Theme Session II: Development and improvement of new methods and models

Fifteen years of annual Norwegian-Russian cod comparative age readings

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Extended abstract

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Fish age readings with great accuracy and precision are fundamental to any age-based fish stock assessments. Age estimation errors may result in incorrect estimation of age structure of the population, misinterpretation of age composition of fish caught, and incorrect estimation of year-class strengths. At the end, current abundance and "stock-recruitment" relationship could be distorted. Besides, age estimation errors may affect estimates of fish biological parameters, such as mean length/weight-at-age, proportion mature, and fecundity at age used in the estimation of fishable and spawning stock biomass. All the above said may entail wrong advices of the fisheries management. Moreover, it may lead to overestimation or underestimation of growth and maturity rates, condition factor and index of stomach fullness by age, which may blur the observation of any relationship with environmental parameters (sea temperature, abundance of food objects, and other environmental and ecological factors).

Annual exchange of material for age determination and of specialists between the laboratories of PINRO (Murmansk, Russia) and IMR (Bergen, Norway) was initiated in 1992. At first, it was necessary to check up paradoxical discrepancies between PINRO and IMR data obtained in trawl acoustic surveys in the Barents Sea using approximately similar fishing gear. The discrepancies were particularly high for the 1990-1991 cod data. This became a reason to advert to the problem of cod age determination with the aim of clearing up possible reasons for age discrepancies. It turned out that this cooperation was of great benefit for specialists of both institutes; and meetings of specialists and exchange of samples became regular.

In all, 6386 pairs of otoliths were exchanged during 1992-2006, and 1331 of these were repeatedly read at the annual joint age readers' meetings. The otoliths exchanged were selected at random (though with some area constraints) from the IMR and PINRO otolith archives. Results of initial age readings were not presented to the other institute upon delivery in order to get blind age reading. At the annual meetings, the specialists re-examined only those otoliths which were read differently, using a discussion binocular. The specialists discussed the otolith structure and, finally, came to an agreement and changed their initial results or continued to disagree. In most cases an agreement was reached. Microsoft Access and Microsoft Excel software was used for the analysis of results. The values of between

reader biases and their significance were determined using STATISTICA and the nonparametrical statistical module Wilcoxon Matched Pairs Test and Sign Test.

The largest initial differences were observed in the first half of the year of 1992 and in the second half of 1993, whereas the smallest ones in the second half of 1999 and in the first half of 2001 (Fig. 1). In total a significant trend of decrease of discrepancies of the initial age determination by specialists of the two laboratories can be seen ($R^2 = 0.19$). The discrepancy after discussing and re-reading the initial disagreed otoliths has in recent years been less than 5%.

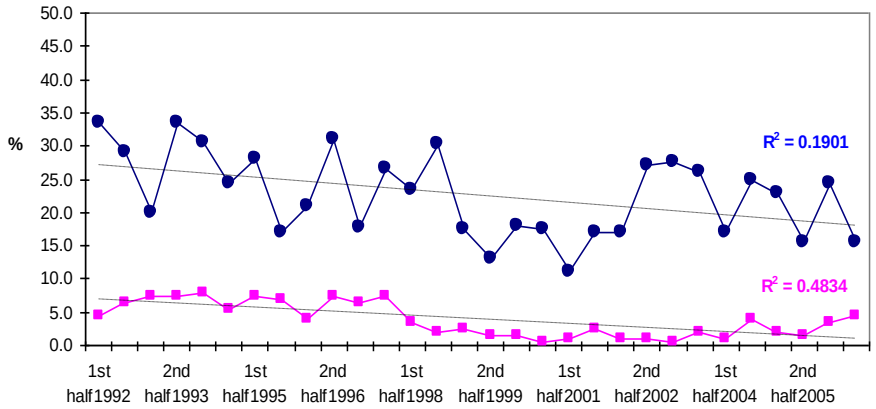

Figure 1. Percentage of discrepancies in the annual (twice per year) comparative cod age readings. Initial discrepancy before joint reading and discussion are shown by the dark curve, and the discrepancy after re-reading and discussion by the pink curve.

Insignificant differences were obtained in 1997-2000, while in the rest of the years differences were significant with the most pronounced ones in 1993-1994. Although a clear systematic bias between age determinations was not always observed, Russian estimates usually showed older age compared to corresponding Norwegian estimates.

Otoliths from the Bear Island-Spitsbergen area should be admitted as the easiest to read (the determined age by the two laboratories coincided in 83.2% of the cases) and otoliths from the southern Barents Sea as the most difficult for age reading (coincided in 75.7%). The intermediate position is occupied by otoliths of cod caught at the north-eastern coast of Norway (coincided in 76.3%).

Discrepancies in age estimates increased with cod age. Based on pooled data for all the years investigated, differences on one-year-olds occurred in only 10.1% of the cases, while in twelve-year-olds differences occurred in 85.7% of the cases. A significant linear trend was observed indicating a decrease in percentage of agreed age estimates by cod age.

Significant between reader biases were noted in fish at age 1-5 years, while no significant biases were observed in fish at age 6-9 and 11 years. For fish older than 11 years very little material was collected to get an indisputable answer. It should be noticed, that the trend in differences in age reading has an S-shaped curve, i.e. in young age groups Norwegian experts are inclined to underestimate the age compared to Russian experts, but from age 7 onwards the trend is opposite.

Important lessons have been learned from these fifteen years of regular and systematic age reading cooperation. Standardization of equipment is an initial and essential step. It is

necessary to evaluate the readers' abilities and to standardize the methods. Specialists should be trained for several years to promote continued consistency among readers. Understanding of mechanisms used for assigning the fish age permits avoidance of serious errors in our routine work and enables us to discover and correct errors immediately and, therefore, to avoid the accumulation of errors over time. Clearly, the differences in cod age reading between two laboratories have apparently decreased over the cooperation period, although we could wish that the "learning-curve" had been steeper.

There is an indisputable necessity in regular meetings and tunings of age readers. The scientific biological, and hence also the economic effect, of this work is obvious.