

Effects of a Reduced Fall Drawdown on Benthos Abundance in Lake Francis Case

NORMAN G. BENSON AND PATRICK L. HUDSON¹

North Central Reservoir Investigations, Yankton, South Dakota 57078

ABSTRACT

Lake Francis Case, a 356-km² Missouri River reservoir, is drawn down each fall to hold water released from upstream for winter power generation. The customary drawdown of 10–12 m in 1953–70 was reduced to 6–7 m in 1971–73. Benthos samples collected from 1966 to 1973 indicated that abundance of benthic organisms in May along two transects (to depths of 10.5 and 15 m) increased more than threefold after the drawdown was reduced; abundance in September did not increase. May increases were most evident for five burrowing forms: chironomids, *Hexagenia*, *Caenis*, oligochaetes, and ceratopogonids.

This study describes effects of reducing the fall drawdown on benthos abundance in Lake Francis Case, a 356-km² (normal pool) Missouri River main stem reservoir in South Dakota. The reservoir was impounded in 1952 and is drawn down each fall to provide storage space for water released from upstream reservoirs for winter power generation. The depth of fall drawdown was 10–12 m during 1953–70, but was reduced to 6–7 m during 1971–73. About 83 km² more reservoir bottom was exposed each fall during 1953–70 than during 1971–73.

MATERIALS AND METHODS

A total of 175 benthos samples were collected along two transects in the Platte Creek Arm of Lake Francis Case from 1966 to 1973. The north shore transect extends lakeward from the north shore, and the west shore transect from the west shore. The substrates on both transects are a mixture of sand, fine gravel, and clay.

Benthos samples were collected at 1.5-m depth intervals from 1.5 to 15 m along the north shore transect, and from 1.5 to 10.5 m along the west shore transect. In 1966 two samples were taken with an orange peel dredge at each depth; in 1967–73 a single Ponar dredge sample was taken at each depth, except that an Eckman dredge was used at the 1.5-m depth in 1967 and 1969. Hudson (1970) compared the efficiencies and showed the relations between the three sampling gears; the data were standardized to a Ponar

grab (520 cm²) and presented in number of organisms per square meter.

Samples were sieved in a 0.243-mm mesh screen and preserved with 10% formalin in the field. In the laboratory a sugar solution was used to separate benthic organisms from detritus and mud (Anderson 1959). Nematodes and rotifers were commonly observed but are not included because they were not retrieved efficiently during the sorting procedure.

Samples were collected monthly from May to October in 1966; in May and September in 1967, 1971, and 1973; in May 1972; and in September in 1968–70. Only broad taxonomic groups are treated in this report except for common genera of Ephemeroptera.

RESULTS AND DISCUSSION

The fauna was dominated by chironomids throughout the period. Oligochaetes, ceratopogonids, Ephemeroptera, and Trichoptera were other common groups. Seasonal changes in benthos abundance were documented only in 1966 before the reduction in drawdown. In that year, densities increased through the summer and reached a peak in September along both transects. The composition of the monthly samples was similar to those shown for May and September in Table 1. Since much of the nearshore area was exposed during the previous fall and winter, the May–June abundance down to 10–12 m would be expected to be low.

Influences of the reduction in fall drawdown are indicated by the May and September samples. Average total benthic organisms in

¹Present address: Southeast Reservoir Investigations, P.O. Box 429, Clemson, South Carolina 29631.

TABLE 1.—Mean number of benthic organisms per square meter, by major groups, along two transects in Platte Creek, Lake Francis Case, during periods when fall drawdown was 10–12 m (1966–70) and 6–7 m (1971–73)^a. (Numbers of samples shown in parentheses).

Taxonomic group	1966		1967		1968	1969	1970	1971	1972	1973	
	May (15)	Sept (13)	May (17)	Sept (17)	Sept (15)	Sept (17)	Sept (15)	Sept (17)	May (16)	May (17)	Sept (16)
Chironomids	564	2,495	1,038	1,725	2,653	1,864	2,363	5,037	4,929	3,611	1,589
Ephemeropterans											
<i>Caenis</i>	0	18	2	150	44	53	31	27	437	39	20
<i>Hexagenia</i>	0	4	5	0	6	9	4	10	57	89	125
Ceratopogonids	14	69	7	37	18	17	45	99	174	311	23
Oligochaetes	6	12	4	125	345	626	28	54	14	29	17
Trichopterans	0	68	6	177	45	26	144	155	17	6	66
Other ^b	0	67	0	187	64	6	75	173	301	29	66
Total	584	2,733	1,062	2,401	3,175	2,601	2,690	5,555	5,929	4,114	1,906

^a Sampling dates were May 2 and 19 and Sept 22 and 29, 1966; May 4 and Sept 6 and 7, 1967; Sept 4 and 5, 1968; Sept 4, 1969; Sept 9, 1970; Sept 2, 1971; May 3, 1972; May 3 and Sept 5, 1973.

^b Hydracarina, Corixidae, Coleoptera, Colembola, other Diptera, other Ephemeroptera.

May 1972 and 1973 (data combined) were more than five times the total in 1966–67, before the reduction in fall drawdown (Fig. 1). The increase occurred predominately below 6 m in the north shore transect, but was evident below 3 m in the west shore transect. The increase was primarily due to increases

in abundance of chironomids, *Caenis*, *Hexagenia*, oligochaetes, and ceratopogonids—all burrowing forms (Table 1).

