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REPORT NO. 1033

PARTIAL ANALYSIS OF THE FISH POPULATION OF DEEP LAKE

by

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Introduction

In 1938, the Institute for Fisheries Research was granted permission to use Deep Lake for scientific purposes by the owners, Messrs. James Inglis and B. E. Young. Deep Lake, located in Oakland County, has a surface area of 14.8 acres and a maximum depth of 61 feet. The lake has neither a permanent inlet nor an outlet. The distance from shore to the five foot contour varies from 10 to 70 feet in width, and the drop-off from shore to the center of the lake is steep. Water analyses indicate that sufficient oxygen is present in the deeper, colder water to support fish (such as trout) the entire year. Results of the inventory (Report No. 855) proved that Deep Lake was moderately productive, despite the limited shoal area.

From 1938 through the summer of 1941, experiments were conducted at Deep Lake on the number of fry produced per nest, the total number of nests used and the estimated number of fry produced in the lake for the bluegill, rock bass, pumpkinseed sunfish and largemouth bass. During the summer of 1941, it was decided that it would be highly desirable to poison Deep Lake and remove the entire fish population. This information

was needed for a correlation between the number of fry produced each year and the number of these fry that survived at the end of each year up to the time of poisoning. Deep Lake was poisoned on September 12, 1941 and subsequent tests proved that the poisoning was complete. After poisoning the lake was restocked with rainbow trout, smallmouth bass and bluegills. Future plans called for making an intensive study on the growth rate and success of the plantings of these species in Deep Lake.

Observations and collections of fish were made at intervals since the lake was restocked on October 31, 1941. Samples of fish were obtained by angling, seining and by the use of gill nets and fyke nets. All pertinent data were recorded from all fish collected. Because of the wartime restrictions on travel and personnel, it was sometimes impossible to make collections as often as would have been desired. Therefore, we find that there are many blanks in our data and many of the samples obtained are obviously inadequate.

It has now been four full years since Deep Lake was poisoned and restocked with fish. Although not enough time has elapsed and not enough data have been secured to enable us to draw any definite conclusions, it was deemed advisable at this time to analyze parts of these data in order to ascertain some of the trends disclosed by our observations. For example, observations made in 1944 and 1945 seemed to indicate that the bluegill population had become stunted. One object of this report is to ascertain if and to what extent this was so, and to determine if a comparable condition existed among the rainbow trout and the smallmouth bass.

We wish to acknowledge the courtesy and cooperation extended by Mr. Benjamin E. Young, now the sole owner of Deep Lake, and his former

partner, Mr. James Inglis. Mr. Young should be commended for his efforts in keeping the records of all of the fish removed from Deep Lake by anglers. Thanks are also due to all of the members of the Institute Staff who have helped in one way or another with this project.

Analysis of the Bluegill Population

One hundred adult bluegills, ranging in length from 2.6 to 5.4 inches (average 4.1 inches), were planted in Deep Lake on November 5, 1941. The bluegills were taken from Thompson (Howell) Lake by means of a fyke net. Left pectoral fins were clipped on all fish for future identification. It was believed, at the time of planting, that sufficient bluegills were stocked to repopulate the lake. Observations in the years that have followed would indicate that it was more than ample.

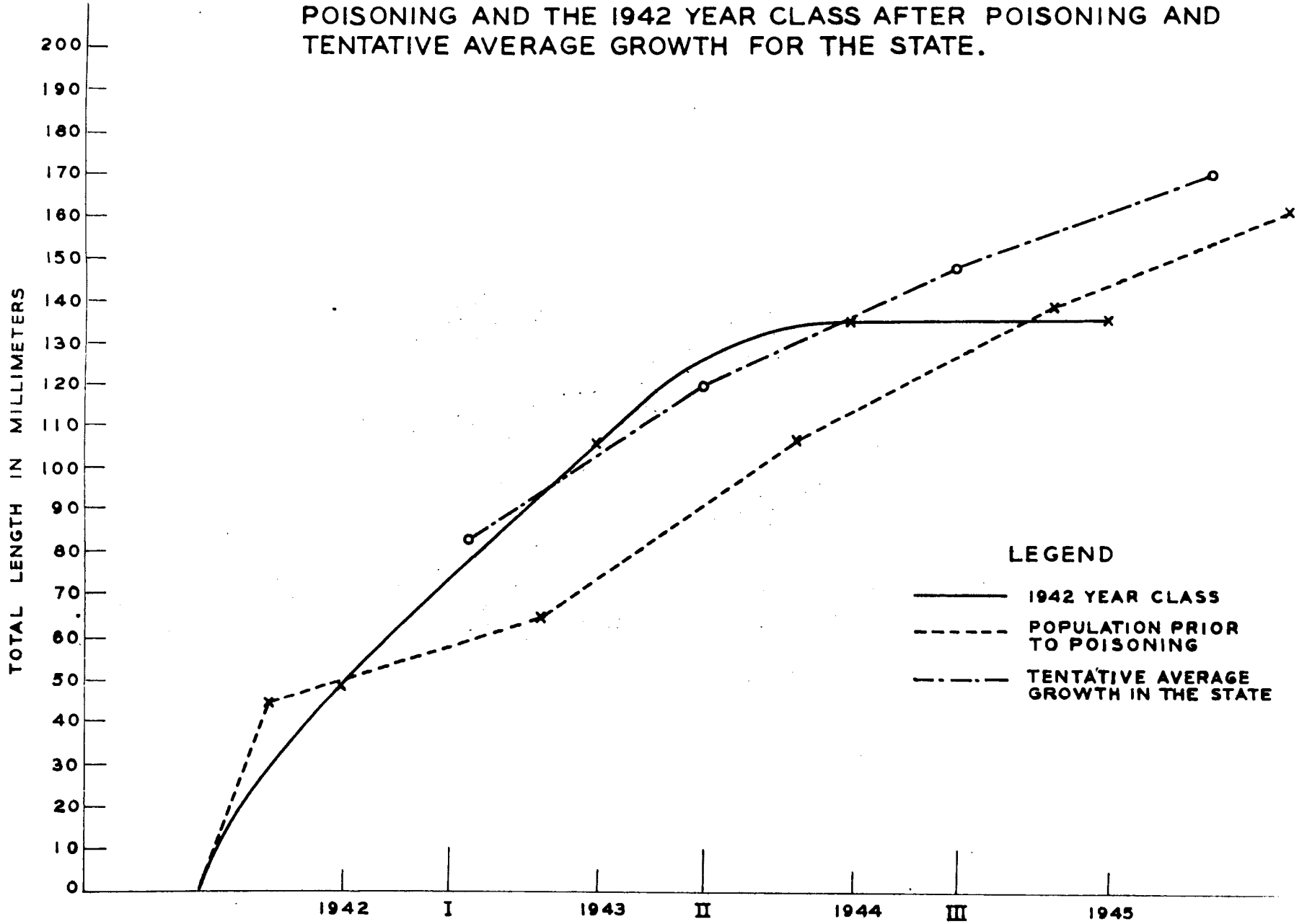
These planted bluegills spawned in the early summer of 1942 and spawning has recurred each year with observed success through 1945. Periodic collections were made by hook and line and by seining, from August 22, 1942 to December 4, 1945. A total of 1,275 bluegills were collected during this period of which 506 were examined for age and relative growth. It is unfortunate that the bulk of the collections made were subject to selective sampling. The majority of the adult fish were taken by hook and line and one of the large samples (1945) of smaller fish was made with a seine whose mesh permitted the escape of the smaller fish whichwere all young-of-the-year. It was not possible to determine some of these irregularities in the data until we were ready to work it up. Collections were scattered over many different months and seasons of each year. All results have been interpreted with these factors in mind and must be considered purely tentative in nature.

