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GROWTH OF CATFISHES IN NORRIS RESERVOIR, TENNESSEE[1]

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In the past few years better market conditions have resulted in increased numbers of commercial fishermen and a greater catfish harvest (2,700,000 pounds in 1962) in Tennessee Valley reservoirs. State and federal agencies are testing new types of commercial gear to improve the harvest further. If the commercial and sport fisheries for these species are to be expanded and properly managed, adequate age and growth data are essential.

TVA and the Tennessee Game and Fish Commission are cooperating in studies to provide more complete knowledge of catfish growth throughout the Tennessee River system. These data from Valley reservoirs will be used as the basis for development, utilization, and regulation of gear wherever necessary to ensure maximum commercial harvest of marketable-size catfish consistent with a sustained sport harvest of catfish. Growth information on channel and blue catfishes in Kentucky Reservoir—the lowermost in the system—was reported by Conder and Hoffarth (1962). The present report covers flathead catfish *(Pylodictis olivaris)* and channel catfish *(Ictalurus punctatus)* in Norris, one of the main tributary reservoirs in eastern Tennessee.

Completed in 1936, Norris Reservoir has a surface area of 34,200 acres at "full pool" or spillway elevation, 1020 m.s.l. The annual minimum elevation is usually reached by January 1, just prior to the rainy season when the greatest amount of flood storage space is needed. The level rises gradually until April and then continues rising to spillway level, if rainfall provides enough runoff water. Drawdown begins June 1. Average annual fluctuation is about 60 feet.

Sport fishing for catfish in Norris is incidental to fishing for other species, which is not the case in many Valley reservoirs. Baits designed specifically for catfish are seldom used. Further, Norris has been opened to commercial fishing only on an experimental basis. Data from three winters of intensive commercial netting indicate that available catfishes of suitable size would support only a limited commercial fishery (Carroll, Hall, and Bishop, 1963).

MATERIALS AND METHODS

Nearly all of the 254 flathead catfish in this study were taken by commercial fishermen in 3- to 5-inch-mesh gill and trammel nets between December 1958 and February 1959. Rotenone samples and small-mesh experimental gill net collections provided a few of the smaller fish. The 87 channel catfish were collected by TVA personnel in routine netting and rotenone samples between 1959 and 1962. All fish were measured for total length in inches; weights were recorded in pounds. The pectoral spine was used for aging both species, according to methods described by Sneed (1951).

Spine cross-sections were cut at the distal end of the basal recess, using a saw similar to the one described by Leonard and Sneed (1951). The cross-sections were placed in water and a binocular microscope, equipped with an ocular micrometer and a movable cross hair, was used to identify and measure annuli (Fig. 1).

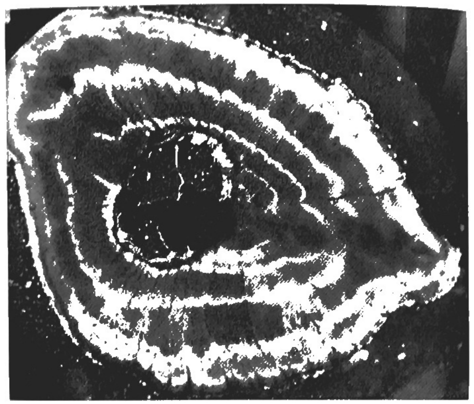

Fig. 1. Enlarged cross-section of pectoral spine from flathead catfish showing annual rings and center cavity (lumen).

Measurements between annuli were made along the lateral axis from the center of the lumen to the outer edge. Some of the older flathead catfish could not be aged accurately because of excessive deterioration of the spine center. However, all fish were used in determining length-weight relationships. In calculating growth, a direct proportion between the body length and spine radius was assumed.

