A Method for Comparing the Precision of a Set of Age Determinations

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An index of average percent error is a better estimate of the precision of age determinations than the conventional percent agreement method because it is not independent of the age of a species.

Key words: age determination, aging errors

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Un indice du pourcentage moyen d'erreur constitue une meilleure estimation de la précision de la détermination de l'âge que la méthode classique du pourcentage convenu, car il dépend de l'âge d'une espèce.

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MANY methods have been developed to compare the precision of age determinations. One of the more common techniques is to compare the percent of determinations that are in agreement within a specified number of years. However, a percent agreement technique does not evaluate the degree of precision equally for all species. For example, if 95% of age determinations between two readers agree within ± 1 yr for Pacific cod (*Gadus macrocephalus*), this can be very poor precision since most commercial samples contain only a few year-classes (Kennedy 1970). Similarly, if 95% of spiny dogfish (*Squalus acanthias*) age determinations agree within ± 5 yr, this can represent very good precision since dogfish may be as old as 60 yr with approximately 30 age groups in a fishery (Wood et al. 1979). The use of an index that is not independent of age would provide a better estimate of precision than the percent agreement technique.

The word precision is used to describe the reproducibility of age determinations. It does not imply that the age estimates are accurate and only relates to the consistency among determinations.

Method — An average percent error can be calculated for a repetitive series of determinations (either by the same reader or by different readers) and compared to any number of other determinations. The calculation is simple and can be defined as follows:

N fish are aged; R is the number of times each is aged. Let X_{ij} be the ith age determination of the jth fish

$$(1)\quad \text{Let } X_j = \frac{1}{R}\sum_{i=1}^{R} X_{ij}$$

(X_j is the average age calculated for the jth fish).

Then

$$(2)\quad \frac{1}{R}\sum_{i=1}^{R}\frac{|X_{ij} - X_j|}{X_j}$$

is the average error in aging the jth fish, as a fraction of the average of the age estimates. Multiplied by 100 it becomes the **average percentage error for the *j*th fish**

and

$$(3)\quad \frac{1}{N}\sum_{j=1}^{N}\left[\frac{1}{R}\sum_{i=1}^{R}\frac{|X_{ij} - X_j|}{X_j}\right]$$

is the index of average error and multiplied by 100 it becomes the index of average percent error.

The index (average percent error) can be used to compare determinations or readers. The set of determinations for a particular species with a smaller index is more precise, or the reader with a smaller index for several sets of determinations **for one or more species would be judged more precise than** another reader or another group of readers with a higher index. In all cases, greater precision is achieved as percent error is minimized. For example, the data in Table 1 can be grouped for each reader to give an index of average percent error of 4.4% for reader 1 and 11.6% for reader 2, indicating that reader 1 is more precise than reader 2. The index can also be used to compare the precision of age determinations laboratories. For example, the combined data set of readers 1 and 2 could be compared to another set of readings perhaps from another laboratory. The level of precision could also be compared between structures or species, or both. That is, the set of age determinations in Table 1 may be more precise than a set of otolith age determinations for some other species.

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TABLE 1. Example of a set of walleye pollock (*Theragra chalcogramma*) ages using the fin-ray method.[1]

Fish no.	Reader 1			Reader 2		
	1st	2nd	3rd	1st	2nd	3rd
1	7	6	7	6	5	6
2	7	6	6	6	5	6
3	6	6	5	5	4	6
4	4	4	4	4	4	3
5	4	5	6	6	5	5
6	3	3	3	3	3	2
7	5	5	5	5	4	5
8	4	4	4	5	4	4
9	4	4	4	4	3	3
10	7	8	7	6	5	7
11	7	7	7	7	5	6
12	3	2	3	3	2	3
13	5	5	5	5	4	4
14	4	4	4	5	2	4
15	6	6	4	6	4	5
16	7	7	7	5	6	5
17	6	6	5	5	5	5
18	7	7	7	7	6	6
19	8	7	7	7	5	5
20	5	5	5	5	4	5

[1]All readings were independent of previous readings and other readers' determinations and several months were allowed between readings. Fish numbers represent the sequence of sampling in the field.

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