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JUL 13 1977
POLLUTION CONTROL BOARD

July 11, 1977

Miss Christan L. Moffett
Clerk, Pollution Control Board
309 West Washington Street
Chicago, Illinois 60606

Dear Miss Moffett:

In re: Coffeen Power Station - Thermal Demonstration - PCB No. 77-158

Enclosed are ten copies of an Addendum which supplements Central Illinois Public Service Company's Thermal Demonstration which was submitted to the Board and the Agency on May 26, 1977.

This Addendum supplements Section 8 of the Thermal Demonstration and is the Addendum mentioned in our May 26, 1977 letter.

Yours truly,

Thomas L. Cochran

tlc:pmy
enclosures

ADDENDUM TO THERMAL DEMONSTRATION
COFFEEN POWER STATION
UNITS 1 & 2

Submitted to
CENTRAL ILLINOIS PUBLIC SERVICE
Springfield, Illinois

by
ECOLOGY CONSULTANTS, INC.
Fort Collins, Colorado

June 1977

ADDENDUM TO THERMAL DEMONSTRATION, COFFEEN POWER STATION, UNITS 1 & 2

Introduction

In late April of 1977 biologists from Ecology Consultants, Inc. carried out the first part of the fact finding survey of Coffeen Lake referred to in CIPS Thermal Demonstration. Observations were made and samples taken at four stations in Coffeen Lake. Station 1 was located in the discharge arm; Station 2, in the deep water near the dam; Station 3, between Station 2 and the largest arm southwest of the generating plant; and Station 4, upstream from the railway bridge.

Sampling was confined to temperature and oxygen profiles, phytoplankton, zooplankton, benthic macroinvertebrates and fish. Fillets and livers of two species of fish were analysed for trace metals, PCB and DDT content. Details of sampling methods and results of individual samples will be reported to CIPS. Only essential data are given here. The main purpose of this addendum is to draw together the available information concerning Coffeen Lake in such a way as to present an integrated picture of biological conditions in the lake.

Physical and Chemical

At the time of the April samplings, Station 1 was homothermous at 17.1C from surface to bottom (Table 1); weak thermal gradients were present at the other stations. Dissolved oxygen was equally distributed at all depths at Station 1; some oxygen reduction at depths greater than 1 meter was evident at the other stations, although only near the bottom at Station 3 did the recorded amount fall below 4 ppm. A dissolved oxygen content of 4 ppm is the recommended minimum in the Water Quality Criteria 1972. Conductivity, an indicator of amount of ionized material in the water, was approximately 1500 micromhos at Station 1, 1200 at Stations 2 and 3 and 1000 at Station 4.

Observations made by CIPS personnel at several locations on Coffeen Lake indicate that concentrations of dissolved oxygen are adequate at near the surface and down to depths of 10 feet (Tables 8G-5 and 8G-5A, CIPS 1977). For example, concentrations at nine locations on July 3, 1974, ranged from 5.5 to 9.0 ppm, corresponding to 87 to 118 percent of saturation for the observed temperatures.

The Illinois Department of Conservation took oxygen profiles at 14 stations on Coffeen Lake, August 19, 1966, and found abundant oxygen to depths of 10 feet at all stations (file report).

Coffeen Lake thermally stratifies during summer. Observations by CIPS and the Illinois Department of Conservation have revealed that oxygen concentrations become reduced at depths greater than about 15 feet (CIPS 1977). Two annual cycles of temperature and dissolved oxygen in the deep water near the dam as revealed by monthly sampling are presented in Tables 2 and 3. Coffeen Lake was one of 31 Illinois Lake included in an eutrophication study carried out by the U.S. Environmental Protection Agency in 1973 (USEPA 1975). Dissolved oxygen at two stations, roughly corresponding to stations 2 and 3 of the April 1977 study, was less than 4 ppm at depths greater than 25 feet at the time of sampling in August.

Although stratification persists throughout much of the year, it is evident that short term changes in temperature and dissolved oxygen concentration do occur (Table 4), thus precluding total stagnation. There is no evidence to date that low oxygen has been responsible for fish deaths in Coffeen Lake. The fish are able to find suitable temperatures and levels of dissolved oxygen in the upper waters and in bays off the cooling loop and in the inlet arm north of the railway bridge.

Coffeen Lake has undergone both gradual and rapid changes in concentrations of some water quality parameters (Tables 5 and 6). From 1965 through 1974, water near the dam tended to increase in total dissolved solids, sodium and sulfate and simultaneously decrease in bicarbonate and alkalinity; for example, the mean concentration of TDS for years 1965, 66 and 67 was 295 ppm; the mean of the years 1972, 73 and 74 was 332 ppm. Corresponding changes in values for sulfate and alkalinity were 88 to 150 and 130 to 74 ppm.

Total dissolved solids, calcium, sodium and sulfate increased dramatically between 1974 and 1976 (Table 5) at the same time bicarbonate and alkalinity decreased markedly. The lake discharged water over the spillway at least part of the time when changes in water quality were taking place; however, there has been no discharge over the spillway since June of 1975.

Water quality near the railway bridge exhibited similar trends (Table 6); however, calcium and magnesium increased concomitantly with TDS, sodium and sulfate. Water quality has been more variable in the inlet arm as is revealed by the greater standard deviations for the different parameters. This is not unexpected since runoff entering Coffeen Lake via McDavid Creek could be expected to differ in quality from the lake water.

