Is Corroborating Ages a Valid Concept in (Walleye pollock, *Theragra chalcogramma*) Fish Age Determination?

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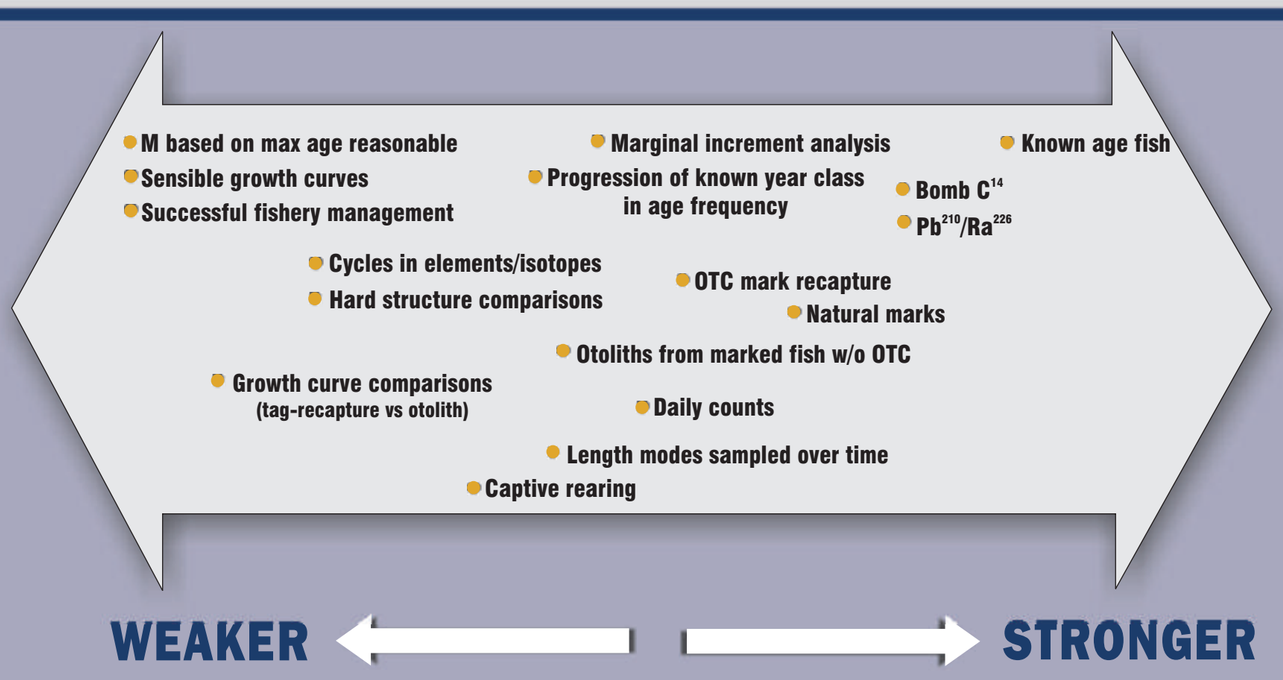
Age Determination Criteria Corroboration Versus Validation

Corroboration

corroboration- a measure of the consistency or repeatability of an age determination method. For example, if two different readers agree on the number of zones present in a hard part, or if two different age estimation structures are interpreted as having the same number of zones, corroboration (but not validation) has been accomplished (Kalish et al. 1995).



Validation

validation- the process of estimating the accuracy of an age estimation method. The concept of validation is one of degree and should not be considered in absolute terms. If the method involves counting zones, then part of the validation process involves confirming the temporal meaning of the zones being counted. Validation of an age estimation procedure indicates that the method is sound and based on fact (Kalish et al. 1995).

Corroboration and validation can be thought of as a continuum providing stronger or weaker evidence supporting fish age determination criteria.

The above definitions suggest that corroboration and validation really constitute a continuum of evidence supporting the ageing criteria being used on a particular species. Not only does the strength of corroborative-validation methods differ intrinsically (i.e., by method), the quality of the study may vary due to other factors including the quality of data and the experimental design.

Should age researchers pursue corroboration of fish ages?
To answer this question we look at three corroboration studies of otolith ages from walleye pollock.

Study 1.
Age Corroboration using Marginal Increment Analysis

This study documents the annual nature of otolith growth through the year, by documenting the faster, summer opaque growth, and the slower winter hyaline growth.

