SEGMENT REPORT

State of TEXAS

Project No. F7R4 Name: Fisheries Investigations and Surveys of the Waters of Region 1-B.

Job No. B-9 Title: Inventory of Fish Species Present in Buffalo Lake (Continued from F-7-R-3.

Period Covered: June 1, 1956 through May 31, 1957

ABSTRACT:

An estimated minimum of 200 tons of fish, mostly gizzard shad and carp, has been removed from Buffalo Lake by experimental selective-kill and spot treatments, seining and gill netting, since May 1956. Details of the treatments and a discussion of factors involved are given.

Inventory has been taken by gill net and seine collections before and after treatments in order to compile comparative data which may indicate possible effects of treatments. A total of 2,108 fishes was collected by gill nets from which data concerning food habits, sexual development, spawning success, coefficient of condition and pathological conditions was recorded, and as far as possible, reduced to tabular form.

OBJECTIVES:

To determine the fish species present and their relative abundance, as well as to determine the ecological factors influencing their distribution. To discover both the immediate and progressive changes which may occur in the fish population as the result of experimental selective-kill treatments under Job E-1.

ACKNOWLEDGMENTS:

Dr. Walter Dalquest, whose employment with the Texas Game and Fish Commission terminated in October 1956, conducted laboratory work and compiled field collected data for the job during the first five months. He has also checked the manuscript of this report. Dr. Carl Gray, Soils Scientist of Midwestern University and Wichita County Water Improvement Districts, made all of the chemical water analyses during the study.

TECHNIQUES:

The work on this job started during the preceding segment period (June 1955 through May 1956) and continued through the present segment period. An attempt was made to continue monthly collections so that data comparable to the preceding segment could be obtained. However, high winds, frozen surface water and other conditions beyond our control prevented collections during the months of July, September and November 1956, and February and March 1957. Approximately 1200 feet of gill net, ranging in size from 1 inch to 3 inch (square mesh) were set on each visit. Each fish taken in these nets was measured, weighed, and the stage of gonadal development recorded. In addition, filled stomachs of predacious species were saved in formalin, as well as ripe ovaries, pathological tissues and parasites. Samples of forage fishes were obtained with the use of small-mesh seines, and the complete collections preserved in formalin. In the laboratory, formalin-preserved materials were identified, examined and the data recorded.

In addition to collections made with gill nets and minnow seines, supplemental data was obtained by the use of a 1200 foot drag seine. Although the use of this seine was limited by stumps, rocks, trotline stakes and other obstructions, it produced some interesting results and removed large quantities of undesirable fish.

Physical data, including air temperature, water-surface temperature and turbidity were recorded at the lake. Samples of lake water were saved and the pH and dissolved solids present were determined. Ecological data pertaining to the lake were obtained in the usual ways and detailed notes were taken.

Data obtained during the last segment (F-7-R-3) is recorded in two separate reports. An Inventory of the Species Present in Buffalo Lake is reported as Job B-9, and Laboratory and Statistical Analyses of Materials and Data Collected in the Field is reported as Job B-4. For the sake of convenience and simplicity, however, all the data obtained from Buffalo Lake during this segment (F-7-R-4) is included in this report. Information reported in this manner should make it much easier to detect any possible results of experimental treatments under Job E-1, as well as to permit the interpretation of the value of such treatments.

FISH COLLECTIONS:

A total of 2,108 fishes was collected by gill nets from Buffalo Lake during the segment period (Segment 4) from June 1, 1956 to May 31, 1957. Percentage composition, sex ratios and average weights by sex of fishes collected by gill nets for Segment 4 are given in Table 2. Identical type information for the preceding segment (June 1, 1955 to May 31, 1956) is given in Table 1 for comparison. Percentage composition by weight and mean weights of fishes collected by gill nets during 1955-1956 and 1956-1957 is given in Tables 3 and 4 respectively.

The total number of forage fishes taken from Buffalo Lake during the present segment with small mesh minnow seines is given in Table 5. The total number of fishes taken during both segment periods is given in Table 6. Not included in Table 6 is the number of fishes taken by the 1200 foot nylon drag seine.

EXPERIMENTAL SELECTIVE-KILL TREATMENTS:

Following 11 months of inventory and study, Buffalo Lake was treated in May 1956, for an experimental selective-kill of gizzard shad and, incidentally, carp and goldfish. Details of this treatment and the immediate results is given in the report for Job E-1, F-7-R-3. A concentration of .35 pounds of 5% rotenone to the acre-foot of water (.13 p.p.m.) was distributed when the temperature of the lake was 18°C (65.4°F). The shoreline count which was made on the third day following treatment estimated the total fish killed as follows:

Total weight of European carp killed,	63,365 lbs.	31 tons
Total weight of gizzard shad killed,	67,920 lbs.	34 tons
Total weight of carp and shad killed,	131,285 lbs.	65.5 tons
Percent of fish killed, other than carp and shad.		2.2 percent
Percent of game fish killed.		1.8 percent

The above estimate is highly conservative because it does not include fishes removed by spectators and bait dealers on the first two days, or the large numbers of fishes that floated in to shore after the shoreline count was made. The count was made on the third day, and fish (mostly shad) were still drifting in when the fisheries crew left the lake, a week later. The concessionaire, who was in charge of the crew that finished the cleanup, estimated that a minimum of 100 tons of fishes were killed in the treatment.