Plans to control wastewater discharge, coal pile runoff and reduce concentrations in ash pond effluents should reverse the trend toward increasing total solids. Intermittent pumping of water from East Shoal Creek should also aid in preventing TDS to increase via evaporation.

Phytoplankton

Depth-integrated samples of phytoplankton were obtained at four stations on Coffeen Lake on April 26, 1977. Samples were settled in the laboratory, examined by inverted microscope and cells counted using a modified Lackey transect method (Vollenweider 1974). Fourteen taxa of green algae, three of blue-green, 36 diatoms, one dinoflagellate and four euglenoids were identified. Total phytoplankton density ranged from 1547 cells per ml at Station 4 to 9,759 at Station 3.

Table 7 lists the number of cells or colonial and filament units per ml of lake water. By far the most abundant alga at Stations 1, 2 and 3 was the blue-green, Phormidium tenue. The abundance of this species depressed diversity at Stations 1, 2 and 3. Although the total number of phytoplankters was lowest at Station 4, the diversity was highest there indicating a more even distribution of cells among the species present.

The abundance of phytoplankters in the April collections from Coffeen Lake (mean = 6,721 units/ml) was similar to those reported for the spring-early summer period for Lake Sangchris (INHS, 1974 & 1975), and slightly greater than those reported for Newton Lake (ECI, 1975, 1976 & 1977). Collections from the spring-early summer periods from both Newton and Sangchris Lakes were typically dominated by green and diatom species, whereas the collections from Coffeen Lake were dominated by a blue-green alga, Phormidium tenue.

Perhaps the most remarkable feature of the collections was the great preponderance of algal species which typically grow on substratum surfaces and the general lack of truly planktonic species. Many species of phytoplankton which are typical of the plankton of small to middle-sized midwestern lakes did not appear in the Coffeen samples.

The only previous samples of phytoplankton from Coffeen Lake were those obtained in the eutrophication survey. In May 1973 the lake contained 9,531 algal units per ml and 4,432 in August and 789 in October (USEPA 1975). Diatoms of the genus Nitzschia were dominant in the May samples, whereas a blue-green alga, Oscillatoria sp., was dominant in August.

In contrast to April 1977, the phytoplankton samples of the 1973 survey were dominanted by planktonic algae, although representatives of the periphyton were also present. The EPA survey ranked Coffeen Lake as the third most eutrophic of the Illinois lakes investigated. Phosphorus was believed to be limiting in May and August but nitrogen was the limiting nutrient in October (USEPA 1975).

To what extent changes in water quality between 1973 and 1977 may have affected composition of the phytoplankton is unclear. Although relationships between species of phytoplankton and the presence of substantial amounts of bicarbonate and alkalinity are by no means simple and not completely known, there is a widely made observation that lakes rich in alkalinity tend to be more productive than those low in this substance (Moyle 1949). Certainly waters rich in bicarbonates are well buffered against rapid changes in pH. Future actions that would tend to increase alkalinity in Coffeen Lake should prove beneficial to the phytoplankton.

Zooplankton

Zooplankton were sampled quantitatively by means of oblique tows with a Clarke-Bumpus plankton sampler on April 26, 1977. Thirty-six taxa were identified, including 19 Rotifera, 9 species of Cladocera, and 8 taxa of Copepoda. The zooplankton contained no unusual species. All species of rotifers but one found in the Coffeen samples had been reported from Lake Sangchris during a two-year study by the Illinois Natural History Survey

(INHS 1975). Anuraeopsis fissa, collected in low numbers at Station 4 was not recorded from Lake Sangchris. A. fissa and five other rotifers common to Coffeen and Sangchris lakes are regarded as indicative of eutrophic conditions (Gannon and Stemberger 1975).

Coffeen Lake zooplankton contained two species of Daphnia (ambigua and galeata mendotae) which were not reported from Lake Sangchris. These species are widely distributed in midwestern United States (Brooks 1957).

Species of Copepoda most common in the Coffeen samples have been reported from Lake Sangchris (INHS 1975) and are widely distributed through midwestern United States. Table 8 compares the numbers of major taxa reported from Lake Sangchris and Newton Lake with Coffeen Lake samples.

Perusal of Table 8 should be tempered by the fact the zooplankters are individually short-lived and that populations wax and wane rapidly. For example, zooplankton populations in Lake Sangchris exhibited three pulses during the year September 1974 through August 1975 (INHS 1975). The yearly range in numbers of zooplankton extended from 2,000 to 736,000/m^3.

Immature stages comprised from 45 to 84 percent of the copepoda collected in Coffeen lake. Numbers of Cladocera appear low in Coffeen Lake in relation to Newton and Sangchris Lakes.

Perhaps the most significant aspect of the Coffeen Lake samples is the paucity of large zooplankters. Rotifers are small, copepod nauplii and young copepodite stages are small and Chydorus sphaericus, the most numerous cladoceran, is also small. One sampling is insufficient to establish lake-wide trends in short-lived zooplankton populations but the data suggest heavy utilization of zooplankton by planktivorous fishes with selective removal of large individuals.

Macroinvertebrates

Macroinvertebrates were sampled by means of an Ekman dredge at four stations in Coffeen Lake on April 27, 1977. Three replicate samples were obtained at each station. Each replicate contained material dredged from one square foot of substratum.

