COMPARISON OF FISH POPULATIONS IN POLLUTED AND NON-POLLUTED ARMS OF A WARM-WATER RESERVOIR

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INTRODUCTION

High Rock Lake is a 15,750 acre warm-water reservoir on the main stem of the Yadkin River located in the upper Piedmont section of North Carolina. Impounded by Carolina Aluminum Company in 1927, High Rock is a shallow (maximum depth approximately 60 feet) normally turbid body of water, subject to extreme annual and seasonal fluctuations of water level.

High Rock is located in the most heavily populated section of North Carolina and sustains a great deal of fishing pressure. As a result of reportedly poor fishing, the North Carolina Wildlife Resources Commission, in 1953, established a project to investigate the fishery of this reservoir. Early in the studies it appeared that there were considerable differences in the fish population of various arms of the reservoir which received varying amounts of municipal and industrial wastes. Accordingly, sampling stations were established to determine, if possible, the extent of any existing differences in the fish population of various segments of the reservoir.

The present paper presents data comparing three main arms of the lake which are subject to varying degrees of pollution. These data were collected on a project of the North Carolina Wildlife Resources Commission financed by the Dingell-Johnson program.

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DESCRIPTION OF STUDY AREAS

The areas selected for study were the Flat Swamp Arm which enters the main stem near the lower end of the lake, Crane Creek which enters in about the middle of the lake, and Abbotts Creek which meets the main river midway between Flat Swamp and Crane Creek (Figure 1).

The Flat Swamp Arm is not polluted and most of the watershed is forested which undoubtedly accounts for the slightly lower turbidity as indicated by the secchi disk (Table I).

Crane Creek receives industrial and sewage wastes from the city of Salisbury and vicinity having a combined population equivalent (P.E.) in terms of BOD of 20,910.

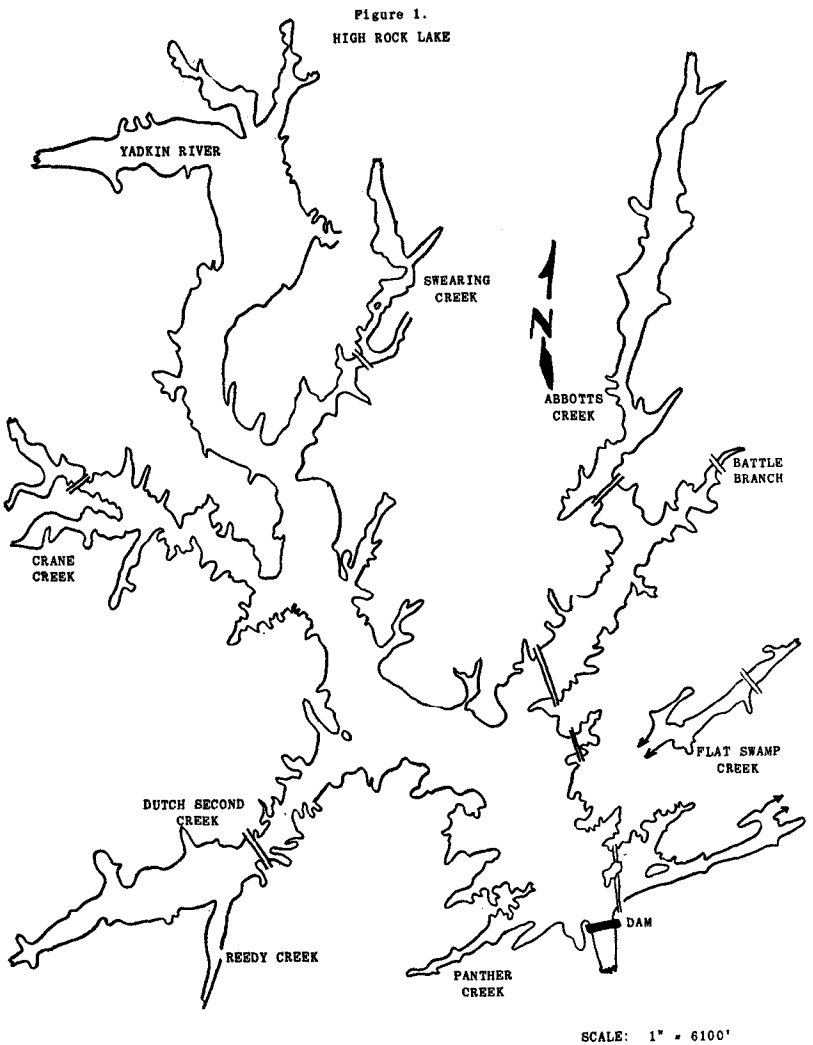
Abbotts Creek, the largest of the three areas, receives from several cities a combination of sewage and industrial wastes having a P.E. of 24,560.

