LIFE HISTORY ASPECTS OF SMALLMOUTH BUFFALO AND FRESHWATER DRUM IN WHEELER RESERVOIR, ALABAMA[1]

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ABSTRACT

The life histories of smallmouth buffalo (*Ictiobus bubalus*) and freshwater drum (*Aplodinotus grunniens*) were studied during 1966-1968 in conjunction with the evaluations of commercial fishery gear on Wheeler Reservoir. In this reservoir, smallmouth buffalo grows as fast as or faster than it does in other reservoirs. They are 5 to 6 years old and 17 to 19 inches long before they are abundant in the commercial catch. Drum growth is slower in Wheeler than in other waters; they are not important commercially until they are 7 to 8 years old and 16 to 19 inches long.

Asiatic clams, 1 to 2 mm in diameter, and copepods were the dominant food items for all sizes of buffalo. Drum less than 10 inches fed primarily on diptera larvae; those over 10 inches fed primarily on Asiatic clams greater than 10 mm in diameter and gizzard shad.

Peak spawning periods in 1967 were mid-April for smallmouth buffalo and late-May for drum. Reproduction potential of both species is high. Female drum, 8 to 13 pounds, had an average of 686,000 eggs; smallmouth buffalo, 5 to 6 pounds, averaged 230,000 eggs. All male drum in age-group IV and all females in age-group VI were mature. All male and female buffalo were mature in age-groups VI and VII, respectively. Larvae of both species were collected in the reservoir; smallmouth buffalo were spawned artificially in indoor tanks.

According to tag returns, buffalo moved an average minimum distance of 7.0 miles and a maximum of 56 miles. The study emphasized the need for more effective gear to harvest the surplus of small drum.

INTRODUCTION

The TVA Fish and Wildlife Branch has been interested in the commercial fishery of the Tennessee River since 1941 (Bryan and Tarzwell, 1941; Tarzwell, 1944; Bryan and White, 1958; Carroll, Hall, and Bishop, 1963). In general the program has measured the annual harvest and promoted better utilization of commercial species. Objectives of current investigations are to develop more efficient harvest methods and find new uses and better markets for surplus fish. This life history study was initiated in conjunction with the exploration and evaluation of new commercial fishing gear.

Adequate life history information is lacking for most rough fish species in TVA reservoirs. This is particularly true of the competitive roles of smallmouth buffalo (*Ictiobus bubalus*) and freshwater drum (*Aplodinotus grunniens*). Smallmouth buffalo rank second to catfish in the commercial fish harvest. In 1967 the harvest exceeded 2.5 million pounds. Drum ranked fourth that year with a harvest of about 250,000 pounds.

Wheeler Reservoir

Wheeler Reservoir, a TVA reservoir on the Tennessee River in northern Alabama, is formed by Wheeler Dam at Tennessee River Mile 274.9. It began filling October 3, 1936. During normal operation, full pool is 67,100 acres, minimum pool 43,000 acres. The reservoir is 74 miles long, 1.4 miles wide on the average, and has 899 miles of shoreline. Average unregulated flow at the dam site is 49,300 cfs and mean depth at full pool is 17.1 feet. Midstream water temperature ranges from 46° to 85° F. in a normal year, and the reservoir does not stratify. Total alkalinity ranges from 49 to 63 ppm, and total hardness (as $CaCO_3$) ranges from 63 to 83 ppm (B. G. Isom, personal communication).

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MATERIALS AND METHODS

Fish were collected periodically from February 1966 through June 1968. Collections were limited primarily to 37 miles of Wheeler Reservoir; however, smallmouth buffalo tagged for movement study were collected in Guntersville Reservoir, just upstream from Wheeler. Collecting gear included Wisconsin-type trap nets, 37- and 45-foot (headrope length) otter trawls, a 50-foot bag seine, and a 220-volt boat-mounted electrofishing unit. Most fish were collected in conjunction with tests of trap nets and otter trawls.

Age and growth determinations were based on the Dahl-Lea method of scale analysis (Lagler, 1956). Scales were read with a Van Oosten-Deason-Jobes Projector (1934), using plastic impressions of four to six scales. A Carver laboratory press, Model B, was used to make impressions. A representative scale was chosen, and annuli were marked on a tagboard strip. Total length of the fish was recorded on the strip, and lengths at preceding annuli determined with a nomograph. Scales used for age and growth determinations were collected from January to June 6, 1967. Length-weight relationships were calculated by a Fortran program on an IBM 360 system at the TVA computing center in Chattanooga, Tennessee.

Eggs were estimated by counting the number in a small weighed portion of ovary, weighing the ovary, and calculating total number (Johnson, 1963 and Stone, 1937). Stone found an average error of 5.1 percent when comparing estimated and actual numbers of eggs in nine cisco ovaries.

For movement studies, smallmouth buffalo were tagged with Atkins tags attached by a short strand of monofilament. An awl was used to insert the monofilament through the musculature behind and below the dorsal fin. Commercial fish markets were the best source for tag returns.

Stomach samples containing food were collected for all size ranges and preserved in 10 percent formalin. Food habits of smallmouth buffalo are based primarily on contents of the gut between the constricted pharynx and the first intestinal loop. In drum, only items in the stomach proper were analyzed.

Total number of organisms in drum stomachs were counted by order. The most numerous item was ranked dominant unless it was clearly evident that a less numerous item had a greater total volume, then that item was ranked dominant. Seasonal items were idicated by percent of occurrence and dominance. Percent dominance was also calculated on a yearly basis.

Analysis of buffalo food items was the same as for drum except that a 3 ml subsample was used instead of the entire stomach contents. A Bausch and Lomb dissecting microscope (7X - 30X) was used in analyzing stomach contents, a Spencer compound microscope (100X - 440X) for identification of small organisms.

Fish names are according to a list of common and scientific names of fishes from the United States and Canada (American Fisheries Society, 1960).

