variance was calculated between sexes for both channel and blue catfish.

RESULTS

Channel catfish length at maturity

A total of 267 gonads from female channel catfish were examined. Approximately 86 percent of the fish were not mature, thus an ample number of the smaller sized fish were checked. The channel catfish examined ranged from 80 mm to 379 mm total length (Table 1). The smallest fish considered mature was in the 200-209 mm class interval (8.0 inches). Only two out of 25 catfish were ripe. The percent maturity gradually increased with size until the 280-289 millimeter class was made up of 75 percent mature fish (11.1 inches average total length). The data did not yield 100 percent mature fish until the 350-359 mm class interval (14.4 inches).

Figure 1 illustrates the equation resulting for the female channel catfish maturity data, $Y = -0.8463 + 0.1186X$. The correlation coefficient (r) equalled 0.8905. The size at maturity for female channel catfish collected from Southwest Louisiana at the 50 percent level of maturity as defined by this equation was 11.35 inches total length.

Table 1. Numbers of mature and immature channel catfish collected from the marshes of Southwest Louisiana, 1972.

Total Length	Mature Males	Immature Males	Mature Females	Immature Females
130-139	-	1	-	-
140-149	-	-	-	1
150-159	-	-	-	-
160-169	-	5	-	3
170-179	1	11	-	6
180-189	-	13	-	8
190-199	-	17	-	12
200-209	2	24	2	23
210-219	2	22	1	30
220-229	6	23	4	15
230-239	7	19	4	21
240-249	7	19	5	26
250-259	8	12	2	13
260-269	6	11	7	19
270-279	10	8	6	8
280-289	14	4	9	3
290-299	9	8	5	3
300-309	5	7	8	2
310-319	5	1	5	7
320-329	5	1	4	1
330-339	5	-	-	-

Total Length	Mature Males	Immature Males	Mature Females	Immature Females
340-349	7	-	1	1
350-359	2	-	1	-
360-369	2	-	-	-
370-379	3	-	1	-
380-389	3	-	-	-
390-399	-	-	-	-
400-409	1	-	-	-
410-419	1	-	-	-

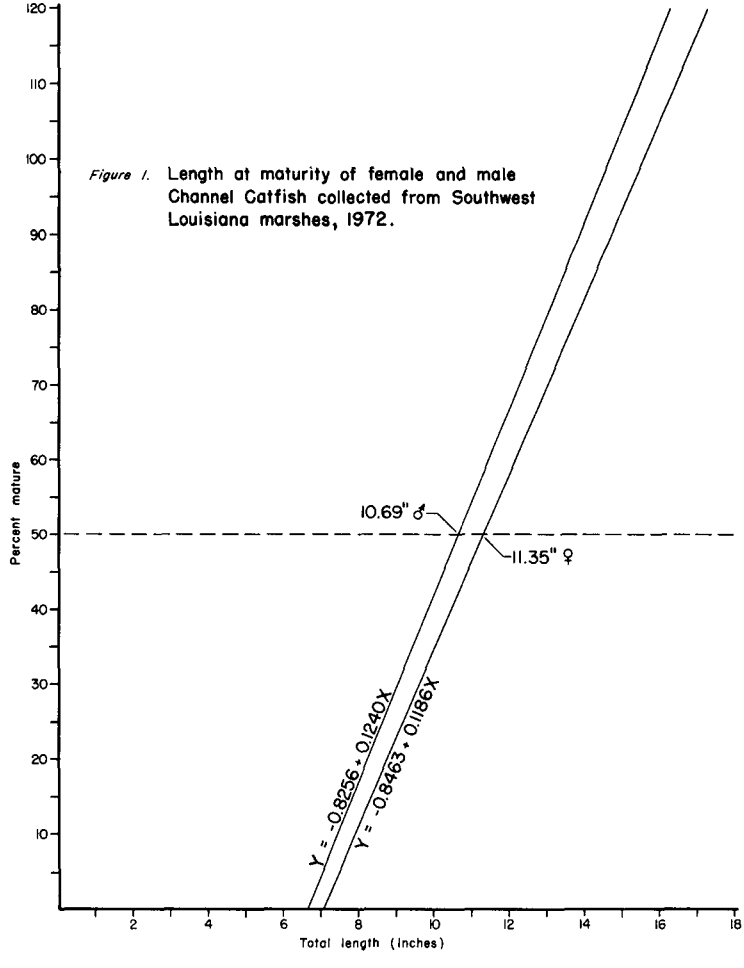

Figure 1. Length at maturity of female and male Channel Catfish collected from Southwest Louisiana marshes, 1972.