September samples varied greatly in abundance by year but were highest in 1971 along both transects and extremely low in 1973 (Table 1). Chironomids—the dominant form

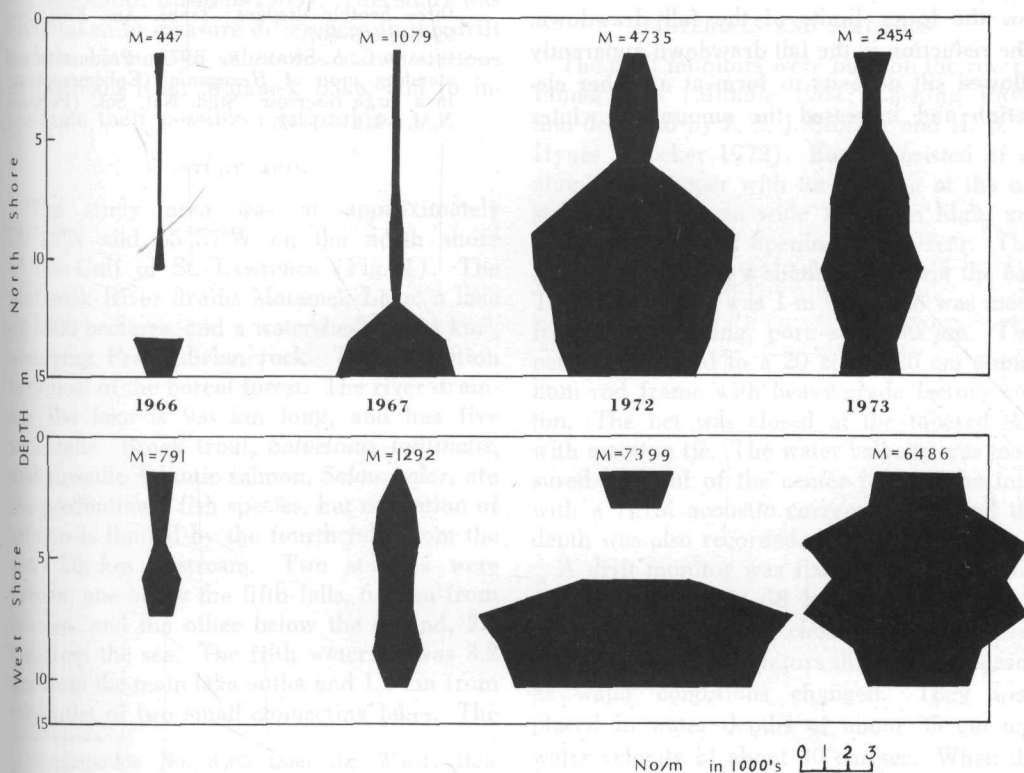


FIGURE 1.—Number of benthic organisms per square meter on north and west shore transects, Platte Creek, Lake Francis Case in May. M = Mean No/m² at all depths.

—have one or more generations during a summer and an increased number in May need not necessarily result in a higher abundance in September.

The only noteworthy difference between the 1973 September sample and the pre-drawdown September samples (1966–71) was the larger number of *Hexagenia* nymphs in 1973. Hudson and Swanson (1972) showed that *Hexagenia* populations in Lewis and Clark Lake, a reservoir immediately downstream from Lake Francis Case, required 13–22 months to complete a single life cycle and required several years to fully occupy new habitat created by silt deposition. The consistent increases of *Hexagenia* shown in Table 1 after 1971 suggest a similar pattern of colonization.

Cowell and Hudson (1968) described the mechanical sorting of shoreline sediments by wave action where drawdown occurs on Lake Francis Case. Terraces of coarse material (sand, gravel, clumps of clay) form on the exposed slopes and silt becomes deposited below the lower limits of the fall drawdown. The reduction in the fall drawdown apparently allowed silt deposits to form at a higher elevation and increased the amount of winter

habitat for benthic organisms that require soft substrates for survival. Grimas (1962) also considered the effects of draining and of freezing of the bottom soils as mainly responsible for the altered species composition of the benthos in the littoral zone following drawdown in Lake Blasjon, Sweden. Reduction in the fall drawdown would also decrease the mortality of benthic organisms due to stranding during the drawdown phase on Lake Francis Case (Cowell and Hudson 1968).

LITERATURE CITED

- ANDERSON, R. O. 1959. A modified flotation technique for sorting bottom fauna samples. *Limnol. Oceanogr.* 4: 223–225.
- COWELL, B. C., AND P. L. HUDSON. 1968. Some environmental factors influencing benthic invertebrates in two Missouri River reservoirs. Pages 541–555 in *Reservoir Fishes Resources Symposium*, Southern Division, Am. Fish. Soc., Athens, GA, 5–7 April 1967.
- GRIMAS, U. 1962. The effect of increased water level fluctuation upon the bottom fauna in Lake Blasjon, Northern Sweden. *Institute Freshwater Research, Drottningholm, Rep.* 44: 14–41.
- HUDSON, P. L. 1970. Quantitative sampling with three benthic dredges. *Trans. Am. Fish. Soc.* 99(3): 603–607.
- , AND G. A. SWANSON. 1972. Production and standing crop of *Hexagenia* (Ephemeroptera) in a large reservoir. *Stud. Nat. Sci. (Portales, N.M.)* 1(4): 1–42.