THE EFFECTS OF DROUGHT CONDITIONS ON THE FISH AND BOTTOM ORGANISMS OF TWO SMALL OXBOW PONDS

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Description of Area

Two oxbow ponds of Squaw Creek, located in Boone County, Iowa, were formed in 1952 when the stream was straightened in building a new bridge. The two oxbows are separated from the creek by an earthen fill and from each other by a road grade. Although there is no direct connection between the two ponds, they become united through overflow waters of Squaw Creek during flood periods.

The ponds are bordered by steep banks and wooded areas on the east and by wooded pastures on the west. Cattle use two areas of the south pond for watering. The north pond does not have watering areas easily accessible to the cattle.

The south pond normally has a surface area of approximately one acre and an average depth of three feet. The north pond normally has a surface area of two acres and an average depth of four feet. The water supply of these oxbows is maintained by run-off, seepage, and flooding from the creek.

The bottom deposits of both ponds are mainly of silt with sand and gravel in isolated areas. Many tree stumps and dead trunks are present in the north pond and the bottoms are covered with dead leaves.

The bulk of the fish population in the oxbows consisted of: carp, *Cyprinus carpio;* black bullheads, *Ameiurus m. melas;* bluntnose minnows, *Pimephales notatus;* and fathead minnows, *Pimephales p. promelas.* In addition, the following species were found: common white sucker, *Catostomus c. commersoni;* western golden shiner, *Notemigonus chrysoleucas auratus;* northern creek chub, *Semotilus a. atromaculatus;* central bigmouth shiner, *Notropis d. dorsalis;* stone cat, *Noturus flavus;* green sunfish, *Lepomis cyanellus;* orange-spotted sunfish, *Lepomis humilis;* white crappie, *Pomoxis annularis;* and central johnny darter, *Etheostoma n. nigrum.*

The water level in the creek was high enough to enter these ponds on July 14, 1955, and by July 19 the water levels had receded and the ponds were no longer connected with the creek. The south pond was rotenoned on July 19, eliminating all fish that had moved in from the creek during the flood. The bottom fauna in this pond was thus freed of predation by fish during the ensuing drought. Rains during July and August did not add enough water to the pond to raise the water level and by September the area was undergoing a severe drought.

Effect of Drought on the Bottom Fauna

Bottom organisms in the south pond were fairly abundant in November, 1954, but dropped off considerably during the summer probably due to the emergence of insects (Table 1). Rotenone treatment apparently did not affect the bottom fauna. The population on July 21, after treatment, was almost identical to that found July 18, before treatment. Furthermore, the samples of July 21 were picked without preservation and no dead bottom fauna organisms were found. By September 13 the area of the pond was much reduced and some of the sampling stations were no longer under water. By the first week in October the south pond was completely dry. The high population of bottom fauna per quarter-square foot in September is probably partly the normal fall increase in bottom fauna and partly the result of concentration of the organisms into a smaller area, without predation by fish.

Nematodes constituted a small part of the bottom fauna of the south pond. These worms were not taken in numbers large enough to draw conclusions concerning concentrations of the bottom fauna due to the drought.

Oligochaetes comprised 34.1% of the samples by number and 11.5% by volume. Concentration of oligochaetes during the drought was not observed. The average number per bottom sample was about the same before and during the drought.

Several clam shrimps (Order Conchostraca) were collected in the south pond during the second application of rotenone on May 28, 1955. Only one specimen was collected in the routine bottom sampling (June 3, 1955).

Two species of mayfly nymphs, *Hexagenia limbata* and *Leptophlebia* sp., were collected from the south pond during November, 1954. A large emergence of *Hexagenia limbata* occurred during May 24-26, 1955. On May 28, 1955, the pond was treated with rotenone. No mayfly nymphs were taken in bottom samples following treatment of the pond with rotenone. No dead mayfly nymphs were found, but the surface of the pond was literally covered with exuviae. In September, 1955, only three mayfly nymphs, *Leptophlebia* sp., were collected in the bottom samples.

Dragonfly nymphs were not taken in bottom samples from the south pond during the normal water levels, but the 7 bottom samples taken on September 13, 1955, during the drought contained 15 dragonfly nymphs (Family Libellulidae).

