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Comparison of Otolith and Scale Age Determinations for Freshwater Drum from the Mississippi River

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A comparative aging study was conducted using scales and otoliths from 123 freshwater drum collected in Pool 14 of the Mississippi River. Two independent readings by 2 investigators resulted in full agreement on ages assigned using otoliths, but only 64% agreement using the scale method. A final age was determined for the remaining scale samples based on the most commonly assigned age. However, there was no agreement on assigned ages for 12% of the scales examined. Otoliths were validated as an accurate method for aging freshwater drum by age frequency histograms for 3 consecutive years. The marked 3-year periodicity in appearance of strong year-classes allowed these strong year-classes to be followed through successive years of study providing a check on the reliability of this aging method. Scales were concluded to be only 61% reliable for aging freshwater drum. The observed trend indicated that assigned ages using scales were commonly overestimated for fish age 9 and younger and underestimated for older fish.

INDEX DESCRIPTORS: freshwater drum, otolith, aging methods, Mississippi River.

Fish scales are widely used as the traditional hard structure for aging most freshwater teleosts (Everhart, et al. 1975). Scales are convenient since they can be easily collected without sacrificing fish. However, for some species, scales are difficult or impossible to interpret (Carlander 1974) and other hard body parts have been found superior for age and growth analyses (Harrison and Hadley 1979). Alternative structures include cleithra (Schmitt and Hubert 1982; Harrison and Hadley 1979), fin rays (Johnson 1971; Quinn and Ross 1982; Mills and Beamish 1980), and otoliths (Gregory and Jow 1976; Beamish 1979).

Results from these studies have generally shown that scales were relatively accurate for aging younger fish, but ages of older fish were frequently incorrect when the scale method was used. Ages determined by the scale method were often lower than corresponding ages determined by alternative methods.

The objective of this study was to compare and validate the ages obtained from otoliths and scales of freshwater drum (*Aplodinotus grunniens* Rafinesque). Inconsistencies in age data based on scale analyses and the availability of otoliths from fish already being sacrificed for research purposes prompted the investigation.

METHODS

Freshwater drum for the study were collected using hoop nets in Pool 14 of the Mississippi River. All fish were collected from 5 April - 14 May 1982. A two-part subsampling procedure was used to select scales and otoliths for aging. Initially, one of every five fish collected in the hoop nets, as determined by random selection, was returned to the laboratory. The largest otolith (sagitta) was removed from each side of the head and placed in a number coded envelope. Scales were then removed from the same fish according to the method of Lagler (1956), and placed in a coded envelope apart from the otoliths. The final specimens for comparative otolith and scale aging were chosen at a frequency of 5 fish per cm length group resulting in a total sample of 123 fish. Total lengths ranged from 16 to 45 cm.

Otoliths were prepared for aging by breaking them in half perpendicular to the longest axis. The freshly broken surface of one half of the otolith was then coated with glycerine and examined under a binocular dissecting scope (7 to 30x). Contrast between opaque and translucent zones was enhanced by side illumination. When transmitted light is used (for otolith sections) the opaque zone is dark and the translucent (hyaline) zone is light. The opaque zones were treated as annuli and counted.

Scales were impressed on 0.08 cm thick cellulose acetate slides by a heated hydraulic press (Greenbank and O'Donnell 1948). Scales and otoliths were each examined twice by 2 investigators. All age determinations using otoliths or scales were made without reference to fish length or weight or previously assigned ages.

RESULTS AND DISCUSSION

Agreement on assigned ages using otoliths after the first reading by each investigator was 91%. Agreement on assigned ages using the scale method was 46% after the initial readings. Five regenerated scale samples could not be used for age determinations and were excluded from the study.

All disagreements on assigned ages using the otolith method were resolved following the second readings. Second readings using the scale method resulted in 64% agreement on assigned ages. A final age was assigned to each of the remaining scale samples on the basis of the 4 independent readings of each sample. The age most often assigned from the 4 readings was considered the final age. Four different ages were assigned on 12% of the scales analyzed. Therefore, no final age could be determined for these particular scale impressions. Final age assignments using scales were compared with assigned ages from the otolith method.

Validation of Otoliths for Freshwater Drum Age

Accuracy of an aging method is ideally evaluated using known age fish. This means of verification can rarely be achieved when a wild stock is under consideration, as was the case with freshwater drum in this study.

Age frequency analyses, however, provided substantial evidence for validation of the otolith method for aging freshwater drum. A marked 3-year periodicity in appearance of strong year-classes over a 3-year period (1980-1982) allowed particularly strong year-classes to be followed on age frequency histograms (Fig. 1). All ages assigned during these 3 years were based on the same otolith methodology outlined above. Ricker (1975) concluded that age frequency histograms provide a valid check for determining the reliability of an aging method, especially when strong year-class periodicity exists. On this basis, ages assigned using the otolith method were considered the actual ages of fish analyzed.