To do this we used edge type data for all ages collected by an experienced age reader from 1989 to 2002. We categorized this data into four edge categories: (1) a full increment of opaque growth or a hyaline zone on the edge (Fig. 1a), (2) slight opaque edge growth beyond the last hyaline zone, (3) an opaque edge with ¼ to ½ the opaque growth of the previous opaque increment (Fig. 1b), (4) an opaque edge with ½ to a full year's opaque growth on the edge.

Categories 1 and 3 are the critical edge categories. If the marks we are interpreting as annular are truly annular, we should see a flip flop of the proportion of each type during the year (Fig. 1c).

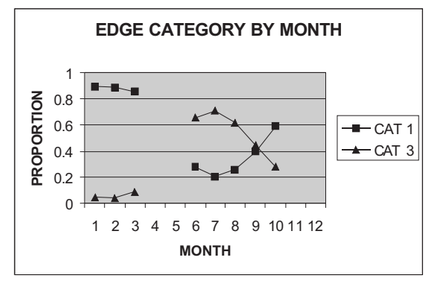
1a.

Photograph of an otolith from a 3 yr-old with an edge category of 1 collected March 16th.

1b.

Photograph of an otolith from a 3 yr-old with an edge category of 3 collected June 7th.

1c.



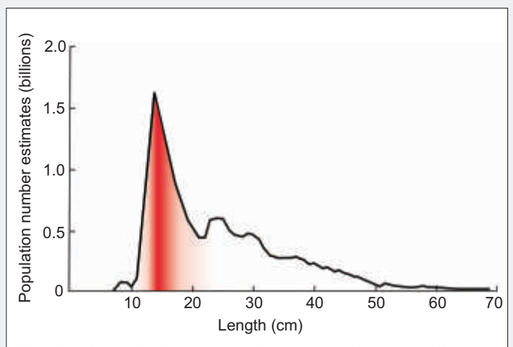
Plot showing the proportions of otolith specimens having an edge category of 1 or 3.

Study 2.
Age Corroboration using the Strong 1978 Year Class

Fish age determination can be corroborated if a strong year class can be followed over time. This indicates that the ageing criteria being used is providing correct ages.

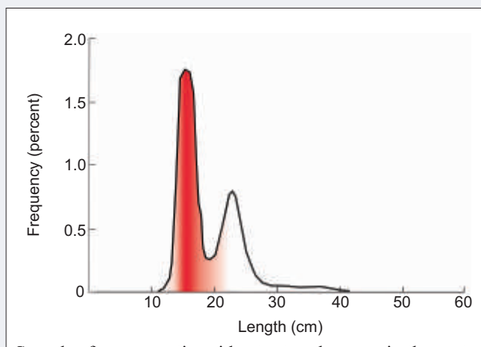
The 1978 year class in the eastern Bering Sea is perhaps the strongest year class of walleye pollock on record (Ianelli, 2002). It showed up well as 1 yr-olds in summer length frequencies in both the bottom trawl survey (Fig. 2a) and the acoustic-midwater trawl survey (Fig. 2b) in 1979 (Bakkala and Wespestad, 1983). The age frequencies from survey samples from 1982 to 1991 also show the predominance of the 1978 year class (Fig. 2c). In interpreting these data, it should be noted that age samples were length stratified on a vessel basis so that tails of the distribution were over sampled.

2a.



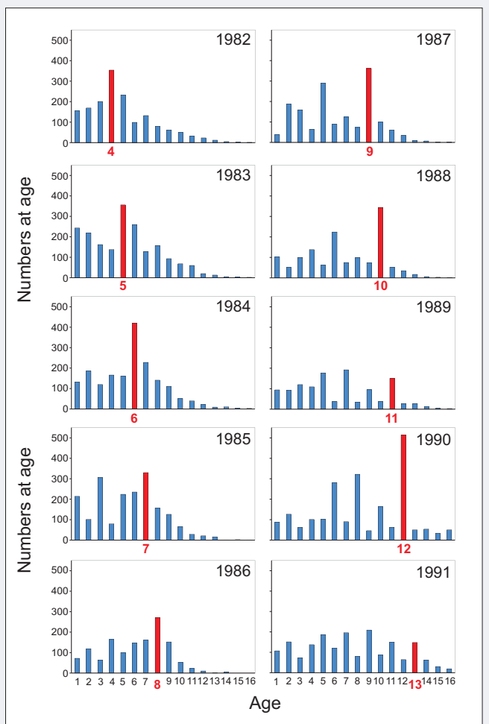
Samples from the bottom trawl survey in the eastern Bering Sea in 1979 showed a strong length mode for the 1-yr old 1978 year class (red).