SMALLMOUTH BUFFALO

Age and Growth

Age and growth calculations from the scales of 140 smallmouth buffalo indicates that increase in length was greatest during the first and second years of life (table 1) and almost constant in succeeding years. Length distribution among age groups overlapped some. Time of annulus formation ranged from April 15 to May 15. According to these calculations some of the fish in age-group IV were marketable; however, the majority of Wheeler smallmouth buffalo were in age-group V or VI before they were abundant in the commercial catch. This is due in part to the regulated mesh size (3-inch square) of fishing gear.

Growth in Wheeler was faster than in Lewis and Clark Lake, South Dakota (Walburg and Nelson, 1966), similar but slightly faster than in Watts Bar Reservoir, Tennessee (Martin, Auerbach, and Nelson, 1964), but slower than in Reelfoot Lake, Tennessee (Schoffman, 1944) (figure 1).

TABLE 1.
Average calculated growth rates of smallmouth buffalo, Wheeler Reservoir.

Year Class	No. of Fish	Average calculated total length in inches at end of year												
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1966	13	7.6												
1965	38	5.7	10.7											
1964	5	5.2	9.8	14.0										
1963	12	5.7	11.3	14.3	16.5									
1962	13	6.3	10.4	13.7	15.9	17.6								
1961	8	5.5	10.3	13.4	16.3	18.2	19.7							
1960	11	5.2	9.2	12.1	14.8	17.4	18.8	20.2						
1959	8	5.2	9.3	12.2	14.5	17.1	18.9	20.4	21.5					
1958	10	5.5	9.5	11.7	14.3	17.2	19.2	21.3	22.7	23.6				
1957	11	4.8	9.1	11.1	13.8	15.1	18.3	20.4	22.2	23.2	24.4			
1956	5	4.8	8.0	10.0	11.9	14.9	17.3	19.5	21.3	23.0	24.2	25.1		
1955	4	4.1	10.9	13.0	16.5	18.2	21.2	23.0	25.0	26.7	27.9	28.7	29.5	
1954	2	4.2	8.7	12.4	15.0	16.2	18.6	22.4	24.0	25.8	27.9	29.7	30.7	31.4
Weighted average		5.6	10.0	12.6	15.0	16.9	18.9	20.7	22.4	23.8	25.3	27.2	29.9	31.4
No. of fish		140	127	89	84	72	59	51	40	32	22	11	6	2

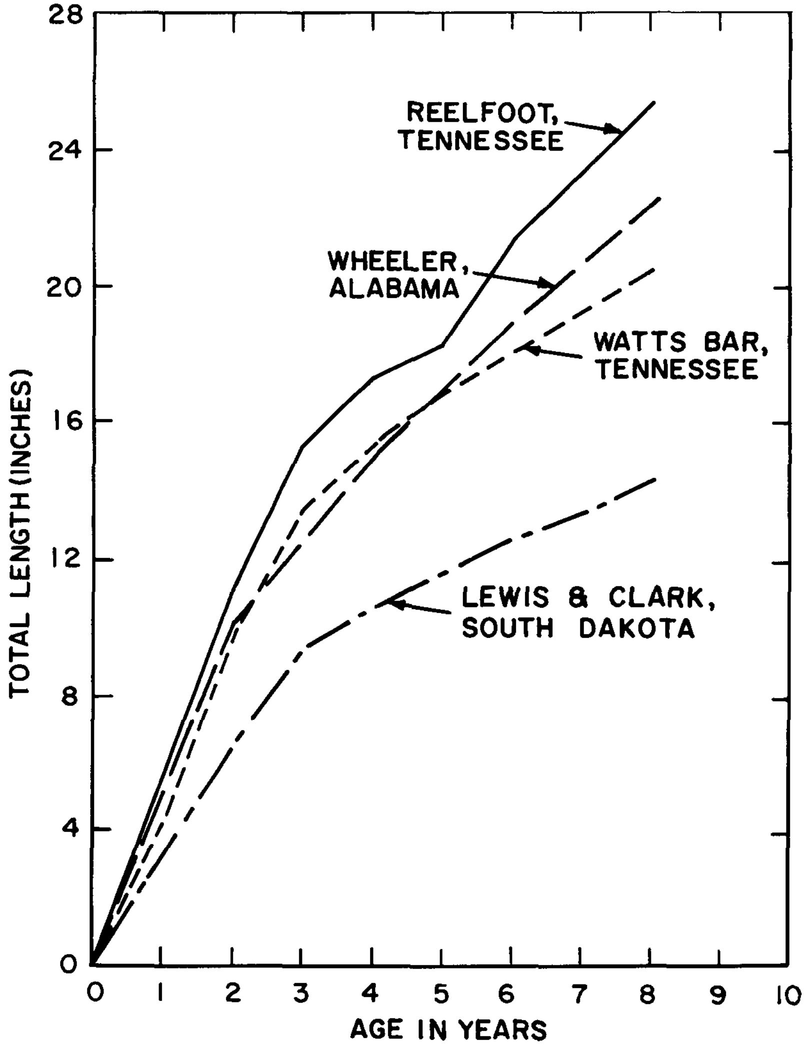

Figure 1. Growth rates of smallmouth buffalo in various reservoirs.

Length-weight Relationship

A length-weight curve determined from 239 fish (figure 2) is described by the formula Log W = -3.35995 + 3.07711 log L

where W = weight in pounds

and L = total length in inches.

Wheeler buffalo in the study had the following length-weight relationships: 5 inches--0.06 pounds, 10 inches--0.5 pounds, 15 inches--1.8 pounds, 20 inches--4.4 pounds, 25 inches--8.7 pounds, and 30 inches--16 pounds. Calculated and empirical weights are presented in table 2. At any given length the average weight of smallmouth buffalo was similar to that reported for this species in other waters (Martin, et al., 1964; Schoffman, 1944; and Walburg and Nelson, 1966).

