Slave to the rhythm: seasonal signals in otolith microchemistry reveal age of eastern Baltic cod (Gadus morhua)

Annual growth zones in cod otoliths from the eastern Baltic stock are less discrete than in other cod stocks leading to biased age reading, which recently led to a failure of age-based assessment in the eastern Baltic cod stock. In this study, we explored the applicability of minor and trace element patterns in cod otoliths for age determination. By first identifying elements of interest in a stock without ageing problems, western Baltic cod, we then tested their applicability on another stock without ageing problems, North Sea cod, and finally applied this knowledge to estimate age of eastern Baltic cod. In western Baltic cod, matching patterns with respect to occurrence of minima and maxima in both otolith opacity and element concentrations were found for Cu, Zn, and Rb, and inverse patterns with Mg and Mn. No match was found for Pb, Ba, and Sr. In the test stock, the North Sea cod, the same patterns in Cu, Zn, Rb, Mg, and Mn signals occurred. All eastern Baltic cod with low visual contrast between growth zones exhibited clearly defined synchronous cycles in Cu, Zn, Rb and Pb. Using a combined finite differencing method and structural break models approach, the statistical significance of the local profile minima were identified, based on which their age could be estimated. Despite extensive environmental differences between the three areas examined, the element concentrations of Cu, Zn, and Rb were strongly correlated in all individuals with similar correlations in all three areas, suggesting that the incorporation mechanisms are the same for these elements and independent of environmental concentrations.

General information
Publication status: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Thunen-Institut, Helmholtz Centre for Ocean Research Kiel, Kiel University
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Pages: 1019-1032
Publication date: 2016
Peer-reviewed: Yes

Publication information
Journal: ICES Journal of Marine Science
Volume: 73
Issue number: 4
ISSN (Print): 1054-3139
Ratings:
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.63
Web of Science (2016): Impact factor 2.76
Web of Science (2016): Indexed yes
Original language: English
Electronic versions:
Publisher's version
DOIs: 10.1093/icesjms/fsv247
Source: FindIt
Source ID: 2290018163
Research output: Contribution to journal › Journal article – Annual report year: 2015 › Research › peer-review