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PRELIMINARY REPORT ON THE AGE AND GROWTH OF THE LAKE TROUT,

CRISTIVOMER N. NAMAYCUSH IN INLAND MICHIGAN LAKES

by

Vernon C. Applegate

At the present time there are no published reports on the age and growth of the lake trout in inland Michigan lakes to be found in the literature. D. S. Shetter in an unpublished report (IFR Report No. 780, 5/1/42) has given the ages of 41 specimens which were determined by scale reading. However, since he obtained 31 of his total specimens from the collections of the U. S. Fish and Wildlife Service, we assume that they were material taken from the Great Lakes and hardly applicable to the present study.

There is a striking paucity of aging data of any description for the lake trout on record today. A more or less comprehensive study has been completed by Royce (Ms) for several eastern lakes in which his age determinations were made by the "scale reading" method. Juday and Schneberger (1930, Mimeographed Report) give the ages of 48 specimens from Wisconsin waters determined by the same technique. Various writers (Eddy, 1941; Greeley, 1936; Neave and Bajkov, 1929; Van Oosten, 1943) have recorded in popular and technical accounts the ages of scattered single specimens and small collections. Growth over known periods of

*abc*

time has been recorded in several instances. Surber (1933) reported on the growth of 2,000 lake trout through their fifth year of life in the ponds of the Lanesboro Hatchery in Minnesota. Smith and Van Oosten (1940) obtained aging data on this species which was based on the returns of tagging experiments carried on in Lake Michigan. Unfortunately, the data they obtained were based on very few specimens. Fry and Kennedy (1937) suggested ages for lake trout in Lake Opeongo, Ontario at varying lengths which were derived from the modes of a length-frequency diagram.

Such of this material by other workers that appeared useful for comparative purposes has been summarized and is incorporated in Table 1.

Materials for the present study consisted of scale samples from 402 specimens that had been accumulated in the scale sample files of the Institute since 1932. The date of the latest collections was May 7, 1946. Of the total available samples, 8 were of lake trout taken in the Great Lakes. The balance, 394 specimens, were taken from inland Michigan lakes and Michigan hatcheries. A check list of the recorded scale samples of lake trout in the files of the Institute is appended to the Institute copy of this report to facilitate further investigation at a later date. This check list covers Scale Sample Record Volumes I and II and Volume III to Sample #81435.

#### Validity of the Scale Method for Age Determinations

Initial attempts by the writer to determine the age of specimens from several inland lakes by the scale markings met with considerable difficulty and a marked uncertainty as to the accuracy of the results. Growth zones on the scales appeared reasonably consistent in some specimens but in many instances defied all efforts at accurate interpretation. Criteria that might be useful in distinguishing annular markings were elusive and variable in character. In general, the annular marking was

Table 1.--Summary of age and growth data for the lake trout reported by other investigators