2b.



Samples from acoustic-midwater trawl survey in the eastern Bering Sea shelf and slope in 1979 also showed a strong length frequency mode for the 1-yr old 1978 year class (red).

2c.



Graphs showing samples aged from annual summer bottom trawl surveys in the eastern Bering Sea. The red category depicts the age class from the extraordinarily strong 1978 year class. The strength of this year class was quite visible from age 4 yr to 13 yr.

Study 3.
Age Corroboration by Comparing Otolith Ages with Vertebra Ages

The basis of age corroboration using an additional hard structure is that if both structures provide similar ages, then the ageing criteria used on each structure is corroborated.

Two age readers made independent readings of otoliths and vertebrae. In this study age structures were randomized so that knowledge of otolith age was not known when reading vertebrae. Reader 1 (Fig. 3a) was experienced in ageing walleye pollock using both otoliths and vertebrae. Reader 2 (Fig. 3b) was extremely experienced in ageing pollock using otoliths, but had never before aged vertebra.

3a.

Reader 1

OTOLITH \ VERTEBRA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	tot
1	25																				25
2		11	12																		23
3			6	1																	7
4				18	8																26
5					15	6															21
6				1	2	3	2	1	1												10
7					3	15	3														21
8					1		3	6	1	1											12
9							1	3	4	2		1	1								12
10							1	1		6		1									9
11								2	2	2	1		1	1							9
12												1	1	1							3
13											1	2	2	1							6
14								1					3	1	1						6
15											1		1		1						3
16											1		1	1	2	1					6
17														1		1	2				4
18																	1	0			1
19																		1	1	2	4
20																				0	0
Tot	25	11	18	20	26	12	22	17	8	11	4	5	10	6	4	2	3	1	1	2	208

Cross-tabulation of walleye pollock otolith and vertebra ages generated by Reader 1.

3b.

Reader 2

OTOLITH \ VERTEBRA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	tot
1	25																				25
2		15	2	2																	19
3		2	9	3																	14
4			2	15	4	1															22
5				4	14	8															26
6				3	2	4	6	2	1												18
7						4	1	7	1			1									14
8						1	5	8	2		1										17
9					1	1	2	2	0												6
10							3	1		2		1		1							8
11											1	1	1	1							4
12								1	2		0	1				1					5
13									1				3		2						6
14							1							2							3
15										2				2	0	1	1				6
16										1	2	1	1			1	1				7
17											1			1			0				2
18												1				1	1	0		1	4
19														1		1		0	1		2
20																			1	0	1
Tot	25	17	13	27	21	19	17	21	5	6	7	5	6	7	1	3	5	0	1	1	207

Cross-tabulation of walleye pollock otolith and vertebra ages generated by Reader 2.

Conclusions

- Examinations of definitions of age corroboration and validation suggest that these terms really constitute a continuum of evidence supporting the ageing criteria being used on a particular species and not necessarily two separate classifications.
- Study 1: Age Corroboration using Marginal Increment Analysis provided strong indication that presumed annuli are being formed on an annual basis.
- Study 2: Age Corroboration using the Strong 1978 Year Class indicates that the otolith ageing criteria successfully followed this year class from ages 4 yr to 13 yr.
- Study 3: Age Corroboration by Comparing Otolith Ages with Vertebra Ages showed that in general ages read using the whole vertebra centrum gave ages similar to otolith ages.
- Taken together these corroborative studies give considerable confidence in the otolith ageing criteria (mixed surface and cut and burn) being used for walleye pollock.
- A corroborative study might be more useful in arguing basic reasonableness of the age data where large differences in ageing criteria are conjectured, rather than the finer interpretation of annular zones.
- **Should age researchers pursue corroboration of fish ages?**
  Yes, we conclude that corroborative studies can contribute greatly to a scientific evaluation of age determination criteria.

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