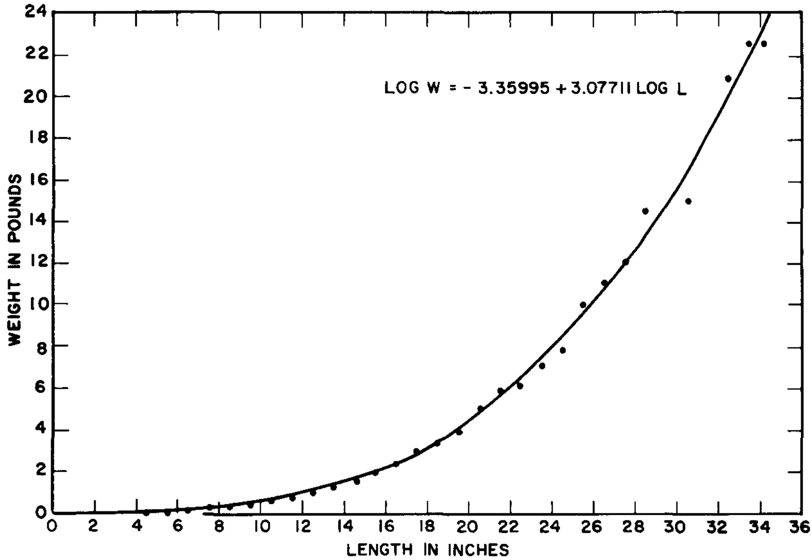

Figure 2. Length-weight relationship of smallmouth buffalo, Wheeler Reservoirs.

TABLE 2.
Length-weight relationship of smallmouth buffalo, Wheeler Reservoir.

Total Length (inches)	*Weight (pounds) Calculated*	*Empirical*	*Total Length (inches)*	*Calculated*	*Weight (pounds) Empirical*
4.0	.03	.06	17.0	2.67	2.89
4.5	.05	.06	17.5	2.92	3.03
5.0	.06	.08	18.0	3.18	3.02
5.5	.08	.10	18.5	3.46	3.39
6.0	.11	.11	19.0	3.76	3.76
6.5	.14	.12	19.5	4.07	4.28
7.0	.17	.18	20.0	4.40	4.85
7.5	.22	.20	20.5	4.75	4.32
8.0	.26	.24	21.0	5.11	5.48
8.5	.32	.34	21.5	5.50	5.70
9.0	.38	.35	22.0	5.90	6.88
9.5	.45	.45	22.5	6.32	6.30
10.0	.52	.51	23.0	6.77	6.52
10.5	.61	.64	23.5	7.22	7.15
11.0	.70	.70	24.0	7.71	7.72
11.5	.80	.72	24.5	8.23	8.18
12.0	.91	.87	25.0	8.74	9.32
12.5	1.04	.95	25.5	9.29	10.71
13.0	1.18	1.10	26.0	9.86	10.05
13.5	1.31	1.35	26.5	10.46	10.47
14.0	1.47	1.41	27.5	11.72	12.38
14.5	1.64	1.51	28.0	12.39	14.60
15.0	1.82	1.74	30.5	16.12	15.77
15.5	2.01	2.41	32.5	19.60	21.00
16.0	2.17	2.70	33.5	21.52	22.50
16.5	2.43	2.83	34.0	22.52	22.50

Reproduction

Some smallmouth buffalo males in age-group IV were sexually mature; all were mature in age-group VI. The youngest mature female was in age-group VI, and all were mature in age-group VII. The smallest mature male was 16.2 inches and 2.70 pounds; the smallest mature female was 17.5 inches and 2.89 pounds. Smallmouth buffalo in Wheeler were larger and three years younger at maturity than reported for Lewis and Clark Lake (Walburg and Nelson, 1966). Apparently it is not uncommon for buffaloes in ponds to weigh a pound and be sexually mature in age-group II (Brady and Hulsey, 1959; Swingle, 1957; and Walburg and Nelson, 1966).

Smallmouth buffalo collections in 1967 indicated that spawning occurred as early as March 28 and continued until May 25. Water temperatures during this period ranged from 57° to 70°F. Inspection of smallmouth buffalo trap netted in Guntersville Reservoir in 1966 indicated that the spawning peak was April 14-26 when water temperatures ranged from 59° to 62°F. Actual spawning was not observed either year. Commercial fishermen on Wheeler Reservoir have reported large catches of spawning smallmouth buffalo during the spring in shallow backwater areas. Harlan and Speaker (1951) reported that smallmouth buffalo spawn in May in Iowa, and that eggs are deposited at random over the bottom or on vegetation. Walburg and Nelson (1966) indicate that smallmouth buffalo in Lewis and Clark Lake spawned between May 25 and June 20, 1964, when water temperatures ranged from 62° to 70°F.

Weiss (1950) reported that an 8- to 10-pound female contained approximately 350,000 eggs. The estimated average for five females from Wheeler, 4.9 to 6.4 pounds, was 230,000 eggs (table 3). Average number of eggs per pound of body weight was 39,400. Smallmouth buffalo eggs are adhesive. Gonad weights of five mature males, 3.3 to 5.9 pounds, averaged 0.18 pound (table 3).

TABLE 3.

Gonad weights and fecundity of mature smallmouth buffalo in Wheeler Reservoir.

