Reproduction and Early Life History of Sauger, *Stizostedion canadense*, in Lewis and Clark Lake

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ABSTRACT

Sauger (*Stizostedion canadense*) reproduction and early life history have been studied to determine factors affecting year-class strength in Lewis and Clark Lake, a 28,000-acre reservoir on the South Dakota–Nebraska border. Sauger spawn over a rubble substrate in the Missouri River below Fort Randall Dam. Spawning is initiated at a water temperature of 43 F and is complete in approximately 2 weeks. Maximum egg survival occurs 4 ft below minimum river water level. Eggs hatch in 21 days at an average temperature of 47 F and larvae drift down the Missouri River and into Lewis and Clark Lake. The yolk sac is absorbed in 7 to 9 days and larvae feed primarily upon *Cyclops*. Larger size larvae feed on *Daphnia* and *Diaptomus*. Fish are a major food after sauger reach 70 to 110 mm lengths. Adult year-class strength was inversely related to water level fluctuations over the spawning grounds. Abundance of larvae was 15 times greater in 1965 when water levels fluctuated 2.67 ft/day than in 1963 when water levels fluctuated 4.44 ft/day. Apparently, year-class strength is dependent upon water level fluctuation during the incubation period and is determined before young-of-the-year enter Lewis and Clark Lake.

INTRODUCTION

A knowledge of reproductive habits and early life history is necessary to determine factors influencing year-class strength. Reproduction of the sauger has not been described and the only study on first year of life concerns the effect of environmental factors on back-calculated growth (Hassler, 1956). This paper describes reproduction and early life history of the sauger in the Missouri River and Lewis and Clark Lake. Factors affecting year-class strength are discussed and a method to increase survival is suggested.

DESCRIPTION OF AREA

Lewis and Clark Lake is the southernmost of six main stem reservoirs constructed by the U. S. Army Corps of Engineers on the Missouri River. This lake was created by the closure of Gavins Point Dam in July 1955 and reached operational pool level (1,204 to 1,208 ft mean sea level) during the spring of 1956.

The reservoir is 21 miles long; maximum width, 2 miles; maximum depth, 58 ft; average depth, 16 ft; and has an area of 28,000 surface acres (Figure 1). Other environmental conditions are described by Cowell (1967).

The shoreline is steep and relatively straight, with only small bays where six intermittent streams enter the reservoir. Bottom type is primarily mud and silt with a few areas of sand and rubble. The upper one-half of the reservoir has large areas of inundated trees. Higher aquatic vegetation is sparse and consists of small beds of *Polygonum* spp. in the upper end of the reservoir.

The Missouri River flows 44 miles from Fort Randall Dam before entering Lewis and Clark Lake (Figure 1). The width of the river varies from 0.25 to 1.0 mile, and the width of the main river channel varies from 50 to 100 yards. Maximum channel depth is 20 ft. The flood plain has numerous sand bars and water depth is generally less than 6 ft. The bottom type is primarily sand with few rubble areas. Backwater and oxbow areas are underlain with mud and silt.

The stream gradient from Fort Randall Dam to Lewis and Clark Lake averages 0.5 ft/mile. Current velocity is dependent upon water releases from Fort Randall Dam and varies from 1.78 to 4.74 ft/sec. Fort Randall Dam is a twin peaking power plant and water releases are maximum about 1200 and 1900 hours and minimum about 0600 hours. Power demands and resultant water releases are less on weekends than weekdays. Water releases during the navigation season (March through

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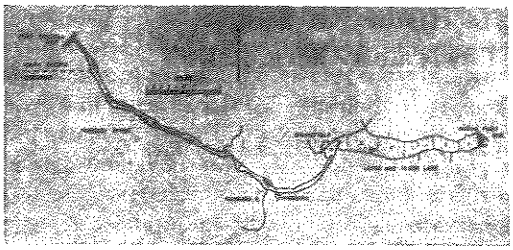

FIGURE 1.—Lewis and Clark Lake and the Missouri River from the headwaters of the lake to Fort Randall Dam (numbers denote sampling areas).

November) vary from 3,000 to 42,000 ft^3/sec (cfs).