The resultant population of the original planting is considered first. The tentative growth curve of the first hatch (1942 year class) is plotted in Fig. I. This year class was selected for illustration because, obviously, more data exists for it than succeeding year classes. A single year class was selected for plotting because it was felt that it would reflect a succession of conditions in the lake more clearly than averages based on age groups of all year classes. The latter would tend to obscure any fluctuations over such a short period of time. Comparison of the growth curve of the 1942 year class with the tentative average growth for the state (dot and dash line) (Beckman, Report No. 741) and a growth analysis of the population present in the lake prior to poisoning (broken line) reveals the following probable conditions:

(1.) During the 1942 growing season the first hatch of the original planting enjoyed near optimum conditions and grew faster than members of the pre-poisoning population of the same age.

(2.) Considering both the 1942 and 1943 growing seasons, the 1942 year class exhibited considerably better growth than the pre-poisoning population of the same ages and a slightly better growth than the tentative average for the state. However, it was obvious while examining the material that the near optimum conditions for the bluegills existing in the lake were beginning to decline in late 1943. Some of the bluegills of the 1942 year class were five inches or more in length in the late fall of 1943. Observations made at this time led us to believe that some bluegills would reach legal length sometime during 1944. But very few legal bluegills were collected during 1944, which indicated to the observers that growth had already begun to slow down.

FIG. 1 COMPARISON OF GROWTH OF BLUEGILLS IN DEEP LAKE BEFORE POISONING AND THE 1942 YEAR CLASS AFTER POISONING AND TENTATIVE AVERAGE GROWTH FOR THE STATE.



(3.) The tentative curve, and more emphatically, the samples when examined, indicate that growth was very poor in 1944 and even poorer in 1945. (See scale photographs.) By the end of the 1945 growing season the average total length had fallen well below that of the tentative state averages, and averages of the pre-poisoning population.

Figure II may illustrate these three points more clearly. Average growth at the end of the second growing season is shown for the 1942, 1943 and 1944 year classes with average growth of yearlings in the population prior to poisoning as a comparison.

In examining the scales of samples taken, notations were made indicating the relative amounts of growth exhibited upon them. This was done in lieu of an extensive calculated growth study which the problem did not warrant because of inadequate samples. Results were as follows:

(1.) 1944 - August and September Collections:

In the majority of cases in this sample, the scales exhibit a relatively excellent growth for the first two growing seasons (1942 and 1943). Specimens in Age Group II, completing their third growing season, showed the following relative growth for 1944.

	Number	Percentage
Fair to Good Growth	5	10.0
Poor Growth	25	49.0
Very Poor Growth	21	41.0
	51	100.0

FIG II COMPARISON OF YOUNG OF YEAR AND YEARLING DEEP LAKE BLUEGILLS SHOWING COMPARATIVE AVERAGE GROWTH INCREMENTS BEFORE AND AFTER POISONING.