TABLE I

MEAN MONTH SECCHI DISK READINGS, IN INCHES, FOR FLAT SWAMP, ABBOTTS AND CRANE CREEK ARMS OF HIGH ROCK LAKE

1956	*Flat Swamp*	*Abbotts*	*Crane*
March	8.1	6.9	5.0
April	10.6	7.2	5.5
May	14.0	13.3	13.0
June	28.6	22.2	22.1
July	18.7	7.7	10.0
October	...	7.0	11.6
November	...	9.5	19.0

Figure 1.



Bimonthly thermal and chemical data were collected in all three arms from March to July, 1956 (Table II). The major difference between the three arms was the more drastic and prolonged reduction in oxygen at the bottom in Abbotts Creek. Bottom oxygen readings were consistently higher in the Flat Swamp Arm than in the other two areas studied. During late May and June the water became less turbid, phytoplankton increased and the surface carbon dioxide dropped to zero as a result of photosynthetic activity. Concurrent with the photosynthetic activity and drop in carbon dioxide the surface waters became supersaturated with oxygen, the pH increased and carbonate alkalinity was present. These phenomena appear to show up sooner and last longer in the pollution enriched Crane Creek and Abbotts Creek arms (Table II).

TABLE II

SURFACE CHEMCAL DATA FOR THREE ARMS OF HIGH ROCK LAKE
MARCH–JULY, 1956

FLAT SWAMP

Date	O_2	CO_2	Alkalinity Pheno.	Alkalinity M. O.	pH	Temp.
3-13-56	7.9	1.5	0	18.5	7.0	. . .
3-27-56	8.1	2.2	0	16.0	7.2	51.7
4-10-56	10.0	2.4	0	14.6	7.2	61.0
4-25-56	8.4	2.6	0	17.3	. .	57.4
5- 9-56	7.8	2.4	0	17.0	7.2	68.2
5-24-56	7.4	3.4	0	21.4	7.4	72.5
6-12-56	12.1	0	5.2	28.4	8.8	81.6
6-26-56	7.9	0	1.6	28.9	8.0	88.9
7-10-56	7.0	3.0	0	34.2	7.3	83.0

CRANE CREEK

Date	O_2	CO_2	Alkalinity Pheno.	Alkalinity M. O.	pH	Temp.
3-13-56	9.1	1.8	0	53.9	7.6	. . .
3-27-56	5.3	5.3	0	40.7	7.0	51.6
4-10-56	9.6	4.0	0	35.9	7.5	59.0
4-25-56	8.1	2.9	0	21.1	7.4	57.3
5- 9-56	6.7	5.6	0	25.4	7.2	71.5
5-24-56	9.4	0	1.7	26.0	8.1	75.3
6-12-56	13.3	0	16.2	32.2	9.3	84.5
6-26-56	9.1	0	4.0	35.9	8.5	87.8
7-10-56	9.2	1.8	0	42.1	8.2	84.2

ABBOTTS CREEK

Date	O_2	CO_2	Alkalinity Pheno.	Alkalinity M. O.	pH	Temp.
3-13-56	5.8	5.1	0	48.0	7.2	46.0
3-27-56	7.7	6.8	0	27.5	7.3	49.7
4-10-56	9.4	7.4	0	35.4	8.0	59.0
4-25-56	8.8	2.6	0	26.1	7.4	55.6
5- 9-56	7.0	2.4	0	32.0	7.2	71.7
5-24-56	9.1	0	0.3	28.3	7.6	75.9
6-12-56	10.2	0	7.8	34.2	8.8	93.0
6-26-56	8.5	0	2.1	33.0	8.1	. . .
7-10-56	10.2	0	2.2	48.5	. .	83.8

METHODS

The chemical methods used are those outlined in the tenth edition of Standard Methods for the Examination of Water and Sewage. Beginning in May, 1956, vertical temperature series were collected in each arm with a Foxbore thermometer. For chemical and temperature determinations, one sampling station was selected in midstream of each arm, approximately one mile above the mouth.