The gonadal development of 317 male catfish was examined for maturity. Microscopic examination revealed several males in the 180-189 mm class interval with motile sperm. These fish had testes not swollen, but stringy and barely distinguishable and probably would not spawn during the present year. The smallest mature male collected was in the 170-179 mm class interval. One 6.7 inch fish out of 12 was mature. Male channel catfish were 100 percent mature once they reached the 330-339 mm (13.1 inches) class interval. The linear regression equation, $Y = -0.8256 + 0.1240X$, computed for the male catfish had a correlation coefficient (r) of 0.9534. It was concluded from this equation that 50 percent of the male channel catfish were mature at 10.69 inches total length (Figure 1).

Growth rates were obtained from length-frequency data from rotenone samples. The age through group III is fairly evident from the size distribution (Figure 2). The lengths of the age groups for combined sexes agree rather closely with data obtained by Perry (1966) from the same area. Age group I was approximately 4.0 inches, age group II was 8.0 inches and age group III 10.7 inches. This indicates that some channel catfish in Southwest Louisiana marshes apparently mature during their second year of growth and 50 percent are mature by the middle of the third year.

The length-weight relationship equation obtained from the data are as follows: female, Log W = -3.77811 + 3.29505 Log L, correlation coefficient (r) = 0.99797; male Log W = -3.68654 + 3.19335 Log L, correlation coefficient (r) = 0.99701. Based upon these equations, the females are approximately 0.49 pound when 50 percent are mature and the males are approximately 0.39 pound.

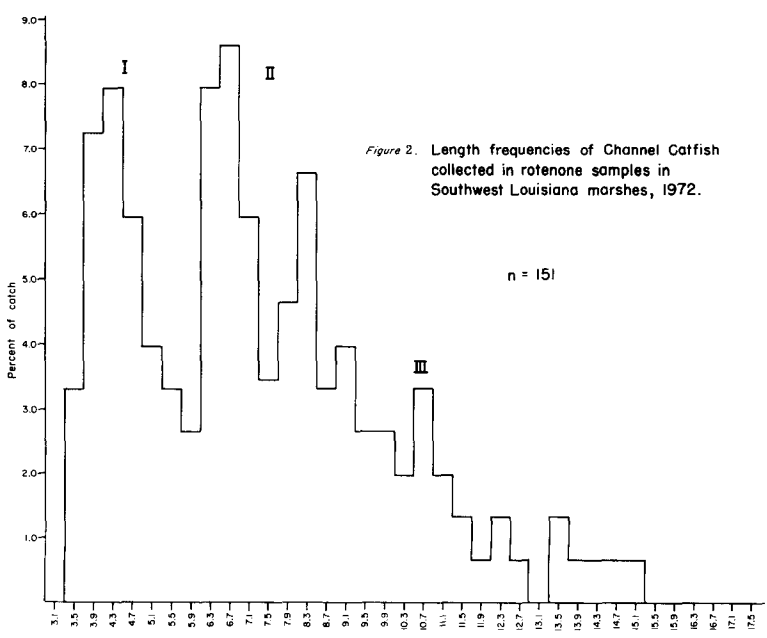

Figure 2. Length frequencies of Channel Catfish collected in rotenone samples in Southwest Louisiana marshes, 1972.

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Channel catfish total length-collarbone length conversion.