FLATHEAD CATFISH

Growth Rates. Based on the average calculated growth of 201 individuals from 1943 through 1958 year-classes, flathead catfish reach 5.2 inches total length at the end of the first year of life and the following respective lengths at the ends of succeeding years: 9.4, 13.8, 18.6, 23.2, 26.4, 29.0, 31.1, 33.1, 34.6, 37.3, 39.0, 39.7, 39.9, 40.8, and 42.0 inches (Table 1). Average yearly growth increment decreased steadily

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TABLE 1
Calculated Age and Growth of Flathead Catfish Collected in Norris Reservoir in 1958-59

Year class	Age group	Number of fish	Calculated average total length (inches) at end of year: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1958	I	1	5.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1957	II	2	5.4	9.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1956	III	6	5.3	8.8	12.2	—	—	—	—	—	—	—	—	—	—	—	—	—
1955	IV	5	6.5	10.8	15.1	21.8	—	—	—	—	—	—	—	—	—	—	—	—
1954	V	22	6.2	11.1	16.8	22.8	28.4	—	—	—	—	—	—	—	—	—	—	—
1953	VI	36	5.3	9.7	14.6	20.2	25.0	29.0	—	—	—	—	—	—	—	—	—	—
1952	VII	34	5.3	9.8	13.4	18.2	23.4	27.5	30.8	—	—	—	—	—	—	—	—	—
1951	VIII	33	4.8	8.4	13.1	17.4	22.1	26.0	28.8	31.3	—	—	—	—	—	—	—	—
1950	IX	27	4.7	9.3	13.2	17.8	21.9	25.7	29.1	31.7	33.8	—	—	—	—	—	—	—
1949	X	16	4.9	9.0	12.7	16.5	20.3	24.2	27.4	29.8	31.7	33.7	—	—	—	—	—	—
1948	XI	10	5.0	8.7	13.0	16.8	20.8	24.7	27.5	31.1	33.6	35.3	37.1	—	—	—	—	—
1947	XII	6	4.6	7.9	11.7	14.3	17.9	21.6	26.2	29.8	32.8	35.5	37.7	39.4	—	—	—	—
1946	XIII	2	2.6	7.5	10.3	14.3	18.6	23.2	27.7	32.3	34.3	36.2	38.1	39.0	40.3	—	—	—
1943	XVI	1	4.9	9.9	13.8	17.4	19.0	22.6	27.3	31.2	32.7	34.7	35.9	36.9	38.4	39.9	40.8	42.0
Grand average length		201	5.2	9.4	13.8	18.6	23.2	26.4	29.0	31.1	33.1	34.6	37.3	39.0	39.7	39.9	40.8	42.0
Average annual increment			5.2	4.2	4.4	4.8	4.6	3.2	2.6	2.1	2.0	1.5	2.7	1.7	0.7	0.2	0.9	1.2

from 5.2 inches the first year to 1.5 inches the ninth year except for the third, fourth, and fifth years when there was above-average growth. The complete growth history by year-classes and age-groups is shown in Fig. 2.

Much of the improved growth of three- to five-year-old fish occurred after 1955 (year-classes 1955-54-53) and may possibly be attributed to an extreme water-

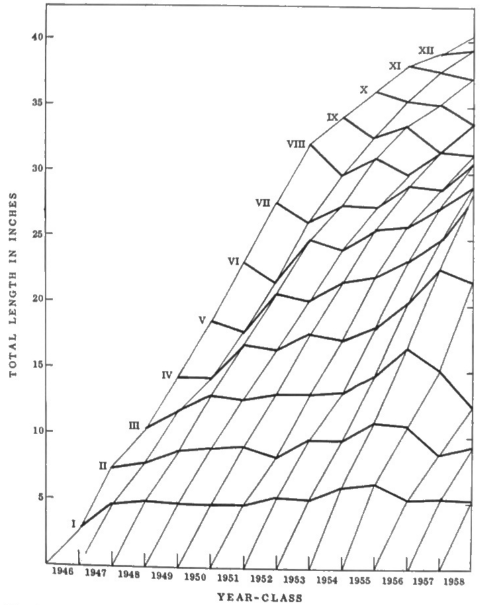

Fig. 2. Thirteen-year (1946-1958) growth history of Norris Reservoir flathead catfish. Heavy solid lines connect points representing lengths attained at ages indicated by Roman numerals.

level drawdown in the winter of 1955-56 (Table 2).