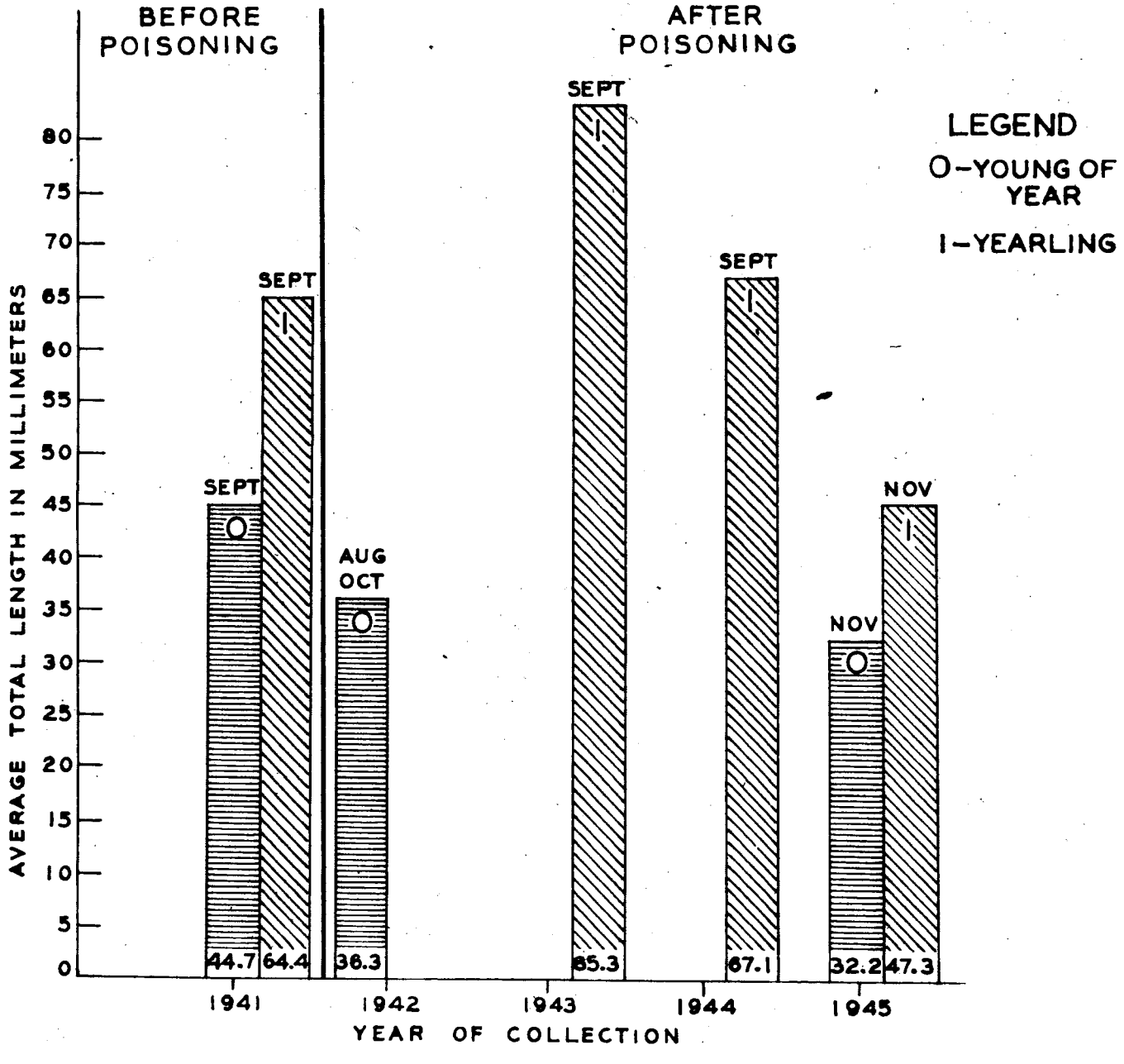
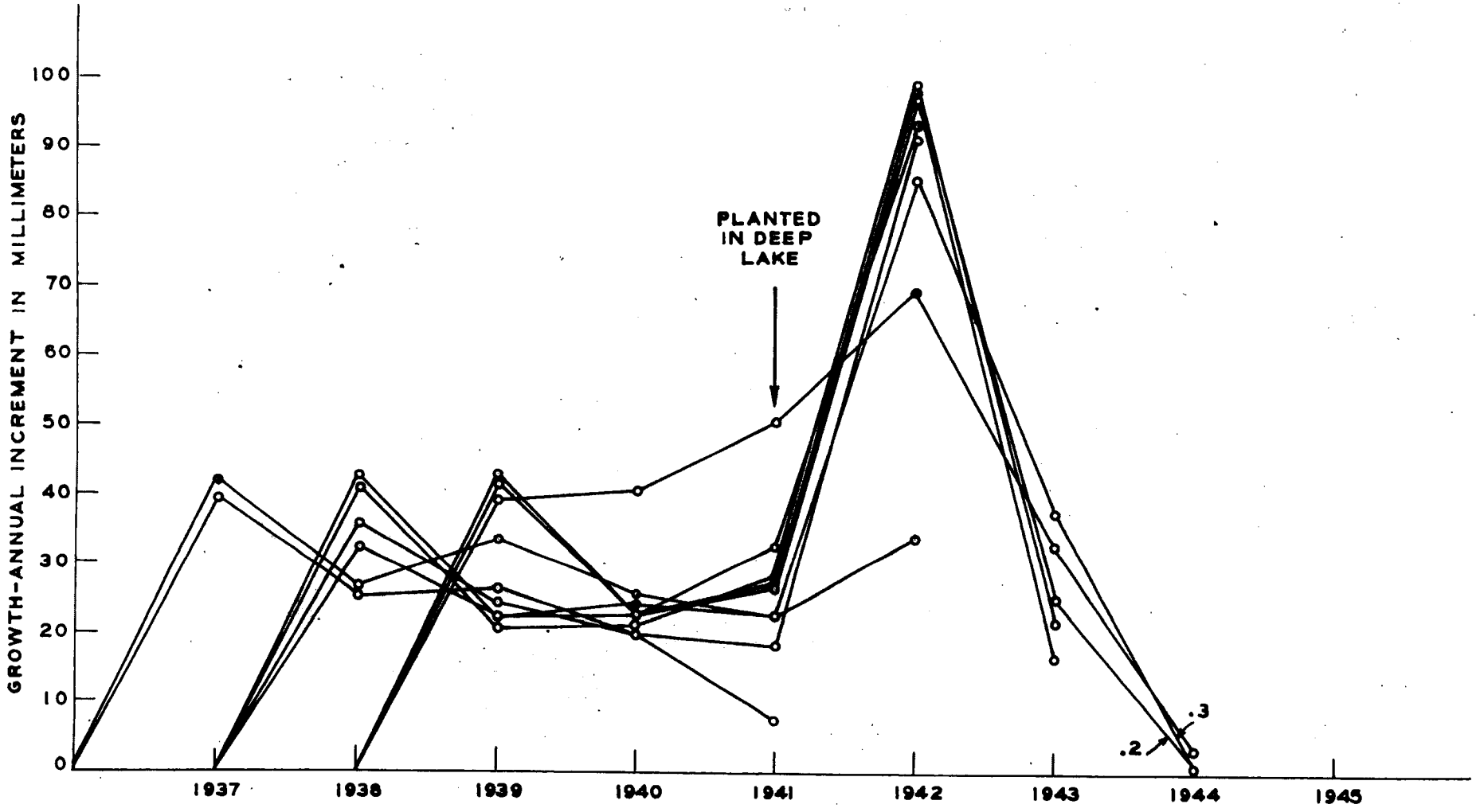
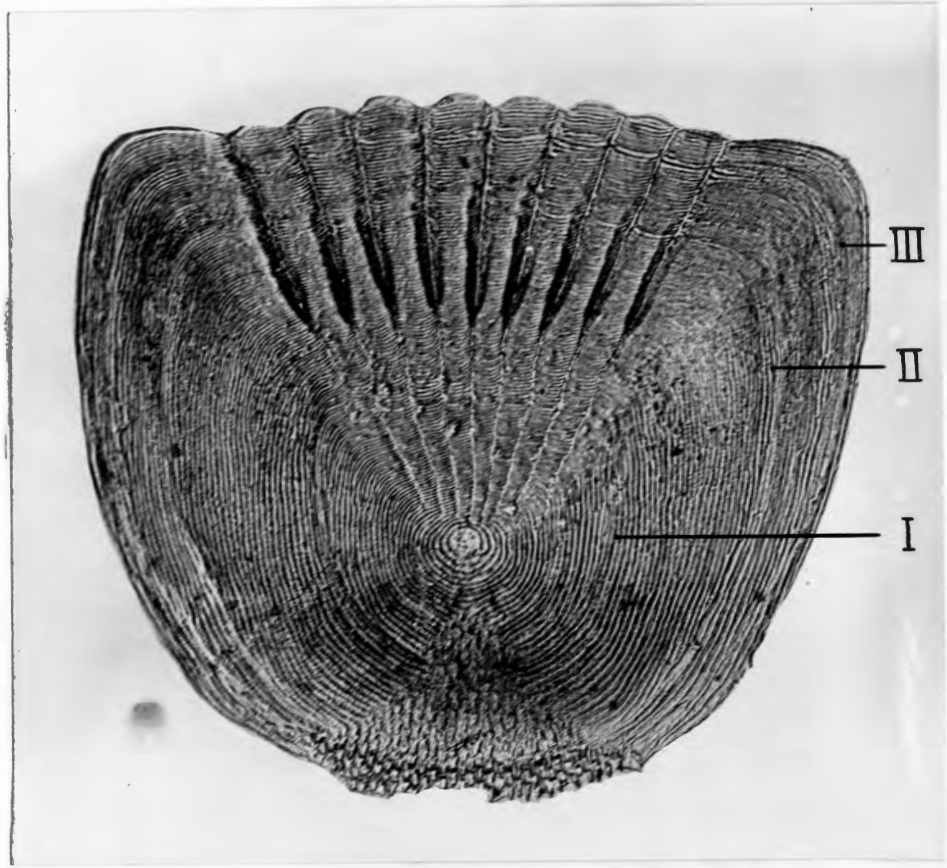
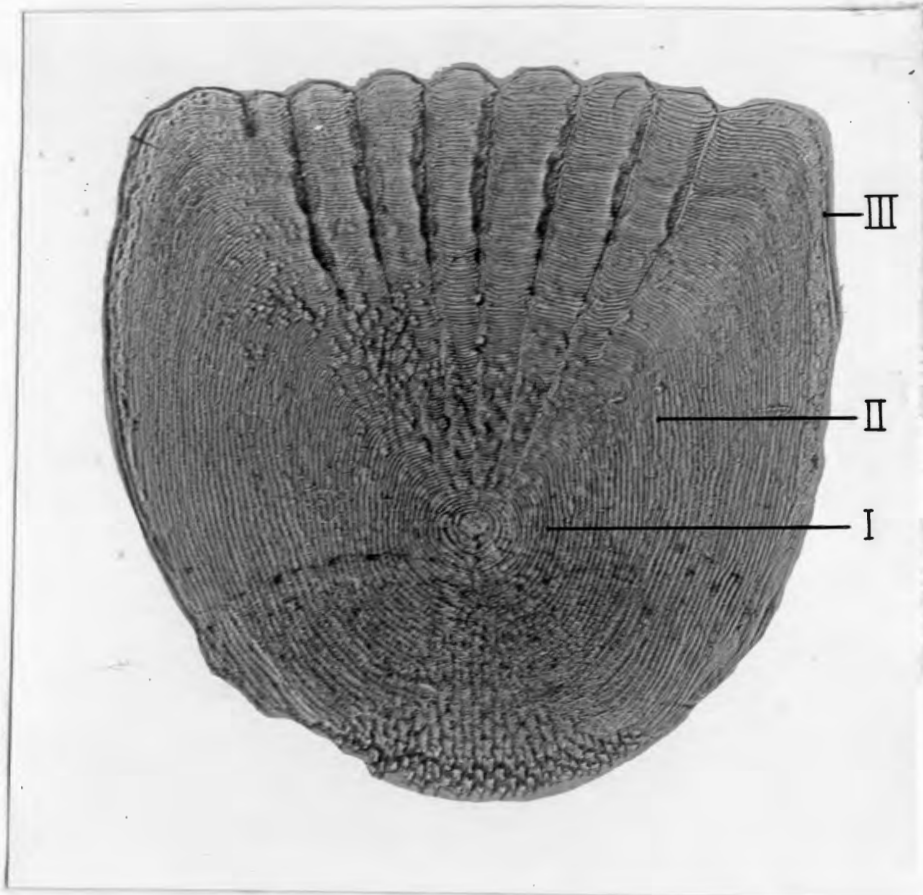


FIG. III ANNUAL GROWTH INCREMENTS FOR 9 FIN-CLIPPED BLUEGILL RECOVERIES FROM DEEP LAKE.