Total length-collarbone length (TL/CB) conversions calculated for each 10 mm class interval revealed the ratios were rather constant regardless of size. The weighted average TL/CB was 1.2169 for channel catfish females and 1.2216 for males. Collarbone length/total length weighted conversions equalled 0.8217 and 0.8185 for the female and male catfish, respectively. This sexual dimorphism was significant at the 0.05 level of probability ($P<0.05$); $F = 4.9200$ for the TL/CB factors and $F = 5.4000$ with 1 and 42 degrees of freedom for the CB/TL factors.

The regression of the total length-collarbone length relationship was computed and is included in Figure 3 for reference. The resulting equations for female and male channel catfish were $Y = -0.0794 + 0.8310X$ and $Y = 0.2386 + 0.7904X$ respectively. The correlation coefficients (r) were 0.9980 for the female and 0.9980 for the male catfish.

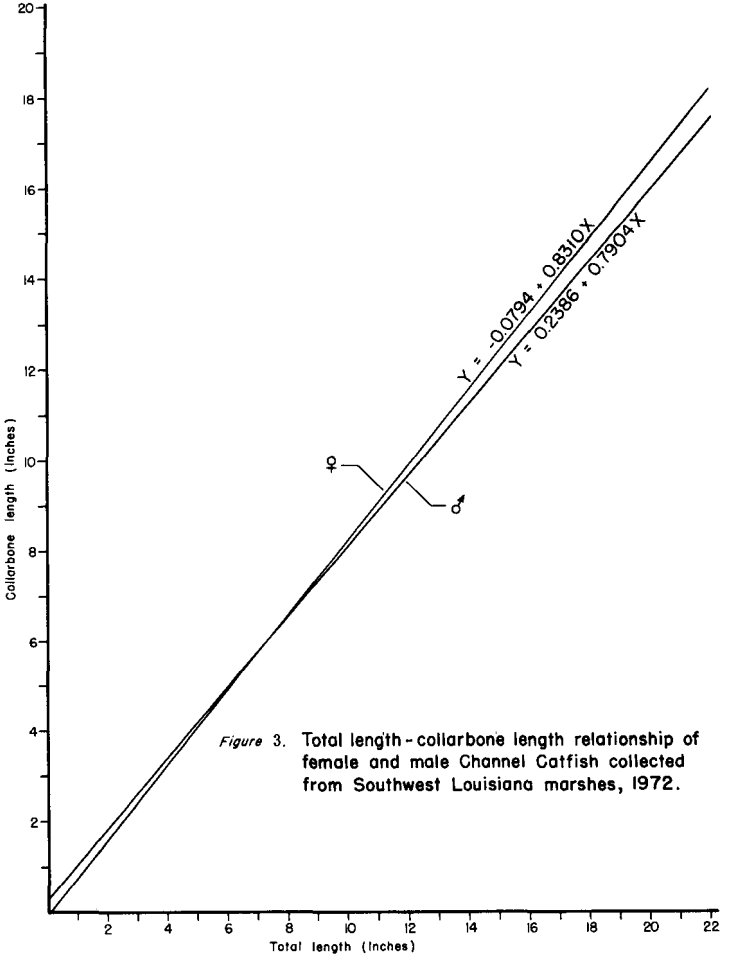

Figure 3. Total length-collarbone length relationship of female and male Channel Catfish collected from Southwest Louisiana marshes, 1972.

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Blue catfish length at maturity

Sample data is not as conclusive for blue catfish, even though the gonads of 315 fish were examined. Additional observations of the sizes approaching maturity will be necessary before any definite conclusions are made. As evident in Table 2, the blue catfish in all size intervals were usually 100 percent immature or 100 percent mature. None of the female blue catfish less than 590 mm (23.2 inches) total length were mature. However, female blue catfish were 100 percent mature once they obtained this length. The males approached maturity in the 410-419 mm class interval (16.4 inches) and were 100 percent mature at 490 mm (19.3 inches) total length. Overlapping occurred in the 410-490 mm class interval (15.8-19.3 inches).

