FECUNDITY, AGE AND GROWTH, AND CONDITION OF CHANNEL CATFISH IN AN OKLAHOMA RESERVOIR

Ambrose Jearld, Jr.[1] and Bradford E. Brown[2]

Oklahoma Cooperative Fishery Unit,[3] Oklahoma State University, Stillwater, Oklahoma

From October, 1967 through August, 1968, channel catfish were collected, chiefly by gill nets, from six major sites in Lake Carl Blackwell, a 3,000 acre, turbid, old (dam completed in 1937) reservoir. Life history information, which can aid in the management of the sport fishery in this and similar bodies of water, was obtained. Data on fecundity, age and growth, length-weight relationships, and condition factors are presented. Size at age and condition factors are among the lowest reported in the literature. The evidence indicated a late May into early June spawning period.

The general lack of information on the life history of channel catfish, *Ictalurus punctatus*, in reservoirs stimulated the present study. Its objective was to obtain life history information which can be useful to management designed to improve the sport fishery in this and similar bodies of water. The information sought included the age and growth relationships, fecundity, spawning time, length-weight relationships, and condition factors of channel catfish taken from Lake Carl Blackwell.

MATERIALS AND METHODS

The study area

Lake Carl Blackwell (Figure 1) is located nine miles northwest of Stillwater, Oklahoma. Construction of the dam was completed in 1937, at which time the basin began filling until it reached spillway level in 1945 with 3,700 acres maximum surface. A description of the reservoir is given by Norton (1). The reservoir at spillway level has a shoreline of about 100 miles. During this study, the shallowest section, in the west end, terminated in wide mud flats at the low water levels.

Collection of fish

Channel catfish included in this study were collected from October, 1967 through August, 1968. The major portion were collected by use of gill nets and, to a lesser extent, by use of a trap net, barrel traps, wire traps, rotenone cove samples, and electrofishing gear.

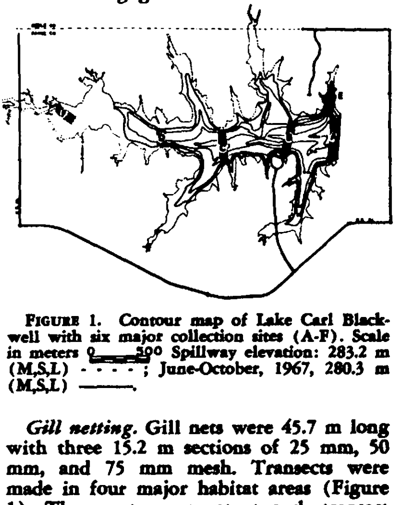

FIGURE 1. Contour map of Lake Carl Blackwell with six major collection sites (A-F). Scale in meters 0 500 Spillway elevation: 283.2 m (M.S.L) - - - - ; June-October, 1967, 280.3 m (M.S.L) ———.

Gill netting. Gill nets were 45.7 m long with three 15.2 m sections of 25 mm, 50 mm, and 75 mm mesh. Transects were made in four major habitat areas (Figure 1). Three nets were set at each transect for approximately 24 hr during each month.

Trapping. Channel catfish were trapped by use of trap net, barrel traps, and wire traps. The trap net had a pocket 2.7 m long, 1.5 m wide, and 1.2 m deep. The central lead was 45.7 m long, while the two lateral wings were 15.2 m in length. This trap was set between areas A and B and tangent to area B during February and March, 1968. It was raised approximately every 48 hr. Channel catfish caught by

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[1] Present address: U. S. Army, Edgewood Arsenal, Edgewood, Md. 21010.

[2] Present address: National Marine Fisheries Service, Biological Laboratory, Woods Hole, Mass. 02543.

[3] Cooperators are the Oklahoma Department of Wildlife Conservation, the Oklahoma State University Research Foundation, and the U. S. Bureau of Sport Fisheries and Wildlife.

this method were generally larger than gill-netted fish.