Concentration of bottom organisms due to the drought was best exhibited by chironomid larvae, ceratopogonid larvae, and *Chaoborus punctipennis*. Dipterous larvae constituted 50.3% by number of the samples collected during normal water levels and 92.4% by number of the samples collected during the drought. In September the south pond contained large numbers of *Notonecta undulata* (Family Notonectidae) and *Arctocorisa* sp. (Family Corixidae), making it impossible to collect a bottom sample that did not contain 20 to 30 notonectids and corixids. These forms were not counted or measured in the bottom fauna as recorded in Table 1.

TABLE 1.—Numbers and Volume of Bottom Fauna Organisms Collected in One-Fourth-Square-Foot Samples from the South Oxbow Pond, Boone County, Iowa.

Date	No. samples	No. organisms per sample			Volume in cubic centimeters		
		Mean	Standard deviation	Range	Mean	Standard deviation	Range
Nov. 9, 1954.....	10	98	65	24-232	0.64	0.76	0.01-2.30
Nov. 27, 1954.....	10	64	29	28-114	0.39	0.28	0.02-0.85
June 3, 1955.....	10	19	10	5-42	0.05	0.09	Trace-0.30
July 18, 1955.....	10	28	17	11-63	0.04	0.025	0.01-0.07
July 21, 1955.....	10	27	22	6-69	0.04	0.023	0.01-0.07
Sept. 13, 1955.....	7	208	85	116-365	0.97	0.69	0.26-2.11

Additional bottom samples were taken from areas of the south pond no longer under water on September 13, 1955. Samples of mud were collected to a depth of 12 inches. The mud samples were collected in layers approximately three inches thick and washed through a sieve to determine if the bottom fauna organisms had penetrated deeper into the mud. No macroscopic organisms were found in these samples. Within two weeks this pond was completely dry.

On November 9, 1955, a series of ten bottom samples were taken from the north pond. Each sample contained at least five leeches identified as *Epobdella* sp. On November 10 another series of ten bottom samples was taken. This group contained a total of five leeches. On November 11 no leeches were present in another series of bottom samples. Sampling to a depth of six inches in the mud failed to locate leeches.

EFFECTS OF DROUGHT ON THE FISHES

The upper end of the north pond was dry by the latter part of September. Many fishes were trapped in drying isolated pools and soon died; fishes over 6.0 inches in total length were not found. The larger fish may have been taken earlier by predators which apparently abounded in the area as evidenced by the number of tracks of herons and raccoons.

By October 27, 1955, this 2-acre pond had been reduced to one large pool 150 by 20 feet with an average depth of 9 to 12 inches. The color of the water was black and the bottom mud had an oily odor. Large numbers of bullheads, fathead minnows, bluntnose minnows, and orange-spotted sunfish were gulping air at the surface of the pool. The dissolved oxygen content of the water at this time was 0.2 p.p.m. The dissolved oxygen content of this pool was again determined on October 31 and on November 8, and each time was found to be 0.2 p.p.m.

On November 8, 1955, the bottom of the north pond contained dead white suckers, creek chubs, bluntnose minnows, fathead minnows, bullheads, orange-spotted sunfish, and green sunfish. Two prostrated carp (15.0 inches, total length) were

retrieved from the surface of the pond. A thin ice cover which had formed on November 8, 1955, probably served to protect the dying fish from predators.

By November 8, 1955, some water was again present in the south pond and the water level of the north pond was no longer dropping. As the temperature dropped and evaporation ceased to be an important source of water loss, the water from small springs began entering the pond.

The concentration of fishes in the remaining water area on November 12 was so great that Ekman dredge samples collected from this pool all contained live bullheads. Some dead fishes were also taken in the bottom samples.

Winter Effects on the Drought-Shrunken Pond

By November 17 a three-inch ice cover had formed on the pond. Areas of thin ice near the bank and around logs contained large concentrations of minnows and bullheads. Continuation of the severe cold weather resulted in the formation of a six to nine inch ice-cover by November 28. Many of the fishes utilizing the small open areas around the logs were found with the lower halves of their bodies frozen in the ice and the upper halves exposed. The exposed halves of the bodies had been eaten away by predators, leaving the heads and backbones intact.

