WATER LEVEL FLUCTUATION—ITS EFFECTS ON VEGETATION CONTROL AND FISH POPULATION MANAGEMENT

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ABSTRACT

The fluctuation of water level as a lake management practice in Louisiana is explained using three lakes as examples. These lakes vary from 1,000 to 2,600 acres and are scattered over the state.

Anacoco Lake, a 2,600 acre impoundment in central Louisiana, was fluctuated primarily for aquatic vegetation control. The vegetation was reduced 90% over a period of three years. The effects on the fish population as shown in annual rotenone samples were an increase in the game fish of available size and a decrease in the intermediate size sunfish. Fishing success improved markedly.

Bussey Lake, an impoundment of 2,200 acres in northeastern Louisiana, was extensively studied. Fluctuation data is presented showing that noxious vegetation was reduced over 95% in two years. The effects on both the fish population and fishing success were extremely favorable with harvest per acre up over 250%.

Lafourche Lake, a 1,000 acre cutoff stream channel in northeastern Louisiana was fluctuated three years for vegetation control. Success on aquatic vegetation control was good. A discussion of the effects on the fish population is presented.

The most important aspects in planning a water level fluctuation program are discussed with particular emphasis on degree and timing.

INTRODUCTION

The fluctuation of water levels as a lake management practice in Louisiana has been studied for a short span of years. Our previous studies have indicated that this is one of the few economical lake management practices that will control noxious aquatic vegetation and will influence the fish population along desired lines. Interest in the effect of fluctuating water level on fish population probably started with the papers of Dr. R. W. Eschmeyer and his collegues (Bennettt, 1962). Eschmeyer, Manges and Haslbauer (1947) stated that stable water levels in permanent pools of T. V. A. reservoirs generally produced poorer fishing than those pools which were fluctuated. Bennett in 1962 indicated that properly planned drawdowns not only affected the fish population but also affected higher aquatic vegetation. He further indicated that, "More experimental work must be done on drawdowns to allow biologists to predict the exact effect of these operations upon fish populations." He stated that the timing of drawdown should be more closely studied to find the most beneficial time. Hulsey (1958) indicated that a winter drawdown in conjunction with heavy commercial fishing resulted in many desirable benefits. These included less turbid water, better spawning and survival of sunfishes, and an increased growth rate and survival of the bass population.

Pierce and Yawn (1963) on work with small impoundments from 2 to 500 acres indicated that in Georgia, winter drawdowns were most effective in relatively infertile ponds. Water level fluctuation was a distinct aid in balancing the bass-bluegill combination. He also

pointed out that there was an increase in bass reproduction and growth and a decrease in the intermediate size bream which allowed for better growth throughout the sunfish population.

This study dealt with three lakes of different types scattered throughout Louisiana. They varied in size from 1,000 to 2,600 acres The results and recommendations are presented not as a final solution of all fish population problems nor as a cure for aquatic vegetation problems. Instead, it is hoped that these observations will assist other interested workers, and encourage the presentation of their findings to show the effects of water level fluctuations on impoundments throughout the southeast.

DESCRIPTION OF STUDY AREAS

Anacoco Lake is a 2,600-acre impoundment in central Louisiana and was constructed in 1951. It is a rather shallow lake with an average depth of 9.2 feet. The lake was built primarily for recreation and is located 4 miles west of Leesville, Louisiana, in a rather infertile watershed. The fish population has remained relatively low compared with the other lakes in this area. In 1957 as a result of a hurricane, the control structure of the lake washed out and was replaced in 1958. Therefore, this study should be considered as starting with a relatively new lake in 1958. Fishermen of the lake come from three metropolitan areas: Alexandria and Lake Charles, Louisiana, and Beaumont, Texas. The lake presently is heavily fished and its use for other water sports has remained at a relatively high level since the start of this study.