METHODS

For sampling purposes Lewis and Clark Lake was divided into six areas, and the Missouri River into two areas (Figure 1). In 1963 and 1964 young-of-the-year sampling was conducted at regular intervals in all six areas of the reservoir while in 1965 only Areas 2 and 3 were sampled. Fish were captured with 16- and 27-ft otter trawls (0.25-inch stretch mesh liner in cod), bag seines (0.25-inch stretch mesh in bag), 220-v pulsating d-c electric shocker, and 0.5-m diameter plankton nets (0.9-mm mesh). Plankton nets collected eggs in the open water, and a suction device (Manz, 1964) collected eggs attached to the bottom. Mature sauger were captured on the spawning grounds with the electric shocker. All length measurements reported are total length.

Zooplankton abundance in number/liter was measured from plankton samples obtained with a metered Miller Sampler (Miller, 1961). In 1963 plankton tows were made at 10 transects and in 1965 plankton tows were made in conjunction with fish sampling.

Water level data were obtained from a recording gauge maintained by the U. S. Geological Survey. Temperature of water released from Fort Randall Dam was obtained from the U. S. Army Corps of Engineers, and a thermograph monitored water temperature on the spawning grounds.

REPRODUCTION

Studies by the North Central Reservoir Investigations indicate little, if any, sauger spawning occurs in Lewis and Clark Lake. Spring netting in 1962, 1963, and 1964 captured only one mature female in the reservoir. Tagging studies suggest mature sauger move out of the reservoir in the fall and winter and concentrate in the Missouri River and the tailwaters of Fort Randall Dam. After completion of spawning in late spring fish return to the reservoir. Possible spawning locations in the Missouri River were sampled during April and May 1963. No mature fish were collected in oxbows, backwaters, or areas where the bottom types were predominantly sand. Mature sauger were captured along a shale shoreline about 1 mile below Fort Randall Dam, and along a rubble shoreline approximately 6 miles farther downstream. Catches of mature fish at the latter location suggested it was a major spawning area, and it was selected for detailed study.

The 4-mile long study area extends from the high-water line to the edge of the channel on the west side of the river. It varies in width from 75 to 250 ft and has a maximum water depth of 15 ft. Rocky points occasionally extend into the river forming eddies which have a sand and silt bottom. The entire river is approximately 0.5-mile wide, and the opposite shoreline is shallow with numerous sand bars.

Spawning time

Electric shocker catches of mature fish on the study area in 1963 varied with time of day. Catches were sparse during daylight, increased rapidly to a peak the first 2 hr after sunset, and then declined during the night. In 1964 and 1965, shocking was begun at dark and about one-half of the study area was sampled. At the beginning of the spawning season catches did not usually exceed five mature fish per hour, but as the season progressed catches increased to over 35 per hour.

The catch in 1964 and 1965 was comprised of 51% males and 49% females, but sex ratios changed considerably before and during spawning (Figure 2). Ripe males were present prior to the spawning season but as water temperature increased the percentage of females increased. Females exceeded 50% of the catch when water temperature reached 42 F.

The sequence of spawning in 1964 and 1965 was illustrated from shocker collections. In 1964, the first near-ripe female was collected on 27 April and spent females were found on 28 and 29 April. On 29 April and 1 May four groups of 1–3 running-ripe males and one partially-spent female were collected; apparently spawning was taking place. Catch-per-hour from 29 April to 4 May varied from 24 to 36 mature fish. They were commonly collected in water less than 2 ft deep. The fact that four fish per hour were captured on 7 May and one on 11 May suggested that spawning was near completion. Sauger eggs were found in downstream drift samples after 27 April. In 1965 near-ripe females were first collected 26 to 28 April, but strong winds prevented further sampling until 2 May. Ripe females were collected nightly between 2 and 6 May and groups of one female and two or more males were collected. Females apparently leave the area soon after spawning since only two completely spent females were taken in 1964 and none in 1965. The above observations indicated sauger began spawning about 27 April 1964 and 29 April 1965 (water temperature 42–43 F). Peak spawning activity occurred shortly thereafter and lasted 5 to 7 days. Spawning was essentially completed in less than 2 weeks.