Data for blue catfish age groups were obtained from the length-frequency histogram. Figure 4 includes age groups through IV. As with the channel catfish, these data were supported by age and growth data reported by Perry (1966). The approximate lengths at each of the year classes as indicated by the histogram are 4.7, 8.0, 13 and 16 inches. These data suggest that male blue catfish in Southern Louisiana apparently approach maturity during their fourth year and females may mature at an older age, possibly age group 5.

The mathematical relationship between total length and weight of blue catfish is described by the formula: Log W = -3.73410 + 3.21531 Log L, correlation coefficient (r) = 0.99763 for females; Log W = -3.75381 + 3.25385 Log L, correlation coefficient (r) = 0.99791 for males. It was calculated from these equations that female and male catfish when approaching maturity will weigh approximately 4.5 and 1.5 pounds, respectively.

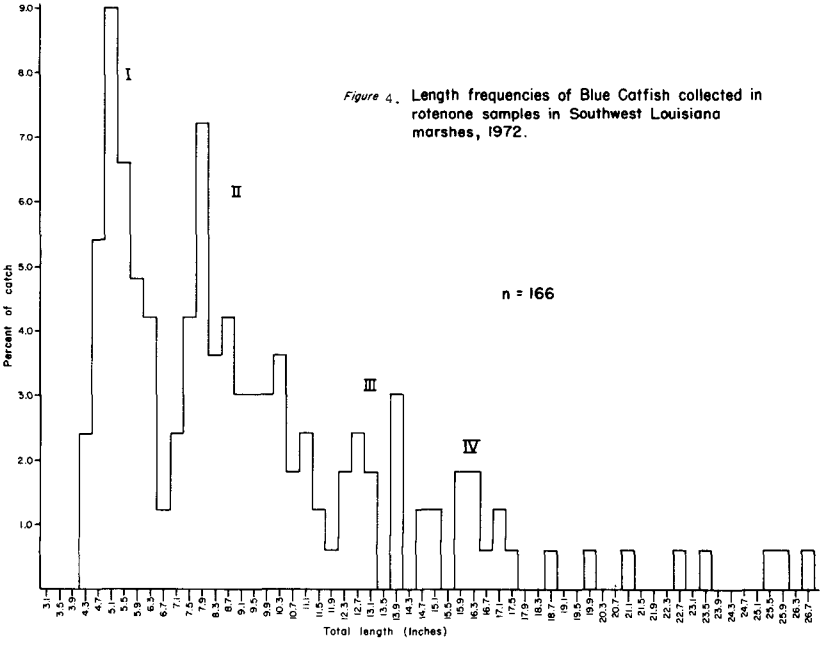

Figure 4. Length frequencies of Blue Catfish collected in rotenone samples in Southwest Louisiana marshes, 1972.

Table 2. Numbers of mature and immature Blue Catfish collected from the marshes of Southwest Louisiana, 1972.

Total Length	M* Males	I** Males	M* Females	I** Females
100-109	-	1	-	1
110-119	-	-	-	5
120-129	-	-	-	7
130-139	-	-	-	7
140-149	-	-	-	4
150-159	-	1	-	1
160-169	-	2	-	1
170-179	-	4	-	2
180-189	-	4	-	3
190-199	-	6	-	6
200-209	-	5	-	9
210-219	-	6	-	6
220-229	-	6	-	9
230-239	-	5	-	1
240-249	-	4	-	4
250-259	-	4	-	9
260-269	-	7	-	10
270-279	-	3	-	5
280-289	-	4	-	4
290-299	-	2	-	5
300-309	-	3	-	3
310-319	-	7	-	6
320-329	-	4	-	4
330-339	-	5	-	4
340-349	-	6	-	4
350-359	-	5	-	4
360-369	-	1	-	1
370-379	-	1	-	4
380-389	-	-	-	5
390-399	-	-	-	2
400-409	-	3	-	3
410-419	2	-	-	4
420-429	-	1	-	2
430-439	-	2	-	1
440-449	1	-	-	1
450-459	-	1	-	1
460-469	-	-	-	1
470-479	-	1	-	-
480-489	-	-	-	1
490-499	1	-	-	-

