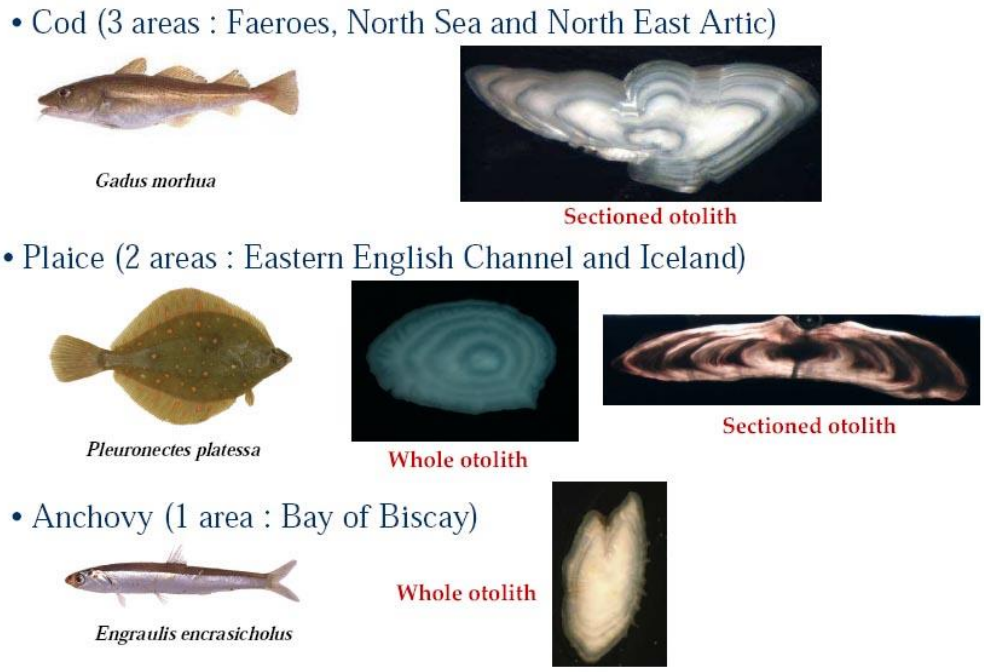
Research & Innovation

AFISA
Automated FISh Ageing
(2007-2009)

Most of the fish stocks are assessed using age-based models, however age estimations using otoliths costs several million euros annually. In this context, Automatic Fish Ageing (EU Project) aimed at providing means to standardize ageing among laboratories and build interpreted image databases ensuring the information conservation. It falls within the framework of the quality approach for ageing and storage. Automation should improve growth studies while reducing the cost of the acquisition of age data.

The overall objectives of this project were (i) the development of algorithms for fish ageing automation from otolith features (ii) the implementation of these automated ageing modules in a software platform dedicated to otolith imaging (iii) a cost-benefit analysis of the proposed automated ageing systems.

The Afisa project focused on three case studies : a) Cod (*Gadus morhua* ; Faeroes, North Sea, North East Arctic) b) Anchovy (*Engraulis encrasicolus* ; Bay of Biscay) c) Plaice (*Pleuronectes platessa*, Eastern Channel, Iceland).



A total of 6729 otoliths were collated from surveys and commercial landings. The associated data were specifically made available for the AFISA project (Area, Year, Quarter, Total Length, Weight, Sex, and Maturity). Using TNPC software, images were acquired (calibrated images under reflected and transmitted light,

otolith features). Age estimates were provided by readers each otolith. All images and data were compiled in the same format.

The consortium developed two different approaches to realise an automated fish age estimation :

- a classifier that estimates individual ages based on intensity profiles along radials of the images of otolith sections.
- models that estimates age proportion based on the otolith and fish features. Conditional and Mixture models were used.

The estimation of individual ages from otolith images involved a series of image processing methods, specifically designed for the considered case studies (morphological segmentation and nucleus detection, 2D ring detection contrast enhancement) and a nearest neighbour classification method. The angular sectors, that a priori contain the best growth marks, are selected, an intensity profile is computed in each sector and the fish's age is estimated by searching for the k most similar intensity profiles among those stored in a reference database (RDB), which has been calibrated by experts. To reduce the effects of non-linear growth the profiles are aligned elastically before measuring the differences between them.