In lake and reservoir sampling, rotenone and a wide variety of entrapment and entanglement devices are presently in use. Rotenone procedures seem to be fairly well standardized and may be comparable. However, because of the variety of entrapment and entanglement devices used, it is often impossible to compare results of published data from different organizations. In North Carolina an effort has been made to standardize the gear used for sampling lentic waters.

The value of a particular type of gear depends on the purpose for which the catch will be used. While the commercial fisherman is interested in selectively capturing a certain size range of one or a group of species, in most biological sampling the ultimate would be a gear which would sample all size ranges of all species indiscriminately, giving a true picture of the population composition. To my knowledge, such a gear has not been found. However, catch data for

inland waters are generally used for making comparisons on an annual or seasonal basis and for comparison between different bodies of water, and for this purpose any gear which will sample a wide variety of species should be satisfactory.

The nylon gill nets and trammel nets described in this paper are used for experimental studies in all North Carolina lakes and reservoirs and both give similar pictures of the species composition. The nylon trammel nets, however, are much more efficient and capture upwards of three times the number and double the weight of fish taken in the gill nets.

In a symposium on warm-water stream fish populations conducted at Iowa State College, Carlander (1957), the relative merits of analyzing catch data on the basis of catch per unit effort or percentage species composition was discussed.

The species taken in a particular type of gear will be ranked identically regardless of whether percentage species composition or catch per unit effort is used. Percentage composition has the advantage that netting data can be compared with information from rotenone and shocker samples which cannot be practically set up on a unit effort basis. Catch per unit effort gives a measure of the efficiency of the gear, the abundance of a given species in the habitat and provides data that is usable for statistical comparisons. Therefore, it would seem that both percentage composition and catch/unit effort are useful for an evaluation of population data as related to the habitat. In the present study the use of either measure alone would have resulted in entirely different conclusions.

All netting was with nylon trammel nets and nylon gill nets. The trammel nets are 120′ long by 6′ deep with one-inch bar inside mesh and eight-inch bar outside walls. The gill nets are 120′ long by 6′ deep divided into three continuous sections as follows: 30 feet, ¾-inch bar mesh; 45 feet, 1½-inch bar mesh; and 45 feet, 2½-inch bar mesh. All netting stations were selected during a period of low water and were on points relatively free of stumps and other debris. The nets were set vertical to the shoreline with the smaller mesh section of the gill nets next to shore.

Two coves in each arm were sampled with rotenone during the latter part of August of each year from 1955 through 1958.

The surface area of the cove to be sampled was measured by a modification of the method used to determine the area of a stream. Average width was determined by a number of successive measurements of width taken along the length of the cove. The number of these measurements depends on the conformity of the cove. The area was then determined from the actual measured length and a computed average width.

Emulsified five percent rotenone was applied with a Homelite pump using a perforated hose in deep water, after which the shoreline and shallow areas at the head of each cove were surface sprayed. The rotenone was applied at a rate of one gallon per surface acre, giving a concentration in excess of 0.5 p.p.m., in the relatively shallow coves sampled. These coves average less than six feet in depth with maximum depths of approximately fifteen feet. Before applying rotenone to the cove proper, a double screen of rotenone is applied across the mouth of the cove with the perforated hose. The rotenone used for this block is in addition to the amount applied to give the concentration mentioned above.

The pickup of fish is carried out with dip nets by a crew of from six to eight men. Fish are picked up on the day of sampling and on the following morning. At the water temperature occurring during the season when these samples are collected, all fish killed the first day are on the surface by the following morning.

All fish picked up the first day were sorted by species, grouped in inch classes and weighed to the nearest one-tenth pound on milk scales. Fish picked up the second day were counted and weighed but no measurements were collected. For very abundant species, on the second day's pickup, a sample of several hundred were weighed to determine average weight for use as a conversion factor.

