PETERMAN

# LIFE HISTORY OF SAUGERS IN GARRISON RESERVOIR[1]

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*Abstract:* Data from Garrison Reservoir and the tailrace area in north-central North Dakota revealed that sauger (*Stizostedion canadense*) growth rates were better than those reported for other waters, with the exception of Fort Randall and Norris reservoirs. Garrison Reservoir saugers grew at a faster rate than those from the tailrace. Average calculated total lengths for saugers from Garrison Reservoir at annuli 1–6 were 4.9, 8.7, 12.3, 15.4, 18.4, and 23.1 inches, respectively, whereas those from the tailrace at annuli 1–8 were 4.7, 8.5, 11.3, 13.8, 16.2, 18.7, 20.6, and 25.6 inches, respectively. The average number of eggs per pound of fish was 27,498. Females were more abundant than males, particularly in older age groups. Some male and female saugers mature at 3 years of age. Generally, spawning activities in the Garrison Reservoir and the tailrace take place between the first of May and the end of June.

This is a study of the life history of the sauger in Garrison Reservoir, the tributaries, and the tailrace. It was initiated in June, 1959, and continued to July, 1960. Aside from the limited surveys on the Missouri River drainage, the sauger has not been investigated previously in North Dakota.

The sauger is indigenous to the Missouri River in North Dakota. It was first reported (Girard 1858) from a collection taken near Fort Union by Dr. Frederick Hayden. Personius and Eddy (1955) reported the sauger for the Little Missouri River, and the North Dakota Game and Fish Department has occasionally taken it in test-netting surveys of Garrison Reservoir.

Evermann and Cox (1894) reported that the sauger was unimportant as a game fish in the Missouri River Basin, but now anglers catch large numbers of them, from May to October, in both the Garrison Reservoir and the tailwaters of the dam.

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## DESCRIPTION OF AREA

The 210-foot dam impounding Garrison Reservoir was completed in 1954 by the U. S. Army, Corps of Engineers. The spillway, elevation 1,825 feet msl (mean sea level), is at the east end of the dam, the tailrace (elevation 1,649 feet msl) at the west end. The tailrace covers approximately 40 surface acres and has a maximum depth of 35 feet.

Garrison Reservoir is a multiple-purpose impoundment on the main stem of the Mis-

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Table 1. Ranges of chemical and physical data for Garrison Reservoir and tailrace in 1959 and 1960.

| ANALYSIS | RESERVOIR | TAILRACE |
|---|---|---|
| Total dissolved solids (ppm) | 295.0 – 492.3 | 395.0 – 484.8 |
| Total alkalinity (ppm) | 122.0 – 185.0 | 106.0 – 180.0 |
| Total hardness (ppm) | 140.0 – 232.0 | 205.0 – 212.0 |
| Conductivity (mho × $10^{-6}$ at 25 C) | 1,625 – 2,475 | 1,650 – 1,845 |
| pH | 7.0 – 8.6 | 5.7 – 8.7 |
| Turbidity (ppm) | 0.5 – 18.5 | 0.7 – 6.0 |
| Temperature (F) | 33.0 – 77.0 | 33.0 – 65.0 |

souri River in McLean and Mercer counties. It is approximately 200 miles long and varies in width from 0.75 to 14 miles (average, 3 miles). At the maximum operating pool (elevation 1,850 feet msl), the shoreline is approximately 1,600 miles long, the surface area about 390,000 acres, and the storage capacity 23,000,000 acre-feet. In an average year, the reservoir level is lowered about 16 feet during the winter to accommodate spring floodwaters. The minimum level is usually attained in February, the maximum in late June or early July.

The principal source of water is the Missouri River, although five main tributaries enter the impoundment: Little Missouri River, Shell Creek, White Earth River, Tobacco Garden Creek, and Little Muddy River.

Maximum water surface temperature recorded for the reservoir during the study period was 77 F and, for the tailrace, 65 F. Ice usually appears during late November or early December and may reach a thickness of 3–4 feet. It disappears in late April or early May. The tailrace does not freeze completely.