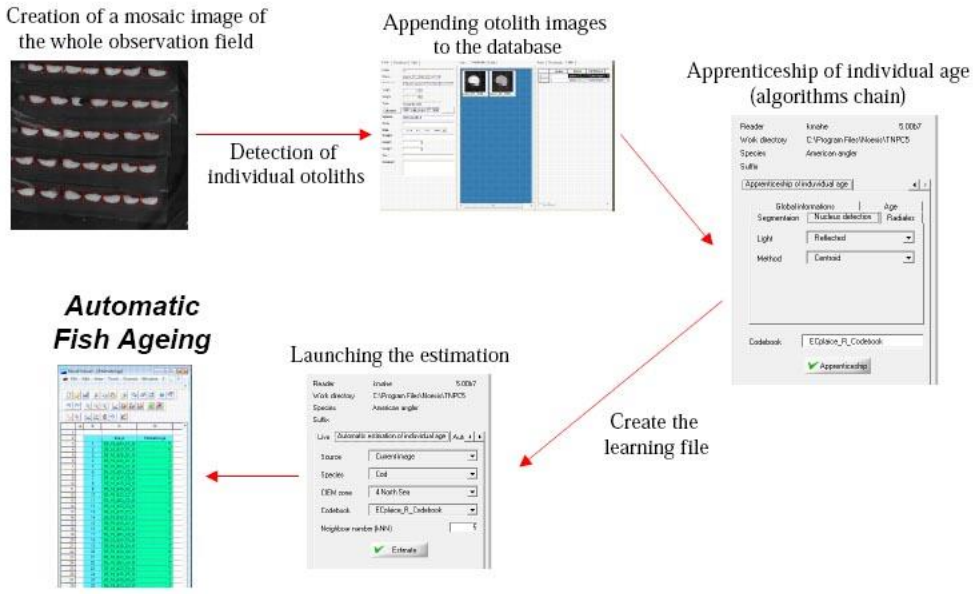
The estimation of age proportion based on morphologic descriptors of the fish and its otolith are estimated by the probability that a fish belongs to a certain age group.
The conditional model is based on the principle that the probability is computed from the distance between the descriptors of the fish of unknown age and the ones with known ages in the calibration set. For a given production set, the age-class proportions are estimated by the sum of the individual classification probabilities.
The mixture model used discriminant analysis which was considered to estimate the unknown age distribution in a production sample including covariates (features) based on a calibration sample for which age as well as covariates were known. For the calibration sample the linear discriminant analysis procedure was used to predict the posterior probabilities and the averages (procedure was repeated 500 times) were used for the age composition. To test and validate the conditional and mixture models, the available data set was randomly divided the into a training set of 50% and a testing set of 50%.

The results of the automatic estimation of individual age showed agreement percentages with the age estimated by the readers from 90.9% (Iceland Plaice) to 33.2% (North East Arctic Cod). Conditional and mixture models were applied for automatic estimation of age structure starting from the features of fish (TL and W) and otolith (TL, W, Area, Major and Minor Axis Length, Perimeter) and showed very strong variations between the cases of study.

These differences could be due to the difficult discrimination of the growth rings for some species (anchovy for example), because of the poor quality of the images, and also the poor representation of some age groups…

Automatic Fish Ageing algorithms (estimation of individual ages and age proportioned), were integrated in the software TNPC 5.0 developed by the Noesis

company. The software now allows automated procedures for the acquisition of otolith image series and for age estimation (individual or age proportions)



A cost/benefit analysis was carried out for the 3 automated methods and the traditional ALK (Age Length Key). Two measures have been applied as measure of goodness: Mean squared error (MSE) and relative bias (RB). Cost associated to the different age estimation methodologies are worked out.
The cost/benefit results showed large differences between species and stocks. By comparing the bias between the automatic methods and the traditional ALK, they are low for the plaice (Eastern Channel, Iceland) and the North East Artic cod whereas they are very significant for anchovy (Bay of Biscay) and cod (Faeroes, North Sea). Moreover, the cost analysis presented the same results. It is important to note that bias can exist for the age estimation among the international readers. For example, inter-reader bias test during the international otolith exchange of NEA Cod, showed that there are significant differences in age estimates among readers from different institutions.

In conclusion, the AFISA project resulted in advances in computer vision which provide more reliable methods to extract information from otoliths in order to estimate the individual age and the age structure. These methods are operational using TNPC software. How ever such methods should not be seen as being able to fully substitute to experts. They should rather been seen as tools to provide automatically extracted information that requires a subsequent control by experts for the estimations of individual age and age structure. For some species such as plaice, these methods could be usable from the perspective of bias and costs.

Project information

Co-ordinator : Ronan Fablet (from 01/04/07 to 25/02/08) Kélig Mahé (from 26/02/08 to 01/04/09)

Kelig.Mahe@ifremer.fr

Contractors Involved :

- Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER, France)
- Fundacion AZTI-AZTI Fundazioa (AZTI, Spain)
- The Centre for Environment Fisheries & Aquaculture Science (CEFAS, United Kingdom)
- Danish Institute for Fisheries Research (DTU, Denmark)
- Institute of Marine Research (IMR, Norway)
- Marine Research Institute (MRI, Iceland)
- University Polytechnic of Catalonia (UPC, Spain)