The mean abundance of benthic macroinvertebrates from the collections taken from Coffeen Lake was 111 individuals per square foot, or 1,194 organisms per square meter (Table 9). This value is similar to the abundance of benthic organisms recorded for Lake Sangchris (INHS 1975) and Newton Lake (ECI 1977). The average yearly abundance of benthic macroinvertebrates from Newton Lake for 1976 was 1,273 organisms per square meter. The average yearly abundance of benthic organisms for Lake Sangchris was 1,278 and 646 organisms per square meter for the 1974-75 and 1973-74 survey periods, respectively.

Aquatic earthworms (Oligochaeta) and immature stages of midges (Chironomidae) and phantom midges (Chaoboridae) were the dominant organisms collected from all three lakes.

Larvae and pupae of the phantom midge, Chaoborus punctipennis, greatly dominated most of the samples collected from Coffeen Lake as was the case with many of the collections from Newton and Sangchris lakes. Thus, in comparison with Lake Sangchris and Newton Lake, the samples collected from Coffeen Lake in April had a typical composition and abundance of benthos for lakes in central Illinois.

Community diversity, based upon the Shannon-Wiener diversity index($\bar{d}$). indicates a difference between the main body of the lake and the area upstream from the railway bridge (Station 4). Diversity was quite low at Stations 1 and 2 where collections were totally dominated by Chaoborus punctipennis. More kinds of animals were found in dredges taken in the area upstream from the railway bridge (Station 4), and the individuals present were more equally distributed among the species present as indicated by the greater community diversity and equitability.

Fish

Fish were collected April 26 to May 1 by means of gill nets, unbaited hoop nets and seines. Gill and hoop nets were set approximately 24 hours at each set.

Table 10 summarizes the combined catch for all methods and locations.

No attempt has been made to calculate relative abundances since the sampling methods used are selective for some species and against others. In addition, the methods used did not sample all water areas where fish might be found. As an example, very few largemouth bass (Micropterus salmoides) were collected, even though intensive and relatively successful bass fishing (by angling) was occurring during the sampling period. This is to be expected because the bass had moved into extremely shallow water and were not moving in the proximity of the nets.

A wide variation was observed in the coefficients of condition between the small and large individuals of white crappie. This difference was also evident in the field; small crappie were emaciated, whereas large crappie appeared to be in good condition. Similarly, small bluegills were emaciated, but too few large bluegills were captured to allow valid comparisons. Channel catfish also exhibited a difference in condition dependent on size. This phenomenon has been observed frequently in Iowa and South Dakota (Carlander 1969) and appears to be a characteristic of the species.

Condition coefficients were compared with available literature values obtained from other waters. Since no statistical variability is available for virtually all literature values, statistical comparisons are not possible.

Condition coefficients for gizzard shad in Coffeen Lake were slightly below the weighted average of all condition coefficients obtained in a wide range of other waters throughout the United States as reported in Carlander (1969).

The mean coefficient of condition for carp from Coffeen Lake was below any of the mean coefficients of condition for other waters throughout the United States as reported in Carlander (1969). The mean value for Coffeen Lake did however fall within the lower end of the ranges reported for other waters. Carp are not overly abundant in Coffeen Lake.

Condition of yellow bullheads in Coffeen Lake was slightly greater than the weighted average of values reported in Carlander but was slightly below the mean reported for northeastern Illinois (Carlander 1969). Yellow bullheads, although not common in Coffeen Lake, appeared to be in average condition.

The mean condition coefficient of channel catfish found in Coffeen Lake is similar to the condition of catfish observed in the Mississippi River. Catfish large enough to interest anglers were above average condition.

Bluegill were in poor condition in Coffeen Lake except in the dam region.

Extreme emaciation was evident in small (< 100 mm total length) fish, and larger fish were few in the samples. Even larger fish had condition coefficients near the lower end of ranges given in Carlander (1953).

Another fish collected which might provide sport fishing was the white crappie. White crappies exhibited two distinct condition coefficients. Fish less than 200 mm total length were in poor condition and resembled the emaciated bluegills. Fish greater than 200 mm total length exhibited good condition, and condition improved as the size of the individual fish became larger. Large crappie sacrificed for pesticide and trace metal analysis had been feeding on gizzard shad.

Although only a few largemouth bass were captured, those that were captured were in excellent condition. Condition factor was well above the weighted average of data presented in Carlander (1953).

Comparisions of data obtained in April 1977 can be made with data collected by the Illinois Conservation Department during October 1968 and October 1971, and by WAPORA in November 1973.

Growth rates for largemouth bass, white crappie and bluegills were examined for Coffeen Lake fishes in November 1973 by WAPORA for CIPS. It was concluded that bass up to about 300 mm in length and 3+ age were growing at about the Illinois statewide average (CIPS 1977) and that fish up to 480 mm and 5+ age were exceeding the statewide average. However, bass of less than 300 mm and 3+ age appeared to be growing more slowly than those examined by Illinois Conservation Department in October 1971. There was little difference in length and age for fishes larger than 300 mm in the two years. Larger individuals were in better condition than smaller bass but most sizes were in poorer condition in 1973 than in 1971. Apparently growth curves and condition factors were based on measurements of 43 fish, a small number for generating a reliable growth curve.

Bluegills and white crappie were making the same growth in 1973 as in 1971.

White crappie growth in 1971 was considerably greater than the statewide average in 1971 (CIPS 1977).

In general, the condition of largemouth bass has remained relatively constant since 1968. Bluegill and white crappie are in poorer shape now and in 1971 than they were in 1968, but little change is apparent between 1971 and 1977. Carp and shad appear to be less numerous now than they were in 1971.