Chemical and physical analyses were made in the reservoir during the summer of 1959 and the spring of 1960. Total dissolved solids, total alkalinity, total hardness, conductivity, pH, turbidity, and temperature were determined (Table 1).

There were 45 species of fish in association with the sauger in Garrison Reservoir and its tributaries. Most of these were native to the drainage. Brown trout (*Salmo trutta*), rainbow trout (*S. gairdneri*), carp (*Cyprinus carpio*), and largemouth bass (*Micropterus salmoides*) were known to be introduced species, and several other species might have been. Judging from net catches, goldeye (*Hiodon tergisus*) was the most abundant species in the reservoir, white sucker (*Catostomus commersoni*) in the tributary streams.

## METHODS

Saugers were collected with experimental gill nets (1.25- to 3-inch mesh); fyke nets (rectangular opening with 100-foot lead fastened to the center of the frame); pocket nets (two typical fyke nets with a single lead fastened to the opening of each net); seines (common-sense and 100-foot bag); by means of toxicants; and from sport fishermen.

Measurements were made on 1,558 saugers ranging in total lengths from 4.0 to 26.5 inches. Standard, fork, and total lengths were taken to the nearest 0.1 inch to facilitate comparison with lengths recorded by other workers. The relationships between these lengths were nearly rectilinear, and single conversion factors (fork length = 1.127 standard lengths, total length = 1.189 standard lengths) could be used for all sizes of saugers. Weights were taken on all fish to the nearest 0.02 pound.

Table 2. Average calculated total length of male and female saugers from Garrison Reservoir, 1959 and 1960.

| Age Group | Sex | Number of Fish | Average Calculated Total Length in Inches at Each Annulus | | | | | | Length at Capture | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | Mean | Range |
| I | Male | 5 | 5.1 | | | | | | 5.82 | 4.0 – 8.1 |
| | Female | 7 | 5.4 | | | | | | 6.00 | 4.0 – 8.0 |
| II | Male | 26 | 5.0 | 8.6 | | | | | 9.90 | 6.7 – 11.8 |
| | Female | 14 | 5.2 | 8.3 | | | | | 9.86 | 7.1 – 12.3 |
| III | Male | 26 | 4.4 | 8.6 | 11.5 | | | | 13.17 | 10.9 – 17.5 |
| | Female | 45 | 4.5 | 8.4 | 11.8 | | | | 13.64 | 9.3 – 16.6 |
| IV | Male | 36 | 4.8 | 8.4 | 11.4 | 14.0 | | | 14.29 | 12.5 – 17.5 |
| | Female | 92 | 4.8 | 8.8 | 12.6 | 15.6 | | | 16.81 | 12.6 – 21.6 |
| V | Male | 3 | 5.4 | 9.1 | 12.9 | 15.5 | 17.6 | | 17.37 | 14.9 – 18.6 |
| | Female | 58 | 5.3 | 9.0 | 12.5 | 15.7 | 18.1 | | 19.04 | 15.7 – 24.3 |
| VI | Male | | | | | | | | | |
| | Female | 6 | 6.5 | 10.9 | 14.6 | 17.7 | 20.8 | 23.1 | 22.48 | 19.7 – 26.5 |
| | Male | 96 | 4.8 | 8.5 | 11.5 | 14.1 | 17.6 | | | |
| Average | Female | 222 | 5.0 | 8.8 | 12.5 | 15.7 | 18.4 | 23.1 | | |
| Increment | Male | | 4.8 | 3.8 | 3.0 | 2.6 | 2.1 | | | |
| of growth | Female | | 5.0 | 3.9 | 3.6 | 3.1 | 2.5 | 2.3 | | |

Sex was determined by examining the gonads. The ovaries are blunt or rounded anteriorly, and the testes are sharply tapered or pointed (Eschmeyer 1950). The gonads in both sexes are joined posteriorly immediately anterior to the genital aperture. The union is Y-shaped in the female, V-shaped in the male.