Age group	1941		1936		1943 (Ms)		1943 (Ms)		1943 (Ms)		1942		1933		1940			
	Number specimens	Av. lgth. (inches)	Number specimens	Av. lgth. (inches)	Number specimens	Av. lgth. (inches)	Number specimens	Av. lgth. (inches)	Number specimens	Av. lgth. (inches)	Number specimens	Av. lgth. (inches)	Number specimens	Av. lgth. (inches)	Number specimens	Av. lgth. (inches)		
	Eddy, S. Localities: Minnesota; inland lakes except 1st specimen in age group IX from Lake Superior		Greeley, J. R. Localities: New York; Otsego Lake		Juday, C. & Schneberger, E. Mimeo. Report (no date) Locality: Wisconsin		Royce, W. F. Localities: New York; Kenka Lake		Royce, W. F. Localities: New York; Seneca Lake		Royce, W. F. Localities: Ontario; Lake Simcoe		Shetter, D. S. Localities: Misc. Michigan waters (over 3/4 of specimens from Great Lakes)		Surber, T. Localities: Minnesota; Lanesboro Hatchery (2,000 lake trout raised to maturity in hatchery ponds)		Smith, O.H. & Van Oosten, J. Localities: Lake Michigan	
0	...	...	...	...	...	...	...	...	...	...	...	(2)	3.6	...	...	...	...	
I	...	...	...	...	...	...	(8)	6.5	(1)	10.8	...	...	(1)	5.3	...	10	...	
II	...	...	(1)	10.4	(2)	7 3/4-8 1/2	(4)	9.2	...	...	(1)	9.8	(2)	8.1	...	14	...	
III	...	...	...	...	(8)	7 3/4-9	(14)	11.1	...	...	(1)	13.3	(1)	10.4	...	16-18	...	
IV	...	...	(1)	10.3	(13)	8 1/4-11 3/4	(10)	17.0	(1)	23.2	(4)	16.1	(3)	13.2	...	18-22	...	
V	...	...	(2)	13.8, 14.4	(13)	8 1/4-21	(34)	20.0	(13)	23.5	(20)	22.1	(13)	18.2	...	18-26	...	
VI	...	...	...	...	(9)	15 1/2-23 1/4	(13)	23.8	(20)	28.3	(17)	24.2	(3)	19.3	...	...	...	
VII	...	...	(2)	24.7, 30.8	(3)	18 1/2	...	...	...	...	(10)	28.0	(3)	20.8	...	...	...	
VIII	...	...	...	...	...	...	...	...	...	...	(4)	29.6	(5)	26.5	...	...	...	
IX	(2)	32.4, 35.9	...	...	...	...	...	...	...	...	...	...	(5)	25.8	...	...	...	
X	...	...	(1)	32.0	...	...	...	...	...	...	...	...	(2)	28.8	...	...	...	
XI	(1)	29.1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
XII	...	...	...	...	...	...	...	...	...	...	...	...	(1)	33.0	...	...	...	

Where not stated by the author it has been assumed that total length was the measurement taken. Fractions or decimals used as originally reported; in one instance (Greeley, 1936) millimeter measurements have been converted to inches to render it readily comparable.

distinguishable by compressed or interrupted circuli or both, varying from fish to fish in character and from lake to lake in facility of recognition. Frequently these distinguishing marks varied in character and extent from scale to scale on the same fish.

Other investigators, familiar with the lake trout, have informed the writer of considerable difficulty experienced by them in attempting to interpret lake trout scales for aging data. Royce (Ms) indicated from his examination of lake trout scales that he met with some difficulty in their interpretation varying somewhat with the lake from which the specimens were taken. He concluded for his specimens that no perfectly objective criteria could be set up for the recognition of an annulus and admitted some possible error in his interpretations.

The material available for this study included a number of lake trout of varying known ages that were recoveries of marked plantings of fish of known age. This provided an excellent opportunity for a check on the validity of the scale method for lake trout in certain Michigan lakes. This check required the examination of a selected series of scales of lake trout of known ages by a group of investigators of moderate to considerable experience at "scale reading." Two examinations of this series of scales were originally planned. The first series of age determinations were to be made with no data available to the investigator but the name of the species and the nature of the study. The second series were to be made with all available data supplied (S.L., T.L., date of capture, locality, sex, etc.). Both examinations were planned as it was felt that the anticipated improvement in the accuracy of interpretation in the second series might emphasize the necessity for this pertinent information in age determinations by the scale method. Due to time limitations the check has been concluded with the first series of determinations and with one investigator's

results for the second series.

Fifty-five samples were selected, varying in known age from groups II to VI. Twenty-seven of these were from specimens taken in Birch Lake, Cass County, and 28 were from specimens taken in Crystal Lake, Benzie County. Five investigators other than the writer made the first and in one instance the second series of age determinations. After all aging had been completed, the correct ages of the samples were computed and results compared. Only the results of the Birch Lake material will be considered in detail. The specimens taken from Birch Lake and used in this check were all collected during the late spring, summer, and fall and lack of knowledge of the date of collection of specimens would have had little or no influence on the interpretations made.

Of the 27 Birch Lake samples (known age groups II to VI), a consistent "reading" by six investigators was recorded for only one specimen and in this instance the age was not correctly interpreted. Three samples (known ages: II, III, and IV) were aged correctly by four of the six investigators. Other than that, there was a striking inconsistency of readings for individual specimens. In several instances ages were assessed as II, III, IV, V, or VI for a specimen with a correct age of IV. The numbers and percentages of scale samples aged correctly by each investigator were as follows: Investigator "A", 2 samples (7.4 percent); "B", 18 samples (66.6 percent); "D", 9 samples (33.3 percent); "E", 8 samples (29.6 percent); "F", 16 samples (59.2 percent); and "G", 12 samples (44.4 percent). Investigator "G" was the only worker that had the date of collection and other pertinent data available when making his determinations. All age determinations upon which the preceding summary has been based are itemized in Table 2.