Barrel traps (2), 2.3 m long with a 1 m diameter, were made of collapsible nylon of 25 mm bar mesh. These traps, along with similar sized wire traps, were used during the period of June through August, 1968 in the extreme uppermost part of the lake (area F).

Rotenone samples. Rotenone samples were taken from a 1.3 acre cove (area E, Figure 1) which had an average depth of 2.2 m. Samples taken included one in October, 1967, two in January and March, 1968, two in May and June, 1968, and one in August, 1968.

Electrofishing. Catfish were collected by electrofishing from 37.2 m sections on the north and south shores of the reservoir; collection sites centered on the gill net transects. Sampling was conducted each month and included both day and night collections.

RESULTS

Gonadal-body weight relations and time of spawning

Gonadal-body weight relations were determined for 106 female and 71 male channel catfish. The gonadal weight was determined to the nearest 0.1 g. The gonadal-somatic index expresses the gonadal weight as percentage of body weight. The 177 fish used in the calculation of gonadal-

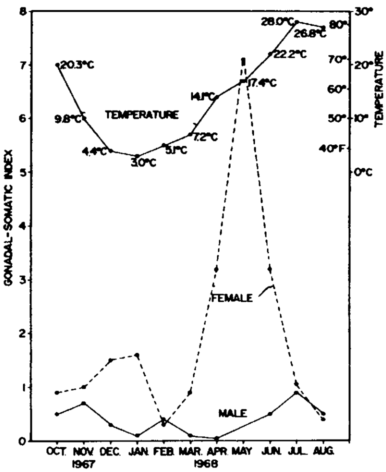

FIGURE 2. Seasonal change in gonadal-somatic index of channel catfish from Lake Carl Blackwell.

TABLE 2. *Seasonal changes in condition factor, with 95% confidence intervals, for Lake Carl Blackwell channel catfish.*

Month	Year	Male	Female	Unidentified	Unknown	Total
October	1967	7.4± .8 (10)[a]	7.7±0.9 (7)	6.5± .81 (4)		7.3±0.1
November	1967	8.3± .3 (11)	6.6±0.4 (13)			7.4±0.1
December	1967	8.7±1.8 (7)	6.6±1.6 (11)			7.4±0.1
January	1968	7.4± .5 (6)	8.3±0.3 (4)			7.8±0.2
February	1968	8.3±1.1 (13)	7.8±1.2 (15)	6.8±0.3 (7)		7.8±0.1
March	1968	8.4±1.3 (12)	8.4±0.8 (15)			8.4±0.1
April	1968	7.6±1.2 (10)	7.2±1.7 (8)			7.3±0.1
May	1968		10.7±0.2 (5)			10.7±0.2
June	1968	7.8±0.4 (30)	8.2±1.4 (33)	6.8±0.9 (4)		7.9±0.1
July	1968	8.0±0.7 (18)	5.9±1.0 (8)	6.8±0.4 (3)	7.7±.7 (3)	7.9±0.1
August	1968	7.2±3.3 (3)	7.3±2.3 (6)			7.3±0.1

[a] Number of fish sample

body weight relationships did not include the immature age groups I through III.

From the middle of June through January, the gonadal-somatic index for females was less than 2% (Figure 2). In February, the gonadal-somatic index for females increased sharply and peaked at approximately 7.1% on May 20 (Figure 2).

Changes in the male gonadal-somatic index were of little magnitude throughout the study period. This could have been due to the small percentage of mature males in the samples. However, there was a noticeable, steady increase in the gonadal-somatic indexes for males, beginning in April and continuing through July, after which a decrease occurred (Figure 2). The increase in gonadal-somatic index and its peak did not coincide with that for females. Perhaps this was due to lower vulnerability to gill net capture of maturing and mature males from March through May. The low magnitude of gonadal-somatic ratios in males, as shown in Figure 2, indicated that gonadal development apparently exerted little influence on condition factors (K).