Bussey Lake is a 2,200 acre impoundment located 7 miles northwest of Bastrop, Louisiana, which is in the northeastern portion of the state (Davis and Hughes, 1963). The lake has an average depth of 11 feet at pool stage and is generally circular with a shoreline of 7.8 miles. The major portion of the trees in the reservoir was a hardwood complex predominately of oak, pecan, elm and gum. This lake differs from the other two in the study in that it was built entirely above ground and all water must be pumped into the lake from Bayou Bartholomew. This lake was designed to furnish freshwater for two mills belonging to International Paper Company at Bastrop. The lake was leased to Louisiana Wild Life and Fisheries Commission in a cooperative fish management project. The lake has been heavily fished since its opening; no other water sports are permitted. Fishermen of the lake come from the Bastrop and Monroe, Louisiana, areas and the neighboring state of Arkansas.

Lafourche Lake is a 1,000 acre impoundment which was constructed by cutting off a loop of the stream channel of Lafourche Bayou. It is located in northeastern Louisiana and was impounded in 1958. Average depth of the lake is 6 feet with maximum depths of 14-18 feet in the old stream channel. The lake is used primarily for recreation and to a lesser extent for irrigational purposes. The fishermen population comes primarily from the metropolitan area of Monroe, Louisiana.

MATERIALS AND METHODS

The drawdown on each lake differed in degree, in speed, and in timing. The drawdown on Anacoco Lake was initiated in 1961 and continued in 1962, 1963, and 1964. The lake is drawn down 5 feet beginning about July 5. Surface acreage is reduced from 2,600 to about 1,300 acres. The drawdown rate is approximately 4 inches per day and therefore requires from 17 to 20 days for completion depending upon the amount of rainfall. This 5 feet drawdown is maintained for approximately 90 days or until the 15th of October. The gates are then closed and the lake is allowed to refill from normal rain-

fall and run off. The rate at which the lake refills, therefore is somewhat erratic. The lake is usually completely refilled by the 15th of February each year.

Bussey Lake has been drawn down only once during this study. After the lake was completed in 1959, the aquatic vegetation problem became steadily more apparent. By 1961, it was obvious that something needed to be done. Accordingly, plans were made for the lake to be drawn down in the summer of 1962. Due to the need of the paper mill for water, the drawdown was not actually started until October 28, 1962. By this time, evaporation had already lowered the lake 3 feet. The gates were opened and the lake was drawn down an additional 5 feet. The drawdown was completed in December and the gates were closed on December 31, 1962. The rate at which this lake was drawn down varied because of the possible need of the mills for water. Normally the drawdown was about 3 inches per day. Pumps started to refill the lake on February 26, 1963. As Bayou Bartholomew was extremely low, the lake was not completely refilled until May 25, 1963. At that time, the average depth of the lake was 11 feet.

In 1961 plans were laid to utilize a drawdown to control the aquatic vegetation in Lake Lafourche. A drawdown structure was built during the summer of that year and the lake was drawn down 4 feet in the winter of 1961. As only a partial drawdown was accomplished, a summer drawdown was recommended for 1962. The structure was opened on July 5 and the final drawdown was 6 feet. This stage was reached 60 days after the structure was opened. Further work on the drawdown channel allowed the lake to be lowered an additional 5 feet. However, only 3 feet of this had drained out by December of 1962. Due to below normal fainfall, the lake did not return to pool stage. The lake was drawn down again in the summer of 1963. In late January, 1964 the lake did return to pool stage. No drawdown was accomplished for this lake in 1964.

Rotenone samples were taken in all three lakes at approximately the same time each year. The methods employed while taking rotenone samples are the standard methods used in Louisiana. Briefly, this is the use of a block-off net to surround the 1 acre with 4 equal sides. The block-off net is of small enough mesh size to prohibit entrance or exit of any fish except fingerlings. One part per million of rotenone is placed inside the seine and fish are picked up as rapidly as they come to the surface of the water. A second day pick-up is also made. As soon as the fish are picked up, they are measured to the closest inch group and weighed in this group according to species. The field data is prepared by averaging all of the rotenone sets for a particular lake for a given year. The fish are grouped within each species according to the standard reporting methods recommended by the Reservoir Committee of the Southern Division of the American Fisheries Society.