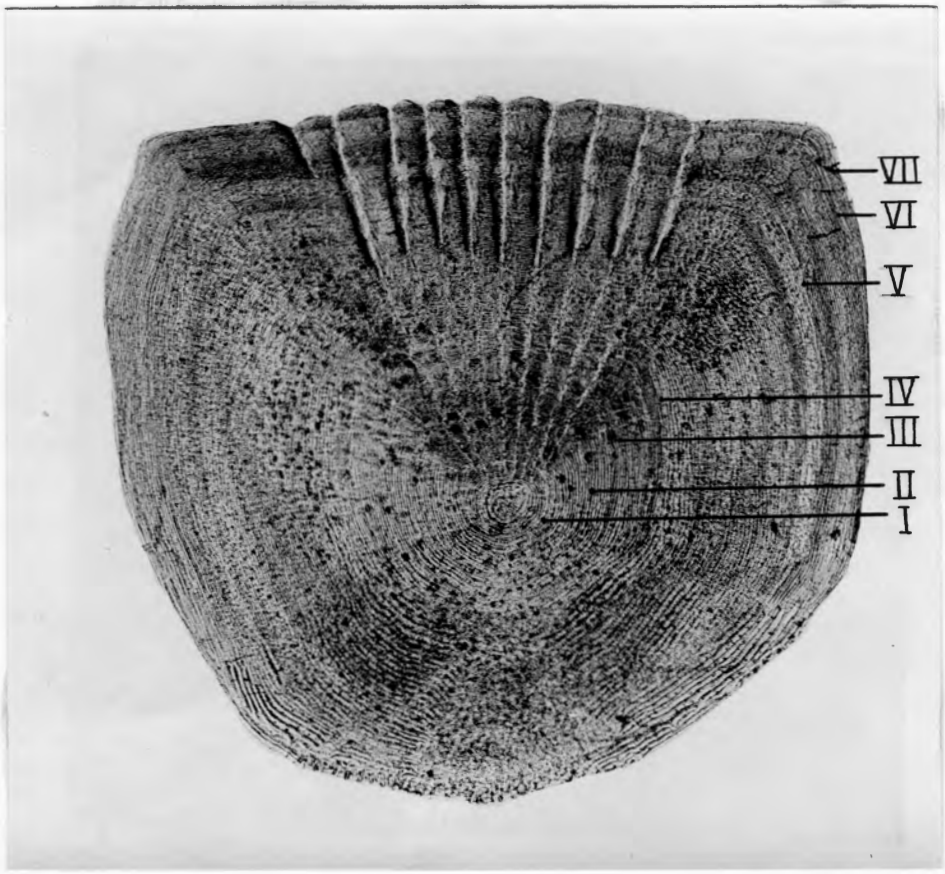




BLUEGILL, Deep Lake, Oakland Co., (IFR#78801),
Age III (1942 Year Class),
Collected Nov. 6, 1945.



BLUEGILL, Deep Lake, Oakland Co., (IFR#78800),
Age III (1942 Year Class)
Collected Nov. 6, 1945.



BLUEGILL, Deep Lake, Oakland Co., (IFR#77258), Age VII.
Recovery from fin-clipped planting of Nov. 5, 1941.

(2.) 1945 - April and May Collections:

Analysis made of specimens entering the fourth season of growth. Same year class as preceding sample. Figures are for the third (1944) growing season:

	Number	Percentage
Fair to Good Growth	4	11.1
Poor Growth	21	58.3
Very Poor Growth	11	30.5
	36	100.0

(3.) 1945 - November Collections:

Specimens in Age Group II (1943 hatch) exhibited relatively very poor growth for their third growing season (1945).

Specimens in Age Group III (1942 hatch) exhibited growth for their fourth growing season (1945) as follows:

	Number	Percentage
Fair to Good Growth	1	3.8
Poor Growth	7	26.9
Very Poor Growth	18	69.2
	26	99.9

Recoveries of the Original (1941) Planting

Fifty (50) specimens of the original fin-clipped planting were sampled at the time of planting in October, 1941, for scales and other pertinent data. Age determinations were made of these scale samples and the data obtained were utilized in Figure IV.

Nine fish (all fin-clipped) of this original planting were recovered by hook and line fishing over the period from 1942 - 1945. Scales from

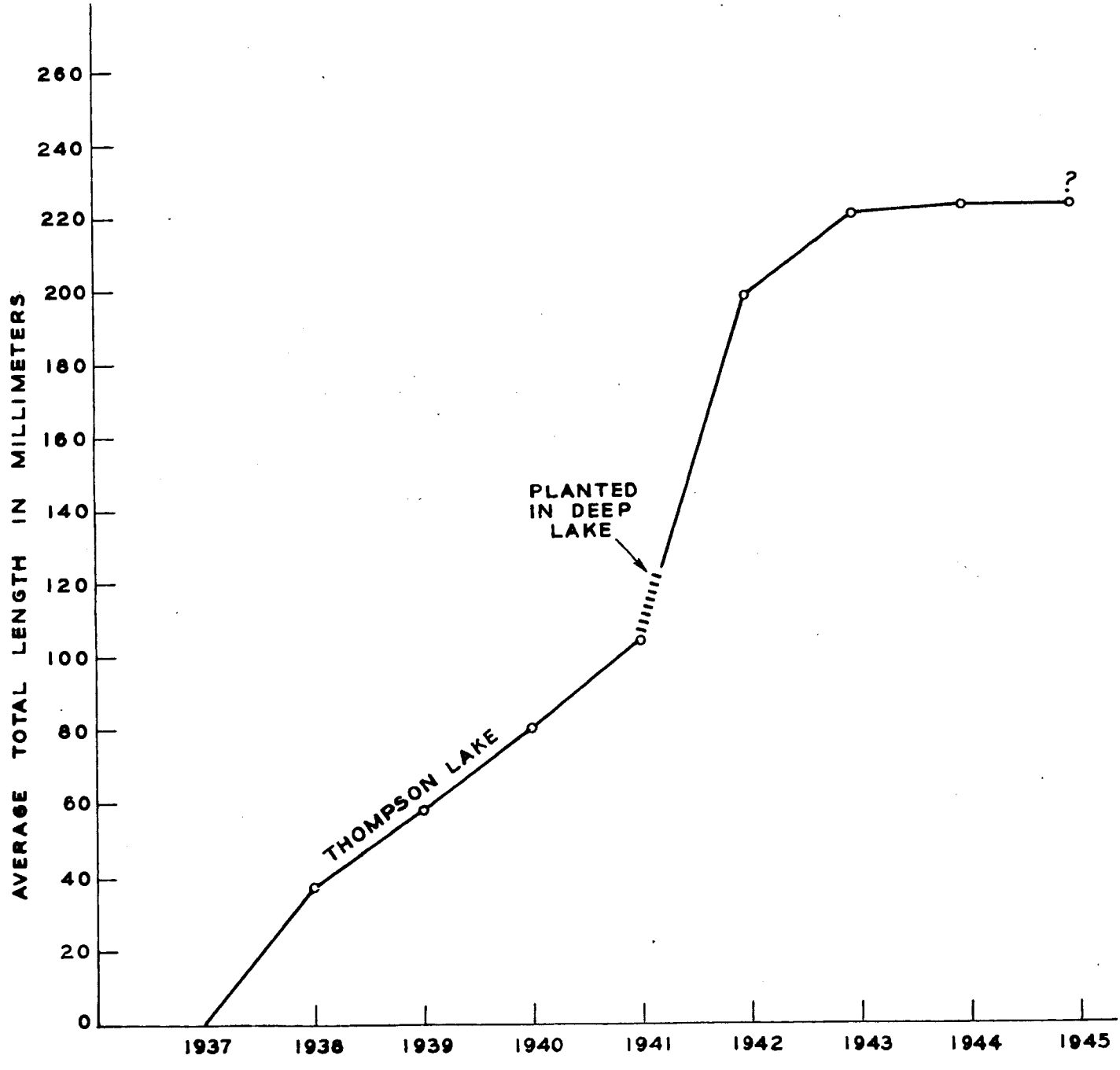
these recoveries were aged and measured and growth for each year of life was calculated. The annual growth increments for these nine recoveries are plotted, as individuals, in Figure III. A growth curve based on the average calculated total lengths of four (4) specimens of the 1937 year class (Thompson Lake) is plotted in Figure IV. The following points seem evident in these two figures:

(1.) The original planting was taken from a population of bluegills in Thompson Lake which were stunted well below the tentative average for the state.