Evidence indicated a May and early June spawning time based on seasonal changes in the gonadal-somatic ratios which reached a peak of 7.1 in May and began sharply declining to 1.1 in July (Figure 2). The same trend was observed in the condition factors for females with the highest peak in May (Table 2). Further support of this assumption was added by observations of sexual dimorphism noted as early as May in several of the fish collected in this study. During the spawning period fish could be sexed with approximately 99 percent accuracy by examining the genital pore (3).

TABLE 1. *Egg counts of channel catfish collected from Lake Carl Blackwell in 1968.*

Date	Age Group	Total Length (mm)	Number of eggs
March	V	201	1052
March	V	273	2759
April	VI	228	1917
June	VI	274	2580
June	VI	275	3111
June	VI	312	6334
April	VI	418	17789
March	VII	282	1857
May	VII	328	7391
March	VIII	406	11369
June	IX	284	1368
May	IX	427	17079
May	IX	437	12358
April	IX	533	25350
May	X	518	16518
March	X	653	31492
June	XI	429	10812
March	XI	590	64629
March		209	1524
May		575	27480

Fecundity

To estimate fecundity, the left ovary of each of 20 fish was weighed (Table 1) and each ovary was sectioned into three portions (anterior, middle, posterior) and the weight of each section taken. The ovarian tissue was removed and weighed and each section was teased apart. A random sample of eggs was selected from each section and weighed.

The number of ova was estimated by the following formula:

$$E = W / W_i / \Sigma(W_{ij} / \bar{w}_{ij})$$

Where: E = number of ova per fish,

W_i = weight of left ovary in grams,

j = 1, 2, 3, = anterior, center, and posterior sections,

W_{ij} = weight in grams of the j th section of the left ovary,

$\bar{w}_{ij}$ = mean weight of eggs in the j th section of the left ovary,

and: W = weight in grams of both ovaries

Mean ovary weight was 7 percent of the body weight, Muncy, (4) in a study of channel catfish from the Des Moines River, Iowa, reported a mean ovary weight of approximately 15% of the body weight. The estimated egg number was considerably higher for fish from Lake Carl Blackwell than for the channel catfish Muncy (4) worked with in Iowa. Channel catfish examined from Lake Carl Blackwell had a mean length of 383 mm with a range from 201 to 653 mm and a mean count of 13,238 eggs with a range from 1,052 to 64,629. The channel catfish Muncy observed had a mean length of 399 mm with a range from 299 to 512 mm and a mean count of 6,123 eggs with a range from 2,628 to 9,721 eggs.

The number of eggs increased with the age and length (Table 1). Linear and curvilinear regressions were computed to relate egg number to fish length. The linear correlation coefficient (r) was 0.84, which was significant at the 0.05 level. Both the linear and curvilinear regressions were significant at the 0.005 level, but the curvilinear term did not significantly (0.05 level) improve the fit of the line. The linear regression of number of eggs (Y) on total length of fish in mm (X) was Y = −22,771 + 94.1X, where Y = egg number, and X = length in millimeters. The 95% confidence intervals of the mean egg count estimated from the regression were ± 4052.

Coefficient of condition

A condition factor K_{TL} was computed for all fish when length and weight measurements were available as follows:

$$K = \frac{1{,}000{,}000\ W}{L^3}$$

where W = weight in grams, and L = total length to tip of tail in millimeters.

Coefficients of condition of channel catfish from Lake Carl Blackwell were calculated separately and combined for males, females, and fish of unidentified sex (Table 2). The total sample size of 266 channel catfish included 120 (45%) males, 125 (47%) females, and 21 (3%) unidentified.

