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Age Estimates of Brook Trout from High-elevation Rocky Mountain Streams using Scales and Otoliths

Abstract

It is important to know the age structure of fish populations when setting management policies. However, techniques for aging fish have met with mixed results. To test reliability of two techniques, age estimates were made from scales and otoliths for brook trout, *Salvelinus fontinalis,* collected at elevations of 2750 m and 3200 m above mean sea level in the Snowy Range of the Rocky Mountains, southeastern Wyoming. Our results indicated that age estimates from otoliths tended to be higher than those from scales. Agreement was poor between independent estimates by different readers, and between separate estimates by a single reader, for both structures. Neither scales nor otoliths produced reliable age estimates for brook trout from high-elevation streams.

Introduction

The use of scales and otoliths to age brook trout have had mixed results. Scales have been shown to be a valid structure for aging brook trout, *Salvelinus fontinalis* (Cooper 1951, Konapachy 1978), but several investigators have reported difficulty in reading scales from fish in slow-growing populations (King 1942, Wilder 1952, Reimers 1958, Rabe and Dyer 1964). Furthermore, otoliths yielded higher age estimates than scales for stream-dwelling brook trout collected north of latitude 56°N (Grande 1964, Dutil and Power 1977). Konapacky (1978), however, found little difference between age determinations using otoliths and scales for brook trout from the Appalachian Mountains of Eastern United States.

To our knowledge, a comparison of otoliths and scales for aging brook trout from high-elevation (>2500 m above mean sea level) streams in the Rocky Mountains has not previously been made. The objectives of our study were to (1) determine whether age determinations based on otoliths and scales from brook trout in high-elevation streams were similar, (2) determine if aging precision by separate readers differed between otoliths and scales taken from brook trout in these streams, and (3) describe the extent of variation in age determinations by a single reader between independent readings of each structure for these fish.

[1]The Unit is jointly supported by the University of Wyoming, the Wyoming Game and Fish Department and the U.S. Fish and Wildlife Service.

Study Area and Methods

Brook trout were collected by electrofishing during summer 1985 from two streams in the Medicine Bow National Forest—Telephone Creek (elevation above mean sea level at the sampling site, 3200 m) and Coon Creek (2750 m). Both streams are in a subalpine zone with a six- to seven-month winter period of snow and ice cover, when water temperatures are about 1°C; they do not exceed 10°C through the ice-free period.

Scales were removed from a point above the lateral line near the dorsal fin. They were prepared in the laboratory by merely soaking them in water in a Petri dish for several minutes for cleaning. Scales were magnified (90X) and photocopied with a microfiche copier.

We removed otoliths through the roof of the mouth, following the procedure described by Schneidervin and Hubert (1986). Otoliths were soaked in anise oil for six weeks to clear and then read with a dissecting microscope. Otoliths were placed on a microscope slide with a drop of toluene to remove the anise oil residue. A light source was placed at an angle to the microscope stage, which had been covered with a black plastic sheet.

Annuli on both scales and otoliths were identified using the criteria of Lux (1971). Two independent readings of each structure by a single reader were conducted. Two additional readers made one independent reading of each structure. The first reading of the first reader and the readings of the two additional readers were used to estimate fish age for a particular structure.

When at least two readings were in agreement, that agreed upon age was used. When no agreement was achieved among the three readers, the median value was used.

Results

The data from all 165 brook trout collected from the two streams were pooled for analysis. Both scales and otoliths indicated slow growth. The average total lengths of brook trout in the sample at different ages, as estimated by the two methods, were as follows (n = sample size):

Age	*Scales*	*Otoliths*
I	120(9)	102(10)
II	127(52)	116(23)
III	174(66)	130(27)
IV	190(36)	189(51)
V	194(2)	—

No growth was detected using otoliths beyond age IV (n=54) to the maximum estimated age of IX. A significant difference was observed when the frequency histogram of estimated ages based on scales was compared with that based on otoliths (chi-square = 93.5, df=8, $P \leq 0.01$; Figure 1). When scales were used the modal age of fish collected was three years (range, 1-5 years); when otoliths were used the modal value was four years (range, 1-9 years).

Otoliths tended to yield higher age estimates than did scales for all ages (Figure 2); individual differences were as great as five years. Ages based on otoliths were higher than those based on scales in 64 percent of the fish studied; ages determined from the two structures agreed for 27 percent of the fish.

The independent readings of three trained readers differed significantly for both otoliths (chi-square = 37.7, df=18, $P \leq 0.01$) and scales (chi-square = 80.3, df=12, $P \leq 0.01$). The agreement between two separate age determinations by a single reader was only 48 percent for otoliths and 55 percent for scales.

Age determinations by a single reader differed by as much as four years when otoliths were used and three years when scales were used. A one-year age difference occurred in 44 percent of the fish when otoliths were used and in 39 percent when scales were used.