On April 23, 1957, Buffalo Lake was treated again for a selective-kill on shad. Rotenone powder (5%) was used at a concentration of .3 lbs/acre foot (.1 p.p.m.), when the lake temperature was 56°F. Excellent selectivity on shad resulted. The number of carp killed was considerably less than during the past treatment, but there was a great reduction in the number of game fishes killed also. Within an hour following treatment, large numbers of shad began to work the surface in a moribund condition. After death, most of the shad (and some of the carp) sank to the bottom where they apparently decomposed without rising to the surface. Since most of the fish that were killed by the treatment did not float before the fisheries crew left the lake, a total kill estimate was not possible.

EXPERIMENTAL SPOT TREATMENTS

On June 8, 1957,* a concentration of spawning carp and goldfish was located at the upper end of Buffalo Lake. This spawning activity was stimulated by recent rains which caused the lake to rise over terrestrial weeds that had grown in the dry lake bottom. Both carp and goldfish utilized this green vegetation for spawning, but they seemed to prefer dry tumbleweeds that had blown into the spawning area from surrounding fields. Although it was not noticed until after treatment, there were almost as many shad in the spawning area as carp and goldfish.

Rotenone was distributed at a concentration of approximately 1½ lb./acre foot of water in the spawning area only. Since most of the water was too shallow to float a loaded boat, rotenone was broadcast by hand. The spawning fish paid no attention to workers distributing the toxicant. After the workers passed over an area, spawning activities ceased immediately, and all fish except shad remained calm from 10 to 15 minutes before surfacing and gasping for air. Shad surfaced and died immediately whereas carp and goldfish continued to die for about 4 hours.

The area was checked early the following morning. Complete kills were apparently affected on the very active parent fishes, as well as fry from earlier spawns, and eggs that were in advance stages of development. Microscopic examination of freshly spawned eggs revealed that they were not affected by the treatment, however, and the rotenone either dissipated very rapidly, or was removed to the lake proper by wind currents before the eggs developed to the stage at which rotenone would be toxic. The feasibility of re-treating the area 2 days after the first treatment was being considered in an

* This work was done shortly after the termination date for the segment covered by this report. It is discussed here, however, so that this information can be considered, and perhaps utilized, by fisheries workers one year sooner than if discussion was postponed until termination of next segment.

attempt to kill all of the eggs and fry, when another large concentration of carp and goldfish began moving back into the treated area for spawning. The next morning, the area was congested with carp and goldfish, very actively engaged in spawning amongst the bloated and stinking corpses of the thousands of fishes that had been killed during the first treatment, and had not been blown to the banks or completely out of the spawning location. The area was treated again at the same concentration so that the parent fishes would be killed before they deposited too many fresh eggs that would not be affected by the rotenone, and to kill fry and eggs in advance stages of development from the past spawn.

An attempt was made the following morning to make a total-kill estimate. Shifting winds had formed windrows of dead fish along the banks and small islands. The thickly weeded areas were so congested with dead fish that many of them could not find room to surface. Many had been blown out of the area and formed windrows along the southeast shoreline for a mile or so. None of the eggs from the previous spawn were found to be alive. No fry were found by seining with small mesh nylon seine. It was quickly apparent that spot treating large concentrations of spawning fish could possibly be the most effective, economical, and certainly the most selective method of controlling carp and goldfish in Buffalo Lake. Condensed information concerning this treatment and the estimated total-kill by shoreline count is given as follows:

Number of treatments - 2
Amount of rotenone used per treatment - 160 lbs.
Total cost of rotenone used - $112.00
Surface area treated - approximately 104 acres.
Shoreline considered for total-kill estimate - 10,000 feet.

Species	Number	Total Pounds	Tons
Carp	22,000	28,600	14.3
Goldfish	4,200	5,040	2.5
Shad	20,800	12,480	6.2
Channel cat	700		
Black bass	200		
Total	57,900	46,120	23.0

Practically all the bass and channel catfish were fingerlings or young of the year fish. Very few were yearlings. Evidence of heavy feeding was obvious in all catfish. Examination of their stomachs disclosed they were gorged with eggs, probably those of carp and goldfish, which explained their presence in the warm, muddy spawning waters. Since gonads of the shad that were killed were in variable stages of development, it is doubtful that they were in the spawning area for the purpose of spawning. They, too, may have been feeding on carp and goldfish eggs.

Immediately following the first spot treatment in the spawning area, observations were made in the Tierra Blanca Creek above Buffalo Lake. At this time, the creek was almost back to its normal stream-flow level following the recent rise. Rocks along the creek banks were coated with millions of dried fish eggs, presumably eggs of shad which were spawned during the rise and stranded as flood water receded. Since a great number of goldfish was observed in the creek, apparently spawning, the creek was rotenoned for about 3/4 mile above the lake. In addition to the spawning goldfish, numerous shad (mostly ripe males), minnows and small channel catfish were killed. All stomachs of channel catfish were filled with fish eggs, apparently those of goldfish. Since the relative abundance of rough fish species to channel catfish and minnows was not great enough to justify further treatment, the remainder of the creek was left unmolested.