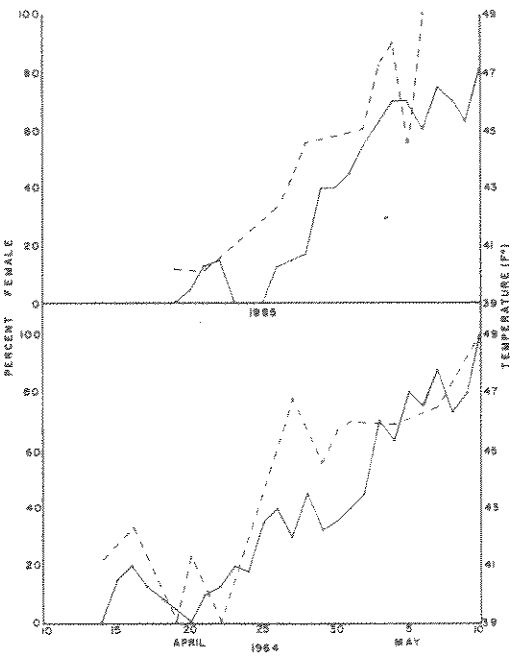

FIGURE 2.—Per cent mature females (broken line) in the sauger spawning population compared to water temperature (solid line) on the study area during April and May, 1964 and 1965.

Egg deposition and development

Fertilized eggs placed in shallow water at the study site adhered to rocks or were carried by currents downstream into cracks and crevices. Eggs were strongly adhesive, even after water hardening. Plankton nets set on the downstream end of the study area collected mostly dead eggs. The suction device sampled specific depths and collected the more exposed eggs, but not those between or under rocks. In spite of this limitation 65% of the eggs collected with the pump were viable, while only 22% of the eggs collected with plankton nets were viable.

Eggs were collected from 10 to 21 May 1965. No consistent difference in the ratio of live to dead eggs occurred over this period. Dead eggs lost their adhesiveness and were carried off by the current. They were coated with fine sand, silt, detritus or fungi, and were more abundant where the substrate was silt or sand. Live eggs were more abundant on the rubble flat areas, especially where filamentous algae covered the rocks.

Viable eggs were collected at water depths from 2 to 12 ft below the maximum water level of 1,234.4 ft msl. Percent of viable eggs collected at various water level elevations (ft msl) were 3% at 1,223, 67% at 1,225, 18% at 1,227, 4% at 1,229, and 8% at 1,231. During the incubation period water levels fluctuated 4.9 ft or between 1,234.4 and 1,229.5 ft msl. At the end of the incubation period viable eggs were only found on substrates below 1,229 ft msl, although they were originally collected at 1,231 ft msl. The absence of viable eggs above 1,229 ft msl suggests that eggs exposed to air, as caused by fluctuating water levels, were destroyed. The presence of viable eggs indicates where survival was greatest rather than depth where the eggs were deposited. The greatest survival occurred at 1,225 ft msl or 4 ft below the minimum water level.

TABLE 1.—*Catch per-unit-effort of young-of-the-year sauger in Lewis and Clark Lake, 1965*

Sampling gear	Depth fished (feet)	Catch per-unit-effort by month					
		June	July	Aug	Sept	Oct	Nov
27-ft trawl	30–35	0.1	0.0	0.4	0.8	0.2	0.5
27-ft trawl	8–12	30.4	3.8	0.8	0.5	0.1	0.4
16-ft trawl	3– 9	8.0	2.2	0.2	0.1	0.5	1.5
100-ft seine	0– 4	7.0	0.4	0.2	0.4	0.0	0.0

Eyed eggs were first collected on 14 May and larvae were first collected on 21 May 1965. The incubation period was approximately 21 days at an average water temperature of 47 F. In a fish hatchery sauger eggs hatched in 9 to 14 days at a water temperature of 55 F (Nelson, Hines, and Beckman, 1965).

YOUNG-OF-THE-YEAR

Movement

Upon hatching larvae were carried by the current down the Missouri River and into Lewis and Clark Lake. Plankton nets set below the spawning grounds captured sauger averaging 5.10 mm in length (range 4.54 to 6.22 mm). Plankton nets fished in the Missouri River above its confluence with the Niobrara River (Figure 1) captured larvae averaging 6.38 mm (range 4.80 to 7.46 mm). Larvae were first captured in the reservoir 28 May 1965, 1 week later than on the spawning grounds. Smallest larvae captured in the reservoir were 7.79 mm, but they usually exceeded 8.5 mm. Hatchery-reared sauger ranged from 4.62 to 5.09 mm at hatching (Nelson et al., 1965).

