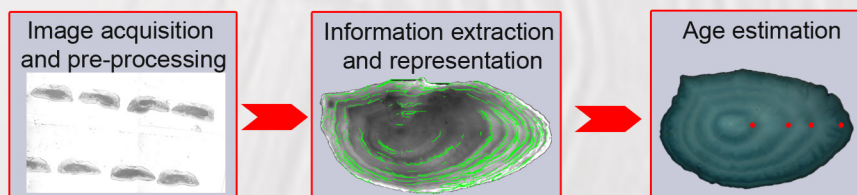


1. Ifremer-150, quai Gambetta, BP 699, 62321 Boulogne sur mer, France ; 2. Universitat Politècnica de Catalunya, Rambla Exposició 59-69, 08800 Vilanova i la Geltrú, Spain ; 3. Ifremer, Technopôle Brest-Iroise, BP 70, 29280 Plouzané, France ; 4. Institute of Marine Research, Postboks 6404, 9294 Tromsø, Norway ; 5. AZTI, Herrera Kaia z/g, 20110 Pasaia, Spain ; 6. CEFAS, Pakefield Road, Pakefield, Lowestoft, Suffolk NR33 0HT, England ; 7. DTU Aqua, Charlottenlund Slot, DK-2920, Denmark ; 8. Marine Research Institute, Skúlagata 4, P.O. Box 121 Reykjavík, Iceland ; 9. Institut Telecom, Technopôle Brest-Iroise, 29238 Brest Cedex 3, France ; 10. Ecole Nationale d'Ingénieurs de Brest, Laboratoire RESO (EA 3380) CS 73862, 29238 BREST Cedex 3, France

Most of the European fish stocks are assessed using age-based models which require otolith age estimations, often associated with high uncertainty, and costs (annually several million euros). The EU project AFISA was aimed at developing and assessing methods which would reduce these costs while providing a means for standardizing ageing among laboratories, ensuring the traceability of information through annotated image databases and improving growth studies.



## Age estimation with morphometric features

Age proportions were calculated from the features of fish (TL and W) and otoliths (TL, W, Area, Major and Minor Axis Length and Perimeter).

Conditional and Mixture (a) models were used

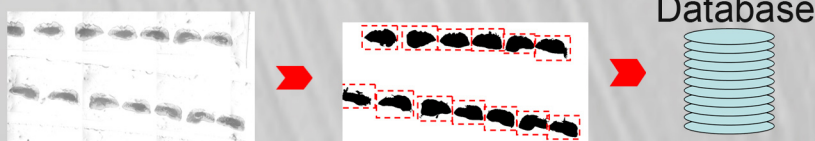
The data set was randomly divided into a training set of 50% and a testing set of 50%. This procedure was repeated 500 times

The results showed percentage agreement with the ages estimated by readers from 90.9% (Icelandic Plaice) to 33.2 % (North East Arctic Cod)

## Integration of automatic fish ageing into TNPC software

### Acquisition of otolith series

- Capture mosaic image of several otoliths (camera+motorized microscope)
- Detect otoliths in the image
- Store images of individual otoliths in a database



### Automated Estimation

Automatic Fish Ageing algorithms (estimation of individual ages and age proportions) have been integrated in the software TNPC 5.0.



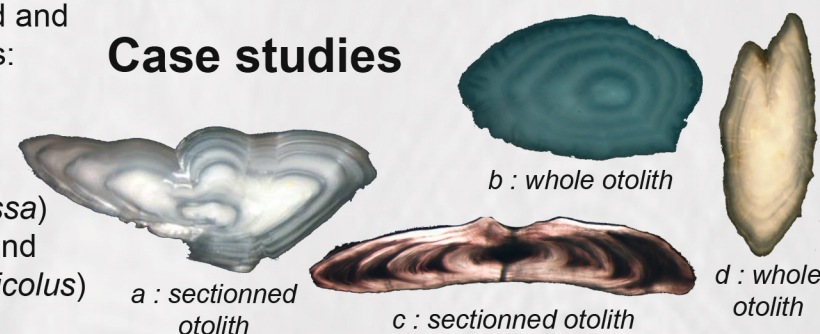
<http://www.noesisvision.com/>

- The procedure can be performed in 2 successive steps :
- a learning procedure using a documented image data base and/or fish characteristics
  - automated age estimation process based on otolith images and/or morphometric otolith and fish features.