FINDINGS:

WATER QUALITY

Table 7 gives the chemical nature of water at Buffalo Lake from June 1955 to May 1957. Other than a slight increase in total hardness, there are no significant changes in water quality.

PHYSICAL CHARACTERISTICS

Physical conditions of Buffalo Lake water, when fish samples were taken, are given in Table 8. All of the turbidity recordings in this table are not accepted as valid data because they do not indicate the increase in water clarity that has been obvious after fish kills. Decrease in turbidity has been the most noticeable immediate effect of fish kills at Buffalo Lake. Sport fishermen report catches of black bass on artificial lures, which was not done before the water cleared. Errors in turbidity are explained by the fact that turbidities were measured with a secchi disk which may vary according to the amount of sunlight at the time of reading, and difference in vision of persons taking the reading. Therefore, this method of determining turbidity has been discontinued. In the future, all turbidities will be taken by the same person, using a standardized candle in the Jackson turbidemeter.

FOOD HABITS

Food remains were found in stomachs of 15 specimens, 11 of which were channel catfish. Table 9 presents results of analyses made on food remains found in stomachs of channel catfish. Conspicious by their absence in catfish stomachs this segment are remains of shad. They could have been present, however, because unidentifiable fish remains were found on numerous occasions. Since all predacious species are presumed to eat other fishes, stomach contents were not recorded unless identification was reasonably certain.

Only one flathead catfish was found to have food in its stomach. It contained two sunfishes about 2½ inches long.

The only crappie collected with identifiable food remains contained a shad, four inches long.

One large black bass contained a 4½ inch shad.

SEXUAL DEVELOPMENT AND SPAWNING SUCCESS

Larger fishes were opened in the field and their gonads examined and the stage of development recorded. If the gonads were of medium-size or smaller, and were poorly developed, they were recorded as "immature." If they were large and well-developed, obviously approaching spawning condition, they were termed "ripe". In those few instances where a fish was captured shortly after spawning, it was called "spent". The latter condition is difficult to determine in males, but easier in females.

Immature individuals of the larger fishes were taken in seine drags and measured and counted. In addition, notes were made of schools of fry seen, young fishes found in the stomachs of predacious fishes, etc.

When ovaries contained large eggs, nearly ready to be spawned, the two ovaries of such a fish were carefully removed, labeled and preserved in formalin. In the laboratory, the ovaries were carefully cleaned of excess tissues and weighed to the nearest one-tenth of a gram. Then a small quantity, roughly a gram, was snipped from one ovary and weighed on a chemical balance to the nearest one-one hundredth of a gram. The eggs in the small portion were then counted. An average of 3 counts was determined and the total number of eggs present in the two ovaries estimated (number of eggs counted times weight of both ovaries divided by the weight of the small section). Table 10 gives the total number of eggs found in ovaries of 13 ripe females.

Dorosoma cepedianum (Gizzard shad)

Ripe shad were found in mid-April, but the major spawning season for shad in Buffalo Lake is late May through June. Young of the year were common in July and became abundant in August. Off-season spawns of shad are quite successful.

Both experimental selective-kills at Buffalo Lake greatly reduced the shad population. This reduction is quite apparent in seine collections following the kills, and to a lesser extent in gill net collections (See Table 14). However, shad have the ability to replenish themselves with amazing rapidity.

Carpiodes carpio (river carpsucker)

Very little information on the spawning of carpsucker was found this segment. Ripe males and females were taken from April to September, but none of the gonads of the 82 specimens taken were in a spent condition. No young-of-the-year were taken in seine samples. Carpsucker are not numerous and do not constitute a problem in Buffalo Lake. The few that are present are in excellent condition with "K" factors up to 4. Efforts will be made in the future to determine reasons for the scarcity of this species. This information may be useful in setting up biological controls in other lakes where they are abundant.

Cyprinus carpio (carp)

Most female carp became ripe in April, but deferred spawning until late May and June. A few ripe females were taken in December, and ripe males were taken in collections every month except January.

Carassius auratus (goldfish)

Gonadal conditions of goldfish are quite similar to those of carp. Overlap of spawning seasons, lack of vegetation on which to spawn, low water levels and scarcity of spawning areas, all of which force carp and goldfish to use the same spawning areas, are responsible for the great number of carp-goldfish crosses in Buffalo Lake.

<u>Carassius</u> X <u>Cyprinus</u>
(carp-goldfish hybred)

Apparently, very few of these generic crosses reproduce successfully. Only two of the 58 males, and two of the 16 females taken during this segment were ripe.

<u>Ictalurus punctatus</u>
(channel catfish)

Spawning started in May, but the main spawn of this species occurs in June and continues throughout the summer.

<u>Ictalurus melas</u>
(black bullhead catfish)

Spawning apparently starts in June and continues throughout the summer.

<u>Pylodictus olivaris</u>
(flathead catfish)

Two of the three females taken in June were ripe. The other one was spent.

<u>Roccus chrysops</u>
(white bass)

No white bass were taken. Fishermen report catching this introduced species occasionally, however, there were no indications of reproduction during this segment.