Date	*Sex*	*Fish Length (inches)*	*Fish Weight (pounds)*	*Gonad Weight (pounds)*	*Estimated Number of Eggs*
1/8/67	female	21.5	4.93	0.56	200,000
1/9/67	female	22.0	6.00	0.91	290,000
1/9/67	female	23.8	6.43	1.06	260,000
4/3/67	female	21.7	5.78	0.53	150,000
4/3/67	female	22.1	6.06	0.88	250,000
3/28/67	male	22.0	5.73	0.24	––
3/28/67	male	18.6	3.32	0.16	––
4/3/67	male	22.4	5.62	0.15	––
4/3/67	male	19.7	4.23	0.20	––
4/3/67	male	22.2	5.87	0.25	––

Approximately 150 buffalo larvae, 20 to 40 mm, were collected from Wheeler Reservoir during May 1968. Additional larvae were obtained by artificially spawning in indoor tanks. Eggs were held in hatching jars and in a Living Stream unit. At 70°F. eggs hatched 96 to 100 hours after fertilization. Larvae were free-swimming at 86 hours and feeding at 105 hours after hatching. Total length was 5 to 6 mm at hatching and 8 to 9 mm at first feeding. Larvae first fed near the surface, but subsequent feeding was on the surface and bottom of a 180-gallon pool. The mouth was terminal rather than inferior as in the adult. Details, of larval development studies will be reported separately.

Food Habits

Bivalved mollusca (primarily *Corbicula*) were the dominant food items found in the stomachs of both subadult and adult smallmouth buffalo (Table 4). Copepods and aquatic diptera ranked second and third, respectively. The copepods were primarily adult *Cyclops*. Chironomid larvae were the most numerous diptera, but *Chaoborus* was also present. Cladocera (Chydorinae), then Bryozoa (*Plumatella*) were next in importance. *Uratellus* (Bryozoa) was present occasionally. Other items occurring in the samples were Algae (Chlorophyta and Chrysophyta), Annelida, Decapoda, Ostracoda, Ephemeroptera (*Hexagenia*), Gastropoda, and sedge or grass seeds. The majority of stomachs also had sand, silt, and detritus in varying amounts. Similar food items were found in 25 young-of-the-year smallmouth buffalo.

TABLE 4.

Seasonal contents of stomachs of 195 subadult and adult smallmouth buffalo (8-34 inches) from Wheeler Reservoir.

Food Item	*Jan-Mar* Occurrence	*Jan-Mar* Dominance	*Apr-June* Occurrence	*Apr-June* Dominance	*July-Sept* Occurrence	*July-Sept* Dominance	*Oct-Dec* Occurrence	*Oct-Dec* Dominance	*Yearly Total* Dominance
	Percent								
Algae	6	0	0	0	32	2	20	0	1
Annelida	7	1	9	3	0	0	0	0	1
Bryozoa	19	6	26	11	54	12	10	0	8
Crustacea									
Copepoda	65	30	74	9	65	18	55	15	21
Cladocera	90	1	60	29	39	4	60	25	9
Decapoda	0	0	0	0	2	0	0	0	0
Ostracoda	6	0	23	6	47	7	10	0	3
Insecta									
Diptera	27	6	29	6	68	32	60	30	16
Ephemeroptera	0	0	0	0	7	0	0	0	0
Mollusca									
Gastropoda	0	0	6	0	28	0	0	0	0
Pelecypoda	75	53	63	37	58	19	75	25	37
Other Plants	0	0	0	0	18	7	20	0	2
Sand and Detritus*									
Number of Stomachs	83		35		57		20		

*Sand and detritus were present in 98% of stomachs analyzed

Judging by the amounts of molluscs, diptera larvae, and bryozoans consumed, smallmouth buffalo in the size groups studied feed on or near the bottom. This observation is in agreement with the findings of Dalquest and Peters, 1966; and McComish, 1967. Three buffalo, either bigmouth or smallmouth observed in mid-August were apparently feeding. They appeared about sunset in a shoal area where the water was approximately two feet deep and clear. More than 15 yards apart, each fish was in or adjacent to an area about 3 feet in diameter that was clouded by silt and other bottom debris. The clouded areas seemed to be caused by the fish rooting along the bottom. Johnson (1963) reported similar swirls of muddy water in his observation of feeding bigmouth buffaloes (*Ictiobus cyprinellus*).

Dalquest and Peters (1966) reported that small arthropods, especially entomostracans, and insects were the principal food of smallmouth buffalo in Lake Diversion (Texas); *Chara*, which often had ostracods and snails in association with it, was also taken regularly. McComish (1967) reported that smallmouth buffalo in Lewis and Clark Lake fed primarily on zooplankton and attached algae. Summers (1960) reported a high incidence of copepods in the diet of smallmouth buffalo in Fort Gibson Reservoir (Oklahoma). Wheeler smallmouth buffalo's utilization of stalked Bryozoa and the apparently associated cladocera, copepods, and ostracods appears comparable to the above *Chara* and attached algae.

Importance of bivalves—primarily Asiatic[2] and fingernail clams—was the main variation in the diet of Wheeler smallmouth buffalo as compared with those in other areas. *Corbicula, Sphaerium,* and other unidentified small bivalves occurred in the stomachs throughout the 23-month sampling period. Since the Tennessee River has a rich bivalve fauna, it is possible that several genera were represented in the unidentified shells. The majority of shells were fragmented, but whole shells and halves were also present. The largest shell was 9 mm (maximum diameter), but the average was 1 to 2 mm.

Plant items in the stomachs included filamentous green algae, an occasional diatom and sedge or grass seeds. A compaction of "seeds" in buffalo stomachs was reported by Martin et al. (1964).

The largest item in the stomach samples was a 1.5-inch crayfish taken from a 15-pound female collected in August 1967. Dalquest and Peters (1966) indicated that a "baby crayfish" was tentatively identified in the stomach of a smallmouth buffalo from Lake Diversion. An outstanding characteristic of the species in Wheeler Reservoir is the variety of organisms consumed. McComish (1967) appropriately described the smallmouth buffalo as an opportunist in its feeding habits.

Movement

In 1966, 380 smallmouth buffalo were tagged and released in Guntersville Reservoir. The tagging was done here because Guntersville was open to commercial netting and this would increase the percentage of tag returns. (Wheeler was opened to netting in 1967). Twenty (5.2 percent) tags were returned (table 5). Four fish were recaptured in TVA trap nets and 16 were returned by commercial fishermen. Average minimum movement was 7.0 miles; the maximum for a single fish was 56 miles (table 5). If this fish and one that moved 27 miles are excluded, average minimum movement by 89 percent of the recaptured fish was 2.8 miles.