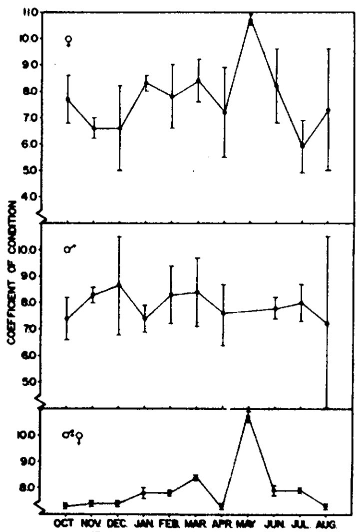

FIGURE 3. Seasonal changes in channel catfish condition factor with 95% confidence intervals for males, females, and combined.

The seasonal variation in coefficient of condition for males and females is shown in Figure 3. There were no appreciable seasonal trends for males. There was also no gross difference seasonally for males compared with females, except during the spawning period. The curve representing the female coefficient of condition increased rapidly prior to spawning and declined sharply thereafter as did the gonadal-somatic index curve (Figure 2) for females. The K values with 95% confidence intervals for females increased from 7.2±1.7 in April to a peak of 10.7±0.2 in May, and began declining sharply from 8.2±1.4 in June to its lowest, 5.9±1.0, in July.

The mean condition factor for males, females, and unidentified channel catfish was 7.7±.3. This value fell below values of condition factors computed for the same size Oklahoma channel catfish, using the state wide length-weight values reported by Finnell and Jenkins (5). Channel catfish in this study were also in poor condition according to values from Reelfoot Lake, Tennessee (6) and the Ponca and Plattsmouth section of the Missouri River (7).

Length-weight relationship

Total length-weight relationship for channel catfish from Lake Carl Blackwell was calculated by combining measurements for both sexes since there was no essential difference in condition factors for males and females.

The length-weight relationship was:

$$\log_e W = 13.637 + 3.3239 \log_e L$$

or

$$W = .000001195\ L^{3.3239}$$

where: W = weight in grams,

L = length in mm

and $\log_e$ = natural logarithm.

Age and growth

The linear regression of the total body length in millimeters (L) on the radius of the expanded edge of the left pectoral spine (X) in ocular units was L = 41.2 + 2.41X, with a correlation coefficient (r) of .80. This regression was significant at the .005 level in an analysis of variance.

Lengths were back calculated for individual fish, utilizing the intercept value given by the previous equation. The means for each age group separately for each year class were then computed and an unweighted mean was calculated for these values. This was done separately for males and females and for both sexes combined.

The annual average calculated growth increments for all age groups are shown

YEAR CLASS	AGE GROUP	NUMBER OF FISH	SIZE AT ANNULUS 1	2	3	4	5	6	7	8	9	10	11	12	13
1967	I	3	54 ±19												
1966	II	2	73 ±16	110 ±14											
1965	III	6	71 ±7	117 ±28	152 ±19										
1964	IV	21	74 ±3	116 ±9	154 ±5	181 ±5									
1963	V	34	79 ±4	122 ±7	159 ±7	187 ±8	213 ±9								
1962	VI	52	82 ±3	123 ±5	159 ±5	187 ±8	210 ±9	235 ±10							
1961	VII	36	82 ±3	136 ±24	156 ±7	189 ±9	216 ±11	242 ±13	267 ±15						
1960	VIII	34	88 ±4	129 ±6	166 ±7	199 ±10	230 ±13	260 ±16	288 ±19	313 ±22					
1959	IX	35	92 ±5	129 ±8	166 ±7	206 ±10	238 ±12	267 ±15	297 ±19	328 ±22	358 ±24				
1958	X	18	100 ±8	139 ±11	181 ±13	213 ±12	242 ±15	270 ±20	304 ±25	336 ±31	373 ±41	407 ±47			
1957	XI	10	116 ±10	151 ±13	189 ±16	227 ±26	266 ±32	304 ±29	343 ±34	376 ±38	424 ±47	480 ±55	514 ±56		
1956	XII	1	134	153	195	220	254	293	335	360	433	517	601	635	
1955	XIII	3	135 ±13	184 ±25	227 ±18	269 ±28	302 ±31	341 ±58	371 ±43	403 ±17	445 ±50	484 ±19	535 ±41	576 ±47	617 ±99
Unweighed means			91	134	173	208	241	277	315	353	407	472	550	606	617
Mean annual increment			91	43	39	35	33	36	38	38	54	65	78	56	11
Number of fish			255	252	250	244	223	189	137	101	67	32	14	4	3