<u>Micropterus salmoides</u>
(black bass)

Female bass were ripe in May, but most of the spawning occurred in June.

<u>Pomoxis annularis</u>
(white crappie)

Most females taken in May are ripe. The major spawn occurs in June.

COEFFICIENT OF CONDITION

"K" factors were worked out for all of the larger fishes taken in gill nets. Distribution of "K" factors for fishes in Buffalo Lake is given in Table 11. All of the fishes taken are not listed in Table 11 because immature animals less than 50 mm. were rejected, and a few were recorded erroneously, resulting in ridiculous "K" factors.

Interesting to note is the general increase in the distribution of "K" factors for nearly all species during the segment ending in 1957, as compared to the one ending in 1956. Also interesting is the agreement between the increase in "K" factors shown in Table 11 and the increase in average weights of species shown in Tables 1, 2, 3, and 4.

An attempt was made to use monthly variations of "K" factor distribution as an indication of any possible effects of selective-kill treatments. This information was worked out for shad only and is presented in Tables 12 and 13. According to information presented in this manner, "K" factors for shad follow a general pattern over a period of a year - increasing during the summer and decreasing during the winter. Apparent also, is that the greatest average "K" factors for the segment preceding the selective-kill treatment are lower than the lowest average "K" factors for the segment following treatment. Immediately, one would conclude that the obvious explanation for this increase is the great reduction in numbers of shad, thereby providing additional space and food, and improving habitat for those that remain.

In search for other explanations for increases in average "K", Table 14 was made to show monthly average lengths and average weights of shad for a 12 month period before and after the first treatment. According to Table 14, the first treatment killed a great portion of larger and older shad, thereby decreasing the average weight and length of both sexes (compare June 1955 to June 1956). Since the treatment was made prior to any major spawn, these figures are not affected by young-of-the-year fish. Interesting to note, however, is that the average shad in April 1957 (11 months after treatment), is considerably larger and heavier than those in April 1956. Apparently, more male shad were killed than females because 24.2% of the collection after treatment were males as compared to 44.6% males before.

PATHOLOGICAL CONDITIONS

All fishes taken during the study were examined for evidence of disease, parasites, or other abnormalities.

The fungus, Saprolegnea parasitica, was present on only a few minnows. In all instances, the infected fishes had escaped from a hook or had otherwise been injured.

Five crappie were found to be infected with the hard, encrusted "tail rot" fungus. Encrustation on one was so large that only the infected portion of the body was caught in the gill net. Infected areas were found on all fins - not restricted to the caudal fin.

Gonads of several goldfish were greatly enlarged and filled with water. It appeared to be an enormous hydrocele which gave the entire fish a round appearance. This condition greatly increased the "K" factor in the infected fish.

Blindness in large shad was common, but it had no apparent effect on their health. Eyes and part of the head of infected fishes were covered with what appeared to be ossified mucous.

DISCUSSION

Since the theory and practice of "selective-killing" is still in its infancy, much work is necessary before it can be accepted as a desirable tool in fisheries management. Great caution must be exercised before attempting to erradicate any particular species of fish from a body of water, even if it were possible. Therefore, the purpose of the work discussed in this report is to attempt to effect selective-kills on undesirable species as a control measure only, and to collect continuous data from which to determine the final effects of the treatments.

The weight of fishes removed from Buffalo Lake, mostly shad and carp, since May 1955, is very conservatively estimated at 200 tons. This figure includes all fishes removed by selective-kill treatments, spot-treatments during spawning periods, seining and gill netting. This report presents data which represents results of this fish removal based on 11 months of inventory prior to the first treatment and 12 months of inventory following the first treatment. Since approximately one-half the total kill estimate has been removed since April 1957 (one month prior to termination date of this segment), final results of this work cannot be expected to appear in data of this report. However, inventory has been approved for continuation into the next project year. The next report on this work will present data from three consecutive segments and should indicate significant effects of the treatments - if they exist.

SELECTIVE-KILL TREATMENTS

Results of selective-kill treatments at Buffalo Lake do not compare with similar treatments in the laboratory. Complete shad kills have been obtained under laboratory conditions without effecting game fish. This has not been accomplished at Buffalo Lake - nor was it expected.

Although results of both selective-kill treatments are gratifying, several factors may be responsible for not achieving even greater success. Certainly, there were errors in water measurements. Water volume of Buffalo Lake was estimated from a height gage reading and capacity curve charts which were made from pre-impoundment survey maps. A reasonable figure was subtracted from the capacity shown on the chart to allow for siltation. Although there may have been errors in water measurements, they were insignificant and are not considered as very great influencing factors in the Buffalo Lake treatment.

Lack of depth penetration, thereby permitting many shad in deeper parts of the lake to avoid contact with rotenone is suspected. The wide dispersal patterns of the treating barge, necessitated by high velocity winds during both treatments, caused excessive concentration of toxicant in some areas and perhaps none in others. If the wind, waves and water currents failed to dilute and spread the rotenone as hoped, many surviving shad failed to come into contact with the toxicant, and the small percentage of game fishes killed may have resulted from being directly in the path of the barge and, hence in areas of higher concentration. Since the rotenone may dissipate before coming in contact with some of the shad, perhaps two treatments with a smaller concentration, and at least 24 hours apart, would be more effective than only one treatment with the original concentration. There is little doubt that reducing the concentration and sustaining the toxicity for an additional 24 hours during the first treatment would have been far more effective, and perhaps eliminated the necessity of the second treatment eleven months later.