Martin et al. (1964) tagged 656 smallmouth buffalo in Watts Bar, another Tennessee River reservoir. Two percent of the tags were returned, and 12 of the recaptured fish moved an average distance of 11.2 miles.

FRESHWATER DRUM

Age and Growth

Age and growth calculations from scales of 120 drum collected between January and June 1967 indicate slow growth in Wheeler Reservoir during the first four years of life but increasing thereafter (table 6). Growth increment between the eighth and ninth years (3 inches) was exceeded only by growth during the first year of life (3.2 inches). Considerable overlap occurred in the length distribution among age groups.

Time of annulus formation ranged from May 17 to May 30. However, ripe specimens of both sexes were still present in the sample when sampling was discontinued the first week in June. Swedberg (1965) reported that the time of annulus formation for drum in Lewis and Clark Lake ranges from May 10 to June 30, and that annulus formation for mature drum is delayed until completion of spawning.

Growth in Wheeler Reservoir was similar to that in Lewis and Clark Lake (Swedberg, 1965; figure 3) but considerably slower than in Oklahoma reservoirs over 500 acres (Houser, 1960), in upper Mississippi River navigation pools (Butler and

[2] Asiatic clams, *Corbicula*, were first recorded in the Tennessee River on October 21, 1959, in Kentucky Lake below Pickwick Dam (Sinclair and Ingram, 1961), approximately 75 river miles downstream from Wheeler Reservoir. By 1962 they had reached Fort Loudoun Reservoir, 328 river miles upstream from Wheeler. Asiatic clams were probably abundant in Wheeler Reservoir by 1960.

TABLE 5.
Movement of tagged smallmouth buffalo in Guntersville Reservoir.

Tagging Date	*Tagging Location*	*Recapture Time Lapse (days)*	*Minimum Distance Moved* (Miles)	*Direction Moved*
3/31/66	Tenn. R. M. 359	4	6.8	Upstream
3/31/66	Tenn. R. M. 359	30	5.0	Downstream
4/5/66	Tenn. R. M. 359	7	0.1	Upstream
4/5/66	Tenn. R. M. 359	20	2.7	Upstream
4/5/66	Tenn. R. M. 359	82	0.5	Downstream
4/5/66	Tenn. R. M. 359	383	4.0	Upstream
4/7/66	Tenn. R. M. 359	359	56.0	Upstream
4/12/66	Tenn. R. M. 359	365	2.0	Downstream
4/13/66	Tenn. R. M. 359	1	0.0	——
4/13/66	Tenn. R. M. 359	379	6.0	Downstream
4/14/66	Tenn. R. M. 359	13	5.0	Upstream
4/15/66	Tenn. R. M. 359	43	2.8	Upstream
4/15/66	Tenn. R. M. 359	306	27.0	Upstream
4/19/66	Tenn. R. M. 359	2	0.1	Upstream
4/19/66	Tenn. R. M. 359	2	0.0	——
4/19/66	Tenn. R. M. 359	6	5.0	Downstream
4/19/66	Tenn. R. M. 359	481	5.0	Upstream
4/21/66	Tenn. R. M. 359	3	1.5	Upstream
4/21/66	Tenn. R. M. 359	59	5.0	Downstream
4/26/66	Tenn. R. M. 359	2	4.8	Upstream

Smith, 1950), and in Reelfoot Lake (Schoffman, 1941). Hargis (1966) indicated overpopulation and growth retardation of drum in Watts Bar Reservoir.

Swedberg (1965) indicated that *Hexagenia* was a limiting food and that an increase in their numbers produced better growth of drum during a two-year interval in Lewis and Clark Lake. *Hexagenia* was a minor item in the diet of drum less than 10 inches (age-groups I-IV) in Wheeler and those over 10 inches fed primarily on Asiatic clams and shad (table 9). Growth in age-groups I-IV was better in Lewis and Clark Lake, while growth of older drum was better in Wheeler Reservoir (figure 3).

Length-weight Relation

A length-weight curve based on 338 fish (figure 4) is described by the formula Log W = -3.47478 + 3.09015 log L

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

Wheeler drum had the following length-weight relationships: 5 inches—0.05 pound, 10 inches—0.4 pound, 15 inches—1.4 pounds, 20 inches—4.3 pounds, and 25 inches—12 pounds. Calculated and empirical weights are presented in table 7. At any given length the average weight of Wheeler drum was similar to that reported for the species in other waters (Houser, 1960; Schoffman, 1941; and Swedberg, 1965).

Reproduction

More than 50 percent of male drum in age-group III were sexually mature; all were mature by age-group IV. Some females in age-group IV and all those in age-group VI were mature. Total length of the smallest mature male was 8.0 inches; the smallest mature female was 8.7 inches. Male and female drum in Wheeler Reservoir matured in similar age groups and proportions as reported for drum in Lewis and Clark Lake (Swedberg, 1965) and the Mississippi River (Butler and Smith, 1950). However, Wheeler drum matured at a smaller size. All males in Lewis and Clark Lake were mature at 13.1 inches as compared with 11.6 inches in Wheeler. Average length of youngest mature females in the Mississippi River was 15.2 inches, in Wheeler 9.2 inches.

TABLE 6.

Average calculated growth rates of drum from Wheeler Reservoir.