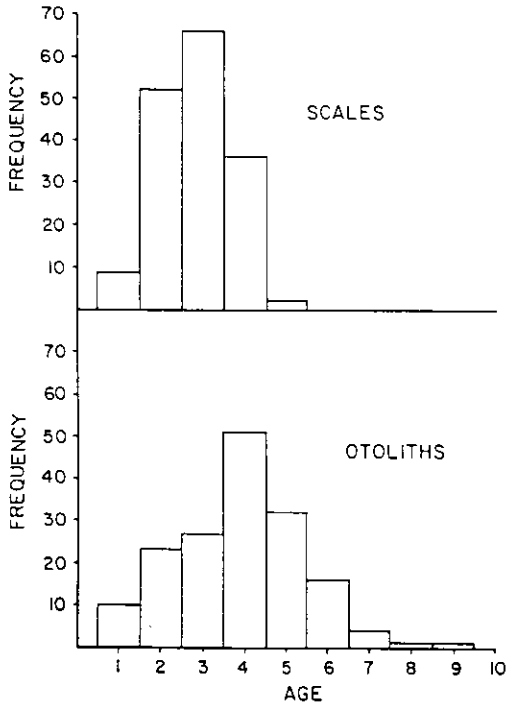

Figure 1. Frequency histograms for estimated ages based on scales and otoliths from brook trout.

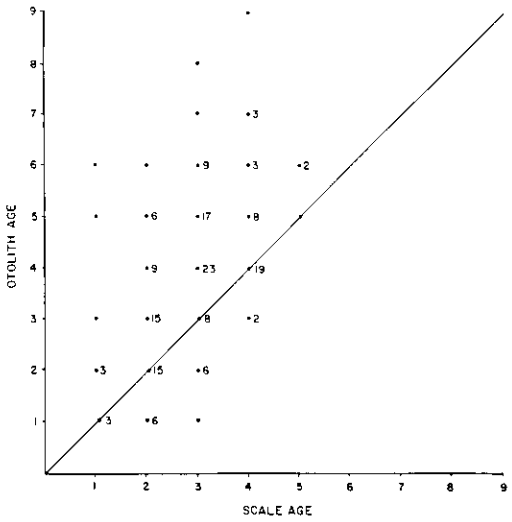

Figure 2. Comparison of age estimates for brook trout based on otoliths and scales. Points represent individual fish except where indicated by numbers. Points on the diagonal line indicate equal age estimates for both structures.

Discussion

Otoliths tended to indicate older ages than scales in this sample of brook trout from high-elevation Rocky Mountain streams. Similar results were observed at more northern latitudes by Grande, 1964; and Dutil and Power, 1977. Grande (1964) observed good correlations between scales and otoliths for the first three years, but differed thereafter with maximum age of scale-aged fish being six years and of otolith-aged fish being eight years. Dutil and Power (1977) observed consistent differences with the maximum age of scale-aged fish being eight years and otolith-age fish being ten years. Such differences, however, were not observed for stream dwelling brook trout at moderate elevations in lower latitudes of the Appalachian Mountains (Konopacky 1978).

Otoliths and scales have been used to estimate the age of other slow-growing fishes in north temperate latitudes, e.g., Arctic grayling, *Thymallus arcticus* (Sikstrom 1983); lake whitefish, *Coregonos clupeaformis* (Barnes and Power 1984); round whitefish, *Prosopuim cylindraceum* (Jessop 1972); cisco or lake herring, *Coregonus artedii* (Morin 1980); longnose sucker, *Catostomus catostomus* (Tripp and McCart 1974); and cutthroat trout, *Salmo clarki* (Hubert *et al.* 1987). In general, few differences between ages determined from scales and from otoliths were observed among young fish, but estimates based on otoliths were consistently older than those based on scales for older fish. Evaluation of aging precision has generally not been made; the only known assessment with a salmonid was by Hubert *et al.* (1987) for cutthroat trout from Yellowstone Lake where poor precision was also observed.

Neither scales nor otoliths appeared to yield sound estimates of age in our sample of brook trout from high-elevation streams. Substantial variation in age determination was observed among independent readers and between readings by one reader with either structure. The inconsistent growth pattern expressed by the average total lengths at annulus formation in our sample is believed to be due to the imprecision of aging among readers and the statistics should not be considered as accurate estimates of growth for either otolith-aged or scale-aged fish. Use of either otoliths or scales is imprecise. Summary statistics developed from such data must be considered merely as rough estimates. Such a conclusion is important to management agencies that use such information to establish regulations and control exploitation.

Validation of otoliths as an aging technique suitable for slow-growing brook trout from high-elevation mountain streams is needed. Although differences were observed between otoliths and scales, we did not determine which structure provided the more accurate estimate of age.

Acknowledgements

We thank J. Hart for field assistance; and J. Lessard and M. Tiezen for laboratory assistance. This study was supported by the Wyoming Cooperative Fish and Wildlife Research Unit.

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Received 11 December 1986
Accepted for publication 1 July 1987