March 12, 1947

Report No. 1100

Original: Am. Fish. Society
cc: Fish Division
Institute for Fish. Research
Education-Game
V. Applegate

# Comparison of the growth of lake trout as determined from the recoveries of marked fish and by the scale method[1]

---

[1] Contribution from the Michigan Institute for Fisheries Research

---

by

Vernon C. Applegate

Michigan Department of Conservation

Ann Arbor, Michigan

## Abstract

Scales of lake trout of known age from an inland Michigan lake were examined. The scales were exceedingly difficult to interpret for aging data. Seven investigators made age determinations from the scales of a series of 27 specimens. Of 189 scale samples on which individual age determinations were made by the group, nine were discarded. Of the balance of 180 determinations, 39.4 percent were correct and 60.6 percent were incorrect. Some personal bias in age determinations was apparent but generally errors in aging were distributed both above and below the true ages. Growth-rate data, computed from the ages estimated by each investigator, deviated slightly in some instances from true measurements, but in other cases resulted in growth rate curves severely displaced to the right or the left.

---

Considerable interest has been displayed by fishery biologists in recent years in the accuracy of age determinations made by the scale method for certain species of fish. The lake trout, Cristivomer n. namaycush, has been the subject of some of this interest. Several investigators, familar with this species, have informed the author that they have experienced considerable difficulty in attempting to determine the ages of lake trout from scales. Initial attempts by the writer to determine lake trout ages by the scale markings were made with difficulty and accompanied by a marked uncertainty as to the accuracy of the results. Growth zones on the scales of some specimens appeared reasonably consistent, but in many they defied all efforts at interpretation. The distinctness of the characters ordinarily most useful in distinguishing annular markings (such as compressed or interrupted circuli and "cutting over" in the lateral regions of the scales) was extremely variable from fish to fish and even from scale to scale.

A collection of lake trout of known age was available and advantage was taken of this opportunity to check the accuracy of the scale method for the population from which these fish had been taken. These specimens were identifiable recoveries of fingerling and "2-year-old" lake trout that had been planted in Birch Lake, Cass County, Michigan. A careful check of state fish hatchery records was made to establish their precise age at the time of planting.

For the purposes of this study, a series of 27 specimens varying in known age from III to VI were picked at random from the Birch Lake materials. These particular lake trout were all recovered during the late spring, summer and fall, and were believed to present no problem as to the

presence or absence of an annulus at the margin of the scales. Lake trout recovered from another lake during the months of February and March showed evidence of annulus formation taking place at that time. The earliest date of collection in the series picked for study was June 25. A small band of growth was evident on the scales of these specimens outside of what was taken to be the last annulus and was considered to be evidence that the seasons' growth had begun sometime prior to the earliest collections.

That the fish recovered were planted as "2-year-olds" might conceivably have caused some errors in age determinations. These "2-year-olds" had spent their first winter in hatchery ponds (they were planted early in their second winter). It has been observed in the past that hatchery-reared fish frequently exhibit irregular or indistinct annular markings for winters spent in the ponds. However, a sample of the Birch Lake planting, taken at the time of planting, was available for examination and an annular mark for their winter spent in the hatchery ponds was distinguishable on the scales.

This series of 27 scale samples was presented to each of a group of investigators with the object of ascertaining what variations in the interpretations of age would result. In addition to the writer, six fishery biologists of moderate to considerable experience at scale reading examined these samples and recorded their age determinations. Four of the cooperating biologists (A, D, E, F - see Tables 1 and 2) were provided with no pertinent information concerning the specimens other than the nature and purpose of the study and an identifying serial number for each mounted scale sample. The remaining three investigators (B, G, H) had at their disposal the total length, date of capture, locality and sex of each specimen.

Table 1.--Distribution of errors of age determination, mean errors, and difference between estimated average age and true average age for 27 lake trout from Birch Lake. (Percentage of specimens aged correctly in parenthesis)

| Investigator | Deviation (number of annuli) of estimated from known age | | | | | | | | | No age assigned (number of fish) | Mean error[1] | Mean estimated age[2] | Difference between mean estimated and mean known age[3] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | | | | |
| A | ... | ... | 1 | 1 | 3 (11.1) | 7 | 5 | 5 | 5 | ... | 2.0 | 6.1 | 1.9 |
| B | ... | ... | 3 | 2 | 14 (51.8) | 5 | ... | ... | ... | 3 | 0.5 | 4.1 | -0.1 |
| D | ... | 2 | 4 | 12 | 8 (29.6) | 1 | ... | ... | ... | ... | 1.0 | 3.3 | -0.9 |
| E | 1 | 1 | 9 | 7 | 3 (11.1) | ... | ... | ... | ... | 6 | 1.5 | 2.7 | -1.5 |
| F | ... | ... | 3 | 2 | 15 (55.5) | 7 | ... | ... | ... | ... | 0.6 | 4.2 | 0.0 |
| G | ... | 1 | 4 | 10 | 11 (40.7) | 1 | ... | ... | ... | ... | 0.8 | 3.5 | -0.7 |
| H | ... | 2 | 3 | 3 | 17 (62.9) | 2 | ... | ... | ... | ... | 0.6 | 3.8 | -0.4 |

[1] Mean of the absolute values of the individual errors.