Table 2.--Age determinations made by six investigators from the scales of 27 lake trout from Birch Lake, Cass County

Serial number	Investigator						Known age
	A	B	D	E	F	G	
70474	IV	III	III	I	II	III	III
70475	V	IV ?	III	II	III	III	III
70476	V	IV ?	III	III	III	III	III
70477	IV	IV ?	III	II ?	IV	III	III
70478	V	IV ?	III	III ?	IV	III	V
70479	IV	III ?	II	I ?	III	III	III
70480	IV	III	II	I	III	II	III
70481	IV	IV ?	IV	II ?	III	IV	III
73498	IV	IV	IV	IV ?	IV	IV	VI
73499	V	IV ?	III	III	IV	III	VI
73501	V	IV	IV	?	V	IV	IV
73502	V	IV	III	III	IV	III	IV
73503	VI	IV	IV	IV	V	III	IV
73504	VIII	IV or V	III	IV	V	IV	IV
73505	VI	V	III	IV ?	VI	IV	VI
73506	VI	IV	III	III ?	V	IV	IV
73507	VIII	IV ?	III	IV or V	IV	IV	IV
73508	VIII	V	III	IV or V	V	IV	IV
73510	VII	IV or V	III	II	IV	III	IV
76094	VIII	V ?	IV	III	V	IV	V
76095	VIII	V ?	IV	III ?	V	IV	V
76096	VII	V	III	IV	V	IV	V
76097	IX	V ?	V	IV or V	VI	V	V
76098	VIII	V ?	IV	V or VI	V	IV	V
76099	IX	V ?	IV	IV or V	V	IV	V
77423	VIII	V or VI	V	IV	V	IV	V
56433	IV	II ?	II	0	II	II	II

It was of interest to note certain tendencies in the aging of scales among even experienced "scale readers." One investigator's "readings" were consistently higher than the correct ages and reflect some lack of interpretation of the growth zones as seen by him. The converse was true of another investigator who apparently "over-interpreted" what he saw and arrived at ages that were consistently lower than the true ones. A check such as this should prove valuable as a guide and a warning to individual investigators who are interested in improving their facility and accuracy in aging fish by their scales.

The aging data for the 28 samples taken from Crystal Lake cannot be examined as thoroughly. These specimens were all captured in February and March and since only the first series of determinations by all investigators were completed, some error could be attributed to a lack of knowledge of the presence or absence of an annulus at the margin of the scale. All of the Crystal Lake specimens examined were of the same age (VI). Readings for individual specimens were only slightly more consistent than the Birch Lake material and in general, errors made were too great to be accounted for by a lack of knowledge of the date of collection and the possible existence of a year mark at the margin of the scales. Numbers and percentages aged correctly by the co-operating investigators varied from 4 samples (14.3 percent) to 19 samples (68.5 percent). It appeared to the writer and several other investigators that age determinations were somewhat easier to arrive at in the Crystal Lake samples than in those from Birch Lake. This is borne out in the slightly improved percentages of correct age determinations.

Some criticism might be directed at this check in so far as the known age material used was taken from lake trout planted as "2 year olds" which had spent their first winter in hatchery ponds. It has been observed in

the past that hatchery raised fish frequently exhibit irregular or indistinct annular markings for winters spent in the ponds. However, a sample of the Birch Lake planting of "2 year olds," taken at the time of planting was available for examination and an annular mark for their winter spent in the hatchery ponds was apparently distinguishable on the scales. Furthermore, had this first annulus been indistinguishable on the Birch Lake samples examined, it could not account for the gross errors in interpretation made by all investigators.