Observations made in April 1977 are consistent with earlier observations (CIPS 1977); namely, those individuals of piscivorous species which can attain a size great enough to permit them to prey on small individuals of other species or to cannibalize small individuals of their own species have in Coffeen Lake a food supply which supports good growth and condition factors.

Twenty-one species of fishes have been recorded from Coffeen Lake since 1966 (Table 11). In comparison 19 and 18 species have been recorded in Lake Sangchris and Newton Lake. Five species, lake chub, emerald shiner, common shiner, orange spotted sunfish and yellow perch, have been found in Coffeen Lake but not in the other two. The fish fauna of Newton Lake probably has not yet stabilized since lake filling only began in July of 1975. Coffeen and Sangchris lakes have 12 widely distributed and commonly occurring species in common.

Trace Metals and Organic Compounds in Fish

Fillets from 15 white crappie and 15 channel catfish were analyzed for mercury, arsenic, DDT and PCB's. Three composite samples made up of flesh from five individual fish of each species were prepared prior to analysis.

Livers from 15 white crappie and 15 channel catfish were composited similarly and analysed for zinc, chromium, copper, cadmium, mercury, DDT and PCB's.

The highest mercury value in flesh, 48 ppb, is well below the U.S. Food and Drug Administration maximum permissible level of 500 ppb (Table 12). Arsenic, DDT and PCB's were below detection limits.

In 1973 the flesh of seven largemouth bass was analyzed for mercury by WAPORA and the mean content was 140 ppb (Table 13).

Mercury content in the flesh of Coffeen fish is compared with analyses from other central Illinois lakes in Table 14. Mean mercury level is lower in the Coffeen fish than in Lake Sangchris fishes and is much below the other lakes.

The liver is an organ of detoxification and known to concentrate many substances. Mercury levels in the fish livers were no greater than those found in the muscle (Table 13). DDT and PCB's were below detection limits.

Analyses of trace metals in gills, liver and gonads of five largemouth bass from Coffeen Lake were made in November 1973. These values are compared with analyses of composited liver samples of fish collected in 1977 in Table 13. Values for zinc are similar in both years.

Overall Biological Assessment of Coffeen Lake

Coffeen Lake is presently supporting a good fishery for three species, largemouth bass, white crappie and channel catfish.

Fish in Coffeen Lake generally exhibit poorer condition when small than when large. This is undoubtedly the result of insufficient forage of sizes suitable for small fish. Exceptions to this generalization appear to apply to those species which are omnivorous or are plankton feeders such as gizzard shad. These species show average growth throughout their size range. The piscivorous fishes such as largemouth bass and white crappie exhibit good to excellent growth once they become large enough to prey on gizzard shad.

Probably the greatest limiting factor to the fisheries of Coffeen Lake is the limited amount of shallow water areas.

The sparseness of shallow water littoral areas is probably more detrimental to the smaller centrarchids, such as bluegills, which inhabit and feed upon benthic organisms in shallow waters, than to the ictalurids, which can prey upon a wide range of food sources in the limnetic, littoral and profundal zones. The poor condition noted in bluegills and smaller crappie from Coffeen Lake could be the result of the limited littoral areas and too many fish to be supported by the food supply available in these areas. Larger centrarchids, such as largemouth bass and the larger white crappie, which can feed upon gizzard shad and the smaller centrarchids appear to be doing well, but they could also be affected by the limited littoral areas and crowded sunfish populations.

Fortunately, most of the littoral areas in Coffeen Lake are located outside of the cooling loop. The arm located west of the intake structure, the area upstream from the railway bridge, and the larger bays off the main body of the lake contain a large percentage of the littoral habitat available. The discharge arm has few large bays, and the remainder of the cooling loop is largely composed of a deep water (greater than 30 feet) profundal zone.

The channel catfish, which is doing quite well in Coffeen Lake, seems particularly well suited to its morphological characteristics. From observations in April it appears this species and the largemouth bass are receiving heavy fishing pressure. This heavy fishing pressure has a significant impact since no supplemental stocking has been done since the original stocking done in 1964 and 1966. The fact that there are catchable populations without supplemental stockings indicates good production of these sport fishes.

Available data suggest that amounts and species of macroinvertebrates in Coffeen Lake are quite similar to those found in Sangchris and Newton Lakes, and are typical for central Illinois lakes and reservoirs.

Water quality has altered during the life of the lake. Planned wastewater treatment facilities and settling of coal pile runoff and improved ash handling should lower concentrations of total dissolved solid and sulfate reaching the lake.

Amounts of phytoplankton and zooplankton in Coffeen Lake are similar to those in Newton and Sangchris Lakes.

The presence of viable fishery for catfish, largemouth bass, and white crappie indicates that areas of Coffeen Lake are suitable in dissolved oxygen, temperature, and other requirements necessary for reproduction and growth of these fishes.