In the spring of 1960, ovaries were collected for fecundity studies. Reproductive tracts were also removed and preserved in Bouin's fluid, AFA (alcohol–formalin–acetic acid) solution, and 10 percent formalin, for histological study.

For age and growth analysis, scale samples were collected from the left side of each fish below the lateral line posterior and adjacent to the distal end of the pectoral fin. Plastic impressions were made of scales (Smith 1954). Annuli were determined with the aid of a microprojector. Scale measurements were determined from the center of the focus along the median anterior radius. A constant ratio of scale radius to body length was assumed; the length of fish at each year of life was determined by use of a nomograph. Condition factors were calculated for each fish.

## LIFE HISTORY

### Age and Growth

For age and growth determinations, 529 saugers were used: 318 from Garrison Reservoir, 211 from the tailrace.

Male and female saugers (from both Garrison Reservoir and the tailrace) showed approximately equal rates of growth during the first 2 years, but females were larger than males in later years (Tables 2 and 3). In Minnesota (Carlander 1950) and Ohio (Deason 1933), female saugers did not grow more rapidly than males until after 3 years of life. In Tennessee (Hassler 1957), female saugers grew faster than males after the first year.

Saugers from Garrison Reservoir grew at a faster rate than those from the tailrace. Growth rates and longevity (age group IX) were greater for saugers from Fort Randall

Table 3 Average calculated total length of male and female saugers from tailrace, 1960.

| Age Group | Sex | Number of Fish | Average Calculated Total Length in Inches at Each Annulus | | | | | | | | Length at Capture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Mean | Range |
| II | Male | 12 | 4.8 | 9.0 | | | | | | | 9.44 | 8.4 – 10.2 |
| | Female | 8 | 4.6 | 9.2 | | | | | | | 9.81 | 8.9 – 10.6 |
| III | Male | 24 | 4.9 | 8.4 | 11.0 | | | | | | 11.31 | 10.3 – 13.1 |
| | Female | 19 | 4.7 | 8.3 | 11.0 | | | | | | 11.35 | 10.6 – 15.2 |
| IV | Male | 35 | 4.4 | 8.2 | 11.2 | 13.3 | | | | | 13.58 | 12.0 – 16.4 |
| | Female | 24 | 4.9 | 8.5 | 11.3 | 13.4 | | | | | 13.84 | 12.3 – 16.5 |
| V | Male | 8 | 4.7 | 8.4 | 11.6 | 13.3 | 15.0 | | | | 15.01 | 14.1 – 16.9 |
| | Female | 37 | 5.0 | 8.7 | 11.6 | 14.0 | 16.2 | | | | 16.46 | 14.6 – 18.2 |
| VI | Male | 2 | 4.6 | 7.8 | 10.9 | 14.3 | 16.6 | 18.0 | | | 18.25 | 18.1 – 18.4 |
| | Female | 22 | 4.7 | 8.3 | 11.7 | 14.2 | 16.6 | 18.8 | | | 19.07 | 17.4 – 21.3 |
| VII | Male | | | | | | | | | | | |
| | Female | 18 | 4.8 | 8.2 | 11.5 | 14.0 | 16.0 | 18.3 | 20.3 | | 20.75 | 18.7 – 23.9 |
| VIII | Male | | | | | | | | | | | |
| | Female | 2 | 5.3 | 8.5 | 11.5 | 14.4 | 17.5 | 20.5 | 23.0 | 25.6 | 26.00 | 25.6 – 26.4 |
| Average | Male | 81 | 4.6 | 8.4 | 11.2 | 13.3 | 15.3 | 18.0 | | | | |
| | Female | 130 | 4.8 | 8.5 | 11.4 | 13.9 | 16.3 | 18.7 | 20.6 | 25.6 | | |
| Increment of growth | Male | | 4.6 | 3.7 | 2.9 | 2.1 | 1.8 | 1.4 | | | | |
| | Female | | 4.8 | 3.7 | 3.0 | 2.4 | 2.2 | 2.3 | 2.1 | 2.6 | | |

Reservoir, South Dakota, than for those from North Dakota (Shields 1956, 1957).