TABLE 2
Minimum Reservoir Elevations and Surface Acres at These Elevations on Norris Reservoir, 1954-59

Year	Minimum elevation during January	Surface acres
1954	930.0	8,200
1955	948.0	11,800
1956	909.0	5,000
1957	965.0	16,000
1958	967.0	16,500
1959	935.0	9,100
Spillway elevation and acreage	1020.0	34,200

Surface elevation of the reservoir that winter went down to 909 feet m.s.l., 111 feet below full pool; surface area was reduced to 5,000 acres. Younger fish (year-classes 1956-57-58) did not show similar improved growth rate after the drawdown. First-year growth was greatest in 1954 and 1955, just prior to and during the drawdown period. These two year-classes, 1954 in particular, continued to achieve the greatest total growth in succeeding years (Fig. 3).

Too little is known about the immediate and after effects of concentrating large numbers of fish in a much reduced area by extensive drawdown, and this is true also of predator-forage relationships. The Norris data offer some indication that extreme drawdown of a large reservoir may briefly accelerate growth rates of some age-groups and depress or have little effect on others.

Comparable growth data for flathead catfish in other Tennessee lakes are not available. However the growth of this species has been studied in Missouri (Purkett, 1958), Kansas (Minckley and Deacon, 1959), and Oklahoma (McCoy, 1953). Comparison of average lengths in different years (Table 3) shows Norris fish

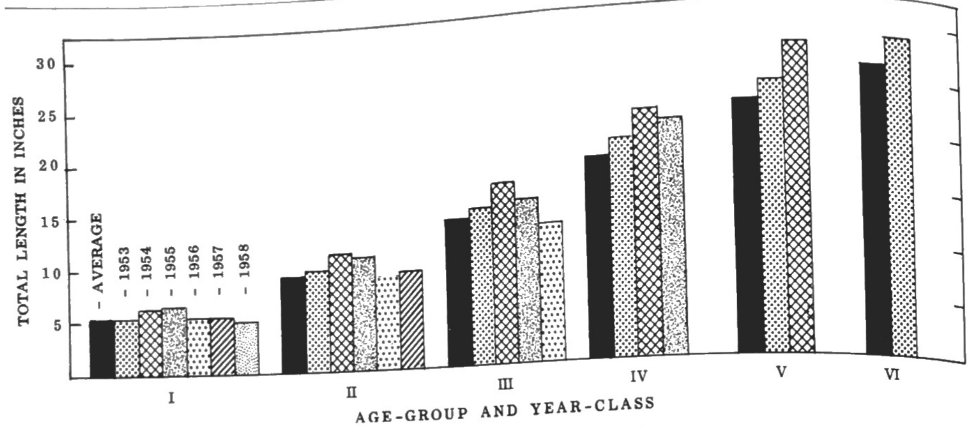

Fig. 3. Total 1953-58 year-class growth of flathead catfish, Norris Reservoir, compared with average growth of all available year-classes in the first six age groups.

Table 3

Comparison of Growth of Flathead Catfish in Norris Reservoir and in Missouri, Kansas, and Oklahoma Waters

Location	Number of fish	Calculated total length (inches) at end of year													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Norris Reservoir, Tennessee	201	5.2	9.4	13.8	18.6	23.2	26.4	29.0	31.1	33.1	34.6	37.3	39.0	39.7	39.9
Salt River, Missouri[1]	53	3.0	6.1	9.1	11.8	13.7	16.6	17.8	19.8	23.6	—	—	—	—	—
Big Blue River, Kansas[2]	75	5.6	10.3	14.4	19.0	24.8	—	27.6	30.4	—	—	—	—	—	—
Oklahoma Lakes[3]	723	4.6	9.7	15.2	20.0	23.4	25.9	28.9	32.4	35.1	38.3	39.0	41.5	42.8	43.3

[1] Purkett, 1958.
[2] Minckley and Deacon, 1959.
[3] McCoy, 1953.

growing slightly faster than those in the Salt River, Missouri, about the same as those in the Big Blue River, Kansas, and somewhat slower than those in Oklahoma lakes.