Yet to be decided is the proper season and water temperature for treating in order to obtain optimum selectivity. Since young-of-the-year fishes are most susceptible to the effects of rotenone, treatment after spawning season will destroy countless numbers of young shad. But, young-of-the-year game fishes will also be killed - especially channel catfish and white bass. Experiments in the lab and on small ponds have proven that greater selectivity on shad (and drum) is obtained with rotenone treatments at temperatures between 55°F and 60°F. Treatment in the early spring, as water temperatures are rising to 60°F may kill ripe shad before the opportunity to spawn is permitted, whereas, treatment in the fall, as temperatures drop below 60°F, may kill off both young-of-the-year as well as the parent fishes. According to "K" factor data (see Tables 12 and 13), shad are in poorer condition during winter months than any other time, and possibly, more susceptible to effects of rotenone; whereas, treatment following the summer months would find shad in their peak of condition.

As previously stated, much work and study must be done before "selective-killing" can be proven and accepted as a desirable tool in fisheries management. Only until the uncertainties and problems mentioned above, and many others, are solved and proven to workable conclusions, can this method be safely and wisely used.

Admittedly, the statement concerning shad feeding on carp eggs is far-fetched and contrary to all available food habit studies on shad. However, non-spawning shad have been found in carp spawning areas in lakes other than Buffalo Lake, and their presence has not been explained. Tables 1 and 2 show that carp increased from 11.1 percent of the total collection before the first treatment, which occurred before the major carp spawn, to 20.3 percent of the collection following. This great increase is not shown for the other species of fish. Therefore, ridiculous as the idea may seem, efforts to conform or deny it should be made. Until this question is answered, all efforts to control shad should be accompanied by equal efforts to control carp. Otherwise, one of the natural biological controls on carp may be removed, and carp may become a greater problem than the carp and shad combination.

Buffalo Lake is an ideal body of water for experimental control of undesirable species. There are no lakes on the tributary streams and watershed which may recontaminate the treated lake by overflowing during floods. Therefore, continuous inventory and study should indicate results of any experimental work that may alter the fish population. Authorization has been approved to continue this work until at least May 31, 1958.

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Approved by: Marion Toole
Chief Aquatic Biologist

Date: September 23, 1957

Table 1. Percentage Composition, Sex Ratios and Average Weights by Sex of Fishes Collected by Gill Nets from Buffalo Lake, 1955 - 1956.

Species	Number Taken	% of Total	% Males	Avg. Male Weight	% Females	Avg. Female Weight
Dorosoma cepedianum	1369	40.9	44.6	.49	55.4	.73
Carpiodes carpio	52	1.6	59.6	2.10	40.4	3.70
Cyprinus carpio	371	11.1	51.8	1.32	48.2	1.45
Carassius auratus	22	.7	50.0	.64	50.0	1.15
Carassius-Cyprinus Cross	26	.8	65.4	.35	34.6	1.05
Ictalurus punctatus	140	4.2	48.6	.62	51.4	.97
Ictalurus melas	13	.4	38.5	.62	61.5	.39
Pylodictus olivaris	10	.3	20.0	2.10	80.0	7.65
Roccus chrysops	16	.5	31.3	.54	68.7	1.15
Micropterus salmoides	74	2.2	36.5	1.93	63.5	2.57
Pomoxis annularis	1252	37.4	49.8	.22	50.2	.21
Total	3345	100.1				

Table 2. Percentage Composition, Sex Ratios and Average Weights by Sex of Fish Collected by Gill Nets from Buffalo Lake, 1956 - 1957.

Species	Number Taken	% of Total	% Males	Avg. Male Weight	% Females	Avg. Female Weight
Dorosoma cepedianum	844	40.0	24.2	.56	75.8	.74
Carpiodes carpio	82	3.9	57.3	3.1	42.7	2.77
Cyprinus carpio	428	20.3	61.9	1.38	38.1	1.70
Carassius auratus	26	1.2	57.7	1.00	42.3	1.67
Carassius-Cyprinus Cross	58	2.8	72.4	.58	27.6	1.36
Ictalurus punctatus	98	4.7	39.8	1.0	60.2	1.10
Ictalurus melas	5	.2	40.0	.21	60.0	.21
Pylodictus olivaris	4	.2	0	0	100.0	6.25
Roccus chrysops	0	0	0	0	0	0
Micropterus salmoides	41	1.9	24.4	2.5	75.6	3.82
Pomoxis annularis	522	24.8	41.6	.2	58.4	.17
Total	2108	100.0				

Table 3. Percentage Composition by Weight and Mean Weights of Fishes Collected by Gill Nets from Buffalo Lake, 1955 - 1956.