Sauger larvae were captured throughout the reservoir with plankton nets until they reached approximately 15 mm. Highest catches oc-

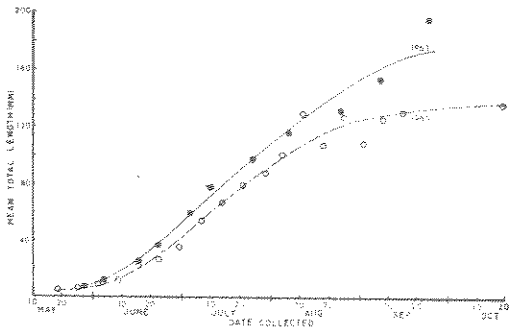

FIGURE 3.—Growth curves of young-of-the-year sauger collected from Lewis and Clark Lake in 1963 (solid line) and 1965 (broken line).

TABLE 2.—*Mean number of organisms and their per cent occurrence (in parentheses) in young-of-the-year sauger stomachs, Lewis and Clark Lake, 1963*

	June 13–18	June 24–25	July 5–11	July 15–17	21 July–2 Aug.	Aug. 6–15	Aug. 20–29	Sept. 3–10	Sept. 23–25	Mean
Crustacea	12.6(100)	24.0 (92)	12.0 (31)	0.5 (18)		0.2 (4)				9.1 (39)
Copepoda	12.3(100)	12.8 (90)	10.3 (26)	0.4 (6)		0.2 (4)				6.1 (38)
Diaptomus	9.3 (91)	8.7 (85)	10.2 (26)	0.4 (6)						4.8 (34)
Cyclops	3.0 (76)	4.1 (50)	0.1 (3)			0.2 (4)				1.3 (20)
Cladocera	0.3 (19)	11.2 (77)	1.6 (15)	0.1 (6)						3.0 (23)
Bosmina		Tr (2)								Tr (1)
Daphnia	0.3 (19)	10.4 (73)	0.1 (5)							2.5 (20)
Diaphanosoma		0.8 (31)	0.2 (13)	0.1 (6)						0.2 (10)
Leptodora		Tr (2)	1.3 (10)							0.2 (2)
Amphipoda										
Hyalella				0.1 (6)						Tr (1)
Insecta	0.5 (5)	0.1 (10)	0.1 (8)	0.5 (6)	0.5 (13)	0.2 (4)				0.2 (6)
Diptera	0.5 (5)	0.1 (10)	0.1 (5)	0.3 (6)		0.2 (4)				0.1 (5)
Ephemeroptera			Tr (3)	0.1 (6)	0.5 (13)					0.1 (2)
Hemiptera				0.1 (6)						Tr (1)
Trichoptera				0.1 (6)						Tr (1)
Fish		0.2 (15)	0.8 (72)	1.5 (94)	0.9 (87)	1.1(100)	1.3(100)	1.0(100)	1.0(100)	0.7 (63)
Gizzard shad			Tr (3)		0.3 (26)	0.2 (21)	0.2 (21)	0.4 (38)	0.2 (20)	0.1 (11)
River carpsucker			0.1 (5)				Tr (4)			Tr (1)
White crappie							Tr (4)			Tr (1)
Emerald shiner		0.1 (8)	0.3 (28)	1.2 (71)	0.3 (26)	0.3 (29)	0.6 (42)	0.4 (38)	0.8 (80)	0.3 (25)
Unidentified		0.1 (8)	0.4 (36)	0.3 (23)	0.3 (35)	0.6 (50)	0.4 (29)	0.2 (23)		0.3 (26)
Mean total length (mm)	25	41	70	84	100	120	134	150	171	
Number of fish	22	53	52	24	34	28	31	19	8	271
Empty	1 (5)	1 (2)	13 (25)	7 (29)	11 (32)	4 (14)	7 (23)	6 (32)	3 (38)	53 (20)

Tr Less than 0.05.
[1] Less than 0.5 per cent.