*Mature
**Immature

Total Length	M* Males	I** Males	M* Females	I** Females
500-509	1	-	-	-
510-519	-	-	-	-
520-529	-	-	-	-
530-539	1	-	-	1
540-549	-	-	-	-
550-559	-	-	-	-
560-569	1	-	-	-
570-579	1	-	-	-
580-589	-	-	-	-
590-599	2	-	2	-
600-609	-	-	2	-
610-619	-	-	-	-
620-629	-	-	1	-
630-639	1	-	1	-
640-649	1	-	-	-
650-659	1	-	-	-
660-669	1	-	-	-
670-679	1	-	-	-
680-689	2	-	-	-
690-699	-	-	2	-
700-709	-	-	1	-
710-719	-	-	-	-
720-729	-	-	-	-
730-739	-	-	-	-
740-749	-	-	-	-
750-759	-	-	-	-
760-769	-	-	-	-
770-779	1	-	1	-
780-789	-	-	-	-
790-799	-	-	-	-
800-809	-	-	-	-
810-819	-	-	-	-
820-829	-	-	-	-
830-839	-	-	-	-
840-849	-	-	-	-
850-859	-	-	-	-
860-869	-	-	-	-
870-879	-	-	-	-
880-889	-	-	-	-
890-899	-	-	1	-

Blue catfish total length-collarbone length conversion.

The TL/CB and CB/TL conversions determined for blue catfish were rather constant with only a small change due to growth. The weighted TL/CB and CB/TL factors calculated for 154 blue females were 1.2221 and 0.8186, respectively. Measurements of 120 males gave a weighted TL/CB factor of 1.2175 and a weighted CB/TL factor of 0.8216. The differences of the TL/CB and CB/TL factors due to sex were non-significant at the 0.05 level of probability ($P<0.05$), $F = 0.16447$ and $F = 0.09090$ with 1 and 83 degrees of freedom.

These data were fitted to a linear regression analysis and two very close parallel lines were obtained (Figure 5) due to the slight sexual differences. The equations were $Y = 0.2285 + 0.7965X$, correlation coefficient (r) = 0.9961, for females and $Y = 0.3519 + 0.7923X$, correlation coefficient (r) = 0.9986, for males.

DISCUSSION

In general this study indicates that there is little difference in the size at maturity of channel catfish with regard to north-south geographic distribution. With the exception of a slight disagreement on the males, our findings are similar to those Davis and Posey (1958) reported for channel catfish collected largely from northern waters of Louisiana. They reported a large percentage of female catfish maturing in the 10.5 to 11.0 inch range. This study shows 11.4 inches for Southwest Louisiana female channel catfish. Davis and Posey's works indicated that males matured at 12-12.5 inches. Southwest Louisiana male channel catfish mature at a smaller size than females, 10.7 inches.

Lantz (1970) in examining gonads of channel catfish from Lac Des Allemands found at least 40 percent of male and female channel catfish between 8.0 and 9.0 inches were either sexually mature or showed signs of development. He reported finding several mature females at 6.5 inches total length. This contradiction may be explained by a statement by Lantz (1970) in his report, "It is quite possible though that lack of adequate harvest in Lac Des Allemands (through restrictive regulations on methods of harvest and legal size limits) have resulted in a crowded channel catfish population and subsequent stunting."

Schafer *et al.* (1965) encountered ripe females as small as 8.0 inches total length in studies involving the "can fishery" in the same South Louisiana lake. They also reported a 6.5 inch male tending fry in a can.

In a study of the upper Mississippi River near Lansing, Iowa, Appelget and Smith (1950) recorded female channel catfish maturing at a larger size than the males. Their report showed approximately 50 percent of the female channel catfish to be mature in the 14-15 inch group or during the fifth year. Mature male channel catfish comprised approximately 50 percent of those 13-14 inches total length or 4-5 years old. They did not report 100 percent maturity until 22 inches was reached. Canfield (1947) in a study conducted at Fairport, Iowa on the propagation of channel catfish stated that the fish will not produce eggs until four years old.