Comparisons of Otolith and Scale Ages

The scale method tended to overestimate freshwater drum age

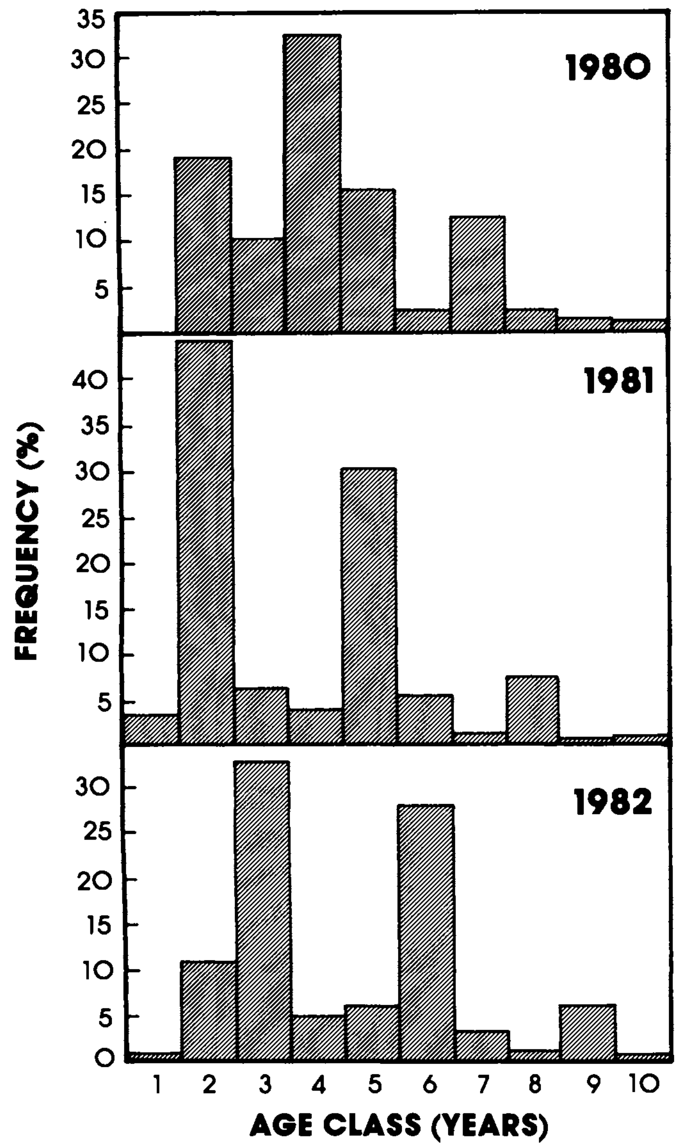

Fig. 1. Age frequency histograms for freshwater drum from the Mississippi River as determined from otoliths (Commonwealth Edison Company, unpublished data).

through age 9 and underestimate age of older fish (Fig. 2). Underestimation of age for older fish using scales has been reported by others (Harrison and Hadley 1979; Power 1978) and discussed in detail by Carlander (1974). Overestimation of age using scales from young fish has not been a prevalent conclusion of these investigations. Average variability of scale age among young fish was generally in error by 1 year or less in this study (Fig. 2). The error in underestimating age of older fish was of greater magnitude with average variability of nearly 3 years (Fig. 2). Inconsistencies of aging using scales were exemplified by one fish, age 18 by the otolith method, which was assigned 4 different ages ranging from 8 to 12 using scales. Overall, scales were only 61% reliable for aging this species.

Management Implications

Age composition data are necessary for calculating many population parameters, but rarely are errors introduced by aging considered a serious source of bias (Mills and Beamish 1980). The argument frequently used is that errors would usually only affect a small portion of a sample, generally old individuals which make up only a small portion of the population (LeCren 1974). Concern for accuracy in aging the older segment of a population is questionable, excepting some special biological or economic importance. This reasoning is not applicable to the freshwater drum stock under consideration since 42% of the fish older than age 3 were aged erroneously using the scale method. Since sexual maturity is not attained by most female freshwater drum until age 5 (Goeman 1983), reproductive biology studies based on these data would promote grossly inaccurate conclusions.

Other population parameters including growth, annual survival, and survivorship could also be calculated incorrectly as a result of aging errors (Mills and Beamish 1980). These errors are potentially significant, particularly when the data are used to regulate the fishery resource.

From comparisons made in this study, it was concluded that otoliths were much more reliable than scales for age analyses of freshwater drum from the Mississippi River. Population analyses based on otoliths could be extended to older age groups more reliably than those derived from scales. Since accuracy of scales for aging freshwater fish varies among species, the use of calcified body parts for age determination is valuable for verification of the scale method and improving confidence in age assignments. Some unknown and unusual aspects of a species life history can be substantiated as age determinations are verified. For example, by using the otolith method one freshwater drum was age 28 when captured in the Mississippi River (Commonwealth Edison Company, unpublished data).

Increased reliability of age determinations using the otolith method may outweigh the major disadvantage of sacrificing fish to obtain otoliths. In many cases, specimens can be readily obtained from commercial or sport catches.

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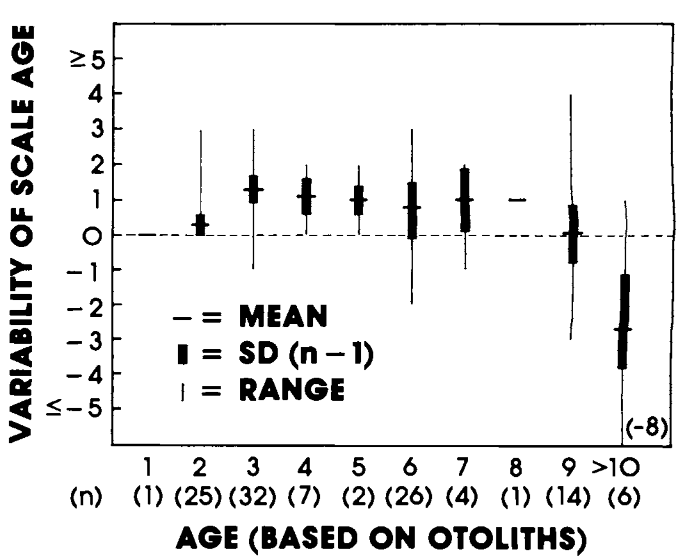

Fig. 2. Age-specific trends in the variability of scale age assignments compared to age based on otoliths for freshwater drum.

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