(2.) These adult bluegills suddenly exhibit an unusual increase in growth during their first growing season in Deep Lake indicating near optimum conditions for them at that time. This is further proof that stunting is due to physiological rather than hereditary factors. When stunted fish are removed to a new habitat and plenty of food is again available, these fish grow fast and compensate for previous poor growth. Seven of the nine specimens examined virtually doubled in one season the total length they had acquired in their preceding 3 to 5 summers of growth.

(3.) This sudden increase in growth rate disappears rapidly late in 1943 and for those recoveries made in 1944 and 1945, little or no appreciable growth is shown. Three specimens examined showed calculated growth increments of 0.5 to 4 millimeters for the 1944 growing season. The sudden increase in growth appears unusual in those fish enjoying it in their fifth and sixth summers of life, since bluegills are believed to be approaching a senile condition at this age. (Ricker, 1945.)

FIG. 4 GROWTH CURVE FOR 4 BLUEGILLS OF THE 1937 YEAR CLASS RECOVERED FROM DEEP LAKE.



Conclusions

(1.) It would appear, then, considering growth in both the original planting and the 1942 "hatch" that excellent conditions existed for the bluegills in Deep Lake in 1942. Extensive spawning was observed in the narrow band (10' - 15') of shoal water around the lake. W. F. Carbine counted 47 nests observed by July 27th of 1942 -- all made by the original planting of 100 bluegills.

(2.) Conditions remained excellent for the bluegills through most of the 1943 growing season. However, by the end of the 1943 growing season, the peak of the carrying capacity of the lake for bluegills appears to have been reached and passed. In the late summer of 1943, schools of small bluegills were observed swimming over the entire surface of the lake. It was not uncommon to obtain several quarts of young-of-the-year bluegills in each haul of a 10-foot seine. Extensive spawning was observed in 1943. Some bluegills of the original planting were spawning but most of the spawners were fish that were hatched in 1942. Spawning males of this 1942 year class ranged in size from 2.6 to 4.6 inches, while the ripe females were from 4.1 to 4.6 inches long. Computations based on minimal utilization of observed nests, and minimal survival indicate that there may have been 1,140 pounds of bluegills of the 1943 hatch in the lake in the fall of 1943. At the time of poisoning in 1941, only 256 pounds of bluegills of all ages were removed from Deep Lake. Observations made in the fall of 1942 lend credence to the fact that bluegills were exceedingly numerous in Deep Lake.

(3.) The growth rate of all age groups of the bluegills declined abruptly in 1944 and remained very poor through 1945. The growth of even the larger fish was only nominal during the 1945 season. These conditions

were reflected in all samples examined and it may be concluded that near minimal conditions for the bluegill population were reached during this season.

(4.) It may be assumed that the lake was rendered overpopulated by 1943 and that this overpopulation was further aggravated by the succeeding hatches of 1944 and 1945.

That Deep Lake was overpopulated by bluegills in two years by a planting of 100 adults is indeed interesting when one considers that Deep Lake has an area of 15 acres, a limited spawning area and a limited amount of vegetation and protection for young fish.

Smallmouth Bass

The first planting of smallmouth bass in Deep Lake on October 31, 1941, consisted of 2,935 fish averaging 4.6 inches (range 3.8 to 6.2 inches). Because of the apparent failure of these fish to establish themselves in the lake (to be explained in more detail later), another planting of 500 fish was made on October 7, 1943. (Average length 5.4 inches - range 4.2 to 6.9 inches.) Returns on both plantings have been small. This was not due wholly to the fact that bass were not present in the lake. Observations during 1942, 1944 and 1945 have indicated that smallmouth bass were present in fair numbers but few were collected because it was our desire not to take many bass until they reached legal size or until they had spawned. From 1942 through 1945, only 105 smallmough bass were collected. Of these, 62 were taken by members of the Institute (18 of these were returned to the lake) and the owners of Deep Lake and their friends took 43 according to the records supplied us by Mr. Young. Growth of the smallmouth bass collected by the Institute is summarized in the following table.

Smallmouth Bass - October 31, 1941 Planting

Date	Number of Specimens	Total Length in Inches			Average Weight Grams	Average Weight Ounces
		Minimum	Average	Maximum		
Oct. 31, 1941	2,935↓	3.8	4.6	6.2	20.8	0.7
Apr. 15, 1942	14	4.4	5.2	7.6	...	...
May 19, 1942	1	...	4.7	...	23.0	0.75
June 23, 1942	10	6.0	6,3	7.2	...	...
July 27, 1942	8	6.7	7.1	7.5	59.2	2.1
Oct. 8, 1942	7	8.2	8.7	9.6	204.0	7.2

Smallmouth Bass - October 7, 1943 Planting

Oct. 7, 1943	500↓	4.2	5.4	6.9	...	1.3
Nov. 2, 1943	1	...	6.5	...	...	...
May 27, 1944	6	5.2	6.1	7.0	55.5	1.9
Aug. 9, 1944	3	9.5	10.2	10.7	280.3	9.9
Aug. 29, 1944	4	8.2	9.5	10.9	...	...
Sept. 6, 1944	4	9.5	10.5	11.5	...	...
Oct. 10, 1944	1	...	11.9	...	...	...
May 8 and 25, 1945	3	9.25	10.2	11.75	...	...

↓ Number of fish planted. A random sample taken for average length and weight.

Not enough fish were taken on any of the collection dates to provide an accurate comparison with the tentative averages for Michigan (Beckman, I.F.R. Report No. 741). However, from the information available, the smallmouth bass that are represented in the collections were growing as

fast and exhibited a degree of well-being (based on length-weight relationship) as good as that tentatively computed as average for the state.

Examination of the table of growth reveals the interesting fact that the smallmouth bass exhibited an average growth increment of 0.6 inches between October 31, 1941 and April 15, 1942.

What was the fate of the first planting of smallmouth bass? When it was decided that smallmouth bass and rainbow trout were to be planted in Deep Lake, 3,000 of each were requested. It was believed that the trout fingerlings would average about 4 to 5 inches and the bass 2.5 to 3 inches. Instead of fish of these sizes we received trout averaging almost 7 inches and bass averaging 4.6 inches. The weight of the fish planted in Deep Lake almost equaled the total weight of the entire fish population when the lake was poisoned. It is therefore entirely possible that the lake was overstocked after poisoning.

As a supplement to the natural food already present in Deep Lake, a total of 17,620 crayfish was planted after poisoning because it is well known that they are a staple in the diet of the smallmouth bass. Crayfish were present in the lake in limited numbers before poisoning. It must also be pointed out at this time that there were no small fish present in Deep Lake after poisoning except the bass and trout that were planted.

Observations would lend credence to the belief that a heavy mortality of the bass occurred. On April 15, 1942 (about a week after the disappearance of the ice cover), over 100 smallmouth bass were observed in shallow water in a very sluggish condition. These fish were apparently in the shallow water at this time capturing small frogs which would jump into the water occasionally and crayfish which were to be found in the mat of

dead leaves at the waterline. It was reported (by Hazzard, Goellner and Carbine) easy to capture these bass by hand or with a small dip net. Several seagulls were on the lake at this time and they were observed to capture at least four bass (?) in just a short time. Despite the fact that these bass were in a rather inactive condition, there were no outward signs of disease or other pathological symptoms and the fish were still rather fat. Measurements that were made at this time indicate that these bass had apparently grown an average of 0.6 of an inch since planting (October 31, 1941 to April 15, 1942), if the sample was representative. Apparently those that survived the winter and spring prospered well during the summer because the several bass caught during the summer of 1942 appeared in excellent condition and were actually fat.