COMPARISON OF ARMS

Netting:

During the period May 22, 1956, through June 29, 1956, nylon gill nets were set and checked each 24 hours in all three study areas. The means for the

combined net catches of the three arms were Abbotts Creek, 34.3 fish weighing 8.5 pounds per net day; Crane Creek, 50.4 fish weighing 22.5 pounds per net day; and Flat Swamp, 15.7 fish weighing 4.3 pounds per net day (Table III). These means were compared by analysis of variance and there was a significant difference, on the basis of both number and weight, ($F = 31.95$ for number, $F = 51.54$ for weight, and $F.01 - 4.85$).

TABLE III

MEAN NUMBER AND WEIGHT OF FISH CAPTURED IN EXPERIMENTAL GILL NETS FROM FLAT SWAMP, CRANE CREEK, AND ABBOTTS CREEK ARMS OF HIGH ROCK LAKE DURING THE PERIOD MAY 22, 1956–JUNE 29, 1956

Net 1:	*Abbotts Creek*	*Crane Creek*	*Flat Swamp*
Net Days	16	16	16
Total No.	565	776	220
Mean	35.3	48.5	13.8
Std. Dev.	14.4	19.2	17.3
Total Wt.	130.7	370.3	60.7
Mean	8.2	23.1	3.8
Std. Dev.	6.5	11.0	2.8
Net 2:			
Net Days	16	16	16
Total No.	533	838	281
Mean	33.3	52.4	17.6
Std. Dev.	15.4	16.8	20.6
Total Wt.	141.9	349.9	76.0
Mean	8.9	21.9	4.8
Std. Dev.	5.3	9.0	3.9
Combined Catch:			
Total No.	1,098	1,614	501
Mean	34.3	50.4	15.7
Total Wt.	272.6	720.2	136.7
Mean	8.5	22.5	4.3

The individual arms were further compared by Students "t" test and the catch in both Crane and Abbotts was significantly higher than in Flat Swamp.

The mean catches of nylon trammel nets set during July in both Crane and Abbotts Creek, were also significantly higher than in Flat Swamp (Table IV).

TABLE IV

MEAN NUMBER AND WEIGHT OF FISH CAPTURED IN NYLON TRAMMEL NETS FROM THREE ARMS OF HIGH ROCK LAKE DURING JULY, 1956

	Abbotts Creek	*Crane Creek*	*Flat Swamp*
Net Days	3	3	3
Total No.	1,140	570	186
Mean	380	190	62
Std. Dev.	273.2	46.1	21.9
Total Wt.	264.2	109.2	38.4
Mean	88.1	36.4	12.8
Std. Dev.	59.8	9.7	1.3

The species composition of the gill net catch in the various arms was surprisingly similar. Crappie (black and white), white perch and white catfish were most abundant numerically, while carp, quillback, crappie and white perch were dominant on a weight basis (Table V). Percentagewise, as compared with Flat Swamp, a larger proportion of the population in the polluted arm is

composed of carp and quillback while bluegill and crappie appear to make up a comparatively larger proportion of the population in Flat Swamp.

The net catches were arbitrarily divided into rough and game species and further compared. The net catches in the polluted arms contained significantly larger numbers and weights of both game and rough fish. Although there is evidently a larger population of game fish in the polluted arms, a comparison of the percentage composition of the net catches reveals that the proportion of game fish is greater in the non-polluted arm. The percentage of carp in particular is much higher in the two polluted arms (Table V).

TABLE V

CATCH OF EXPERIMENTAL GILL NETS IN HIGH ROCK LAKE FOR THE PERIOD MAY 15–JUNE 29, 1956

(Flat Swamp—43 Net Days, Crane Creek—47 Net Days, Abbotts Creek—44 Net Days)