A creel census was not conducted on Anacoco Lake due to financial limitations. The other two lakes have all been censused for a varying number of years. The creel census design on Bussey Lake was reported by Davis and Hughes, 1963. Briefly, it consists of an accurate count of fishermen entering the lake at a small number of entrances. Fish and fishermen are checked upon leaving the lake at the two major exits. The lake is censused for 7 randomly chosen days each month. The creel census and count data are returned to the Monroe Office for coding and then are placed on electronic data cards for further analyses.

Lake Lafourche differs from Bussey Lake in that this lake is situated so that there is practically unlimited access areas available. The two commercial docks located on the lake account for less than 30 per cent of the fishermen using the lake. There are over 125 private camps on the lake. In this census, the clerks travel from a mid point in the lake to either end in 45 minutes or less. On each of these trips, a count of the fishermen using the lake is made. On the return

trip, all fishermen whose creel has not been previously checked during this census day are interviewed. The census is so devised that two complete trips to each end of the lake are made each census day. Days to be censused are chosen using a stratified random selector. The hour in which each count will be made is subsequently selected using the same technique. This census was started in 1961 immediately after the first winter drawdown. Therefore, the comparative figures are not as adequate for a predrawdown comparison as we would like. However, they do show a decided harvest change.

RESULTS AND DISCUSSION

Aquatic Vegetation Control

Prior to the 1961 summer drawdown of Anacoco Lake submergent aquatics created a problem both for access and fishing success. Over 40 percent of the lake surface was closed out to fishing. The dominate plant species were mixed mats of pondweed *(Potomogeton sp.)* and southern naiad *(Najas guadaleupensis)*. These extremely dense mats made travel with an outboard motor practically impossible and effective fishing very improbable. Other common but relatively non-troublesome species were parrotfeather *(Myriophyllum brazilense)*, water shield *(Brasenia schreberi)*, water lily *(Nymphaea odorata)*, and muskgrass *(Chara vulgaris)*. None of the latter four species was found in large enough quantities to either hinder movement of boats nor trouble the fishermen. The fishermen felt that the most prevalent plant was the water lily; this is probably because this was the most easily seen.

After the summer drawdown, the aquatic vegetation problem had been greatly reduced. Submergents now close out only about 5 per cent of the surface acreage of the lake. The dominant plant species present in the lake in July, 1964, were again pondweed, southern naiad, and now muskgrass has become a problem in some areas. Water lily and parrotfeather are found in only small quantities. The water shield has disappeared from the lake entirely. From this it is apparent that the drawdown definitely restricts the growth of pondweed and greatly retards the growth of the water lily and parrotfeather. The drawdown has favored the spread of muskgrass to a limited extent but this condition is expected to be only temporary.

From the standpoint of the fishermen, fishing conditions are much improved from those of 4 years ago. As we were unable to conduct a creel census on Anacoco Lake prior to the drawdown, it is not possible for us to know exactly what effect this clearing of the vegetation had for the fishermen, except by the comments of local people. Probably the outstanding and most general comment is that "Now we have a year round lake." It is the opinion of the authors that this drawdown must be continued if successful control is to be achieved.

During the summer of 1960, a survey of the weed species in Bussey Lake indicated that the predominant species were pondweed and southern naiad. These two species created a definite problem by the end of the summer of 1960. It was apparent that this problem would have to be alleviated. By July 1962 over 700 acres of the lake were effectively closed out to fishing by these two plants and a small portion of white water lily in the open water and bladderwort *(Utricularia sp.)* intermixed with the submergents. The water was drawn off starting in October and pulled down far enough to subject the weed infested flats to both dessication and freezing. Pumps were started and the lake was refilled by May 1963. By the late fall of 1963 less than 30 acres had been reinfested.