TABLE 3. *Mean calculated total lengths (millimeters), with 95 percent confidence limits, of channel catfish from Lake Carl Blackwell.*

in Table 3. As there was no obvious difference in growth between sexes (8) the combined values will be discussed.

Fish between ages of 5 and 9 years constituted 75% of the total number in the sample and 40% of the channel catfish were over 7 years old. Other investigators have reported that channel catfish seldom live longer than 7 years (3, Kansas; 5, Oklahoma). The 1962 year class (age group VI) was the most abundant single year class.

A comparison of the calculated total lengths in millimeters at each annulus for channel catfish from Lake Carl Blackwell with channel catfish from other bodies of water in Oklahoma and elsewhere can be seen in Table 4. The calculated total length in millimeters for channel catfish from Lake Carl Blackwell at annulus one is 91, as it is for fish from all statewide reservoirs in the same class. However, sizes at annuli 2 through 14 are much lower for Lake Carl Blackwell. Except for annulus 1 and 2, channel catfish from Lake Carl Blackwell fell below each length at annulus for waters in all other states listed in Table 4, except for Lake of the Ozarks, Missouri.

The growth of channel catfish from Lake Carl Blackwell may be a reflection of a sparse food supply, perhaps because of its high turbidity. Finnell and Jenkins (5) reported that environmental factors, including age, turbidity, and extent of successful reproduction, appeared to influence rate of growth. The majority of their poor growing channel catfish populations were found in turbid waters among dense populations of catfish.

The greatest length increment occurred in the first year of life (Table 3). The increment of the succeeding years was progressively smaller as Sneed (9) and Sneed and Leonard (10) found to be evident in Grand Lake, and Lake Texoma, respectively, in Oklahoma. The second year had the greatest increment for channel catfish in the Mississippi River (11). Such growth patterns may be due to seasonal conditions with longer growing seasons in warmer areas. The seasonal differences for

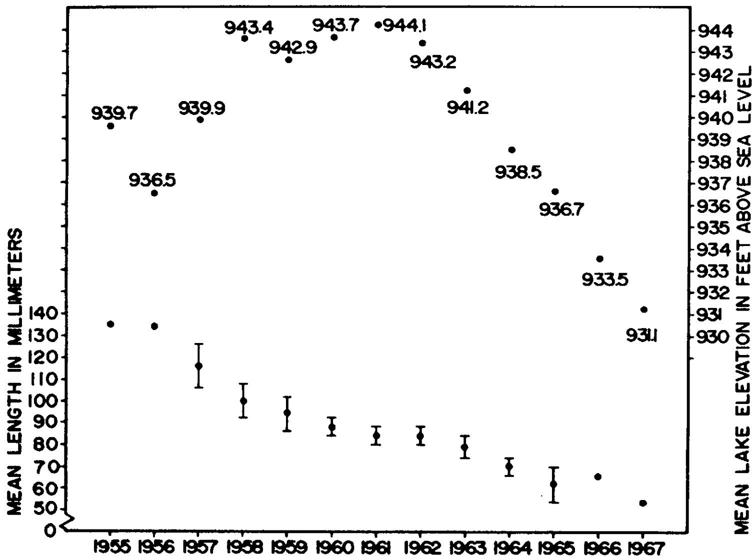

FIGURE 4. Back-calculated mean length (mm) at age 1, with 95% confidence intervals, of channel catfish from Lake Carl Blackwell for the 1955-1967 year class, and annual mean of the lake's water elevations (feet above mean sea level) from 1955 through 1967.

different areas as well as yearly fluctuation in water levels in the same area may have marked effects on available food.