	Flat Swamp				*Crane Creek*				*Abbotts Creek*			
Species	*Total No.*	*%*	*Total Wt.*	*%*	*Total No.*	*%*	*Total Wt.*	*%*	*Total No.*	*%*	*Total Wt.*	*%*
B. & W. Crappie	445	52.7	40.8	20.1	690	30.8	63.2	6.6	712	49.9	48.9	14.7
White Perch	233	27.6	30.9	15.3	963	43.0	147.0	15.4	398	27.7	52.6	15.8
W. Catfish	83	9.8	23.3	11.5	209	9.3	67.5	7.1	149	10.4	34.0	10.2
Carp	31	3.7	56.0	27.7	185	8.3	436.4	45.6	114	8.0	181.4	54.6
Quillback	26	3.1	44.6	22.0	109	4.9	230.7	24.1	5	0.3	9.8	2.9
Bluegill	10	1.2	1.0	0.5	9	0.4	1.6	0.2	9	0.6	0.7	0.2
Y. & B. Bullhead	5	0.6	0.5	0.2	–	–	–	–	4	0.3	0.6	0.2
Largemouth Bass	3	0.4	5.0	2.5	4	0.2	5.6	0.6	1	0.1	1.0	0.3
Yellow Perch	3	0.4	0.2	0.1	7	0.3	0.3	–	4	0.3	0.3	0.1
Pumpkinseed	2	0.2	0.1	–	3	0.1	0.1	–	3	0.2	0.1	–
Golden Shiner	2	0.2	0.1	–	57	2.5	3.2	0.3	29	2.0	1.5	0.5
Warmouth	1	0.1	tr.	–	2	0.1	–	–	1	0.1	tr.	–
Goldfish	–	–	–	–	–	–	–	–	1	0.1	1.5	0.5
Redhorse	–	–	–	–	1	–	1.4	–	–	–	–	–
TOTAL	844		202.5		2,239		957.1		1,430		332.4	

ROTENONE

Probably the most useful information provided by rotenone samples is a measure of the success of reproduction and survival of Centrarchidae. In late summer young-of-year largemouth bass appear to be distributed throughout the shallow littoral areas of a lake and rotenone sampling in coves appears to give an excellent picture of their relative abundance.

The differences in number of young-of-year largemouth bass collected in samples from different arms and in different years were compared by analysis of variance. As indicated by the rotenone samples, the reproduction and survival of largemouth bass in the non-polluted Flat Swamp arm was significantly greater in all but one year (Table VI). In the 1958 samples a few more young bass were collected in the Abbotts Creek arm. The 1958 sample probably does not present a true picture of the young bass killed in Flat Swamp Cove number two. Offshore winds carried most of the fish out of this cove and as a result the second day pickup was very low. The first day pickup of young bass in the 1958 sample for Flat Swamp was considerably higher than the first day pickup in Abbotts Creek and Crane Creek.

TABLE VI

YOUNG-OF-YEAR LARGEMOUTH BASS PER ACRE COLLECTED IN ROTENONE SAMPLES FROM VARIOUS ARMS OF HIGH ROCK LAKE OVER A FOUR-YEAR PERIOD

	Crane Creek				*Abbotts Creek*				*Flat Swamp*			
Year	*1955*	*1956*	*1957*	*1958*	*1955*	*1956*	*1957*	*1958*	*1955*	*1956*	*1957*	*1958*
Cove 1	19	823	46	20	38	323	56	42	273	1,520	145	51
Cove 2	31	1,202	90	37	23	375	56	48	102	1,145	107	29
Mean	25	1,012.5	68.0	28.5	30.5	349.0	56.0	45.0	187.5	1,332.5	126.0	40.0

For a period of several months (November-March) during the winter of 1955-1956, the water level in High Rock was twenty to thirty feet low. High Rock is a relatively shallow reservoir and during most of this time, the only impounded water was in the main river channel for a distance of approximately one mile upstream from the dam. The only water in the tributary arms was flowing in the old creek channels. Many fish perished in potholes which dried up and the reduced area created optimum conditions for predation. The available space over most of the reservoir area was similar to conditions existing prior to impoundment.

The reproduction and survival of largemouth bass following this severe and extended drawdown was much higher than has ever been recorded in rotenone cove samples from impounded reservoirs in North Carolina. The number of young bass was significantly higher in all three arms of High Rock Reservoir in 1956 as compared with the other years in which these coves were sampled ($F = 77.6$, $F.01 = 5.95$).

COMPARISON OF GEAR

For comparing the two types of gear and the rotenone samples, data for comparable periods of time in Abbotts Creek and Crane Creek were combined. The ranking of the various species on a percentage basis is almost identical in the two types of net. White perch, crappie, white catfish and carp, in that order, made up more than 90% of the catch in both types of gear (Table VII).