The census of aquatic vegetation in 1964 indicates that only about 40 acres of the lake is presently infested. The two major weeds found are southern naiad and bladderwort. There is a small amount of pond-

weed also present in the lake, but the amount is definitely smaller than that originally found. For this reason, we feel that the drawdown on this lake was about 90 percent effective in removing the aquatic vegetation problem.

On Bussey Lake the evaluation of the drawdown should continue for at least two more years. At present, it appears that there will not be a large enough weed infestation to necessitate the drawdown for aquatic vegetation control. However, from experience with other lakes in Louisiana, it appears that a drawdown may be necessary on this lake to influence the desired fish population balance.

Initial surveys on Lafourche Lake indicated that there was a heavy population of coontail *(Ceratophyllum demersum)*, bladderwort, duckweed *(Lemna minor)*, and several species of filamenous algae associated with the mats of coontail. The cost of chemical treatment of this lake was deemed too high to be feasible. Therefore, plans were laid to attempt to control the aquatic vegetation problem through water level fluctuation. It should be pointed out that the latter three species are directly dependent upon the presence of a higher aquatic, if they are to reach amounts to cause a severe problem to the fishermen. Therefore, the species which we were primarily trying to combat was the coontail. This plant in Louisiana has hold fast organs and therefore, it was felt that it would be sufficiently rooted to allow us to get good control.

Accordingly the water was first drawn down a small amount more or less to test the control structure in the winter of 1961. As the drawdown was only a partial drawdown we recommended a continuation of our drawdown studies starting in the summer of 1962. The winter of 1963 was very cold and there was a considerable amount of moisture, sufficient to fill Lafourche Lake to its normal level. This enabled us to get the first good study of the effect of this drawdown on the aquatic vegetation.

We found that the drawdown does seriously affect coontail and also the other species. In September of 1964 a survey indicated that over 60 percent of the lake was clear of aquatic vegetation. This was a decrease of approximately 50 percent in the amount of vegetation cover since 1961. There has been no change in the weed species present in the lake since 1961. Due to the problem of refilling the lake over the past three years, the water was not pulled down during 1964. A strutcure is planned on Bouef River which will definitely allow refilling of the lake. Therefore, we anticipate a continuation of this drawdown study in future years.

Fish Population Management

A summary of the rotenone samples of Anacoco Lake is presented in Table I. Certain facts from this table should be emphasized. The overall population of available size fish has increased since the first drawdown in 1961. Intermediate size fish have dropped in overall poundage while the fingerling size fish have been slightly erratic. There is a tendency toward a small increase. The shad population has increased in the lake since the drawdown. As this is a rather infertile lake with a limited quantity of forage fish available, this increase in shad production was welcomed. Probably the most significant change from the standpoint of the fish manager is the effect on the game fish population. There has been a steady increase in the percentage of available size game fish since the first drawdown. This is most pronounced in the case of bluegill sunfish but carries over to the other non-predatory game fish also. There is little change in the pounds per acre of available size predatory game fish. The game fish of intermediate size show a decline which is primarily in the non-predatory game fish group. This is a welcomed addition to the population as it indicates two things: (1) that the intermediate sized fish are being depleted

which allows the fingerlings to grow more rapidly to fill the void, and (2) that a fast growing population is developing into the fish of available size range. The fingerling reproduction has increased in the game fish categories, this again is primarily in the non-predatory game fish area. A summary of the fish population findings from Anacoco Lake would indicate that a very desirable change has occurred in the lake since the first drawdown. The numbers and pounds of game fish of available size have increased with only a slight increase of forage species. Also of particular significance, is the depressant effect on the intermediate sized non-predatory game fish.