Length-Weight Relationship. Data from 254 flathead catfish were used to determine a length-weight relationship. The logarithmic expression of the relationship of length to weight resulted in the equation:

$$\text{Log } W = -4.03252 + 3.49758 \text{ Log } L$$

Examination of the length-weight curve (Fig. 4) shows that a Norris flathead catfish weighs approximately 0.4 pound when it reaches 10 inches or harvestable size. Other averages are 2.1 pounds at 20 inches, 13.5 pounds at 30 inches, and 25 pounds at 40 inches. The largest fish in the study measured 48 inches and weighed 70 pounds. The fastest rate of weight increase occurs above 30 inches or in the eighth year of life. Average calculated weights of Norris flatheads at one-inch intervals from 3 to 48 inches are given in Table 4. Up to 30 inches, these correspond closely with data from Oklahoma reservoirs (McCoy, 1953); Norris fish in the 30- to 50-inch range are heavier.

The coefficient of condition, or relative plumpness,

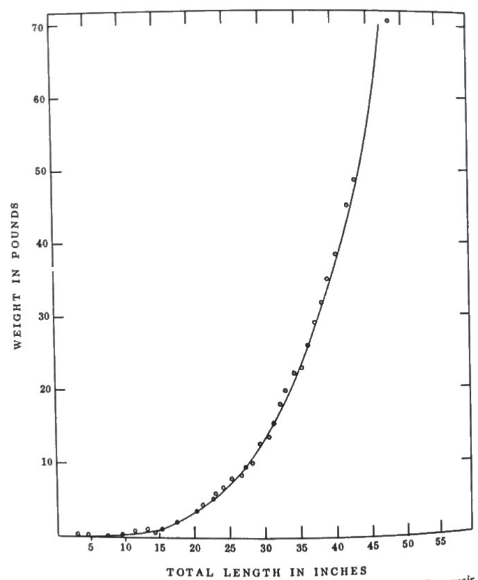

Fig. 4. Length-weight relationship of flathead catfish in Norris Reservoir.

of Norris flatheads increased gradually with size, from 18.2 at 3.8 inches to 63.4 at 48 inches (Table 4).

Table 4

Length-Weight Relationship of Flathead Catfish in Norris Reservoir, Tennessee

Size interval (inches)	Number of fish	Average total length (inches)	Weight (pounds) Average	Weight (pounds) Calculated	Coefficient of condition (C)
3.0– 3.9	1	3.8	0.01	0.01	18.2
4.0– 4.9	1	4.6	0.03	0.05	30.8
7.0– 7.9	1	7.2	0.1	0.1	26.8
9.0– 9.9	1	9.8	0.3	0.4	31.9
11.0–11.9	2	11.4	0.5	0.5	33.8
13.0–13.9	2	13.4	0.9	0.8	37.4
14.0–14.9	2	14.4	0.9	1.0	30.1
15.0–15.9	2	15.2	1.4	1.3	39.9
17.0–17.9	1	17.5	1.5	2.1	28.0
20.0–20.9	2	20.4	3.4	3.5	40.1
21.0–21.9	2	21.2	4.6	4.0	48.3
22.0–22.9	3	22.6	5.1	5.1	44.2
23.0–23.9	1	23.0	6.0	5.4	49.3
24.0–24.9	3	24.3	6.9	6.5	48.1
25.0–25.9	11	25.4	7.7	7.6	47.0
26.0–26.9	19	26.4	8.6	8.7	46.7
27.0–27.9	15	27.4	9.7	9.9	47.2
28.0–28.9	8	28.4	10.2	11.2	44.5
29.0–29.9	9	29.5	12.8	12.8	49.9
30.0–30.9	17	30.4	13.9	14.3	49.5
31.0–31.9	20	31.4	15.6	16.6	50.4
32.0–32.9	19	32.4	18.1	17.8	53.2
33.0–33.9	20	33.3	20.0	19.6	54.2
34.0–34.9	6	34.4	22.4	21.7	55.0
35.0–35.9	12	35.3	23.1	24.4	52.5
36.0–36.9	24	36.4	26.3	26.8	54.5
37.0–37.9	13	37.3	29.3	29.2	56.5
38.0–38.9	16	38.4	32.0	32.3	56.5
39.0–39.9	2	39.0	35.0	34.1	59.0
40.0–40.9	6	40.3	38.5	38.2	58.8
41.0–41.9	6	41.4	45.0	42.0	63.4
43.0–43.9	5	43.5	48.6	49.9	59.0
48.0–48.9	2	48.1	70.5	70.9	63.4