TABLE VII

PERCENTAGE COMPOSITION OF SPECIES IN FOUR ROTENONE SAMPLES TOTALLING *1.8* ACRES COLLECTED IN JULY, 1956 AND CATCH IN EXPERIMENTAL GILL NETS AND TRAMMEL NETS FOR THE PERIOD 3/22/56 THROUGH 11/9/56

	Total Number			*% of Total No.*			*Total Weight*			*% of Total Wt.*		
Species	*Gill*	*Trammel*	*Rotenone*	*Gill*	*Trammel*	*Rotenone*	*Gill*	*Trammel*	*Rotenone*	*Gill*	*Trammel*	*Rotenone*
White Perch	1,487	3,224	5,505	36.5	53.6	37.9	217.8	492.2	95.8	14.9	35.5	18.7
Crappie	1,448	1,385	3,069	35.7	23.0	21.0	119.8	163.7	85.0	8.2	11.8	16.6
White Catfish	422	701	1,635	10.4	11.6	11.3	138.3	197.6	154.6	9.5	14.2	30.3
Carp	360	453	767	8.8	7.5	5.3	588.8	238.5	77.3	40.2	17.2	15.1
Quillback	171	88	. . .	4.2	1.5	. .	368.6	195.9	. .	25.2	14.1	. .
Bluegill	18	51	665	0.4	0.8	4.6	2.3	5.6	33.8	0.2	0.4	6.6
Golden Shiner	126	44	1,044	3.1	0.7	7.2	7.0	4.2	32.6	0.5	0.3	6.4
B. & Y. Bullhead	5	33	. . .	0.1	0.5	. .	0.9	7.8	. .	0.1	0.6	. .
Largemouth Bass	7	24	1,316	0.2	0.4	9.1	12.0	69.3	23.4	0.8	5.0	4.6
Redhorse	2	5	. . .	. .	0.1	. .	2.7	3.2	. .	0.2	0.2	. .
Pumpkinseed	6	3	. . .	0.1	. .	. .	0.2	0.2	. .	. .	. .	. .
Warmouth	3	2	. . .	0.1	. .	. .	0.1	0.3	. .	. .	. .	. .
Yellow Perch	13	2	519	0.3	. .	3.6	0.6	0.2	8.1	. .	. .	1.6
Bowfin	. .	2	. . .	. .	. .	. .	. .	8.0	. .	. .	0.6	. .
Gar	. .	1	. . .	. .	. .	. .	. .	1.6	. .	. .	0.1	. .
Chubsucker	. .	. .	2	. .	. .	. .	. .	. .	0.5	. .	. .	0.1

On a weight basis, the percentage composition was similar to that on the basis of numbers. The major difference was the dominance of white perch in the trammel nets. This species is gilled very effectively in the one-inch mesh of the trammel nets and in the gill nets they are only taken in the ¾-inch mesh sections. The difference in catch is undoubtedly attributable to the 120 feet length of effective trammel net used, while only 30 feet of the gill nets had mesh which would effectively capture white perch.

The main differences in the size of fish taken in the two nets were the much larger carp taken in gill nets while the trammel nets caught larger bass. Individual weights of carp were not recorded so there is no way of testing the significance of this difference. However, the magnitude of the difference, combined with the numbers taken in the samples would indicate that the gill nets were more effective in capturing large carp. The difference in mean weight of largemouth bass was not significant.

The catch per net day was considerably higher both numerically and gravimetrically in the trammel nets. With the exception of golden shiners, the trammel net was much more efficient in taking all species of fish captured in the two types of gear (Table VIII).

The species composition of the net catches and rotenone samples are very similar. Four species—gar, bowfin, redhorse, and quillback—taken by net, were not picked up in the rotenone samples. Largemouth bass comprise 9.1% of the number of fish taken in the rotenone sample while they only make up 0.4 and 0.2 percent of the net catch. Most of the bass picked up in the rotenone samples are young-of-year fish which are not captured with the mesh sizes of the nets used.