The results of rotenone studies of Bussey Lake are presented in Table II. Two or three results presented in the table should be explained. The samples in 1959 were taken prior to the time that the lake had filled completely. This may account in part for the rather unbalanced population which is shown in these samples. After the drawdown in the summer of 1962, the fish population changed. As in the case of Anacoco Lake, the harvestable size non-predatory game fish increased in Bussey Lake. There was an increase in the pounds of predatory game fish found. This was particularly evident in the fish of available size and also in the fish of fingerling size. There was a sharp decrease in the non-predatory food fish in 1963, but this has been offset by an increase in the numbers of buffalo during the past year. The shad population is probably the most interesting of these studies. The drawdown in 1962 seriously depleted the intermediate sized shad in the 1963 samples. This is shown by the rather minor increase of intermediate sized shad in 1963 after a tremendous increase of fingerling shad in 1962. This deficit in the population is carried over into 1964 when the shad of available size showed a marked decrease from that of the previous year. As this was one of the major objectives in the water level fluctuation program on Bussey Lake, this in itself would have been sufficient to encourage such a program. One further item should be noted in the study on Bussey Lake. This is the lateness in raising the water level on Bussey Lake did deplete both the crappie and bass spawn. However, it is felt from the data shown that this was not sufficient to seriously deplete harvest of these fish by fishermen.

The rotenone data from Lafourche Lake is presented in Table III. A single glance at the data would seem to indicate that the drawdown on Lafourche Lake was detrimental. This is partially caused by the failure of the lake to return to normal pool stage after the first drawdown until 1964. Immediately after the first drawdown, the figures as shown for 1962 indicate an immediate increase in the number of available size predatory and non-predatory game fish. It shows a corresponding decrease in the numbers of intermediate size. The non-predatory food fish dropped sharply after the first drawdown while the predatory food fish increased slightly. The failure of the water to return to normal level apparently caused the predatory game fish to fail to spawn both in 1962 and in 1963. This is borne out by the absence of fish of the appropriate sizes in the rotenone samples. The non-predatory game fish did increase in the available size group in 1963. There was a further decrease in the non-predatroy food fish but the shad population took advantage of the lack of spawn of the predatory fishes and the shad population increased very rapidly. In the spring of 1964, the water level returned to its normal pool stage and there was a spawn of both predatory and non-predatory game fish. These fish are represented in the columns of fingerling sized fish in the rotenone samples of 1964. It should also be noted that there was a decrease in the shad population in 1964. This decrease was probably caused by the increased activity of the predatory game and food fish during the spring months. Lafourche Lake was drawn down primarily for aquatic vegetation control, however, it is apparent that when conditions were normal the fish population benefited by the water level fluctuations. One lesson was learned. If, after a drawdown, the water

Table I

Pounds Per Acre of Fish Collected by Rotenone in Anacoco Lake Before and During Drawdown [1]

	Available Size						Intermediate Size						Fingerling Size					
	Pre-drawdown			Drawdown			Pre-drawdown			Drawdown			Pre-drawdown			Drawdown		
Species	1959	1960	1961	1962	1963	1964	1959	1960	1961[2]	1962	1963	1964	1959	1960	1961	1962	1963	1964
Predatory Game Fish																		
Largemouth bass	0-8	—	—	1.4	0.6	1.2	2.0	0.7	0.1	0.1	0.5	0.6	tr	0.3	3.0	0.3	0.2	0.3
Black crappie	—	0.3	0.8	—	0.2	2.1	—	0.6	0.5	—	0.1	1.1	0.1	tr	—	—	tr	tr
White crappie	0.8	0.1	0.3	1.3	—	—	0.2	—	1.4	—	tr	0.1	0.1	—	—	—	—	—
Total	2.6	1.3	1.1	2.7	0.8	3.3	2.2	1.3	2.0	0.1	0.6	1.8	0.2	0.3	3.0	0.3	0.2	0.3
Non-Predatory Game Fish																		
Bluegill sunfish	0.9	0.6	0.8	4.1	2.3	1.6	23.6	5.7	11.5	3.7	0.6	0.6	1.2	0.2	—	2.5	2.0	0.7
Redear sunfish	2.0	0.5	0.3	2.0	2.1	2.1	tr	0.8	4.3	1.0	0.1	0.6	—	0.2	—	—	0.1	tr
Misc. sunfish	1.0	0.1	0.1	0.1	0.1	—	1.0	0.6	1.5	0.1	0.3	tr	0.1	tr	—	—	0.1	tr
Total	3.9	1.2	1.2	6.2	4.5	3.7	24.6	7.1	17.3	4.8	1.0	1.2	1.3	0.4		2.5	2.2	0.7
Non-Predatory Food Fish																		
Total	—	—	0.2	—	0.1	—	0.2	—	—	tr	—	—	—	0.6	—	—	—	—
Predatory Food Fish																		
Total	—	—	0.5	—	—	—	—	—	—	—	tr	0.3	—	—	0.1	—	—	—
Forage Fish																		
Gizzard shad	1.6	8.5	6.1	5.9	20.7	14.1	0.9	0.1	1.2	—	2.3	tr	—	—	9.4	—	—	—
Miscellaneous	1.7	—	—	0.1	0.3	—	0.2	3.2	0.3	tr	0.1	—	—	—	—	—	—	—
Total	3.3	8.5	6.1	6.0	21.0	14.1	1.1	3.3	0.3	tr	2.4	1.0	—	—	9.4	—	—	—
Grand Total	9.8	11.0	9.1	14.9	26.4	21.1	28.1	11.7	19.6	4.9	4.0	4.3	1.5	1.3	12.5	2.8	2.4	1.0