TABLE 3.—*Mean number of organisms and their per cent occurrence (in parentheses) in young-of-the-year sauger stomachs, Lewis and Clark Lake, 1965*

	June 3	June 8–10	June 22–24	July 7–8	July 20–22	Aug. 3–5	Aug. 17–19	31 Aug.–3 Sept.	Sept. 15–16	Oct. 19–21	Nov. 9–10	Mean
Crustacea	6.1(100)	6.1(100)	14.3(84)	60.4(93)	62.9(82)	53.3(83)	5.5(50)			0.5(50)	0.1(12)	22.8(84)
Copepoda	5.7 (95)	5.6(100)	11.6(81)	40.3(79)	56.0(79)	42.5(83)				0.5(50)		18.5(78)
Diaptomus	0.5 (20)	2.2 (71)	7.1(68)	40.2(79)	57.2(79)	40.5(67)						15.4(56)
Cyclops	5.2 (92)	3.4 (68)	4.5(54)	0.1(8)	0.8(34)	2.0(33)				0.5(50)		3.1(47)
Cladocera	0.5 (31)	0.5 (32)	2.8(48)	20.1(83)	4.8(59)	10.8(33)	5.5(50)					4.3(43)
Bosmina		Tr (3)	0.1(2)									Tr(1)
Ceriodaphnia					Tr(3)							Tr([1])
Daphnia	0.5 (31)	0.5 (26)	2.7(48)	19.7(83)	4.2(52)	10.8(33)	5.5(50)					4.1(35)
Leptodora		Tr (3)	Tr(2)	0.4(33)	0.6(31)							0.1(8)
Amphipoda												
Hyalella											0.1(12)	Tr([1])
Insecta			0.1(6)	0.1(8)	0.3(17)			0.7(67)			0.7(25)	0.1(6)
Diptera			0.1(5)	0.1(8)	0.3(17)							0.1(5)
Ephemeroptera					0.1(7)			0.3(33)			0.7(25)	Tr(2)
Unidentified			Tr(1)					0.3(33)				Tr([1])
Fish		0.1 (3)	1.1(21)	0.1(8)	0.2(17)	0.3(33)	0.5(50)	0.3(33)	1.0(100)	0.5(50)	0.8(87)	0.5(17)
Orangespotted sunfish											0.2(25)	Tr([1])
Yellow perch					Tr(3)							Tr([1])
Freshwater drum						0.2(17)						Tr([1])
Emerald shiner		0.1 (3)	1.0(17)					0.3(33)			0.1(13)	0.4(7)
Fathead minnow										0.5(50)		Tr([1])
Unidentified			Tr(4)	0.1(8)	0.1(14)	0.2(17)	0.5(50)		1.0(100)		0.5(63)	0.1(8)
Mean total length	11	15	28	41	70	98	107	106	130	135	134	
Number of fish	39	40	83	28	32	11	3	8	9	4	10	267
Empty	0	2 (5)	2 (2)	1 (4)	3 (9)	5 (45)	1 (33)	5 (63)	6 (67)	2 (50)	2 (20)	29 (11)

Tr Less than 0.05.
[1] Less than 0.5 per cent.

curred at a depth of 10 ft, and none were caught below 20 ft. Young-of-the-year primarily inhabited areas less than 12 ft deep during June and July and then dispersed throughout the reservoir (Table 1).

A small cove in Area 1 and a sand and gravel beach in Area 5 were sampled in mid-July and late August 1963 to determine if diel movement occurred. One-hour shocking samples were made along the shoreline every other hour for 24 hr. An onshore movement occurred just before sunset, and the catch continued high until sunrise, when it decreased rapidly. The trends in catch rate were similar in both habitats. Average fish catch by 4-hr intervals was 2 at 1100 hours, 4 at 1500, 16 at 1900, 16 at 2300, 10 at 0300, and 4 at 0700 hours.

Growth

The mean lengths of sauger captured during each sampling series in 1963 and 1965 were plotted and growth curves fitted by inspection (Figure 3). The onset of spawning was one week earlier in 1963 than 1965 and the smaller size during May and early June of 1965 may be attributed to this factor. The two growth curves became more divergent as the season progressed. Growth was nearly complete by mid-August 1965, while in 1963 growth continued into September. Sauger by 1 October averaged 35 mm longer in 1963 than 1965.