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Table 1. Temperature, dissolved oxygen, pH and conductivity in Coffeen Lake, April 29, 1977

	Station 1				Station 2				Station 3				Station 4			
Depth (m)	Temp. (C)	D.O. (ppm)	pH	Cond.	Temp. (C)	D.O. (ppm)	pH	Cond.	Temp. (C)	D.O. (ppm)	pH	Cond.	Temp. (C)	D.O. (ppm)	pH	Cond.
0	17.1	10.8	8.35	1550	17.2	11.2	8.35	1280	18.9	12.2	8.4	1280	18.0	12.0	8.2	1060
1/2	17.1	10.8	-		17.2	11.2	-		18.9	12.2	-		17.2	12.0	-	
1	17.1	10.8	-		17.2	11.0	-		18.9	12.2	-		17.0	11.4	-	
2	17.1	10.8	-		17.2	10.6	-		18.0	12.2	-		17.0	10.6	-	
3	17.1	-	8.35	1480	17.1	10.2	-		18.0	12.0	-		16.8	10.3	-	
4					17.0	9.6	-		17.5	11.6	-		16.5	10.3	-	
5					16.9	9.2	-		17.0	11.1	-		16.5	9.5	-	
6					16.9	9.0	-		17.0	10.8	-		16.5	8.4	8.0	1060
7					16.2	8.0	-		17.0	10.4	-					
8					16.1	7.6	-		16.8	10.2	-					
9					15.5	6.7	-		16.5	8.9	-					
10					15.1	6.5	-		15.5	6.0	-					
11					14.9	6.1	7.35		14.5	3.5	7.8	1210				
12					14.6	4.9	-	1230								

Table 2. Monthly trends in temperature and dissolved oxygen, dam at Coffeen Lake, 1966-67

Date	Mar 15	Apr 18	May 19	June 21	July 18	Aug 19	Sept 15	Oct 17	Nov 17	Dec 15	Jan 20	Feb 24
						TEMPERATURE (°F)						
Depth (feet)												
0	66	66	67	86	94	89	81	62	62	48	40	41
10	49	60	67	78	88	84	80	62	53	-	-	41
20	46	58	67	75	86	81	80	62	52	-	40	41
30	44	53	62	68	71	74	76	62	51	-	-	41
40	44	52	55	56	57	58	59	62	51	-	-	40
50	44	52	51	53	53	53	54	54	51	46	40	40
						CONCENTRATION (ppm)						
0	7.0	6.8	7.8	6.8	6.8	7.0	4.6	7.0	8.0	8.6	10.4	11.4
10	8.0	6.2	7.4	6.8	4.6	7.4	3.8	6.2	7.7	-	-	11.0
20	8.6	5.6	6.2	3.0	0	2.0	3.6	6.4	7.0	-	10.4	10.4
30	8.1	5.2	4.4	1.6	0.4	0.4	0.2	5.2	7.0	-	-	9.6
40	7.8	4.6	3.2	1.6	t	t	t	6.2	7.0	-	-	9.0
50	7.4	4.0	3.6	3.4	1.2	1.4	0	0.2	7.0	8.6	10.4	9.0
						PERCENTAGE SATURATION						
0	75	72	84	90	96	95	57	71	82	74	79	89
10	69	61	80	82	61	95	47	63	71	-	-	86
20	72	54	67	35	t	25	44	65	63	-	79	81
30	67	48	45	17	t	t	t	53	62	-	-	75
40	65	42	30	15	t	t	t	63	62	-	-	70
50	61	39	32	32	11	13	0	t	62	74	79	70

Data from Illinois Conservation file on Coffeen Lake

Table 3. Monthly trends in temperature and dissolved oxygen, dam at Coffeen Lake, 1973-74

Date	Apr 30	May 4	June 29	July 26	Aug 31	Sept 26	Oct 26	Nov 20	Dec 27	Jan 31	Feb 28	Mar 28
						TEMPERATURE (^{o}F)						
Depth (feet)												
0	71.5	73.5	86.5	96.0	91.0	86.0	62.8	58.8	55.8	60.0	58.5	64.5
10	64.5	68.0	86.0	91.0	87.5	80.0	61.8	58.5	55.8	59.2	47.8	57.5
20	62.0	66.0	81.5	85.0	85.5	78.5	61.0	58.2	55.5	51.0	47.0	54.5
30	58.5	60.5	72.5	79.2	82.0	76.0	59.0	58.0	55.5	49.8	46.2	52.8
40	53.8	56.2	60.8	61.8	62.0	63.5	58.0	58.0	55.5	49.0	46.0	52.2
50	51.2	54.0	55,5	56.0	56.0	56.0	56.0	58.0	55.2	48.0	45.5	51.8
						CONCENTRATION (ppm)						
0	6.4	4.4	5.2	4.4	5.0	4.8	5.8	8.0	8.4	8.4	5.2	8.0
10	6.4	5.6	4.2	4.2	5.0	5.0	7.0	7.6	7.8	6.8	5.2	8.0
20	5.6	5.8	4.0	3.8	3.4	4.4	8.2	8.0	8.0	9.0	7.0	8.0
30	6.0	5.0	4.0	0.6	1.2	3.7	7.1	7.9	8.2	7.4	8.4	7.4
40	6.5	4.6	1.4	0.6	1.6	1.2	8.0	8.0	8.2	8.0	8.0	8.0
50	0	4.4	1.6	0.6	1.2	1.8	7.4	7.8	7.8	9.8	8.4	7.2
						PERCENTAGE SATURATION						
0	73	51	68	62	68	63	60	78	79	83	51	84
10	67	61	55	58	67	61	68	74	74	67	44	76
20	57	62	50	49	45	54	82	78	75	80	59	76
30	58	50	46	t	15	44	70	77	77	66	70	68
40	60	44	11	t	16	12	78	78	77	70	67	72
50	0	41	15	t	11	17	70	77	74	84	69	65

Data from Illinois Conservation file on Coffeen Lake

Table 4. Concentration and percentage of saturation of dissolved oxygen near the dam at Coffeen Lake, 1976