6729 otoliths were digitalized and interpreted by expert readers:

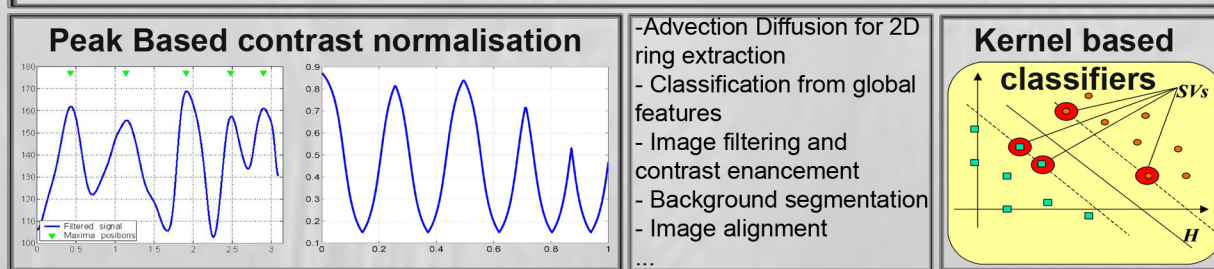
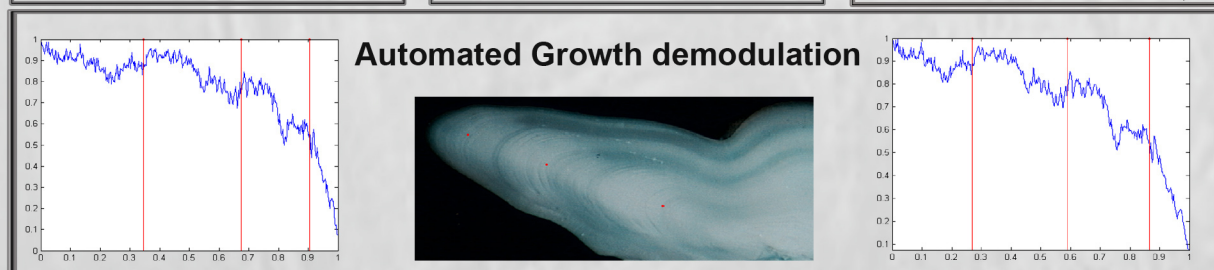
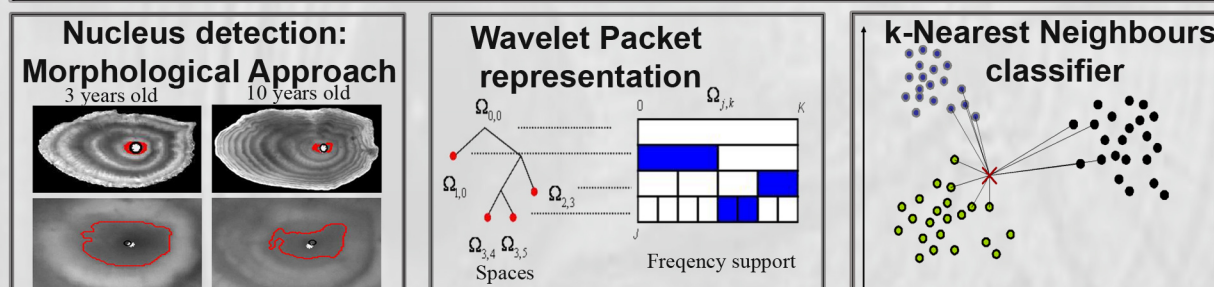
- Cod (*Gadus morhua*) North Sea, North East Arctic, Fareos (a)
- Plaice (*Pleuronectes platessa*) Eastern Channel (b, c), Iceland
- Anchovy (*Engraulis encrasicolus*) Bay of Biscay (d)

## Case studies



## Algorithms for age estimation

Signal processing methodologies developed specifically for the project or first time applied to otolith image processing



## Cost-Benefit Analysis

### Cost

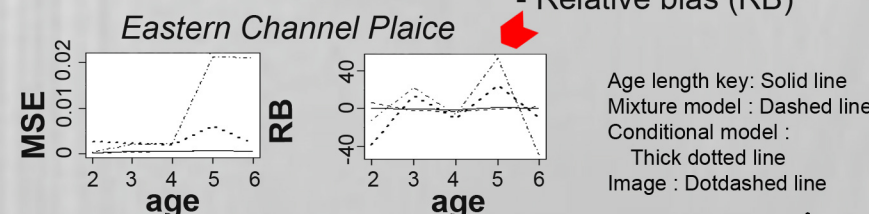
Cost associated to the different methodologies

Euro per fish  
ALK : 2.13

Automated age : 1.38

### Benefit

- Mean Squared error (MSE)
- Relative bias (RB)



The cost/benefit analysis showed large differences between species and stocks. By comparing the bias and the cost between the automatic methods and the traditional ALK, they are low for the plaice and North East Arctic cod whereas they are very significant for anchovy and others stocks of cod.

## Conclusion

The AFISA project allowed development and evaluation of new algorithms for otolith image processing. These tools have been implemented in the TNPC software as well as algorithms for automatic estimation of age and age proportions based on fish and otolith morphometric features. As shown by the cost benefit analysis, results are promising and strengthen the need for further research to fully optimize automatic age and growth estimation systems. Such systems will not replace experts but should rather be seen as useful tools for improving data acquisition, standardization between laboratories and traceability of analysis while reducing their costs.