Channel Catfish

Growth Rates. Based on the calculated growth of 87 individuals (Table 5) representing year-classes 1953 through 1959, Norris channel catfish average 3.9 inches total length at the end of the first year and 6.9, 10.7, 12.8, 14.7, 16.7, 18.0, and 21.3 inches respectively at the ends of succeeding years. The average yearly growth increment was erratic, with increases in the second, sixth, and eighth years and decreases in other years.

The effects of extreme water-level drawdown on growth of older fish was not as pronounced in channel as in the flathead catfish. However, channels hatched in 1956, immediately following the drawdown were generally longer at all ages than those in the 1954 and 1955 year-classes. Also, the 1957 year-class appeared to be a strong one, since it was dominant in 1960 and 1961 collections.

Comparison of channel catfish growth in Norris and Kentucky reservoirs (Conder and Hoffarth, 1962) shows first-year fish growing faster in Kentucky but average lengths about the same at the end of the second year. At ages III through VIII, Norris fish were a year ahead in growth (Table 6). The better growth in Norris strengthens the conclusion of Conder and Hoffarth that Kentucky Reservoir channel catfish are stunted after their second year and that a heavier harvest of three- to seven-year-old fish might bring about a better balanced population and a faster growth rate.

Average growth of Norris channel catfish was better than in Des Moines River, Iowa, and about the same as in Oklahoma reservoirs (Table 6).

Length-Weight Relationship. Data from 70 Norris channel catfish from 8 to 21 inches were used to determine a length-weight relationship. Logarithmic expression resulted in the following equation:

$$\text{Log } W = -7.01702 + 3.69656 \text{ Log } L$$

Table 5

Calculated Age and Growth of Norris Reservoir Channel Catfish, Year-Classes 1953-59

Year class	Age group	Number of fish	Calculated total length (inches) at end of year							
			1	2	3	4	5	6	7	8
1959	II	17	2.7	5.1	—	—	—	—	—	—
1957	II	9	4.4	7.4	—	—	—	—	—	—
1959	III	1	1.8	3.5	4.8	—	—	—	—	—
1958	III	1	3.3	6.1	12.8	—	—	—	—	—
1956	III	8	4.7	7.9	10.7	—	—	—	—	—
1958	IV	2	3.5	6.0	8.9	10.9	—	—	—	—
1957	IV	13	3.8	7.5	11.1	13.3	—	—	—	—
1955	IV	4	3.0	5.5	8.4	10.9	—	—	—	—
1957	V	16	4.6	7.8	11.0	12.8	14.7	—	—	—
1954	V	3	3.4	6.0	9.3	11.3	13.6	—	—	—
1956	VI	3	5.0	8.5	11.9	14.7	16.3	18.2	—	—
1955	VI	5	4.2	7.7	11.2	12.6	13.7	15.5	—	—
1955	VII	1	4.4	7.2	9.6	12.4	15.4	17.0	18.2	—
1954	VII	3	4.5	6.9	10.1	12.8	14.7	16.2	17.4	—
1953	VII	1	6.6	11.7	15.5	16.3	17.5	18.9	19.5	21.3
Grand average length		87	3.9	6.9	10.7	12.8	14.7	16.7	18.0	21.3
Average annual increment			3.9	3.0	3.8	2.1	1.9	2.0	1.3	3.3

Table 6

Comparison of Average Growth of Channel Catfish in Norris and Kentucky Reservoirs and Iowa and Oklahoma Waters