Food

Diet of young-of-the-year sauger was determined from 271 stomachs collected in 1963, and 267 collected in 1965 (Tables 2 and 3); 20% in 1963, and 11% in 1965, were empty. Feeding began before the yolk sac was completely absorbed at an average length of 9.5 mm. Larvae 8 to 17 mm long, collected on 3 June 1965, all contained food and *Cyclops* were present in 92% of stomachs. With increasing size sauger began feeding on *Diaptomus* and *Daphnia*. Except for *Bosmina*, smaller zooplankters (*Moina*, *Chydorus*, nauplii, and rotifers) were not eaten. The average number of *Diaptomus* and *Cyclops* per stomach was less in 1963 than in 1965, while more *Daphnia* were ingested in 1963 than in 1965. The average number of crustacea ingested was consistently less in 1963 than in 1965.

The electivity index (Ivlev, 1961) showed that *Diaptomus* was the most selected and *Cy-*

TABLE 4.—*Per cent age-class composition and coded year-class strength of sauger in Lewis and Clark Lake, 1956–1966*[1]

	Year captured										
	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
Number of fish	25	64	103	145	111	89	90	636	424	268	411
Age-class											
I		77	18	1		5	14	64	2	1	36
II	42	2	64	7	6	12	31	22	32	16	27
III	42	11	13	50	27	17	12	3	20	34	15
IV	16	8	2	30	62	23	14	3	11	24	15
V		2	3	12	6	36	14	3	5	17	2
VI						7	15	3	5	4	1
VII								1	3	3	1
VIII									2		
Coded year-class strength[2]	198	93	29	1	63	82	151	23	67	257	—

[1] 1956 to 1961 data from South Dakota Department of Game, Fish, and Parks' Dingell-Johnson Reports on Fisheries Investigations of Gavins Point Reservoir; 1962 to 1966 data collected by North Central Reservoir Investigations.
[2] Calculated by method of el-Zarka (1959) and coded to eliminate negative sign.

clops the least selected crustacean utilized in 1963 and 1965. *Daphnia* were selected both years for a short period in late June and early July. Selection of crustaceans continued later in the summer of 1965 than in 1963. Positive electivity for *Cyclops* on 10 August 1963 and the increase in electivity for *Daphnia* on 17 August 1965 resulted from ingestion of these organisms by single fish.

Insects were of minor importance in the diet of young-of-the-year sauger. Chironomid larvae and pupae were the most commonly utilized insects in both years. *Baetis* nymphs were of secondary importance in 1963 and *Hexagenia* nymphs in 1965.

The change from a crustacean to a fish diet occurred approximately 6 weeks later in 1965 than 1963 (Figure 4). On 8 July 1963, 72% of the stomachs contained fish, while in 1965 fish did not become the predominant food until 17 August. This change in diet occurred before sauger attained 70 mm in 1963, but not until they reached 110 mm in 1965.

Fish were a more important food in 1963 than 1965 (Tables 2 and 3). Emerald shiners, *Notropis atherinoides*, were the primary forage species both years. Gizzard shad, *Dorosoma cepedianum*, were important in 1963, but none were found in stomachs from the 1965 sample. River carpsucker, *Carpiodes carpio*, and white crappie, *Pomoxis annularis*, were minor forage species in 1963. Orange-spotted sunfish, *Lepomis humilis*, yellow perch, *Perca flavescens*, freshwater drum, *Aplodinotus grunniens*, and fathead minnow, *Pimephales promelas* were present in 1965.

YEAR-CLASS STRENGTH

The age-class composition of sauger taken in net catches shows the variation which has occurred in year-class strength since impoundment of Lewis and Clark Lake (Table 4). From 1956 to 1962 the fish were collected with experimental gill and frame nets and since 1963 with gill nets and electric shocker. Although the number of fish was small in some years we believe the catch adequately reflects age-class composition. Strong year classes were established in 1956 and 1962, and apparently in 1965 (Table 4). Weak year classes were established in 1958 and 1959.

Factors affecting sauger year-class strength can be separated into those which affect reproductive success in the Missouri River, and those which affect survival of the progeny during their first summer of life in Lewis and Clark Lake. Of the numerous physical and biological conditions influencing these two

TABLE 5.—*Year-class strength of sauger in Lewis and Clark Lake and the mean daily water level fluctuation on the spawning grounds for 21 days after initiation of spawning, 1956–1965*

Year class	Coded rank of year class	Mean daily maximum water level[1]	Mean daily minimum water level[1]	Difference in feet
1956	198	1233.42	1234.84	1.42
1957	93	1232.33	1234.87	2.54
1958	29	1230.95	1234.47	3.52
1959	1	1230.53	1234.27	3.74
1960	63	1229.92	1232.28	2.76
1961	82	1230.86	1233.89	3.03
1962	151	1230.27	1233.12	2.85
1963	23	1229.95	1234.39	4.44
1964	67	1230.53	1233.01	2.48
1965	257	1230.92	1233.59	2.67

[1] Elevation in feet mean sea level.