[2] Expressed in terms of the number of annuli observed on the scales.

[3] Mean known age was 4.2.

Table 2.--Average total lengths (in inches) of age groups of lake trout from Birch Lake as estimated from scale readings by seven investigators and by the recovery of marked fish of known age. (Number of specimens in parenthesis)

| Investigator | Age Group | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | I | II | III | IV | V | VI | VII | VIII | IX |
| A | ... | ... | ... | ... | 12.1 (7) | 14.2 (6) | 15.2 (3) | 17.5 (2) | 18.8 (7) | 20.9 (2) |
| B | ... | ... | 8.3 (1) | 12.1 (3) | 14.4 (12) | 18.9 (8) | ... | ... | ... | ... |
| D | ... | ... | 10.8 (3) | 15.2 (14) | 17.1 (8) | 20.8 (2) | ... | ... | ... | ... |
| E | 8.3 (1) | 12.1 (3) | 14.0 (4) | 16.2 (7) | 16.9 (6) | ... | ... | ... | ... | ... |
| F | ... | ... | 10.3 (2) | 13.2 (5) | 14.6 (7) | 18.2 (11) | 17.6 (2) | ... | ... | ... |
| G | ... | ... | 10.4 (2) | 13.9 (10) | 17.4 (14) | 20.4 (1) | ... | ... | ... | ... |
| H | ... | ... | 10.4 (2) | 13.3 (9) | 16.2 (10) | 20.0 (5) | 21.2 (1) | ... | ... | ... |
| True averages | ... | ... | ... | 13.0 (7) | 15.0 (9) | 18.9 (8) | [1] 15.4 (3) | ... | ... | ... |

[1] Only smaller specimens of this age group represented in random sample used in this study.

After all aging had been completed, the correct ages of the samples were computed and the results compared. A total of 189 individual age determinations by the group were possible. Nine specimens were discarded by two workers as unreadable. Of the balance of 180 determinations, 71, or 39.4 percent, were correct and 109, or 60.6 percent, were incorrect. The distribution of errors of age determination, mean errors, and difference between estimated average age and true average age for the 27 lake trout examined by all investigators is detailed in Table 1. The deviation in years of estimated from true age is expressed in terms of the number of annuli observed or not observed on the scales. The true average, or mean known age, of these specimens was 4.2 years. This figure is used for statistical convenience. In actuality, it represents the average number of annuli theoretically present on the scales of the fish at the time of recapture.

The scores recorded for individual investigators extended from 11.1 percent to 62.9 percent correct age determinations. Three individuals aged more than 50.0 percent of the specimens correctly. Some personal bias in the interpretation of the scales was evident in several instances. Investigator "A" consistently overestimated the ages, where as all errors made by investigator "E" were errors of underestimation. These two individuals were extreme cases. Errors made by the balance of the investigators were distributed both above and below the true ages, although the general tendency was to underestimate the ages of the fish.

It is interesting to consider the diversity of growth-rate data that might have resulted had each investigator prosecuted an independent growth study with the material at hand. To illustrate this possibility the average total lengths of age groups of the lake trout examined, as

estimated from the scale readings of each investigator, are presented in Table 2. The true average total lengths for age groups represented in the series studied is inserted for comparison.

In view of the tremendous numbers of errors in aging, some of the errors of estimate of the average length of the age groups are surprisingly small. For example, in age group III, four of six investigators were within 1.0 inches of the correct estimate. In age group IV, three of seven investigators and in age group V, four of six investigators were within 1.5 inches of correct estimates. Some compensatory errors have contributed to their success in this regard. The greatest error lay in the establishment of age groups that were not present in the sample. This was so prevalent in two instances (Table 2) as to completely displace, to the right and to the left, the rate of growth as visualized on an age group scale.

The data of this report cannot serve as a basis for any general conclusions as to the applicability of the scale method for the lake trout, or to imply that the data on age, based on scale studies, that have been presented by other workers are inaccurate. It is conceded that lake trout scales are generally difficult to interpret for aging data. Furthermore, it is now recognized that the facility with which scales may be read will vary from population to population within the same species. The data presented herein demonstrate that the population from which the specimens used in this study were drawn does not lend itself well to determinations of age by the scale method. It may well be a measure of the success that may be anticipated with this technique when applied to populations of fish whose annular scale markings are

indistinct, irregular, or poorly defined. On the other hand, it is entirely possible that in other populations of lake trout, the scale method may prove to be successful within narrow limits of accuracy.

INSTITUTE FOR FISHERIES RESEARCH

Vernon C. Applegate

Approved by: A. S. Hazzard
Typed by: S. E. Bommer