Year Class	*No. of Fish*	*Average calculated total lengths in inches at end of year*												
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1966	7	4.1												
1965	13	3.2	5.6											
1964	7	3.6	5.9	7.7										
1963	13	3.1	6.1	8.1	9.5									
1962	4	3.4	7.2	9.3	11.1	12.8								
1961	9	3.3	6.1	7.9	9.6	11.3	13.2							
1960	12	3.2	6.0	7.9	10.0	12.1	14.5	17.0						
1959	11	3.0	5.7	7.4	9.1	11.5	13.4	16.0	19.0					
1958	12	3.0	5.6	7.6	9.2	11.7	13.7	16.2	19.2	22.5				
1957	10	3.0	5.4	7.1	8.7	10.9	13.6	16.6	19.0	21.8	23.4			
1956	10	2.9	5.1	7.9	9.6	11.8	14.0	16.0	18.7	22.1	24.4	26.0		
1955	6	2.7	5.3	7.6	9.7	11.9	14.2	16.2	18.6	21.6	23.9	25.3	26.7	
1954	6	2.8	5.2	7.4	9.2	11.1	12.8	14.9	16.9	19.3	22.1	25.0	26.5	27.4
Weighted average		3.2	5.7	7.8	9.5	11.6	13.7	16.0	18.7	21.7	23.9	25.5	26.6	27.4
No. of fish		120	113	100	93	80	76	67	55	44	32	22	12	6

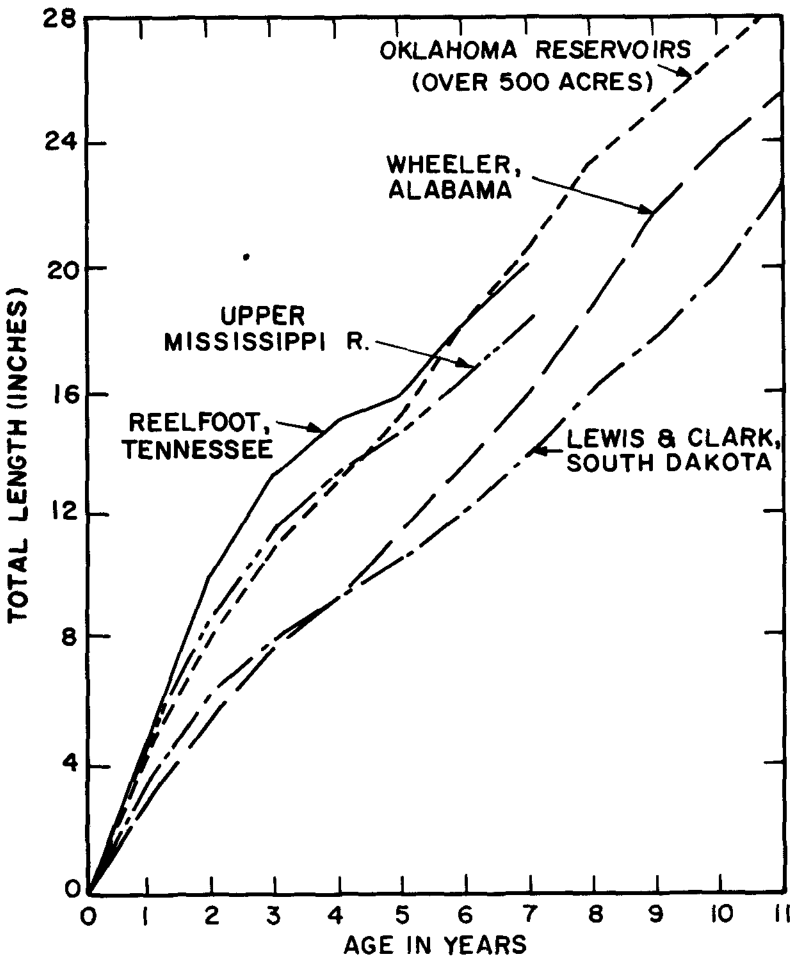

Figure 3. Growth rates of freshwater drum in various reservoirs.

Spawning male and female drum were collected May 23, 1967. Water temperature was 68°F. Eggs and larvae were also collected in mid-June 1968 when water temperature was 78°F. Butler and Smith (1950) report that the general spawning period for drum in the upper Mississippi River is the first of May to the last of June. In Wisconsin, water temperature ranges from 66° to 72°F. during drum spawning (McLeod, 1953; Wirth, 1958).

Eggs of drum are pelagic, and fecundity of females is high (Diaber, 1953; Davis, 1959). Three females (24.2 to 28.9 inches) contained as estimated 686,000 eggs each (table 8). Average number of eggs per pound of body weight was 60,600. Ovaries of several female drum larger than 5 pounds appeared to be atrophied. This condition was observed throughout the year. Average gonad weight of three of the largest mature males was 0.024 pound (table 8).

Drum eggs and larvae were collected with set and tow-nets during June 1968. Priegel (1967) reported that drum eggs require one to two days for hatching. The fry

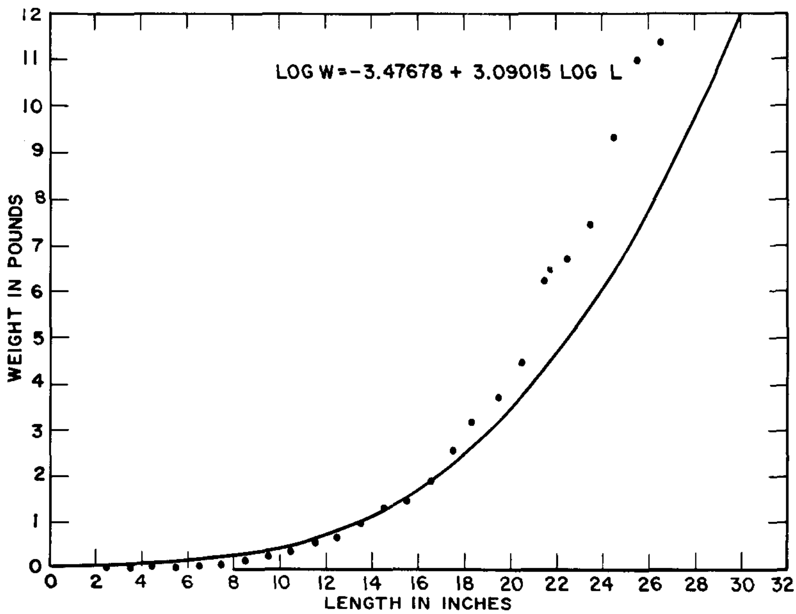

Figure 4. Length-weight relationship of freshwater drum, Wheeler Reservoir.

remain at the surface drifting helplessly for approximately two weeks. By the time they are an inch long, they are found on or near the bottom where they remain most of their life.