[1] Annual summer drawdowns began in July, 1961 following collection of fish sample that year.

[2] 1961 field data for intermediate and fingerling non-predatory game fish combined by field crew. Data is presented in this table under intermediate class.

Table II

Pounds Per Acre of Fish Collected by Rotenone in Bussey Lake
Before and After Drawdown[1]

	Available Size						Intermediate Size						Fingerling Size					
	Pre-drawdown				Post-drawdown		Pre-drawdown				Post-drawdown		Pre-drawdown				Post-drawdown	
Species	1959	1960	1961	1962	1963	1964	1959	1960	1961	1962	1963	1964	1959	1960	1961	1962	1963	1964
Predatory Game Fish																		
Largemouth bass	47.0	5.6	13.6	7.2	5.0	12.9	3.0	4.3	0.1	0.4	1.6	0.5	—	tr	0.1	0.1	0.3	0.7
Crappie	0.3	4.9	38.4	7.5	1.9	3.5	0.2	3.5	1.8	tr	0.2	1.3	—	—	—	tr	0.2	0.6
Miscellaneous	—	—	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—	—
Total	47.3	10.5	52.0	14.7	6.9	16.4	3.2	7.8	2.0	0.4	1.8	1.8	—	tr	0.1	0.1	0.5	1.3
Non-Predatory Game Fish																		
Bluegill sunfish	0.9	16.5	13.0	9.2	20.1	26.4	0.1	0.3	2.9	12.0	17.1	7.8	0.1	1.0	2.0	6.5	3.9	1.6
Redear sunfish	—	—	0.3	2.0	5.7	5.3	—	—	tr	0.3	2.1	—	—	—	—	—	0.1	—
Miscellaneous	1.8	2.9	3.2	0.9	4.5	1.7	1.3	1.0	0.1	0.2	2.2	1.4	0.3	tr	tr	tr	0.2	0.2
Total	2.7	19.4	16.5	12.1	30.3	33.4	1.4	1.3	3.0	12.5	21.4	9.2	0.4	1.0	2.0	6.5	4.2	1.8
Non-Predatory Food Fish																		
Buffalo	—	1.5	1.8	10.7	9.2	32.9	—	—	—	—	—	—	—	—	—	—	—	—
Bullhead	0.9	1.2	0.4	0.8	0.4	0.7	—	0.4	—	—	tr	tr	—	—	—	tr	0.2	tr
Miscellaneous	1-0	—	—	—	—	0-2	0-2	—	—	—	—	—	—	—	—	—	—	—
Total	1.9	2.7	2.2	11.5	9.6	33.8	0.2	0-4	—	—	tr	tr	—	—	—	tr	0-2	tr
Predatory Food Fish																		
Total	2.5	2.6	—	1.3	0.7	4.9	—	73.0	6.0	0.7	2.0	4.0	—	—	—	36.6	23.0	1.4
Forage Fish																		
Gizzard shad	12.1	18.3	198.1	132.4	247.0	82.3	18.9	—	—	—	—	—	—	—	—	—	—	—
Miscellaneous	—	—	0.4	0.1	—	0.2	—	—	0.4	0.3	tr	tr	—	—	tr	tr	tr	—
Total	12.1	18.3	198.5	132.5	247.0	82.5	18.9	73.0	6.4	1.0	2.0	4.0	—	—	tr	36.6	23.0	1.4
Grand Total	66.5	53.5	269.2	172.1	294.5	171.0	23.7	82.5	11.4	14.9	25.2	15.0	0.4	1.0	2.1	43.2	27.9	4.5