Species	Weight Taken	% of Total Weight	Mean Weight
Dorosoma cepedianum	829.7 lbs.	39.0%	.6 lbs.
Carpiodes carpio	146.0	6.9	2.8
Cyprinus carpio	474.3	22.3	1.3
Carassius auratus	19.7	.9	.9
Carassius-Cyprinus Cross	14.3	.7	.6
Ictalurus punctatus	112.8	5.3	.8
Ictalurus melas	6.2	.3	.5
Pylodictus olivaris	62.8	2.9	6.3
Roccus chrysops	15.3	.7	1.0
Micropterus salmoides	174.3	8.2	2.4
Pomoxis annularis	274.3	12.9	.2
Total	2129.7 lbs.	100.1%	

Note: Not included in the above table are the following fishes taken in seine hauls and counted but not measured or weighed: 72 *Dorosoma*, 4 *Carpiodes*, 9 *Cyprinus*, 1 *Carassius-Cyprinus Cross*, 2 *Ictalurus punctatus*, 4 *Micropterus*, 8 *Pomoxis*, 1 *Carassius auratus*.

Table 4. Percentage Composition by Weight and Mean Weights of Fishes Collected by Gill Nets from Buffalo Lake, 1956 - 1957.

Species	Weight Taken	% of Total Weight	Mean Weight
Dorosoma cepedianum	589.0 lbs.	30.6%	.69 lbs.
Carpiodes carpio	242.5	12.6	2.96
Cyprinus carpio	642.1	33.4	1.50
Carassius auratus	34.1	1.8	1.31
Carassius-Cyprinus Cross	46.1	2.4	.79
Ictalurus punctatus	105.6	5.5	1.07
Ictalurus melas	1.1	.1	.21
Pylodictus olivaris	25.2	1.3	6.25
Roccus chrysops	0	0	-
Micropterus salmoides	143.6	7.5	3.50
Pomoxis annularis	93.3	4.8	1.78
Total	1922.6 lbs.	100.0%	

Table 5. Total Number of Forage Fish Taken from Buffalo Lake, 1956 - 1957.

Species	Total
Dorosoma	10
Cyprinus	3
Carassius-Cyprinus Cross	1
N. percobromus	2
N. bairdi	5
N. girardi	3
N. lutrensis	689
Hybognathus	203
P. vigilax	4
P. promelas	147
Ictalurus punctatus	1
Fundulus	16
Gambusia	4
Micropterus	32
L. macrochirus	12
L. humilis	107
L. auritus	4
L. megalotis	2
Pomoxis	5
L. humilis & *L. megalotis cross*	1
Total	1251

Table 6. Total Number of Fishes Taken from Buffalo Lake.

Species	Number Taken 1955-1956	Number Taken 1956-1957
Dorosoma cepedianum	1441	854
Carpiodes carpio	56	82
Cyprinus carpio	380	431
Carassius auratus	23	26
Carassius-Cyprinus Cross	27	59
N. percobromus	0	2
N. bairdi	0	5
N. girardi	0	3
N. lutrensis	2233	689
Hybognathus	14	203
P. vigilax	0	4
P. promelas	342	147
Ictalurus punctatus	142	99
Ictalurus melas	13	5
Pilodictus olivaris	10	4
Fundulus kansae	22	16
Gambusia affinis	35	4
Roccus chrysops	16	0
Micropterus salmoides	78	73
L. cyanellus	1	0
L. macrochirus	12	12
L. humilis	8	107
L. auritus	0	4
L. megalotis	10	2
Pomoxis annularis	1260	527
L. humilis- L. megalotis cross	0	1
Percina caprodes	9	0
Totals	6132	3359

Table 7. Chemical Nature of the Water at Buffalo Lake.

Date	Calcium	Sodium	Chloride	Sulfate	Carbonates	Bicarbonates	Total Salts	pH
6-23-55	70	33	54	50	127		334	8.30
7-20-55	68	23	36	48	159		434	8.05
8-9-55	76	28	45	-	484		633	7.73
9-15-55	70	30	46	-	314		460	-
11-9-55	78	21	33	-	292		424	7.90
12-14-55	92	36	55	-	317		500	8.32
2-28-56	82	92	50	36	329		589	-
4-27-56	104	118	62	98	379		761	-
5-7-56	106	124	61	134	339		764	-
5-12-56	104	124	61	134	339		762	-
6-13-56	98	98	92	55	18	293	654	-
8-13-56	86	124	55	73	30	340	708	8.2
10-16-56	92	144	80	331	0	102	749	8.50
1-7-57	104	84	64	7	18	378	655	8.4
1-9-57	140	150	54	216	42	366	968	8.5
2-18-57	98	147	43	168	42	312	810	7.69
4-16-57	102	126	89	52	24	366	759	-
5-23-57	100	132	98	58	3	402	793	7.90

Note: The water sample taken January 18, 1956, froze and shattered in transit. The pH was determined with a Beckman pH meter. This machine was out of order on dates when pH is indicated by a dash. Sulfates indicated by dash were insignificant, less than 5 p.p.m., but were not measured exactly. Carbonates include dioxide, carbonate and bicarbonate but, at the prevailing pH, were largely bicarbonate. Figures for calcium include magnesium as well.

Table 8. Buffalo Lake Physical Data.