Growth rates of saugers from Garrison Reservoir and the tailrace were approximately the same as those of saugers from Fort Peck Reservoir, Montana (Alvord 1957), for the first 4 years of life but were more rapid in the fifth through eighth years of life.

Saugers from the TVA Reservoirs (Eschmeyer and Jones 1941, Stroud 1949, Hassler 1957) grew at a faster rate than those from Garrison Reservoir and the tailrace.

The growth rates of saugers from both Garrison Reservoir and the tailrace were greater than those reported for waters other than reservoirs: Ontario (Hart 1928), Manitoba (Bajkov 1930, Kennedy 1949), Ohio (Deason 1943, Roach 1949), and Minnesota, except for the first year of life (Carlander 1950).

The youngest sauger to appear in the sport fishery of Garrison Reservoir and the tailrace was 2 years old; the oldest was 8. The smallest sauger taken in the sport fishery was 7.0 inches (0.12 pound), the largest 26.5 inches (6.7 pounds). The largest sauger ever recorded from this area was 30.0 inches in total length and weighed 8.2 pounds.

In a partial creel census for 1959 and 1960, 249 saugers averaged 15.6 inches in length and 1.12 pounds in weight. Creel reports (4,637 saugers) for 1954, 1955, 1956, 1957, and 1958 showed similar average total length and weight.

### Condition

Female saugers tended to have slightly higher condition factors than did males (Table 4).

### Fecundity

The number of eggs for each of 12 saugers from Garrison Reservoir and 38 from the tailrace was estimated by counting the

Table 4. Condition factors of the sauger.

| Location, Date, and Sex | Number | Range in Total Length (inches) | Condition Factor | |
|---|---|---|---|---|
| | | | Mean | Range |
| Garrison Reservoir | | | | |
| Summer, 1959 | | | | |
| Males | 57 | 6.7 – 18.6 | 28.7 | 15 – 39 |
| Females | 162 | 5.0 – 26.5 | 30.3 | 11 – 44 |
| Spring, 1960 | | | | |
| Males | 44 | 11.3 – 18.5 | 27.1 | 16 – 33 |
| Females | 69 | 9.3 – 24.6 | 29.0 | 18 – 39 |
| Tailrace | | | | |
| Spring, 1960 | | | | |
| Males | 82 | 8.4 – 18.4 | 28.4 | 15 – 44 |
| Females | 138 | 8.9 – 26.4 | 30.0 | 11 – 47 |

eggs from known portions (5 percent) of each ovary and calculating the total from the weight of the ovaries. This method of estimation was checked by making total counts on six fish. The estimated number of eggs, based on partial counts, ranged from 1.5 to 6.0 percent less than actual total counts. The best estimates were made when samples were taken from the central part of the ovary. There was no important difference between the average number of eggs for saugers from Garrison Reservoir and for those from the tailrace. Saugers used for egg counts ranged from 12.9 to 24.6 inches in total length and 0.60 to 4.62 pounds in weight.

The number of eggs (Table 5) ranged from 10,488 (12.9-inch saugers) to 117,058 (24.6-inch sauger). Carlander (1950) reported a higher average number of eggs for Minnesota saugers (14.0–14.2 inches in total length) than was found for those of similar length in Garrison Reservoir and tailrace.