The percentages of correctly aged lake trout scale samples are so low, even in the case of the most successful investigator, that we must tentatively conclude that the scale method of determining age is neither accurate nor dependable for the populations of this species in Birch and Crystal Lakes. It may be considered by some that an accuracy of 65 to 70 percent in age determinations is adequate for some practical applications. In this respect, and with reference to the present material, considerable hesitancy and indecision was noted in the recording of age determinations. Decisions as to age, correct and incorrect, were accompanied by question marks and in many instances alternate possibilities as to age were offered. It seems evident from this that even among the more successful "readers" a percentage of fortuitous guessing has contributed to their scores.

In view of the results obtained to date it was not deemed advisable to determine the age and growth of the lake trout samples under discussion by the scale method.

#### Growth of Known Age Lake Trout

Of the total scale samples available for examination, 247 were taken from fish of known age. Unfortunately, only 89 of these lake trout were mature specimens. Of the balance, 99 specimens were from sample lots of immature lake trout held in hatchery ponds at Marquette to determine



extent of fin regeneration after clipping: 46 were a planting sample of 9 month old hatchery raised fish; and 13 were a planting sample of "2 year old" hatchery raised fish. All known age samples, with the exception of the 99 specimens held to determine extent of fin regeneration, are related to plantings in three Michigan lakes: Birch Lake, Cass County; Crystal Lake, Benzie County; and Higgins Lake, Roscommon County. Each will be treated separately.

Birch Lake, Cass County.---Plantings of lake trout fry are recorded for Birch Lake for the years 1907-1910. Evidently these plantings failed to establish this species in Birch Lake. None had been reported caught there for many years prior to 1937 either by angling or in the gill net fishing for cisco permitted there from November 15 to December 10 each year. On November 22, 1937, 9,500 nine month old unmarked fingerlings were planted. On December 2, 1940, 790 "2 year olds" were marked by clipping the dorsal fin and planted. This is known to be the extent of the plantings of lake trout in Birch Lake. Since it is believed improbable that lake trout can, or ever could, reproduce in Birch Lake, it is unlikely that any progeny of the 1907-1910 plantings could be confused with the unmarked planting of November 22, 1937. There have been only 5 recoveries of this latter planting and these are itemized with the planting sample as follows:

Date	Known age	Number of specimens	Total length in inches		
			Minimum	Average	Maximum
Nov. 22, 1937	0 (9 mos.)	46 †	2.8	3.2	3.9
Aug. 7, 1941	IV	1	...	8.3	...
July 12, 1942	V	1	...	10.4	...
Aug. 18, 1943	VI	3	14.2	15.4	17.2