In a study conducted in Western Lake Erie, DeRoth (1965) reported similar results to Appelget and Smith's (1950) Lansing, Iowa study if ages rather than total lengths were used as a criterion for comparison. He reported 50 percent males and females were mature at five years. However, fish collected from Lake Erie matured at a smaller total length; 50 percent of the females in the 10-11 inch group were mature; 50 percent of the males in the 11-12 inch group were sexually mature.

Mony Jaspers (Personal Communication) supported microscopic findings of this study when 48 known-aged, pond-reared, channel catfish were observed as part of a Louisiana State University genetics study. She reported finding a large percent of two year old males (10.9 inches and above) with motile sperm even though several of these fish did not have well developed testes.

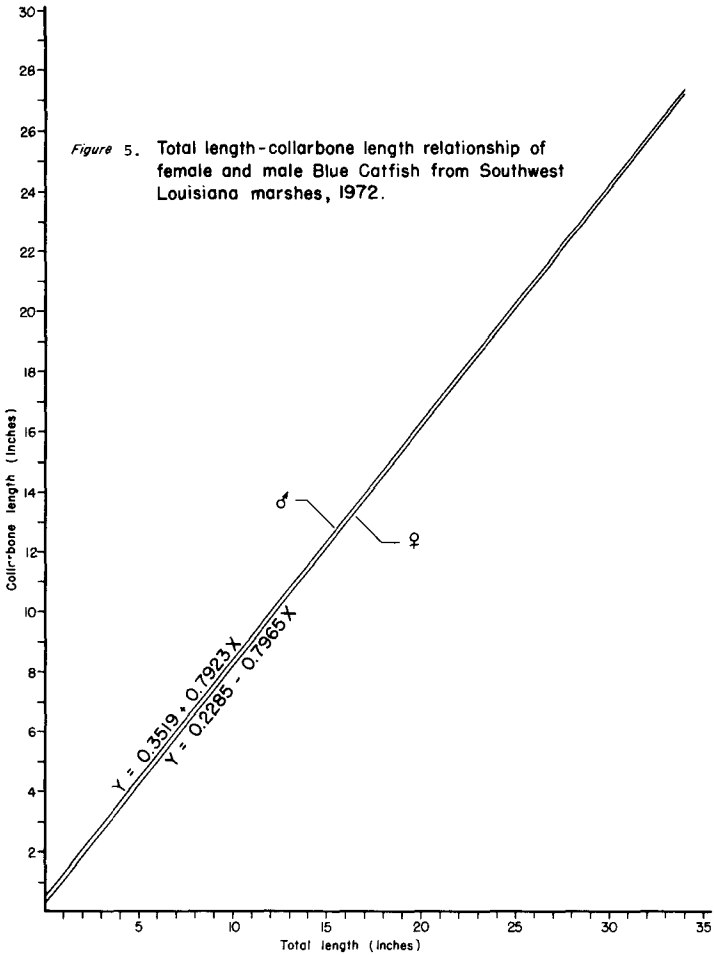

Figure 5. Total length-collarbone length relationship of female and male Blue Catfish from Southwest Louisiana marshes, 1972.

For all practical purposes, in the inspection of dressed channel and blue catfish, one has only to multiply the collarbone length by 1.22 to obtain the total length of the fish in question. The potential collarbone off values may be also obtained in a like manner, the total length multiplied by 0.82. For a more detailed answer, the entire weighed factor should be included by species and sex.

The authors were unable to find any references of age or size at maturity of blue catfish. However, there are numerous age and growth, food habit and similar studies reported. The importance of this fish should have warranted this type study long before now.

Several years of pond culture experienced with this fish have indicated that very few farmers will stock brood blue catfish less than 5 pounds. Mr. Edgar Farmer (Personal Communication) stated a small percent of pond reared blue

catfish spawn at four years of age. At 5 years of age he describes considerably better results. Also, it may be interesting to report that the blue catfish are usually much harder to spawn, especially for the novice farmers.