Date	Aug 25	Aug 26	Sept 8	Sept 11	Sept 13	Sept 14	Sept 15	Sept 17
				CONCENTRATION (ppm)				
Depth								
0	6.0	9.0	6.9	7.1	7.3	7.1	7.4	7.5
10	4.5	8.5	6.7	6.5	7.7	7.8	7.4	6.9
20	2.4	3.5	6.2	5.6	7.1	4.5	6.2	4.0
30	0.7	2.1	3.8	4.1	3.8	1.3	2.4	2.1
40	0.5	2.1	0.4	1.6	2.4	0.3	2.0	1.9
50	0.3	2.0	-	-	-	-	-	-
				PERCENTAGE SATURATION				
0	87	132	100	99	99	99	100	99
10	62	118	86	83	98	100	95	87
20	58	47	78	69	88	56	76	49
30	32	26	47	50	46	16	29	25
40	7	22	4	17	26	3	21	20
50	t	12	-	-	-	-	-	-

Data from CIPS (1977)

Table 5. Summary of analyses of surface water samples taken monthly near the dam, Coffeen Lake. N, number of samples; $\bar{X}$, mean; S, standard deviation; Se, standard error of mean

		Total Dissolved Solids	pH	Calcium	Magnesium	Sodium	Sulfate	Bicarbonate	Alkalinity
1965	$\bar{X}$	297.45	8.018	46.109	18.991	26.245	83.827	158.491	134.455
n=11	S	19.76	.166	4.903	.745	3.254	11.996	6.703	6.455
	Se	5.96	.050	1.478	.255	.981	3.617	2.021	1.946
1966	$\bar{X}$	311.92	7.90	52.150	19.167	27.133	93.442	166.842	139.750
n=12	S	16.71	.27	9.192	1.045	4.130	4.395	10.527	8.771
	Se	4.82	.08	2.653	.302	1.192	1.269	3.039	2.532
1967	$\bar{X}$	276.000	7.913	42.900	16.363	23.950	88.338	132.829	114.625
n=8	S	15.584	.270	1.782	1.036	3.133	5.910	7.002	4.779
	Se	5.510	.095	.630	.366	1.108	2.089	2.646	1.690
1968	$\bar{X}$	250.182	7.918	44.073	13.764	15.927	82.318	117.118	99.636
n=11	S	16.732	.147	3.249	2.273	3.717	5.604	7.221	3.233
	Se	5.045	.044	.980	.685	1.121	1.690	2.177	.975
1969	$\bar{X}$	242.182	7.655	41.891	12.318	17.227	83.855	102.255	85.636
n=11	S	14.736	.202	5.626	3.104	5.036	5.520	5.913	4.178
	Se	4.443	.061	1.696	.936	1.518	1.664	1.783	1.260
1970	$\bar{X}$	259.800	7.720	44.960	12.850	18.970	90.980	103.660	88.000
n=10	S	12.345	.326	4.128	2.171	5.437	7.085	6.137	3.830
	Se	3.904	.103	1.305	.686	1.719	2.241	1.941	1.211
1971	$\bar{X}$	292.667	7.911	47.378	15.144	22.989	108.644	109.811	93.778
n=9	S	17.328	.220	3.067	2.716	2.583	7.405	7.374	3.232
	Se	5.776	.073	1.022	.905	.861	2.468	2.458	1.077

Table 5. (continued)

		Total Dissolved Solids	pH	Calcium	Magnesium	Sodium	Sulfate	Bicarbonate	Alkalinity
1972	$\bar{X}$	324.364	7.745	50.836	14.118	29.882	131.882	104.482	85.636
n=11	S	18.250	.266	3.690	2.470	5.780	18.289	7.010	5.749
	Se	5.503	.080	1.113	.745	1.743	5.514	2.114	1.733
1973	$\bar{X}$	336.600	7.720	48.960	13.960	35.820	154.940	84.775	70.000
n=5	S	28.806	.239	2.677	1.774	3.978	14.500	4.592	3.464
	Se	12.883	.107	1.197	.793	1.779	6.485	2.296	1.549
1974	$\bar{X}$	334.000	7.730	49.840	12.630	34.720	163.035	73.070	67.035
n=20	S	33.567	.306	4.658	1.351	5.111	18.091	2.599	6.010
	Se	7.506	.068	1.042	.302	1.143	4.045	.581	1.344
1975									
n=2									
1976	$\bar{X}$	1090.785	7.331	125.723	21.154	166.292	671.800	16.631	13.615
n=13	S	182.276	.407	19.764	4.095	36.982	125.115	9.736	7.974
	Se	50.554	.113	5.481	1.136	10.257	34.701	2.700	2.212

Data from CIPS

Table 6. Summary of analyses of surface water samples taken monthly north of railway bridge, Coffeen Lake. N, number of samples; $\bar{X}$, mean; S, standard deviation; Se, standard error of the mean