[1] Single drawdown—fall, 1962.

level does not return to normal by the early spring, the fish population will suffer from the increased crowding caused by a smaller lake.

The final criterior of the success of any fish management pratice is the improvement of the harvest of fish from the lake. This is actually the point toward which we are striving. Improving the balance or percentage of game fish in a lake without improving the harvest is a questionable goal. Removing the weeds from the lake and causing a decrease in the harvest will incur great wrath from the fishermen. If we must use harvest as a criterion, we then must determine whether or not the water level fluctuation actually improved the harvest.

The creel census on Bussey Lake furnished us with interesting information on the effectiveness of the drawdown in improving the harvest. Table IV shows that the harvest increased over 100 percent from the 1962-1963 year and the 1963-1964 census year. This is in spite of the fact that the actual catch in pounds per hour dropped. From this it is apparent that on this lake the water level fluctuation had a very beneficial effect on the harvest of sport fishing. Looking at a portion of the other data within this table we note that the catch in pounds per hour on Bussey Lake has been dropping steadily since its opening. At the same time, the catch in pounds per acre had dropped until the time of the drawdown. The major species or class of fish which were harvested more heavily after the drawdown were the crappie. It appears from the table that the catch of bass was smaller. Actually, the catch in total pounds of bass was larger but the percentage of

Table IV

RESULTS OF CREEL CENSUS
ON
BUSSEY LAKE

	Pre-drawdown 1960-1961	1961-1962	*Drawdown* 1962-1963	*Post-drawdown* 1963-1964
Pounds/Acre	96.10	91.75	79.80	215.30
Pounds/Hour	1.03	0.86	0.83	0.73
% Total Pounds				
Bass	51.3	19.5	20.0	13.8
Crappie	11.3	44.1	30.0	44.8
Sunfish	26.0	32.6	45.5	39.1
Misc.	11.4	3.8	4.5	2.3

Table V

RESULTS ON CREEL CENSUS
ON
LAFOURCHE LAKE

	Drawdown 1962-1963	1963-1964
Pounds/Acre	23.48	14.33
Pounds/Hour	0.64	0.61
% Total Pounds		
Bass	10.7	5.6
Crappie	65.5	48.1
Sunfish	23.3	39.5
Misc.	0.5	6.8

Table III

Pounds Per Acre of Fish Collected by Rotenone in LaFourche Lake Before and During Drawdown[1]