In 1943, observations were made and intensive fishing (hook and line and nets) was attempted on the following dates: May 6; May 26; July 13 and 14; August 4; September 10. No smallmouth bass were caught by Institute personnel and in only one instance was a bass observed during 1943. The owners' records reveal that none were caught in 1943. The smallmouth bass apparently disappeared from Deep Lake sometime between October 8, 1942 and May 6, 1943, because only one bass was observed during all of 1943.

No nesting or spawning of smallmouth bass was observed in 1942 or 1943.

There is no apparent explanation for the heavy mortality and/or disappearance of the first planting of bass. Inadequate food is a plausible explanation, yet, there was an abundant supply of crayfish, pollywogs and small bluegills in 1942. In all of the years before Deep Lake was poisoned, crayfish or pollywogs were seldom seen or taken in seines. From 1942 through 1945 it was rather unusual not to find a dozen or more

crayfish (both native and planted) in every haul of a seine, and pollywogs were to be seen anywhere you looked.

About the only shortage of food after Deep Lake was poisoned and restocked was small fish such as minnows and the young of game fish. Previous studies have indicated that there is a negligible mortality among insects (except for aeschnine dragonflies and Corethra) and other invertebrate organisms in a lake following poisoning of a lake with derris root (Brown and Ball, 1942). Therefore, the volume of aquatic insect food could have been but little below normal. Perhaps the rainbow trout as active winter feeders seriously depleted the available food supply, prior to such time in the early spring when the bass resumed feeding. But this is hardly plausible even though the lake might have been overstocked with fish because there was an abundant population of pollywogs and crayfish present in 1942. It is also known that quite a few smallmouth bass were present during 1942. Perhaps the above would have been more applicable for the winter of 1942 - 1943, when the trout were much larger. Less probable is the suggestion that the bass population was destroyed by some endemic disease or infection, brought with them from the hatchery or acquired in Deep Lake. There have been no reports of any mortality nor has any unusual infestation of parasites been observed in the Deep Lake smallmouth bass.

Another possible explanation that might account for the disappearance of the smallmouth bass, is the apparent relationship between growth and mortality. This theory has considerable support in the literature but is seldom considered in fish culture. A random sample of smallmouth bass planted in Deep Lake averaged 4 - 6 inches in total length and ranged from 3.8 to 6.2 inches. Several fish among the 3,000 planted that were not

measured in the sample had an estimated length of between 8 and 9 inches. The average weight of these bass was 20.8 grams or 0.73 ounces each. It is believed that the smallmouth bass planted in Deep Lake were either cannibals that had been sorted out from many thousands of bass raised at the hatchery (a practice sometimes employed by hatchery men) or else they were just fast growing fish that were raised in an extremely productive pond or a pond stocked with just a few fish. These fish were definitely much larger than the usual run of smallmouth bass raised in our hatcheries. The average length of 1,000 smallmouth bass measured by the Institute on October 11, 1945, was 2.8 inches (range 2.4 to 3.9 inches). Another lot of 2,000 smallmouth measured by the Institute in September 1942, ranged in length from 2.25 to 2.8 inches. Observations made over a period of years indicate that the average smallmouth bass that is four months old will average between 2 and 3 inches. Therefore, we must definitely conclude that the smallmouth bass planted in Deep Lake were fast growing fish.

Dr. R. W. Eschmeyer (1938, pp. 126-132) gives a good discussion of this problem of the relationship between growth and mortality, and a summary of the literature on the subject. For the largemouth bass, Dr. Eschmeyer found from an examination of the scales of over 100 fish that none of the older fish (age groups II to V) had attained an exceptionally large size during their first year of life. The following is a summary of the discussion of this subject that is given by Dr. Eschmeyer: 1. Some young perch had a large first-year growth, but similar growth was not noted in the older perch. 2. A temporary preliminary stunting delayed maturity and extended the life span of rats. 3. Trout that do

not grow lived longer than those which showed growth on a similar diet. 4. Life was prolonged in the black beetle and the roach when a retardation of growth was affected. It is apparent from the above that there is some relationship between individual growth rate and longevity. It is possible that the fast-growing fish have an early mortality and that such fish die from natural causes before they grow to legal size.

It is interesting to note that on August 17, 1944, Mr. and Mrs. Paul Young raised three very large smallmouth bass at Deep Lake while fishing with flies. One was landed and measured 18 inches in length. On August 23, 1944, Mr. Ben Young took one on a spinner that measured 17 inches and weighed 3.75 pounds. These fish were undoubtedly survivors of the first planting. Mr. Ben Young also saw several very large bass on spawning beds in 1945. Outside of these few bass, the original planting disappeared from the lake.

If we had realized that there might possibly be some relationship between growth rate and longevity, we would have insisted on receiving slower growing individuals for the second planting of smallmouth bass in Deep Lake. As it turned out, the second planting made in October, 1943, consisted of all fast growing fish (average length 5.4 inches; range, 4.2 to 6.9 inches; and average weight, 1.3 ounces; age, 5 months).

The second planting was not observed to nest or spawn and no young-of-the-year were observed or collected in 1944. In 1945, a total of 36 smallmouth bass nests was counted. It might be interesting to note at this time that the smallmouth bass were building their nests in sand and gravel bottom and many nests contained small sticks and roots. Male

smallmouth bass were observed on over 90 per cent of the nests. No eggs or fry were observed on any of the nests up to June 13. Again on June 18, no eggs or fry were observed on any of the nests. In the succeeding months of 1945 no young-of-the-year were taken in any of the collections.

The 1943 planting undoubtedly enjoyed a much greater survival rate during their first winter in the lake (1943 - 1944). Some bass also survived the second winter (1944 - 1945). Their inability to spawn successfully may be attributed to one or more of the following suppositions:

(1.) Very poor hatches of smallmouth bass (if any) were the rule during the spring of 1945 at the hatcheries because of the "unseasonable" weather -- hot then cold. The eggs may have been deposited in Deep Lake during a warm period and killed by a cold snap. Or, the females may have been "ripe" and had their spawning delayed for several weeks or more, which resulted in resorption or deterioration of the eggs.

(2.) At the time the nests were prepared the males were "ripe" and the females were still "green," or immature.

(3.) The bluegills ate the eggs or fry as soon as or soon after deposition. Swingle and Smith (1943) have found that when a large population of bluegills is present in a lake that the bass (largemouth) are unable to spawn successfully because the bluegills eat the eggs.

(4.) Nesting of the smallmouth bass was unsuccessful because of severe competition with the bluegills for lebensraum (space).

It is interesting to note that only three smallmouth bass were collected during 1945 and these were taken during the month of May.

Rainbow Trout

A summary of the growth of the rainbow trout is presented in the following table and has been tabulated to show the growth for each of the three plantings.

RAINBOW TROUT - 1941 PLANTING

Date	Number of Specimens	Total Length in Inches			Average Weight Grams	Average Weight Ounces
		Minimum	Average	Maximum		
Oct. 31, 1941	1/	5.2	6.6	8.2	54.0	1.9
May 19, 1942	19	7.1	8.4	9.4	88.5	3.0
Oct. 8, 1942	30	8.0	9.3	10.4	115.4	4.1
Jan. 17, 1943	5	8.5	9.1	10.5	122.8	4.3
Apr. 24, 1943	5	7.6	8.8	10.0	...	...
May 6 - 26, 1943	33	8.0	9.4	11.5	127.6	4.4
July 13 - Aug. 4, 1943	29	8.8	10.4	13.2	184.1	6.5
Sept. 30, 1943	8	9.6	10.7	12.8	190.4	6.7
Nov. 2, 1943	27	8.9	10.3	14.9	160.6	5.6
Jan. 19 - Feb. 16, 1944	27	9.3	11.5	17.4	257.6	9.0
May 26 - 27, 1944	6	10.7	12.1	14.1	239.7	8.4
Aug. 29 - Sept. 6, 1944	5	14.2	15.9	19.0	644.4	22.8
Oct. 10 - 31, 1944	3	15.3	15.6	15.9	...	...
Feb. 2 - 18, 1945	4	13.9	17.7	21.7	930.8	32.8
Apr. 23 - May 8, 1945	2	17.5	18.6	20.1	...	...
Total	203					

1/ Random sample, taken at time of planting.