TABLE VIII

CATCH PER UNIT EFFORT * DURING THE PERIOD 3/22/56 THROUGH 11/9/56 (56 NET DAYS) FOR TRAMMEL NETS AND PERIOD 5/3/56 THROUGH 11/9/56 (118 NET DAYS) FOR GILL NETS

	No. Per Net Day		*Average Weight*	
Species	*Gill*	*Trammel*	*Gill*	*Trammel*
White Perch	12.6	57.6	0.15	0.15
Crappie	12.3	24.7	0.08	0.12
White Catfish	3.6	12.5	0.33	0.28
Carp	3.1	8.1	1.64	0.53
Quillback	1.4	1.6	2.16	2.23
Bluegill	0.2	0.9	0.13	0.11
Golden Shiner	1.1	0.8	0.06	0.09
Bullhead	t	0.6	0.18	0.24
Largemouth Bass	0.1	0.4	1.71	2.89
TOTAL NUMBER	34.4	107.2	. . .	. . .
TOTAL WT. PER NET DAY	12.3	24.6	. . .	. . .

* Species having a catch of less than 0.1 fish per net day are not included in the Table.

DISCUSSION

Two major arms of High Rock Lake, Crane Creek and Abbotts Creek, receiving sewage and industrial wastes having combined population equivalents (P.E.) in terms of BOD of 20,910 and 24,560 respectively, were compared with the non-polluted Flat Swamp Arm.

The primary physical and chemical differences noted were the consistently higher turbidity of the polluted arms and the more prolonged and drastic reduction in oxygen near the bottom. Photosynthetic activity at the surface, as denoted by reduction in carbon dioxide, increase in pH and appearance of carbonate alkalinity, began earlier and occurred for a longer period of time in the polluted arms.

If catch per unit effort is considered as a measure of population size, the total population is significantly higher in the two polluted arms of the reservoir as compared with the non-polluted arm. When the net catches were arbitrarily divided into coarse and game species, it was found that the population of both groups was higher in the polluted arms. However, on a percentage composition basis the non-polluted Flat Swamp Arm has a balance in favor of game species. The percentage of carp in particular is much higher in the two polluted arms. If pollution is actually the major contributing factor to the population differences shown by the data, then the pollution appears to have a beneficial effect

on both game and coarse species but the coarse species are able to utilize the polluted habitat to greater advantage than are the game fish.

Data from rotenone samples indicate that reproduction and survival, through late summer, of the largemouth bass was definitely greater in the non-polluted arm. Although it cannot be proven with the present data, I feel that it is reasonable to assume that the better survival is the result of differences in population pressures of the various areas studied.

These data point out the necessity for using a great deal of care in the selection of sampling stations in larger bodies of water, particularly impounded reservoirs with a number of sizeable inflowing streams that may be subject to varying degrees of pollution, and whose watershed characteristics are dissimilar.

The use of properly timed drawdowns as a means of manipulating fish populations has received increasing attention in recent years. However, there is very little factual data to demonstrate the effects of drawdown, particularly in large, impounded reservoirs. Drawdowns have been mentioned as a possible means of controlling rough fish in TVA waters by Eschmeyer, Stroud and Jones, 1944. The state of Arkansas has, in recent years, utilized fall and winter drawdowns combined with intensive commercial fishing to reduce coarse fish. Hulsey (1957) presented information indicating that a drawdown and intensive harvest of coarse fish may have had a beneficial effect on the game fish population in Nimrod Lake, Arkansas. Bennett (1954a) presents evidence, for a small 17-acre lake, that a fall and winter drawdown drastically reduced the numbers of small fish and stimulated the spawning of bass the following spring. Dr. Bennett presents an excellent discussion of the probable effect of a drawdown on a population comprised mainly of bass and bluegill.

Severe and prolonged drawdowns obviously upset the predator-prey relationship in a body of water and any differential would appear to be in favor of the larger predator species. The prey species are confined in a smaller area and are more vulnerable to predation and in addition the food supply of bottom and plankton feeders is reduced in relation to the decrease in bottom area and volume of water.

Upon restoration of water levels the reduced population pressure would be expected to result in very high levels of reproduction and survival of all species. In particular, a high level of largemouth bass reproduction and survival would be expected because of this species' demonstrated ability to produce large numbers of young under conditions of reduced population pressure (Bennett, 1954b).

In the present study it was definitely demonstrated that a severe drawdown of an impounded reservoir for a period of five months during the fall and winter months was followed by unusually successful reproduction and survival of largemouth bass.

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