SUMMARY

1. Little difference in size at maturity of channel catfish in Louisiana waters have been found with the exception of one study which may have been in a stunted population.

2. The criterion of total length may be as good as any factor in describing maturity. A review of the literature revealed in all but one study, approximately 50 percent of the channel catfish females were mature in the 10-12 inch group. Fifty percent of the male channel catfish were mature in the 9.5-12.5 inch groups. Ages at maturity ranged from age group II-III in Louisiana, age group IV in Fairport, Iowa, and age group V in Western Lake Erie.

3. In Southwest Louisiana, female channel catfish mature in 2-3 years at 11.4 inches total length and a weight of 0.5 pound; males mature at 10.7 inches and 0.4 pound when the 50 percent level of maturity is used.

4. Weighted average conversion factors TL/CB and CB/TL computed for female channel catfish are 1.2169 and 0.8217, respectively. Total length/collarbone length and CB/TL are 1.2216 and 0.8185 for male channel catfish. Sexual dimorphism was significant ($P<0.05$).

5. Limited data only permitted the authors to make suggestions within degrees concerning the blue catfish size a maturity. It seems that females approached maturity at 23.2 inches or approximately 4.5 pounds. The males seem to mature somewhat smaller, around 16.4 inches total length and 1.6 pounds.

6. Considering age, if blue catfish follow the same trend exhibited by channel catfish, the fish should approach maturity after 4 years.

7. The weighted TL/CB and CB/TL conversions determined for blue catfish females were 1.2221 and 0.8186, respectively. Males had TL/CB and CB/TL factors of 1.2175 and 0.8216. Difference due to sex was non-significant at the 0.05 level of probability ($P<0.05$)

8. Further study should be devoted to the growth characteristics of the blue catfish.

ACKNOWLEDGEMENTS

The authors are extremely grateful to Messrs. Steve DuBois, Steve Murphy, Tom Hess and Randy Moertel, advanced wildlife students, Louisiana Tech University, who donated their time and efforts in assisting in most phases of this study. Sincere appreciation is also extended to Messrs. Henry Ratcliff, Brandon Carter and Kim Fawvor for their assistance to the authors in much of the field data collection without which this project could not have been conducted. Thanks are extended to Mr. Eddie Bennett, Engineering Specialist, Louisiana Wild Life and Fisheries Commission, for his aid in the preparation of the figures.

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TEMPERATURE-LIGHT EFFECTS ON GROWTH, FOOD CONSUMPTION, FOOD CONVERSION EFFICIENCY, AND BEHAVIOR OF BLUE CATFISH, *ICTALURUS FURCATUS* (LESUEUR)

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INTRODUCTION

Temperature and light are two environmental forces that affect the lives of fishes in complex and often interrelated fashion. The growth patterns of fishes are influenced by the seasonal changes in temperature and light as well as the amount of food consumed, the efficiency of conversion, and the behavior of the fish.

A great deal of published information on the effects of temperature and light individually on fish growth is available. Except for the work of Kilambi, Noble and Hoffman (1971) on channel catfish, knowledge on the combined effects of temperature and light on fish growth, food consumption, etc., is meager. This paper reports on the influences of temperature and light combinations on growth, food consumption, food conversion efficiency, and behavior of fingerling blue catfish.

METHODS AND MATERIALS

Experiments were conducted over a two-year period under controlled laboratory conditions. The experimental conditions used in the first year (1969-1970) were 20, 25, 30, and 35 C with 8- and 16-hour photoperiods and total darkness. Due to thermo-regulator malfunctions, all the fish in the experimental conditions 20 C and 25 C - 8-hr photoperiod, and 30 C - total darkness died. The fish at 35 C and all the light conditions showed high incidence of vertebral deformities and therefore the data were not analyzed. The experimental conditions used in the second year (1971) were 20, 25, and 30 C with 8- and 16-hour photoperiods and total darkness. In addition a 25 C - 8-hour photoperiod having one-half the light intensity of the previous conditions, was also used in the second year.