Date	Air	Water	Turbidity (mm.)
6-23-55	65	65	350
7-20-55	68	72	205
8-9-55	75	77	220
9-15-55	79	71	170
11-9-55	61	44	270
12-14-55	30	34	210
1-18-56	26	32	200
4-27-56	59	59	110
5-12-56	63	59	200
6-12-56	68	73	415
8-18-56	93	79	250
10-17-56	65	63	145
12-7-56	38	40	150
1-19-57	28	32.5	110
2-18-57	37	44	130
4-10-57	48	48	130
5-23-57	57	61	110

Table 9. Food of Channel Cat in Buffalo Lake.

Food Item	Frequency of Occurrence	Total No. Identified
Goldfish (*Carassius*)	3	3
Crappie (*Pomoxis*)	4	4
Crayfish	2	2
Fish Scales	2	26
Tumblebug (*Scarabidae*)	1	2
Bird leg	1	1

Table 10. Reproductive Potential.

Date Collected	Length of Fish	Weight of Fish	Total Number of Eggs
		Dorosoma cepedianum	
5-23-57	320 mm	715 g	546,148
		Carpiodes carpio	
4-10-57	280 mm	875 g	188,592
4-10-57	330 mm	1210 g	213,177
4-10-57	330 mm	1295 g	176,264
4-10-57	425 mm	2290 g	507,609
4-10-57	330 mm	1230 g	249,296
4-10-57	345 mm	1495 g	305,216
5-23-57	320 mm	1245 g	253,253
		Ictalurus punctatus	
4-10-57	445 mm	2130 g	23,846
5-23-57	405 mm	1645 g	14,777
		Pylodictus olivaris	
4-25-57	870 mm	18,370 g	83,165
5-23-57	570 mm	3,675 g	24,545
		Micropterus salmoides	
5-23-57	385 mm	1985 g	206,298

Table 11. Distribution of "K" Factors for Buffalo Lake.

Dorosoma cepedianum

1955 - 1956

Factor	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9
Males	2	20	55	106	113	111	107	36	14	5	6	1	5	2	1	0	1
Females	4	9	69	111	153	171	129	65	20	10	1	0	2	3	1	0	0

1956 - 1957

Factor	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9
Males			2	1	3	7	33	59	46	19	12	9	4	3	1	2	3
Females			3	3	5	10	26	119	205	136	71	34	16	10	9	1	1

Carpiodes carpio

1955 - 1956

Factor	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3
Males	1	0	1	3	6	4	5	2	2	4	1									
Females						1	1	1	1	1	3	0	3	3	4					

1956 - 1957

Factor	2.4	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3
Males		1	1	1	5	6	11	4	5	5	4	2	0	1				1	
Females	1	1	0	1		3	4	2	3	6	3	5	1	2	0	1	0	1	1

Cyprinus carpio

1955 - 1956

Factor	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6
Males	4	12	20	31	45	31	13	3	4	1							
Females	6	12	19	30	28	26	12	6	7	4	4	6	4	3	1	-	-

1956 - 1957

Factor	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6
Males	4	11	31	46	48	42	28	27	9	2	4	4	3	2	-	-	-
Females	4	6	9	18	16	29	14	18	18	13	5	5	2	1	1	-	1

Table 11. (Continued).

Carassius auratus

1955 - 1956

Factor	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6
Males	2	-	-	-	1	2	1	1	-	-	1	-	1	-	1
Females	-	1	-	-	-	1	-	1	1	-	1	2	1	2	-

1956 - 1957

Factor	3.6	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.7	4.9	5.0	5.2	5.3	5.7	5.9	6.9	7.0
Males	2	3	1	4	-	2	1	1	-	-	-	1	-	-	-	-	-
Females	-	-	-	-	1	-	-	-	1	1	3	-	1	1	1	1	1

Cyprinus X *Carassius*

1955 - 1956

Factor	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7
Males	-	-	-	-	-	-	1	1	5	2	3	1	1	2	-
Females	-	-	-	-	-	-	-	1	1	5	1	-	-	-	-

1956 - 1957

Factor	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7
Males	1	-	-	-	-	3	6	6	7	6	6	4	2	-	1
Females	-	-	-	2	-	2	4	2	4	2	-	-	-	-	-

Ictalurus punctatus

1955 - 1956

Factor	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5
Males	1	-	1	1	4	15	15	12	11	6	2	-	-	-	-	-
Females	-	-	2	1	6	13	11	16	11	8	2	2	-	-	-	-

1956 - 1957

Factor	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5
Males	-	-	-	1	1	2	6	6	10	5	3	1	2	-	2	-
Females	-	-	-	-	2	2	3	7	15	12	5	4	2	2	3	1

Table 11. (Continued).