By December 28 the pond had completely frozen to the bottom and the bottom mud had frozen to a depth exceeding nine inches. Fishes were found frozen into the ice and the ice had a strong "fishy" smell due to decomposition of the fishes. The dark color of the bullheads absorbed heat and some decomposition was occurring even when the surrounding ice was solid.

Thirteen holes, approximately 18 by 18 inches, were cut and the fishes frozen into the ice were counted. The ice was arbitrarily marked off into three zones: upper two inches of ice, intermediate zone, and frozen bottom mud with the lower two inches of ice. No fishes were found frozen in the upper two inches of ice. In the intermediate zone 105 bullheads, 7 central bigmouth shiners, and 4 fathead minnows were found. In the lower zone 6 bigmouth shiners, 4 bluntnose minnows, and 25 fathead minnows were found.

Two possible explanations may be advanced to explain the presence of bullheads in the upper portions of the ice and the minnows in the lower portions of the ice and bottom muds. The minnows may have succumbed to the adverse conditions in the pond first and the ability of the bullheads to gulp air may have kept them near the ice until they were trapped there and frozen. A second explanation may be that the bullheads prevented the minnows from utilizing the area immediately under the ice.

Chironomid larvae were present in the frozen mud, and a sample of this mud was returned to the laboratory. Water was placed in the pail containing the frozen mud and it was allowed to thaw out to room temperature. All macroscopic bottom organisms in this sample of mud were dead.

Above-freezing temperatures during the last of February melted ice and snow, and by March 1, 1956, both oxbows were again completely

covered with 12 inches of water. Fifteen seine hauls made in the north pond contained no live fish, but a total of 55 dead fish were collected in the seine hauls—45 bullheads, 9 fathead minnows and 1 orange-spotted sunfish.

Eighteen bottom samples were taken in the north pond and ten bottom samples were taken in the south pond. No live macroscopic bottom forms were found.

Discussion

The destruction of the fish population and the macroscopic bottom fauna population of the two oxbow ponds apparently was complete.

Restocking of the two oxbows with fish is dependent on Squaw Creek overflowing into the ponds during the high-water periods and on fish survival in Squaw Creek. Preliminary spring field data collected from Squaw Creek indicate a low survival rate of fishes, but the extent of survival has not been determined.

The repopulation of the two oxbows by the bottom organisms will not be dependent on the overflow of Squaw Creek into the ponds, but will be dependent on the amount of survival of the bottom fauna in the creek. Most of the bottom fauna organisms have adult forms capable of repopulating the isolated pools.

Summary

Severe drought conditions in Boone County, Iowa, resulted in the complete drying of a 1-acre oxbow and in reducing a 2-acre oxbow to one large pool 150 by 20 feet.

As the water levels receded in the south pond a concentration of the bottom fauna, mainly dipterous larvae, was observed. By the latter part of September this pond was dry and the macroscopic bottom fauna was apparently destroyed.

As the water levels receded in the north pond many fishes were stranded in isolated pools and died when the isolated pools dried up. The remainder of the fish population was concentrated in the last remaining pool. Severe winter conditions resulted in the complete freezing of the pool resulting in the destruction of the fish population.

Bullheads were concentrated in the intermediate zone of the ice and the minnows were located in the lower two inches of ice and in the frozen bottom muds. Apparently all fishes and macroscopic bottom fauna organisms were killed.

Repopulation of the two oxbows by fishes and bottom fauna organisms will be dependent on the amount of survival of fishes and bottom organisms in Squaw Creek.

Acknowledgments

The writer wishes to express his appreciation to Dr. Kenneth D. Carlander under whose direction this study was conducted and to Mr. Carl Fast and Mr. Ervin Turner on whose land the two oxbow ponds are located. Their cooperation and information concerning the history of the creek and the oxbow ponds were invaluable.

This paper is from Project 38, Iowa Cooperative Fisheries Research Unit, sponsored by the Iowa State Conservation Commission and the Industrial Science Research Institute of Iowa State College.