RAINBOW TROUT - 1942 PLANTING

Date	Number of Specimens	Total Length in Inches			Average Weight Grams	Average Weight Ounces
		Minimum	Average	Maximum		
Aug. 23, 1942	↓	2.0	2.1	2.3	...	...
May 27, 1944	12	8.6	9.7	10.3	121.3	4.3
Aug. 9 - Sept. 6, 1944	5	10.1	10.9	11.7	177.3	6.2
Oct. 10, 1944	14	9.8	10.6	11.6	165.6	5.8
Feb. 28, 1945	26	9.9	10.9	12.6	216.5	7.6
Apr. 23 - May 25, 1945	28	10.2	11.3	12.4	...	...
Nov. 6, 1945	8	10.7	12.6	15.4	355.0	12.5
Total	93					

↓ Random sample, taken at time of planting.

RAINBOW TROUT - 1944 PLANTING

Date	Number of Specimens	Total Length in Inches			Average Weight Grams	Average Weight Ounces
		Minimum	Average	Maximum		
Oct. 23, 1944	↓	3.1	4.3	5.2	16.5	0.6
Feb. 28, 1945	2	4.5	5.6	6.6	28.5	0.9
Apr. 23, 1945	1	...	6.7	...	...	...
May 5, 1945	3	5.0	5.3	5.5	45.3	1.6
Nov. 6, 1945	1	...	9.7	...	135.0	4.75
Total	7					

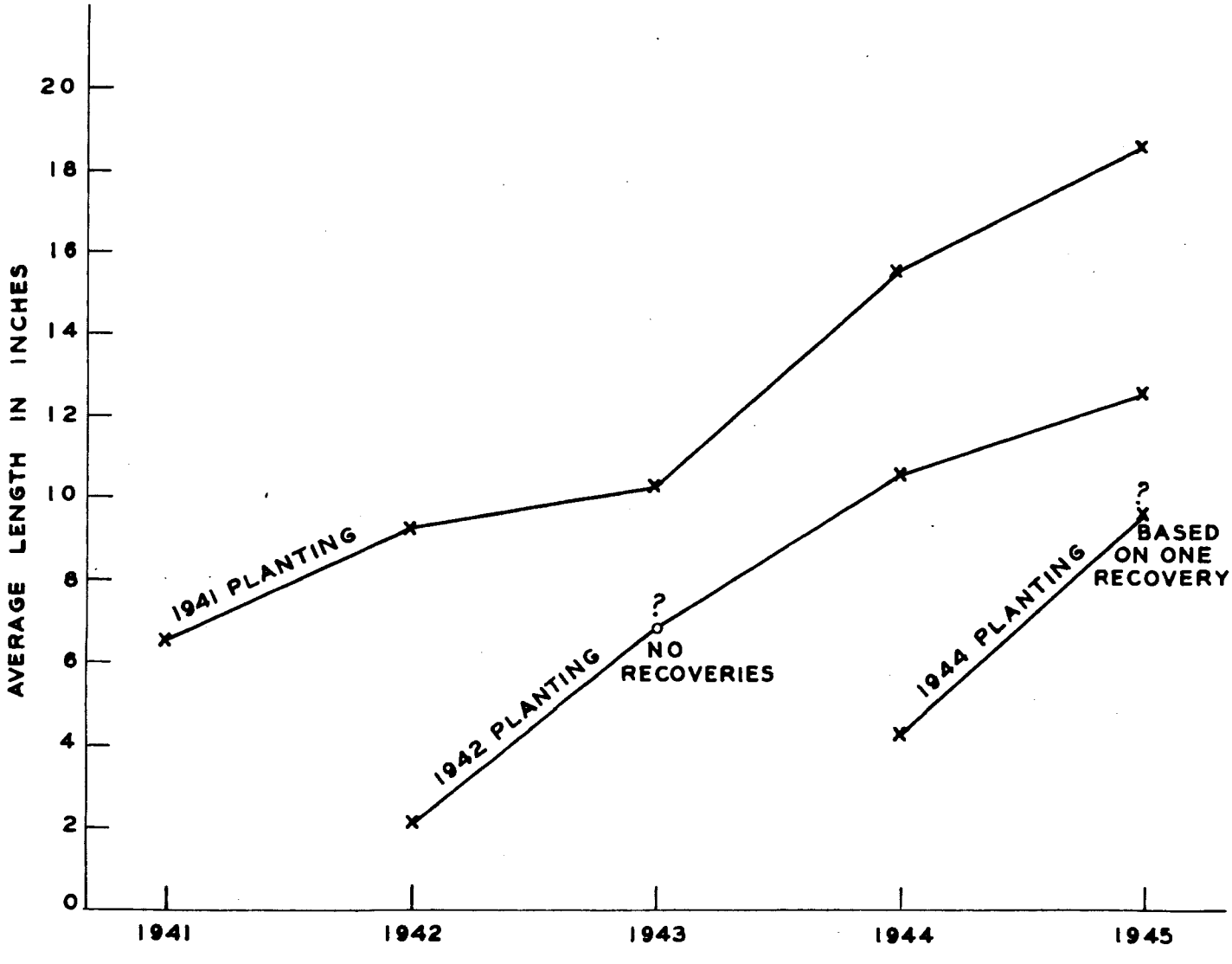
↓ Random sample, taken at time of planting.

There is no apparent radical dissimilarity in the rates of growth of the three plantings. By the late fall of consecutive years (Figure V) the first planting had attained lengths for the year of life indicated as follows: 1 - 6.6 inches; 2 - 9.3 inches; 3 - 10.3+ inches; 4 - 15.6 inches; 5 (spring) - 18.6 inches. Figures for the 4th and 5th years of life are undoubtedly larger than actual averages because of the limited number of specimens.

No comparison can be made between the growth of the Deep Lake rainbow trout and that for other lakes. When available data from Birch Lake trout are computed, comparison can be made between these lakes. In general, rainbow trout are growing at a fairly good rate in Deep Lake. This growth would undoubtedly be much better if the stunted bluegill population were not present.

It is interesting to note that the second planting of trout made on August 23, 1942, did not enter the catch until May 27, 1944. It is rather remarkable that these fish, only a little over two inches in length when planted, survived at all. Mr. Applegate found it rather easy to determine the age of these rainbow trout from the scales. Age determinations were necessary to separate the first and second plantings because these fish were neither fin-clipped nor tagged.

FIG. 5 GROWTH OF THE THREE PLANTINGS OF RAINBOW TROUT IN DEEP LAKE.



The coefficient of condition was calculated only for those samples where both length and weight data were available for each individual. The average coefficient of condition by samples is summarized in the following table. Computations were made in the English System after Klak (1940), and were computed on the basis of total length in inches and weight in ounces.

RAINBOW TROUT - COEFFICIENT OF CONDITION

Date	Number of Specimens	1941 Planting			1942 Planting			1944 Planting		
		Minimum C.E.	Average C.E.	Maximum C.E.	Minimum C.E.	Average C.E.	Maximum C.E.	Minimum C.E.	Average C.E.	Maximum C.E.
1942										
Oct. 8, 1942	30	25.28	32.07	40.10						
1943										
July 13-Aug. 4	28	26.49	34.19	47.29						
Nov. 2,	27	27.51	30.99	36.44						
1944										
Aug. 29-Sept. 6	5	32.73	35.34	38.54						
Oct. 10,	11				28.14	30.20	33.15			
1945										
Feb. 2-18,	4	31.65	36.11	40.72						
Feb. 28	23				29.76	36.72	42.42			
Nov. 6	8				28.21	35.21	42.00			
Feb. 28	2							33.23	33.29	33.35
Nov. 6	1							...	32.76	...