The average number of eggs for North Dakota saugers was greater than that reported by Hassler (1958) for Tennessee, but was approximately the same as that given by Smith (1941) for the same area. Simon (1946) reported 50,000 eggs for a 3-pound sauger from Wyoming, a lower number than was found in saugers of sim-

Table 5. Estimated number of eggs for saugers from Garrison Reservoir and tailrace, 1960.

| Number of Females | Total Length by Inch Classes (average) | Number of Eggs | | | Average Weight of Fish (pounds) | Average Number of Eggs per Pound of Fish |
|---|---|---|---|---|---|---|
| | | Minimum | Maximum | Average | | |
| 2 | 12.9 | 10,448 | 10,925 | 10,685 | 0.60 | 15,130 |
| 3 | 13.5 | 15,888 | 25,437 | 20,662 | 0.71 | 26,654 |
| 13 | 14.4 | 14,092 | 25,893 | 20,774 | 0.88 | 23,282 |
| 4 | 15.3 | 21,194 | 34,847 | 28,966 | 1.13 | 25,316 |
| 7 | 16.6 | 24,510 | 47,035 | 34,672 | 1.34 | 25,887 |
| 4 | 17.5 | 30,117 | 54,778 | 41,969 | 1.64 | 25,517 |
| 3 | 18.3 | 42,861 | 57,415 | 49,854 | 2.09 | 24,108 |
| 9 | 19.4 | 48,634 | 116,641 | 78,759 | 2.32 | 34,441 |
| 1 | 20.1 | 64,400 | 64,400 | 64,400 | 2.66 | 24,210 |
| 1 | 21.5 | 152,110 | 152,110 | 152,110 | 3.92 | 38,903 |
| 2 | 22.2 | 86,395 | 92,520 | 89,457 | 4.16 | 21,688 |
| 1 | 24.6 | 117,058 | 117,058 | 117,058 | 4.54 | 25,784 |

ilar weight from Garrison Reservoir and tailrace. The average number of eggs produced by North Dakota saugers for the following age groups was: III—13,168; IV—25,932; V—45,330; VI—85,465; VII—101,115. The weight of ovaries increased in proportion to the total length and weight of female saugers (Table 5). The number of eggs (total diameter) per lineal inch ranged from 15 to 21. Individual egg diameters ranged from 1.0 to 1.8 mm (0.04–0.07 inch).

### Sex Ratios

Of 721 saugers from Garrison Reservoir and 745 from the tailrace, 71 percent were females and 29 percent males. The sex ratio of male to female (age groups I–III) in Garrison Reservoir was 1 : 2.5 and in the tailrace 1 : 1.6. The male to female sex ratio of saugers from both localities (age groups IV–VI) ranged from 1 : 4.0 to 1 : 22.0. No males over age group VI were taken; two females were age group VIII.

### Maturity

Maturity of saugers was determined by examination of the gonads and, in a few instances, by histological study.

During the spawning season (1960), total lengths for the smallest mature male and female from Garrison Reservoir were, respectively, 12.5 and 14.0 inches; corresponding lengths for saugers from the tailrace were 10.6 and 12.9. Deason (1933) and Roach (1949), reporting on Ohio saugers, found the smallest mature males to be 9.0 inches, the females 10.5. Hart (1928), for Manitoba, reported the smallest mature females to be 14.0 inches.

Twenty-one percent of the 3-year-old males and all older males were mature. Nineteen percent of the 3-year-old females, 63 percent of the 4-year-olds, and all females older than 5 years were mature. Kennedy (1949) reported the largest number of mature male and mature female saugers from Manitoba were 4 and 5 years old, respectively. Hassler (1958) found most mature male and female saugers from Tennessee to be 3 years old. Carlander (1950) reported that some mature female saugers from Minnesota were 4 years old.

The spawning season for the saugers in Garrison Reservoir and the tailrace is probably from late April to the end of June. In 1960, the first ripe male was observed May 2, the last on June 25. The first ripe female was found May 15, the last on June 11. The height of the spawning season was from May 8 to May 28. During the spawning season, water temperatures ranged from 39 to 53 F.

Eschmeyer and Smith (1943) reported that saugers did not spawn when water temperatures were below 50 F and that eggs in ovaries were deformed when cold water temperatures were maintained. This condition was not observed for saugers from Garrison Reservoir and the tailrace.

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