	Available Size				Intermediate Size				Fingerling Size			
	Pre-drawdown	Drawdown			Pre-drawdown	Drawdown			Pre-drawdown	Drawdown		
Species	1960	1962	1963	1964	1960	1962	1963	1964	1960	1962	1963	1964
Predatory Game Fish												
Largemouth bass	8.3	13.0	2.2	0.3	0.5	0.3	—	0.1	—	—	tr	1.6
Crappie	8.1	30.9	5.6	0.2	0.8	2.2	0.2	tr	2-0	0.1	—	5.2
Miscellaneous	—	1.4	—	—	0.1	—	—	—	—	—	—	—
Total	16.4	45.3	7.8	0.5	1.4	2.5	0.2	0.1	2.0	0.1	tr	6.8
Non-Predatory Game Fish												
Bluegill sunfish	23.3	36.1	51.7	5.3	5.6	2.3	0.2	4.0	1.7	1.7	0.3	7.4
Redear sunfish	1.1	2.9	2.1	0.3	0.1	—	—	0.3	—	—	—	0.1
Warmouth	2.4	3.2	4.8	2.4	0.4	—	0.2	2.5	0.2	tr	—	1.0
Miscellaneous	1.3	3.6	0.4	0.4	0.1	—	—	0.6	0.1	tr	—	—
Total	28.1	45.8	59.0	8.4	6.2	2.3	0.4	7.4	2.0	1.7	0.3	8.5
Non-Predatory Food Fish												
Buffalo	66.7	16.5	8.7	1.2	2.4	—	—	—	—	—	—	—
Bullhead	1.2	5.5	0.7	0.3	0.2	—	—	tr	—	tr	—	0.1
Miscellaneous	1.5	—	—	0.7	0.1	0.1	—	—	—	—	—	—
Total	69.4	22.0	9.4	2.2	2.7	0.1	—	tr	—	tr	—	0.1

Table III—Continued

Predatory Food Fish												
Total	2.1	23.9	4.3	3.0	0.3	5.6	5.1	0.5	—	—	—	—
Forage Fish												
Gizzard shad	15.0	19.2	194.1	40.9	—	—	0.3	3.0	—	—	—	0.7
Miscellaneous	—	—	—	—	0.1	—	tr	—	—	tr	—	0.1
Total	15.0	19.2	194.1	40.9	0.1	—	0.3	3.0	—	tr	—	0.8
Grand Total	131.0	156.2	274.6	55.0	10.7	10.5	6.0	11.0	4.0	1.8	0.3	16.2

[1] Annual summer drawdown began in July, 1961.

the total was smaller. The same is true for the sunfish population. In this lake we can safely say that both the fish manager and the fishermen were satisfied. The population improved, the aquatic vegetation was controlled, and the fishermen harvested more fish.

On Lafourche Lake we were not quite as successful in improving the harvset of fish. Table V shows the results of the creel census conducted on Lafourche Lake. The catch in pounds per acre shows a slight decrease and there is a slight drop in the catch in pounds per hour. As previously stated the weeds were controlled but the improvement in the fishing was not sufficient to be easily recognized by the average fisherman. This explains in part their unwillingness to fluctuate the water level in the lake again this year. As previously pointed out in the discussion of the rotenone results, the bass and crappie population showed a decline while the sunfish population actually increased. This is borne out in the creel census figures which show that the harvest of bass dropped considerably as did the harvest of crappie. The sunfish harvest almost doubled.

A summary of our experiences with water level fluctuations in Louisiana is probably best summed up by saying "more study is required." In this paper we have presented our results from both summer and winter drawdowns. Two points should be brought out. To be effective, water level fluctuations must be carefullly planned. The most important elements are degree and timing. Each lake is an entity in itself. When to fluctuate the water on a particular lake must be determined for that lake. With our present knowledge, it is too early to say that either a winter or a summer drawdown is better in Louisiana. Instead, we must plan according to the problems of a particular lake. It is apparent that certain weed species respond better to a winer drawdown while other species may respond better to a summer drawdown. This is also undoubtedly true as far as influencing certain fish species. Winter drawdowns are probably more effective in removing population of small sunfish and shad. Summer drawdowns are more effective in preventing spawning of these species. These drawdowns may have a depressent effect on the predatory fish populations and at the same time decrease the amount of forage fish of desirable size in the spring of the year and also during the winter.

The other lesson learned from our study of fish management through water level fluctuation is that the time and method by which water returns to the lake must also be carefully considered. A drawdown is only as effective as the time and degree by which the lake refills. A too short period of drawdown has very little effect, as shown on the study of Anacoco Lake. An extensive period of drawdown through the spring months is equally ineffective, as shown by the study on Lafourche Lake. Proper timing of drawdown and refill are the areas which determine how successful a water level fluctuation program will be.

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