Location	Number of fish	Calculated total length (inches) at end of year							
		1	2	3	4	5	6	7	8
Norris Reservoir, Tennessee	87	3.9	6.9	10.7	12.8	14.7	16.7	18.0	21.3
Kentucky Reservoir, Tennessee[1]	95	4.3	6.7	8.7	10.3	12.1	14.3	16.7	19.5
Des Moines River, Iowa[2]	504	1.8	4.9	7.7	10.1	12.3	15.0	17.4	19.3
16 Oklahoma Reservoirs[3]	3,291	3.6	7.0	9.8	12.0	14.3	16.4	18.6	20.9

[1] Conder and Hoffarth, 1962.
[2] Muncy, 1959.
[3] Finnell and Jenkins, 1954.

Channel catfish from Norris weigh approximately 0.3 pound when they reach 10 inches or harvestable size (Fig. 5). At 15 inches they weigh about 1.0 pound and at 21 inches nearly 4 pounds. Fastest growth in weight is above 15 inches or when 5 years old. Average calculated weights and coefficients of condition at one-inch intervals from 3 to 22 inches are shown in Table 7.

SUMMARY

1. Spines from 254 flathead and 87 channel catfish were used to determine growth rates of these two species in Norris Reservoir.

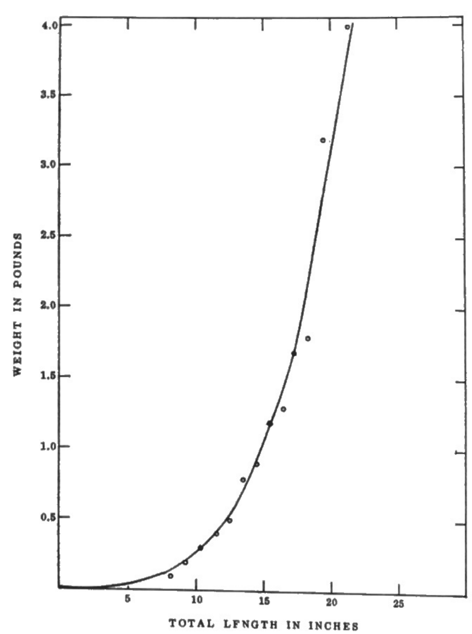

Fig. 5. Length-weight relationship of channel catfish in Norris Reservoir.

Table 7

Length-weight Relationship of Channel Catfish in Norris Reservoir

Size interval (inches)	Number of fish	Average total length (inches)	Average weight (pounds)	Calculated weight (pounds)	Coefficient of condition
3.0– 3.9	3	3.4	—	0.004	10.2
4.0– 4.9	6	4.6	—	0.01	10.3
5.0– 5.9	6	5.5	—	0.03	18.0
6.0– 6.9	1	6.2	—	0.04	16.9
7.0– 7.9	1	7.0	—	0.06	17.5
8.0– 8.9*	1	8.1	0.1	0.1	18.8
9.0– 9.9	6	9.4	0.2	0.2	24.1
10.0–10.9	5	10.4	0.3	0.3	26.7
11.0–11.9	5	11.5	0.4	0.4	26.3
12.0–12.9	5	12.4	0.5	0.5	26.2
13.0–13.9	13	13.4	0.8	0.7	33.3
14.0–14.9	10	14.5	0.9	0.9	29.5
15.0–15.9	15	15.4	1.2	1.2	32.9
16.0–16.9	4	16.4	1.3	1.5	29.5
17.0–17.9	2	17.1	1.7	1.7	34.0
18.0–18.9	1	18.2	1.8	2.2	29.9
19.0–19.9	1	19.3	3.2	2.7	44.5
21.0–21.9	2	21.2	4.0	3.8	42.0

* Fish below 8.0 inches were not used in the length-weight calculations.