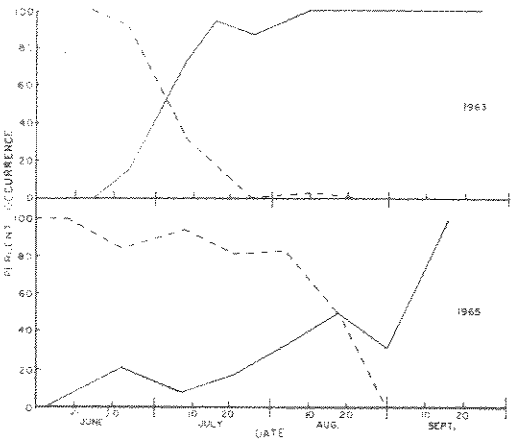

FIGURE 4.—Per cent occurrence of fish (solid line) and zooplankton (broken line) in stomachs of young-of-the-year sauger in Lewis and Clark Lake in 1963 and 1965.

phases, fluctuating river water levels during incubation appeared to exert the greatest influence. Water level fluctuations caused by the operation of Fort Randall Dam intermittently exposed large areas of spawning habitat. Because sauger spawn during the evening when water levels are maximum the harmful effects of fluctuating water levels are increased. Egg sampling in 1965 revealed maximum survival occurred at a depth 4 ft below the minimum water level, but the original depth distribution of the eggs was not determined. The depth where viable eggs were sampled increased as the incubation period progressed.

I assumed that sauger spawning periods from 1956 to 1962 began when water discharged from Fort Randall Dam reached 42 F. Comparison of river water levels for 21 days after spawning was initiated, with year-class strength since impoundment of Lewis and Clark Lake, showed above average year classes were produced when the average daily water level fluctuated less than 3 ft. Below average year classes were produced when fluctuations exceeded 3 ft (Table 5). Water level fluctuation during incubation was least in 1956 when the strongest year class was established and fluctuations were next to the highest in 1959, when the weakest year class was produced. Correlation of water level fluctuations with year-class strength showed a significant negative relationship ($r = -0.72$; $p < 0.02$).

TABLE 6.—*Comparison of mean daily water level fluctuation and indices of young-of-the-year sauger abundance in Lewis and Clark Lake, 1963 and 1965*

Sampling method	Abundance indices			
	1963		1965	
	Effort	C/E	Effort	C/E
0.5-m plankton net (May)[1]	13	0.4	29	6.3
27-ft trawl (June)[2]	8	7.8	16	18.3
16-ft trawl (June)[2]	8	0.0	12	8.0
Mean daily water level fluctuation	4.44 ft		2.67 ft	

[1] C/E = 1-hr sample.
[2] C/E = 10-min haul.

The catch of larvae provides further evidence of the effect of water level fluctuation on spawning success. Abundance of larvae in the Missouri River increased from 0.4 to 6.3/hr when water level fluctuations decreased from 4.44 ft/day in 1963 to 2.67 ft/day in 1965 (Table 6). Catch of young-of-the-year in June trawl catches were also considerably greater in 1965 than in 1963. These larval abundance indices are substantiated by the relative strength of the 1963 and 1965 year classes as yearlings in the 1964 and 1966 net catches (Table 4).

Growth of young-of-the-year sauger was less in 1965 than in 1963. Sauger utilized more crustaceans and less forage fish, especially gizzard shad, in 1965 than in 1963. Abundance of crustaceans and emerald shiner was similar both years but catch per-unit-effort of gizzard shad, with a 16-ft trawl, declined from 7.2 in 1963 to 0.1 in 1965. This decrease in abundance was apparently severe enough to reduce their availability as a sauger food item. There was no evidence that the differences in growth and diet between 1963 and 1965 were sufficient to influence survival.

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