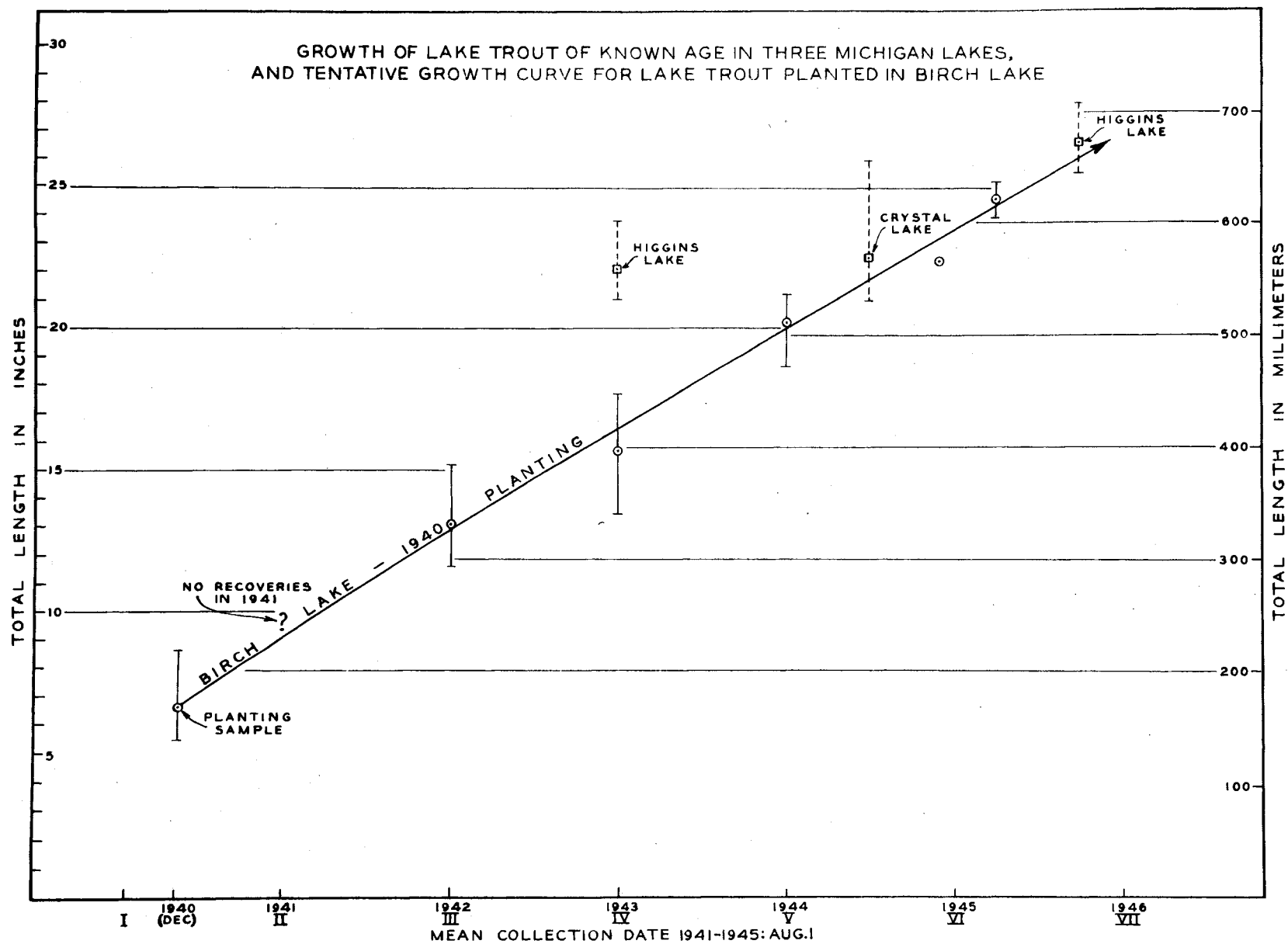
† Sample taken at time of planting.

Recoveries of the marked "2 year olds" planted on December 2, 1940 have totaled 28 fish to date. Correspondence with Mr. J. T. Wilkinson (Ltr. dtd. 3/2/45), at present District Fisheries Supervisor at Paris, Michigan, has established these "2 year olds" as young-of-the-year in the summer of 1939. Known age groups have been determined on this basis. All recoveries and the planting sample are tabulated in the following summary:

Date	Known age	Number of specimens	Avg. wt. in pounds and ounces	Total length in inches		
				Min.	Avg.	Max.
Dec. 2, 1940	I	13 <sup>✓</sup>	...	5.4	6.6	8.7
July 25- Aug. 17, 1942	III	7	0 lb., 10 oz.	11.6	13.0	15.2
July 12- Sept. 5, 1943	IV	10	1 lb., 1 oz.	13.4	15.7	17.7
June 25- Nov. 25, 1944	V	7	2 lbs., 8 oz.	18.7	20.2	21.2
July 7- Nov. 25, 1945	VI	4	4 lbs., 0 oz.	22.4	24.1	25.2

<sup>✓</sup> Planting sample.

Data in the preceding tabulation have been projected on a graph and a tentative growth rate curve has been interpolated for the marked lake trout in Birch Lake (Figure 1). For convenience, total length has been plotted against both a metric and an English scale. Collection dates of recoveries of marked fish were scattered from early summer to fall. August 1st was selected as the mean collection date in plotting the 1942 to 1944 recoveries. The 1945 recoveries are plotted as two collections, each in its proper calendar position, because of the great disparity in time between the first recovery of the year (July) and the remaining three samples which were taken in November.



Crystal Lake, Benzie County.---In May and June, 1941, 7,335 "2 year old" lake trout were planted in Crystal Lake. Of this total, 2,000 were fin-clipped (dorsal) at the time of planting. Correspondence with Mr. R. S. Marks (Ltr. dtd. 4/12/45) has established these fish as 25 to 26 months old at the time of planting. This would have made them young-of-the-year in 1939 and known ages have been computed on this basis.

