

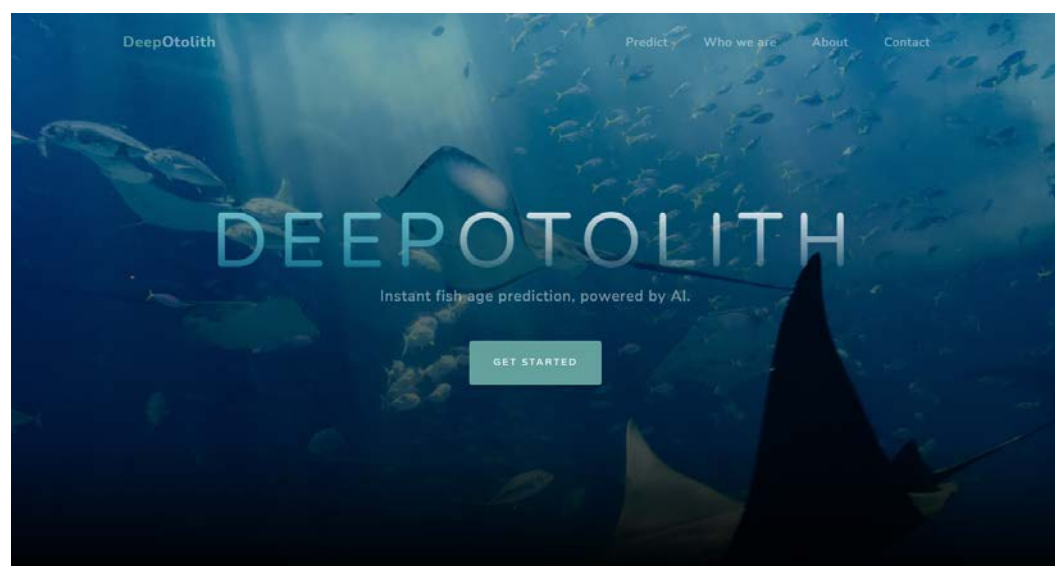
## 1. Introduction

Fish age-reading from otolith images is a key information in achieving sustainable exploitation of fisheries resources. However, extracting age information from otolith images requires a considerable effort by experienced readers. This suggests a need for cost-effective approaches that could facilitate a more streamlined analysis.

Here, we present DeepOtolith, an automatic web-based system for estimating fish age by combining otolith images with deep learning. DeepOtolith receives as input otolith images from a specific fish species and predicts fish age. DeepOtolith currently contains three case studies species (Fig. 1), but it is scalable to include more species from interested researchers. DeepOtolith is accessible at the following URL address: <http://otoliths.ath.hcmr.gr/>.



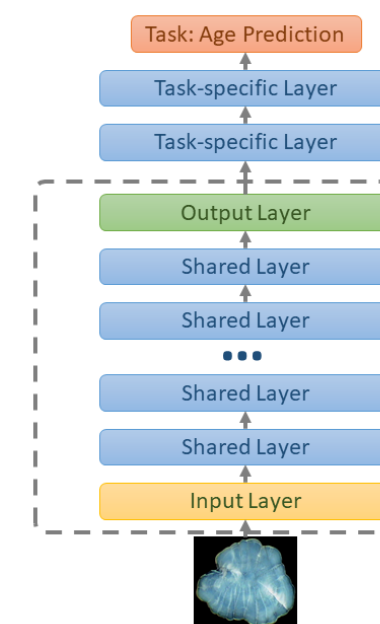
**Fig. 1.** Otoliths tested with DeepOtolith: Red mullet (*Mullus barbatus*), Greenland halibut (*Reinhardtius hippoglossoides*), Atlantic salmon (*Salmo salar* L. 1758).



**Fig. 2.** Front page of DeepOtolith.

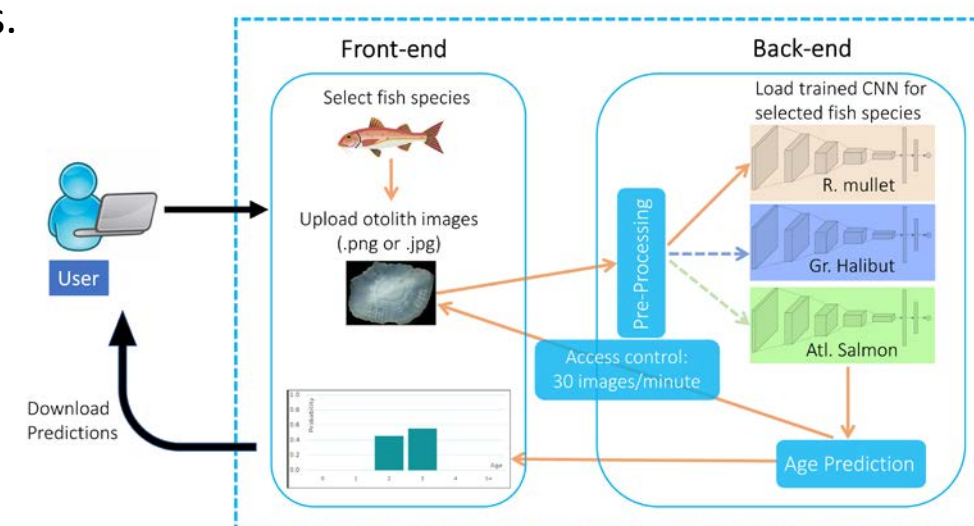
## 2. Methodology

DeepOtolith was based on convolutional neural networks (CNNs), a class of deep neural networks designed to process images efficiently and thus often used for computer vision tasks. CNNs are built in a series of subsequent layers (convolutional, pooling) that apply filters to recognize meaningful features within images. Once they are trained on a set of images, they can be used to make predictions on a new, unseen set of images.



## 3. Web architecture

The web tool consists of two main components, the front-end, visible to the end user, and the back-end, where all processing takes place. In the frontend, the user can select one of the three currently available fish species models, and then consecutively upload otolith images from the selected species. The uploaded images are transferred to the back-end and the corresponding trained CNN model is loaded. Then, the loaded model is applied on the pre-processed images in order to make fish age predictions.



**Fig. 3.** The web architecture of the DeepOtolith web tool.

## 4. References

- Ordoñez A. et al. 2020. Explaining decision of deep neural networks used for fish age prediction. PLoS ONE 15(6), e0235013.
- Politikos D. et al. 2021. Automating fish age estimation combining otolith images and deep learning: the role of multitask learning. Fisheries Science 242, 106033.
- Vabø R. et al. 2020. Automatic interpretation of salmon scales using deep learning. Ecological Informatics 63, 101322.