There is no significant difference in the state of well-being, i.e. coefficient of condition of the three plantings at any given age. That is, in different years, fish of the same age appear to exhibit essentially a consistent state of well-being. A significant difference in condition

between the younger and older fish will be noted in the two earlier plantings. This is not per se an indication that the relative condition of the trout had improved materially as a result of improved environmental factors. It may best be attributed to the assumption that fish change in form and relative heaviness with age, i.e. a fish's rotundness and relative heaviness increase faster in proportion to its increase in length as it grows older.

For comparative purposes , samples of lake-inhabiting rainbow trout of another Michigan "trout lake" were analyzed for condition factors. Twenty-eight (28) specimens from Birch Lake, Cass County (size range in T.L. 236 - 343 mm.) had an average C.E. of 34.02 with a range of 25.42 - 42.13. Thirteen (13) additional specimens (size range in T.L. 405 - 525 mm.) had an average C.E. of 33.09 with a range of 20.91 - 38.22. Observations indicate that hatchery trout in hatchery ponds will exhibit this same phenomenon.

It would appear that the rainbow trout in Deep Lake are enjoying a degree of "well-being" as good as those living in a large established trout lake.

Observations and notes made on the quality of the trout fishing in Deep Lake would indicate that the trout were in better condition in 1944-1945 than they were in 1942 - 1943. Aside from the May 19, 1942 collecting trip, when the trout were extremely active and put up an excellent fight, most of the trout caught during 1942 - 1943, were poor fighters. Most of the fish captured on hook and line in 1944 - 1945, were good scrappers.

From 1941 through 1945, a total of 711 rainbow trout have been taken at Deep Lake. Of these, 45 were returned to the water. Therefore, a total of 666 trout has been harvested, as follows:

	Number Retained	Number Returned
Institute		
1942	31	21
1943	139	19
1944	74	..
1945	80	3
Total	324	43
Owners		
1942	136	..
1943	157	2
1944	38	..
1945	11	..
Total	342	2
Grand Total	666	45 = 711

The total catch, to date, of rainbow trout from each of the three plantings is presented in the following table:

TOTAL CATCH OF DEEP LAKE RAINBOW TROUT BETWEEN 1941 AND 1945 FROM EACH OF THE THREE PLANTINGS

	Year of Capture					Number	Percentage
	1942	1943	1944	1945	Total	Planted	Recovery
1941 Planting							
Institute	31	139	42	8	220		
Owners	136	157	22	1	316		
					536	3,000	17.9
1942 Planting							
Institute	..	..	32	65	97		
Owners	..	..	16	10	26		
					123	1,000	12.3
1944 Planting							
Institute	..	..	..	7	7		
Owners	..	..	..	..	..		
					7	1,000	...

The recovery percentages presented in the immediately preceding table are not complete, because there are undoubtedly some trout from the 1941 and 1942 plantings left in the lake. The 1944 planting of fin-clipped rainbow trout should be dominant in the 1945 catch.

Stomachs were saved from most of the rainbow trout captured by the Institute members. Examination of the contents revealed that 29 per cent of the trout taken in 1943 had eaten at least one bluegill. For 1944, at least 21 per cent of the trout had fed on bluegills. Results of the stomach examinations will be the subject of a separate report.

Salmon

On March 27, 1945, a total of 3,190 salmon was planted in Deep Lake. These salmon were planted in Deep Lake because it was the only lake near Ann Arbor on which the Institute could obtain accurate records on the catch, growth and survival.

The salmon eggs (5,000 each of three species) were sent to the Belle Isle aquarium from the State of Washington. The eggs were received in Detroit on December 20, 1944 and hatched on or shortly after December 26, 1944. All of the surplus fingerlings were delivered to the Drayton Plains Hatchery.

A sample of 103 salmon was preserved for identification at the time of planting in Deep Lake. Dr. Reeve M. Bailey and W. F. Carbine identified these salmon as follows:

6 (5.8 per cent) Chum salmon (Oncorhynchus keta)-185 estimated planted.

25 (24.3 per cent) Silver salmon (Oncorhynchus kisutch)-775 estimated planted.

72 (69.9 per cent) King salmon (Oncorhynchus tshawytscha)- 2,230 estimated planted.

On April 23, 1945, young salmon were observed in shallow water and many were seen jumping out of the water. On May 5, a total of 10 salmon was taken in two seine hauls. Two king salmon, 6.4 and 6.5 inches in length, were taken with hook and line on November 6, 1945. This indicates that some salmon have survived and are making good growth in Deep Lake.

Future Management Suggestions

Further observations should be made in the future on the growth rate, feeding habits and spawning habits of Deep Lake fishes. Special emphasis should be directed towards obtaining more adequate samples of all sizes and ages of bluegills. It is extremely important that an accurate record should be kept of all fish that are caught during 1946. Lengths and weights should be recorded for all fish that are caught. Mr. Young has already been provided with a measuring board, but should obtain a trustworthy balance for weighing the fish. A creel census book and scale envelopes will be provided. The caretaker at Deep Lake should be instructed to contact all fishermen and record the catch.

It is evident that some effort should be made to control and reduce the bluegill population in Deep Lake. Before Deep Lake was poisoned, it was decided to restock the lake with smallmouth bass and rainbow trout only because we were reasonably certain that bluegills, if planted, would become stunted. Bluegills were stocked in Deep Lake after poisoning for the following two reasons: (1.) The owners insisted that bluegills be planted because this species is easily caught by children. (2.) The Institute wanted to obtain evidence to support their theory that bluegills would become stunted in the lake.

What should be done to control the bluegill population? The easiest and most efficient method would be to repoison the lake. But at this time it is believed to be more important to attempt some other measure of control that could be used on the many lakes in the State that contain stunted populations of bluegills. The introduction of a predator species is not deemed advisable. The destruction of nests would probably be the most efficacious method. This would require a minimum of effort and would determine if a year class could be controlled, and if so, the effects this would have on the remainder of the bluegill population and the other species present in the lake. It would be of value to ascertain which method of nest destruction is most effective. Suggested methods are as follows:

1. Destroying those nests containing eggs or fry by stirring up the nests.

2. Localized poisoning with rotenone.

3. Salting immediate area of nest.

4. If the above do not work, to siphon eggs or fry from all nests.

Adequate controls should be maintained for each experiment. Perhaps these experiments could be conducted in one or more hatchery ponds (Drayton Plains recommended). The destruction of the nests in Deep Lake would require the time of at least one person for about a two-hour period twice a week. The experiments at the fish hatchery would require the services of only one man part of each day and could be scheduled to fit in with some other work at the hatchery or vicinity. The writers believe that this problem is important enough to be scheduled for 1946.

Observations should be made on the spawning habits of the smallmouth bass in Deep Lake. If weather conditions are average in 1946, the smallmouth should spawn. In the event that smallmouth bass do not spawn successfully in 1946, it may be tentatively concluded that they are not going to establish themselves successfully in Deep Lake. In that event, a planting of 1,000 largemouth bass fingerlings (2 to 3 inches in length) should be made. Largemouth bass were maintaining themselves successfully in Deep Lake prior to poisoning.

Another planting of 1,000 rainbow trout is recommended for 1946. Arrangements have already been made to obtain 1,000 fingerling rainbow trout from the Northville Hatchery (U. S. Fish and Wildlife Service) in the fall of 1946. These rainbow trout will be marked by fin-clipping before planting.

The growth rate and the survival of the salmon will be checked at intervals during 1946.

INSTITUTE FOR FISHERIES RESEARCH

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