There is only one collection of marked recoveries of this planting. It consisted of 48 fin-clipped lake trout taken from the lake between February 19 and March 3, 1945. These trout were all entering age group VI and their seventh season of growth. They averaged 22.8 inches in total length with a range of 21.0 to 26.0 inches. Weights had been taken for all specimens. They averaged 3 pounds, 13 ounces (3.8 lbs.) with a range of 2 pounds, 8 ounces to 5 pounds, 15 ounces. The average length and range in length of these specimens has been plotted in Figure 1 for comparison with the same age group of the Birch Lake material. The chronological and age group scale plotted along the base of Figure 1 is valid for the Crystal and Higgins Lake material as well as the 1940 planting in Birch Lake.

Higgins Lake, Roscommon County.---On May 24 and June 3, 1941, 4,165 "2 year old" lake trout were planted in Higgins Lake. The records indicate that the entire planting was marked by clipping the dorsal fin. In the same correspondence pertaining to the Crystal Lake plantings previously discussed, the age at planting and year class was established as identical for the plantings in both Crystal and Higgins Lakes.

Nine recoveries of these marked lake trout have been received by the Institute to date. Six were recovered between September 16 and November 18, 1943. These fish were in their fifth season of growth (age group IV). They averaged 22.2 inches in total length and ranged

from 21.1 to 23.8 inches. Their average weight was 3 pounds, 13 ounces with a range of 2 pounds, 14 ounces to 4 pounds, 11 ounces. The remaining three specimens were recovered between April 29 and May 7, 1946. These fish were entering their eighth season of growth (age group VII). They averaged 26.6 inches in total length and ranged from 25.6 to 28.0 inches. They had an average weight of 5 pounds, 15 ounces with a range of 5 pounds, 6 1/2 ounces to 7 pounds, 0 ounces.

The average length and range in length of these two groups of specimen has been plotted in Figure 1 for comparison with the Birch and Crystal Lake materials.

#### Discussion

Although recoveries of known age specimens have been too few to be conclusive, it appears from the material available that the lake trout in Crystal Lake were growing at a rate comparable to that of the trout in Birch Lake. This is based on the assumption that all age groups approximated each other as closely in average total length as did age groups VI in both lakes. Average weights of the age group VI collections from both lakes were similar and we may conclude from these data that there was little difference in the "condition" of the lake trout in the two lakes.

If the small collection of marked fish taken in Higgins Lake in 1943 and 1946 was a fair sample of the marked lake trout remaining in the lake on those dates, they would indicate that the 1941 planting enjoyed a markedly accelerated growth rate during their first two seasons in the lake (Figure 1). In their fifth season of growth, the specimens recaptured had identically the same average weight as those taken from Crystal Lake that were in their seventh season. They were only exceeded by the latter by 0.6 inches in average total length. However, the small collection taken in 1946 reflects a deceleration in growth rate and in

their eighth summer the Higgins Lake planting had attained an average length similar to that of the Crystal and Birch Lake plantings.

There is an appreciable disparity in the rates of growth of the 1937 and the 1940 plantings in Birch Lake. If the five unmarked lake trout samples from that lake are valid recoveries of the 1937 planting, then it would appear that for some reason the 1937 planting had some difficulty in maintaining itself. In view of the satisfactory growth rate of the 1940 planting, it is difficult to ascertain just why this should have occurred.

In general these marked lake trout in the three lakes exhibited a rate of growth comparable with those populations studied from New York and Ontario waters (Royce, Ms) and with Surbers' (1933) hatchery raised fish (see Table 1). Their growth was measurably better than that reported by Juday and Schneberger (1930) for lake trout in certain Wisconsin waters and by Greeley (1936) for the same species in Otsego Lake, New York.

In view of the difficulties encountered in securing aging data for this species by the scale method, it is recommended that elaboration of the present growth rate data and the future construction of growth rate curves for specific Michigan waters be based on recoveries of lake trout of known ages. Summaries of available known age material have been included in, or appended to, this report. It is suggested that these tabulations be cummulatively maintained and re-worked periodically to improve and expand that data which has been analyzed.

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