		Total Dissolved Solids	pH	Calcium	Magnesium	Sodium	Sulfate	Bicarbonate	Alkalinity
1971	$\bar{X}$	278.375	7.800	43.600	14.850	20.288	96.913	109.175	90.250
n=8	S	40.253	.200	5.624	3.898	3.941	20.063	18.842	15.145
	Se	14.231	.071	1.989	1.378	1.393	7.093	6.662	5.354
1972	$\bar{X}$	290.909	7.773	48.073	11.991	27.191	113.682	102.700	84.545
n=11	S	42.980	.224	6.139	3.592	6.236	28.661	10.408	8.190
	Se	12.959	.068	1.851	1.083	1.880	8.642	3.138	2.469
1973	$\bar{X}$	267.667	7.700	41.867	10.150	25.883	106.133	86.860	68.333
n=6	S	64.211	.141	9.728	2.573	7.966	43.273	8.346	9.309
	Se	26.214	.058	3.971	1.050	3.252	17.666	3.733	3.801
1974	$\bar{X}$	298.200	7.620	46.720	11.400	27.870	138.290	70.400	57.700
n=10	S	79.388	.301	10.149	2.828	11.457	48.238	7.168	5.870
	Se	25.105	.095	3.209	.894	3.623	15.254	2.267	1.856
1975									
1976	$\bar{X}$	956.091	7.464	112.436	19.373	133.445	577.645	25.845	21.182
	S	365.378	.317	39.882	6.069	10.946	244.934	17.669	14.469
	Se	110.166	.096	12.025	1.830	18.376	73.850	5.327	4.363

Data from CIPS

Table 7. Phytoplankton Assemblages in Coffeen Lake, April 26, 1977

Parameter	Station 1	Station 2	Station 3	Station 4
Total Phytoplankton Density (units/ml)	6922	8859	9759	1547
Total Taxa Observed	35	32	25	34
Total Blue-green Algae (units/ml)	5249	6482	7070	47
Total Green Algae (units/ml)	413	441	506	1015
Total Diatoms (units/ml)	1260	1936	2162	391
Total Other Algae (units/ml)	0	0	21	94
Species Diversity ($\bar{H}$)	1.62	1.40	1.31	3.36
Maximum Diversity ($\bar{H}$ max)	4.25	4.00	3.91	4.46
Equitability (%)	38.2	35.1	33.5	75.4
Total Taxa Used for $\bar{H}$ Calculation	19	16	15	22

Table 8. Comparison of major taxa of zooplankton in Coffeen, Newton and Sangchris Lakes

	X Sangchris		XX Newton		Coffeen Lake Station 1		Station 2		Station 3		Station 4	
	No.	%	No.	%	No.	%	No	%	No.	%	No.	%
Rotifera	9,358	55	182,030	59	1,834	4.5	12,325	17.6	4,825	7.6	18,477	43.9
Cladocera	3,403	20	16,822	9.6	912	2.2	958	1.4	1,152	1.8	3,268	8.8
Copepoda	4,254	25	70,120	31.4	38,543	93.3	56,701	81.0	57,340	90.5	19,899	47.3
TOTAL	17,015		268,972		41,289		69,984		63,317		42,044	

X means of 34 samples taken at monthly intervals over two years at three depths at one station. Data from Illinois Natural History Survey, 1975.

XX means of six samples taken at three stations on two dates. Data from ECI, 1977.

Table 9. Macroinvertebrates collected from Coffeen Lake, April 1977

Taxa	Station 1			Station 2			Station 3			Station 4		
	A	B	C	A	B	C	A	B	C	1	2	3
Oligochaeta												
Naididae												
Unknown genus A	16	4								3		
Dero digitata				2							6	
Tubificidae												
Limnodrilus claperedeanus							28			58	41	
Unknown genus A											10	12
Other oligochaets											10	4
Diptera												
Chaoboridae				6	8	8		2			2	
Chaoborus punctipennis			238	248	217	220		22	7	3	3	2
Ceratopogonidae												
Palpomyia group sp.									1		1	
Chironomidae									3			
Chironomus sp.	4			1		1					9	
Coelotanypus sp.								8	8	24	14	20
Cryptochironomus sp.					1			2		1	2	
Cryptocladopelma sp.								2	7	1		1
Parachironomus sp.												1
Procladius sp.	4		1	2	3	1	4	3	5	7	3	2
Unidentified Chironomini	4											
$\bar{d}$ =	N.A.	N.A.	0.04	0.32	0.36	0.30	N.A.	N.A.	N.A.	1.66	2.73	2.02
e =	N.A.	N.A.	3.91	14.00	17.94	14.91	N.A.	N.A.	N.A.	59.21	78.36	72.[illegible]1
N.A. = Not appropriate, sample size too small												
Ind/sq. meter	301	43	2573	2788	2465	2476	344	420	334	1044	1037	452
Total Taxa	4	1	2	5	4	4	2	6	6	7	11	7

Table 10. Combined catch of all fish sampling in all regions, Coffeen Lake, April 1977

Species	Mean length (mm)	Mean standard error	Mean weight (gm)	Mean standard error	Mean K_{TL}	Mean standard error	Number of fish
Gizzard shad	144	1.44	28	1.13	0.869	0.00749	229
Carp	576	31.60	2156	309.69	1.090	0.01619	6
Golden shiner	178	4.37	44	1.86	0.801	0.09651	3
Black bullhead	268	-	222	-	1.153	-	1
Yellow bullhead	215	12.20	144	29.19	1.351	0.03002	7
Channel catfish	303	12.61	407	61.28	0.761	0.02268	89
Warmouth	93	-	9	-	1.119	-	1
Green sunfish	109	0.89	16	1.12	1.266	0.09438	6
Orange spotted sunfish	62	2.50	2	0.00	0.868	0.10543	2
Bluegill	104	2.41	18	1.84	1.364	0.04574	80
Longear sunfish	116	4.70	30	3.51	1.854	0.08834	13
Lepomis hybrid	121	-	19	-	1.073	-	1
Largemouth bass	360	38.89	790	182.42	1.413	0.05219	6
White crappie	189	5.22	140	14.57	1.002	0.02032	213