Ictalurus melas

1955 - 1956

Factor	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9
Males	1	-	-	2	-	1	1	-	-	-
Females	2	-	1	-	1	1	1	-	-	-

1956 - 1957

Factor	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9
Males	-	-	-	-	-	1	-	-	-	1
Females	-	-	-	-	1	-	2	-	-	-

Pylodictus olivaris

1955 - 1956

Factor	1.8	1.9	2.0	2.1	2.2	2.3	2.4
Males	1	-	-	-	-	1	-
Females	2	-	2	1	2	-	-

1956 - 1957

Factor	1.8	1.9	2.0	2.1	2.2	2.3	2.4
Males	-	-	-	-	-	-	-
Females	-	-	-	3	1	-	-

Micropterus salmoides

1955 - 1956

Factor	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6
Males	1	2	2	2	1	4	4	1	2	3	1	2	1	2	1
Females	1	1	2	1	5	1	4	4	7	7	5	2	1	3	1

1956 - 1957

Factor	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6
Males	-	-	-	-	1	-	2	1	1	-	2	1	-	-	-
Females	-	2	1	-	2	-	1	4	3	7	3	4	2	1	-

Table 11. (Continued).

Pomoxis annularis

1955 - 1956

Factor	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.5
Males			27	45	63	89	99	91	47	43	29	19	11	13	13	7	5					
Females			19	43	52	94	89	102	39	40	27	22	11	11	8	5	5					

1956 - 1957

Factor	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.5
Males	1	1	-	4	9	19	25	44	42	23	21	7	9	3	1	2	2	-	-	-	1	2
Females	-	1	3	9	33	45	41	34	48	16	34	20	11	6	3	1	-	-	-	1	-	-

Table 12. Monthly Variations of "K" Factors in Buffalo Lake - Dorosoma cepedianum - Males

	.7	.8	.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	Total
June 1955							2	14	28	41	29	8	1			1									124
July								2	12	19	8	20	23	10	4	1	2		4	1			1		107
August								1	8	24	47	67	75	21	6	1	1			1	1				253
September										1	4	2	2	1	1										11
October																									
November								2	1	7	6	1	2	1	2										22
December										4	6	4	2	1	1	2	1								21
January 1956									6	7	7	4	2				2	1	1						30
February																									
March																									
April								1		3	6	5		2											17
May																									
Total for Segment							2	20	55	106	113	111	107	36	14	5	6	1	5	2	1		1		585
June 1956									1	1	1	5	5	7	3	2	3	1							29
July																									
August															1	1	1	6	3	1	1	2	3		19
September																									
October									1				3	20	20	3	2								49
November																									
December														1	3	1		1							6
January 1957											2	2	23	28	15	8	2		1	1					82
February																									
March																									
April													2	2	3	3	4	1		1					16
May														1	1	1									3
Total for Segment									2	1	3	7	33	59	46	19	12	9	4	3	1	2	3		204

Table 13. Monthly Variations of "K" Factors in Buffalo Lake - <u>Dorosoma</u> <u>cepedianum</u> - Females.

	.7	.8	.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.6	Total
June 1955	1						1	6	35	43	39	24	9	8					1						167
July							1	1	1	3	14	10	14	10	2	1								1	58
August	1			1		1			3	11	35	76	66	24	9	5				3	1				236
September										1	3	10	10	3	1										28
October																									
November										5	9	15	6	5	2	1									43
December									2	4	9	10	6	4	3		1								39
January 1956							1	2	23	39	35	17	9	3		2									131
February																									
March																									
April							1		5	5	9	9	9	3	3	1			1						51
May																									
Total for Segment	2			1		1	4	9	69	111	153	171	129	65	20	10	1		2	3	1			1	753
June 1956									3	1	3	5	3	5	7	5	4	5	3		3				47
July																									
August												1			1		2	5	4	6	5		1		25
September																									
October										1		1	3	12	21	12	4	2							56
November																									
December												2	4	23	33	19	2								83
January 1957												1	14	71	122	49	14	1	1						273
February																									
March																									
April											2		1		11	30	38	16	6	3	1				108
May										1			1	8	10	11	7	5	2	1		1			47
Total for Segment									3	3	5	10	26	119	205	136	71	34	16	10	9	1	1		639

Table 14. Monthly Totals, Average Lengths and Average Weights of Gizzard Shad, June 1, 1955 to May 31, 1957.

Date	Number Taken Males	Number Taken Females	Monthly Total	Average Length Males	Average Length Females	Average Weight Males	Average Weight Females
June, 1955	123	167	290	266	286	224	394
July, 1955	107	58	165	177	231	181	291
August, 1955	234	236	470	170	217	150	283
September, 1955	11	28	39	262	279	355	502
October, 1955	0	0	-	0	0	0	0
November, 1955	22	43	65	264	274	388	405
December, 1955	21	39	60	279	284	481	423
January, 1956	30	131	161	238	209	258	346
February	0	0	-	0	0	0	0
March	0	0	-	0	0	0	0
April	17	51	68	149	200	69	201
May	*	*	*	*	*	*	*
June	29	47	76	172	177	183	164
July	0	0	-	0	0	0	0
August	19	25	44	196	215	187	264
September	0	0	-	0	0	0	0
October	49	56	105	225	254	234	367
November	0	0	-	0	0	0	0
December	6	83	89	267	254	475	345
January, 1957	2	273	275	235	251	285	335
February	0	0	-	0	0	0	0
March	0	0	-	0	0	0	0
April	16	109	125	233	251	285	374
	**	**	**	**	**	**	**
May	3	47	50	203	261	219	420

* - First Selective-Kill Treatment on Shad.
** - Second Selective- Kill Treatment on Shad.