Food Habits

Food habits of drum less than 10 inches differed markedly from those over 10 inches. The smaller ones (excluding young-of-the-year) were generally in age-groups I-IV, those longer than 10 inches in age-groups V-XIII. The smaller drum fed predominatly on diptera larvae (*Chaoborus* and Chironomidae), with copepods, Ephemeroptera, and Plecoptera of lesser importance. Insect larvae (primarily diptera) were also the principal food of drum in western Lake Erie (Daiber, 1952), Norris Reservoir (Dendy, 1946), and the lower Missouri River (Berner, 1951).

Drum longer than 10 inches fed predominantly on bivalve molluscs (*Corbicula*) and fish (table 9). The *Corbicula* (Asiatic clams) were 0.5 inches in diameter and larger. Drum apparently crush the clams with their pharyngeal teeth since shells in the stomachs were partially fragmented. Sinclair and Isom (1963) reported *Corbicula* were eaten by drum in Kentucky Lake, Tennessee.

Gizzard shad (*Dorosoma cepedianum*) was the predominant fish in the diet. Other fish were identified as shad, but could not be further identified as gizzard or threadfin. Both species are abundant in Wheeler Reservoir. A fingerling bluegill and a fingerling drum were present in two of the stomachs. Fish is not an important food item of drum in Lake Winnebago (Priegel, 1967) or in western Lake Erie (Daiber, 1952), but it ranks second in the lower Missouri River (Berner, 1951) and in four Iowa lakes (Moen, 1955).

Copepods (*Cyclops*) and diptera larvae (*Chaoborus* and Chironomidae) were dominant food items in 61 (2.2 to 3.8 inches) young-of-the-year Wheeler drum. Cladocera and ostracods were of minor importance. Priegel (1967) reports that in Lake Winnebago midge larvae are the most important food items for drum over 1.6 inches and *Cyclops* the most important for those under 1.6 inches. Daiber (1952) and Moen (1955) reported that Entomostraca are important in the diet of young drum.

TABLE 7.
Length-weight relationship of Wheeler Reservoir freshwater drum.

Total Length (inches)	*Weight (pounds)*		*Total Length (inches)*	*Weight (pounds)*	
	Calculated	*Empirical*		*Calculated*	*Empirical*
2.5	.01	.01	16.5	1.93	2.27
3.0	.01	.01	17.0	2.11	1.97
3.5	.02	.03	17.5	2.31	2.48
4.0	.02	.03	18.0	2.52	2.83
4.5	.04	.04	18.5	2.75	3.23
5.0	.05	.05	19.0	2.98	2.95
5.5	.07	.05	19.5	3.23	3.88
6.0	.09	.06	20.0	3.50	4.31
6.5	.11	.07	20.5	3.77	4.04
7.0	.14	.09	21.0	4.07	5.50
7.5	.17	.10	21.5	4.37	6.08
8.0	.21	.18	22.0	4.69	6.56
8.5	.25	.20	22.5	5.03	6.50
9.0	.30	.31	23.0	5.38	7.48
9.5	.35	.33	23.5	5.76	7.19
10.0	.41	.33	24.0	6.14	9.00
10.5	.48	.45	24.5	6.54	11.92
11.0	.55	.47	25.0	6.97	11.90
11.5	.63	.51	25.5	7.41	11.32
12.0	.72	.68	26.0	7.87	12.05
12.5	.82	.78	26.5	8.34	12.60
13.0	.92	.85	27.0	8.84	13.11
13.5	1.04	.95	27.5	9.35	11.75
14.0	1.16	1.16	28.0	9.89	13.52
14.5	1.29	1.48	28.5	10.44	14.00
15.0	1.44	1.72	29.0	11.02	13.81
15.5	1.59	1.62	29.5	11.62	18.57
16.0	1.75	2.15	30.0	12.24	17.00

TABLE 8.
Gonad weights of mature drum in Wheeler Reservoir.

Date	*Sex*	*Fish Length (inches)*	*Fish Weight (pounds)*	*Gonad Weight (pounds)*	*Estimated Number of Eggs*
5/17/67	female	9.3	0.26	0.020	––
5/18/67	female	17.7	1.48	0.070	––
5/18/67	female	24.2	8.38	0.430	385,000
5/18/67	female	27.6	11.75	0.950	822,000
5/18/67	female	28.9	13.80	0.650	850,000
5/17/67	male	8.7	0.24	0.003	––
5/17/67	male	9.0	0.30	0.004	––
1/9/67	male	19.6	3.56	0.010	––
2/6/67	male	22.1	7.10	0.013	––
1/9/67	male	22.6	6.31	0.030	––
2/6/67	male	24.0	10.00	0.030	––

TABLE 9.

Seasonal contents of stomachs of drum less than 10 inches and over 10 inches, Wheeler Reservoir.