Table 11. Species of fish recorded from Coffeen, Sangchris and Newton lakes

	Lake Sangchris	Newton Lake	Coffeen Lake
Bowfin (<u>Amia calva</u>)		x	
Gizzard shad (<u>Dorosoma cepedianum</u>)	x	x	x
Grass pickerel (Esox americanus vermiculatus)		x	
Lake chub (<u>Couesius plumbeus</u>)			x
Carp (<u>Cyprinus carpio</u>)	x	x	x
Hornyhead chub (<u>Nocomis biguttatus</u>)	x		
Golden shiner (<u>Notemigonus crysoleucas</u>)	x	x	x
Emerald shiner (<u>Notropis atherinoides</u>)			x
Striped shiner (<u>Notropis chrysocephalus</u>)	x		
Common shiner (<u>Notropis cornutus</u>)			x
Bigmouth shiner (<u>Notropis dorsalis</u>)	x		
Red shiner (<u>Notropis lutrensis</u>)	x		
Bluntnose minnow (<u>Pimephales notatus</u>)		x	x
White sucker (<u>Catostomus commersoni</u>)	x	x	x
Creek chubsucker (<u>Erimyzon oblongus</u>)		x	x
Spotted sucker (<u>Minytrema melanops</u>)		x	
Black bullhead (<u>Ictalurus melas</u>)	x	x	x
Yellow bullhead (<u>Ictalurus natalis</u>)	x		x
Channel catfish (<u>Ictalurus punctatus</u>)	x		x
Blackstripe topminnow (<u>Fundulus notatus</u>)	x		x
White bass (<u>Morone chrysops</u>)	x		
Yellow bass (<u>Morone mississippiensis</u>)	x		
Green sunfish (<u>Lepomis cyanellus</u>)	x	x	x
Warmouth (<u>Lepomis gulosus</u>)		x	x
Orange spotted sunfish (<u>Lepomis humilis</u>)			x
Bluegill (<u>Lepomis macrochirus</u>)	x	x	x
Longear sunfish (<u>Lepomis megalotis</u>)		x	x
Largemouth bass (<u>Micropterus salmoides</u>)	x	x	x
White crappie (<u>Pomoxis annularis</u>)	x	x	x
Johnny darter (<u>Etheostoma nigrum</u>)		x	
Yellow perch (<u>Perca flavescens</u>)			x
Walleye (<u>Stizostedion vitreum vitreum</u>)		x	
Freshwater drum (<u>Aplodinotus grunniens</u>)	x		
TOTAL	**19**	**18**	**21**

Table 12. Concentrations of mercury, arsenic, DDT and PCB's in composite samples of fish flesh, Coffeen Lake, April 1977

Composite	Hg (ppb)	As (ppm)	DDT (ppm)	PCB's (ppm)
White Crappie 1	39	<.25	<.01	<1
White Crappie 2	48	<.25	<.01	<1
White Crappie 3	12	<.25	<.01	<1
Channel Catfish 1	13	<.25	<.01	<1
Channel Catfish 2	5	<.25	<.01	<1
Channel Catfish 3	37	<.25	<.01	<1

Table 13. Concentrations of metals, DDT and PCB's in composite liver samples of fish, Coffeen Lake, April 1977, and concentration in viscera* of individual largemouth bass, November 1973

Composite	Zn (ppm)	Cr (ppm)	Cu (ppm)	Cd (ppm)	Hg (ppb)	DDT (ppm)	BCB's (ppm)
White Crappie 1	21	<1	2.3	4.9	27	<.01	<2
White Crappie 2	20	<1	2.4	4.4	11	<.01	<2
White Crappie 3	21	<1	3.8	3.6	1.5	<.04***	<8***
Channel Catfish 1	32	<1	13.9	4.4	11	<.04***	<8***
Channel Catfish 2	23	<1	5.2	3.9	10	<.01	<2
Channel Catfish 3	16	<1	3.7	2.5	12	<.01	<2
Largemouth Bass**	21.5	–	.52	.44	none	–	–
Largemouth Bass	25.1	–	.28	.88	none	–	–
Largemouth Bass	26.1	–	1.60	1.56	none	–	–
Largemouth Bass	26.4	–	.61	.80	none	–	–
Largemouth Bass	26.0	–	.60	1.56	none	–	–

* gills, liver and gonads

** data from CIPS 1977

*** small sample

Table 14. Comparison of mercury in fish fillets from Coffeen Lake and other lakes in central Illinois

Lake	Date	N	Mean (ppb)	Range (ppb)
		LARGEMOUTH BASS		
Shelbyville*	July 1974	12	560	230-1240
Otter*	July 1974	12	240	170- 320
Decatur*	July 1974	12	160	110- 290
Sangchris*	October 1973- July 1974	44	70	30- 150
Coffeen**	November 1973	7	140	70- 190
		BLACK BULLHEAD		
Shelbyville*	July 1974	12	180	120- 270
Otter*	July 1974	12	250	160- 390
Sangchris*	October 1973	10	160	90- 360
		WHITE CRAPPIE		
Coffeen	April 1977	3***	33	12- 48
Coffeen**	November 1973	4	80	50- 120
		CHANNEL CATFISH		
Coffeen	April 1977	3***	18	5- 37
		CARP		
Coffeen**	November 1973	4	20	5- 30

* data from INHS 1975

** data from CIPS 1977

*** three composited samples from fifteen individual fish