Back-calculated sizes at annuli for channel catfish from Lake Carl Blackwell gradually decreased in length starting from the older back-calculated age group to the younger age groups (Table 3). This is a reverse of Lee's phenomenon.

After a study of effects of size-selective mortality and sampling bias on estimates of growth, mortality, production, and yield, Ricker (12) indicated that sampling bias does not produce negative Lee's phenomenon (at any rate with likely patterns of growth and vulnerability to sampling gear). Thus, any examples observed must reflect actual change, provided random variability is excluded as a cause.

Water level fluctuations have been reported as having some effect on fish growth. Stroud (13) indicated that growth increases when water levels in a lake rise after the spawning period. In Greenwood Lake, Indiana, Johnson (14) noted a retardation of crappie growth due to extremely low water levels.

The yearly averages of the water levels for Lake Carl Blackwell are given along with the mean calculated total length with 95% confidence intervals for annulus I for corresponding year classes from 1955 through 1967 (Figure 4). The lake began decreasing in water level in 1961 and there was a deficit in rainfall for the years 1962 through 1968.

From Figure 4, it can be seen that there was a decrease in length from 1955 to 1967 (the reverse of Lee's phenomenon) and a decrease in water level from 1958 to 1967. A correlation coefficient was computed for yearly average lake level and first year mean calculated total length. The coefficient of correlation was 35.8, which was not significant at the 0.05 level. To have a significant correlation of that magnitude, it would be necessary to have 30 years of average water levels and mean fish lengths. It might be possible to obtain a large correlation value by correlating mean lengths with seasons of the year and periods when food production is greatest. It is possible that the decrease in growth of channel catfish in the years of high water levels may have been due to factors such as popu-

TABLE 4. *Total length (millimeters) of channel catfish for each year of life back-calculated from pectoral spine sections.*[a]

Water	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Oklahoma														
Lake Carl Blackwell	91	134	173	208	241	277	315	353	407	472	550	606	617	
New reservoirs over 500 acres[b c]	116	274	335	444	525	522	642							
Old reservoirs over 500 acres[b,c]	91	177	248	304	362	416	472	530	576	601	589	571	657	700
Large lakes (111-500 acres)[c]	91	182	251	309	368	413	477	482	528	540	568	632	652	761
Small lakes (5-110 acres)[c]	111	233	340	416	472	512	586	660	731	759	782	774		
Ponds (less than 5 acres)[c]	108	218	309	373	373	412	436	520	589	619	672	800		
Streams[c]	106	195	279	347	408	472	495							
Clear reservoirs[c]	96	190	258	317	383	441	502	561	657	705	746			
Turbid reservoirs[c]	75	152	213	261	309	357	421	479	467	497	510			
Oklahoma average 1946-1954[c]	101	215	301	368	408	451	505	555	606	629	644	647		
Other														
Lake of the Ozarks, Mo.[d]	53	108	157	180	233	263	291	329						
Des Moines River, Iowa[e]	20	124	195	256	312	380	441	489	545	616	644	639	675	
Lewis and Clark Lake, Nebraska and S. Dakota[f]	108	157	205	248	284	327	378	446	505					
Lake Moultrie and Sanctuary, S. Carolina[g]	86	185	284	368	441	530	601	665	726	771	795	840	902	890

[a] Values given in inches in the 1966 report by Miller (15) were converted to millimeters.
[b] Reservoirs less than 4 years old at time of collection.
[c] Finnell and Jenkins, 1954 (5).
[d] Marzolf, 1955 (16).
[e] Muncy, 1959 (4).
[f] Walburg, 1964 (17).
[g] Stevens, 1959 (18).

lation pressure. This should be the subject of further research.

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