Food Item	*Jan-Mar*				*Apr-June*				*July-Sept*				*Oct-Dec*				*Yearly Total*	
	Occurrence		*Dominance*		*Occurrence*		*Dominance*		*Occurrence*		*Dominance*		*Occurrence*		*Dominance*		*Dominance*	
	<10	>10	<10	>10	<10	>10	<10	>10	<10	>10	<10	>10	<10	>10	<10	>10	<10	>10
	Percent																	
Annelida	5	—	0	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0
Bryozoa	—	3	—	0	—	—	—	—	—	—	—	—	4	—	0	—	0	0
Crustacea																		
Copepoda	—	—	—	—	56	—	0	—	14	—	0	—	42	—	2	—	1	0
Cladocera	—	—	—	—	—	—	—	—	3	—	0	—	—	—	—	—	0	0
Insecta																		
Diptera	73	—	70	—	100	—	91	—	86	—	80	—	89	—	81	—	81	0
Ephemeroptera	32	6	16	—	25	—	9	—	3	—	0	—	9	13	6	13	8	2
Plecoptera	9	—	0	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0
Tricoptera	—	—	—	—	—	—	—	—	3	—	0	—	—	—	—	—	0	0
Unidentified animal matter	14	—	14	—	—	—	—	—	23	—	20	—	23	—	11	—	10	0
Mollusca																		
Pelecypoda	—	3	—	3	—	57	—	57	—	75	—	75	—	53	—	53	0	44
Pisces*	—	97	—	97	—	43	—	43	—	25	—	25	—	33	—	33	0	54
Number of stomachs			44	33			57	30			35	28			48	15	189	106

*Primarily gizzard shad

In general, the smaller Wheeler drum fed on insects and crustaceans which were important items for drum in most other waters. The predominance of fish eaten by the larger Wheeler drum was similar to that reported for drum in the lower Missouri River and in Iowa lakes.

SUMMARY AND DISCUSSION

Freshwater drum and smallmouth buffalo are important commercial species in the Tennessee River. The 1967 harvest included 250,000 pounds of drum and 2.5 million pounds of smallmouth buffalo. Market demand for drum is variable and prices are relatively low ($.05 per pound). The average price for smallmouth buffalo is $.12 per pound. Legal fishing gear, primarily 3-inch (square measure) gill and trammel nets, prevent adequate harvest of the overpopulation of drum. Houser (1960) described the same problem in Oklahoma.

Growth rate of Wheeler smallmouth buffalo is equal to or better than that reported in most other reservoirs. In Wheeler, they are 5 to 6 years old before they are abundant in the commercial catch. Drum grow slower in Wheeler than in other waters. They are not abundant in the commercial catch until they are 7 to 8 years old.

Available information does not indicate that food is a limiting factor for drum in Wheeler Reservoir. However, smallmouth buffalo of all sizes do compete with drum under 10 inches for zooplankton and diptera larvae. Priegel (1967) reported that young-of-the-year drum in Lake Winnebago compete for food with most young-of-the-year game fish, such as sauger and white bass. In Wheeler, Asiatic clams are an important food item for smallmouth buffalo of all sizes and for drum longer than 10 inches. Smallmouth buffalo prefer Asiatic clams up to 4 mm in diameter, while drum normally feed on those larger than 10 mm. Catfish, carp, and redear sunfish also feed on Asiatic clams, but the supply of clams in Wheeler and other Tennessee River reservoirs is practically unlimited. Gizzard shad, which are important in the diet of drum, are also present in adequate numbers.

Peak spawning periods in 1967 were mid-April for smallmouth buffalo and late-May for drum. Reproductive potential of both species in Wheeler Reservoir is high. Female drum, 8 to 13 pounds, averaged 686,000 eggs; smallmouth buffalo, 5 to 6 pounds, averaged 230,000. All male drum in age-group IV and all females in age-group VI were mature. All male and female buffalo were mature in age-groups VI and VII, respectively. In general, smallmouth buffalo in Wheeler enter the commercial harvest in significant numbers at maturity. Drum are usually sexually mature 2 to 3 years before entering the commercial catch.

Tag returns show buffalo moving an average minimum distance of 7.0 miles and a maximum distance of 56 miles. Additional tagging may provide further information on dispersion and concentrations and thus permit increased harvest.

The harvest of buffalo could be increased several times without depleting the population. Gill and trammel nets will have to be relied on because buffalo frequent areas where the water is too shallow for trawls or trap nets. These latter could, however, greatly increase the catch of drum if new and better markets provided the incentive.

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TILAPIA AUREA (STEINDACHNER), A RAPIDLY SPREADING EXOTIC IN SOUTH CENTRAL FLORIDA

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ABSTRACT

Tilapia aurea were introduced into Florida by the Florida Game and Fresh Water Fish Commission in 1961. Original stocking was in managed pits at Pleasant Grove Research Station. From this beginning they have spread to numerous private ponds, four creeks, two rivers and several public lakes. Enriched bodies of water are preferred habitats and native species present have not retarded establishment of *T. aurea*.

Most of the present study was conducted on Lake Parker, a 2291 acre eutrophic lake in Polk County. Surveys of the fish population on Parker revealed seasonal congregations of *T. aurea*. This gregarious behavior was correlated with temperature and habitat preference. During January and February, the species was heavily congregated at an electro-power plant. Water temperatures at the plant ranged as high as 9 degrees Fahrenheit above background lake temperatures. Concentrations were also evident in areas where the lake bottom was primarily muck. As water temperature increased, tilapia competed with centrarchids for sand-bottom spawning areas.

Length-weight studies revealed above average empirical weights, when compared to Alabama pond-raised tilapia. A 14 day creel, randomly selected over a 2 month period, was conducted on the lake to determine catachability.

INTRODUCTION

The Florida Game and Fresh Water Fish Commission obtained 3,000 *Tilapia aurea* from Auburn University in August, 1961, (Crittenden, 1962). These individuals were placed in experimental phosphate pits at the Pleasant Grove Research Station. Several media publicized *T. aurea* as a highly desirable species. With this encouragement friends were given fish for stocking, fishermen caught them and stocked private ponds, and some fishermen who felt the Commission was proceeding too slowly, stocked them in public lakes.

After the Florida Game and Fresh Water Fish Commission completed the experiments, it was decided that *T. aurea* would be undesirable to the Florida