2. Flathead catfish averaged 5.2 inches in total length at the end of their first year and 9.4, 13.8, 18.6, 23.2, 26.4, 29.0, 31.1, 33.1, 34.6, 37.3, 39.0, 39.7, 39.9, 40.8, and 42.0 inches respectively at the ends of succeeding years. Channel catfish averaged 3.9 inches in total length at the end of their first year and 6.9, 10.7, 12.8, 14.7, 16.7, 18.0, and 21.3 inches respectively, at the ends of succeeding years.

3. Length-weight relationships show flathead catfish weigh approximately 0.4 pound at 10 inches, or minimum harvestable size, 2.1 pounds at 20 inches, 13.5 pounds at 30 inches, and 25 pounds at 40 inches. Channel catfish weigh approximately 0.3 pound when they reach 10 inches, 1 pound at 15 inches, and 4 pounds at 21 inches.

4. Comparative data show Norris flatheads growing slightly faster than those in the Salt River, Missouri, about the same as those in the Big Blue River, Kansas, and somewhat slower than those in Oklahoma lakes. Norris channel catfish grow about the same as those in Iowa and Oklahoma waters through age VIII; after the first year they grow faster than those in Kentucky Reservoir, Tennessee.

5. Some evidence of accelerated growth was found in three- to five-year-old flathead catfish after an extreme water-level drawdown in the winter of 1955-56, but growth of younger fish remained average or below. The 1954-55 year-classes had the greatest first-year growth and these fish continued to achieve greater total lengths in succeeding years.

6. Growth acceleration was not evident in older channel catfish but fish of the 1956 year-class were longer at all ages than those of 1954 and 1955. The 1957 year-class was strong as evidenced by its dominance in 1960-61.

7. Little is known about the present catfish harvest in Norris, but it is assumed to be light since there is no commercial fishing and sport catches are largely incidental. From this growth study no regulation appears necessary. A year-long creel census begun in January 1963 will provide reliable harvest information for further management considerations.

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NEWS OF TENNESSEE SCIENCE

A $24,000 grant has been awarded to the University of Tennessee Department of Electrical Engineering by the National Aeronautics and Space Administration for research in the area of automatic control. The research is applicable for control of missiles and submarines. Dr. J. C. Hung, Associate Professor of Electrical Engineering, is supervisor for the program, which began in early April. Also working with Dr. Hung are Dr. N. K. Sinha, Associate Professor of Electrical Engineering, and two doctoral candidates.

Dr. William K. Stair, Professor of Mechanical and Aerospace Engineering, at the University of Tennessee has been awarded a grant of $27,096 by the National Aeronautics and Space Administration to develop special new seals that are critical components in the machinery for space and nuclear applications. The research project is entitled "Theoretical and Experimental Studies of Visco-Type Shaft Seals." Development of the new pressure-type seal, especially essential in preventing leakage from space vehicles, is now in the theoretical stage, but the NASA grant will push forward the design of the unit.

The Board of Trustees of the University of Tennessee has authorized the University of Tennessee to join East Tennessee State University in developing a cooperative center for resident credit at Kingsport, to be known as the Kingsport University Center, offering both undergraduate and graduate programs. ETSU will continue to offer a broad program of undergraduate courses and continue to develop such graduate programs as need and facilities make feasible. UT will develop graduate programs, on both master's and doctoral levels, in the sciences, engineering, and business administration in accordance with the level of work authorized on UT's Knoxville camuus. As the KUC develops, it is anticipated that joint graduate programs may become feasible, but for the present, each university will continue to administer its degrees and programs under its own regulations.

UT and ETSU will each have a director for its program, but the general coordinator will be Dr. Fred McCune, Dean of ETSU's Continuing Education.

A comprehensive study of the radiation problems that may be encountered in manned space flight is being undertaken by the Medical Division of the Oak Ridge Institute of Nuclear Studies (ORINS) for the National Aeronautics and Space Administration. As part of the NASA study, the Medical Division will attempt to become a repository for information on radiation effects in man. "The information compiled will not be limited to that of immediate use of NASA problems, but will include much of the available information of radiation effects in man," said Dr. William G. Pollard, ORINS Executive Director. The research staff will be headed by Dr. C. C. Lushbaugh.

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