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## Introduction

Apart from private companies, the pioneer work of digital echo integration for fisheries research had prefigured the first fisheries acoustics software, then several software were developed. A common point for all of these software is that they are not shared in open-source. Nevertheless, fisheries acoustics data follow an increasing use and interest in fisheries, fisheries ecology, and aquaculture. In this way the processing methods suffer from two major constraints, first the processes are regularly improved by new methodologies and second the software is expensive particularly for developing countries although their fisheries resources are often crucial for their economy and thus need to be accurately described by scientific surveys. Another point which limits the use of acoustic data is the human resources needed to clean the echograms, an unavoidable prerequisite; such work is particularly time consuming for routine surveys and when done by hand made can suffer of lack of replicability. Matecho was designed to assure a complete traceability of the applied cleaning, filtering and treatments along the whole standardized processing chain.

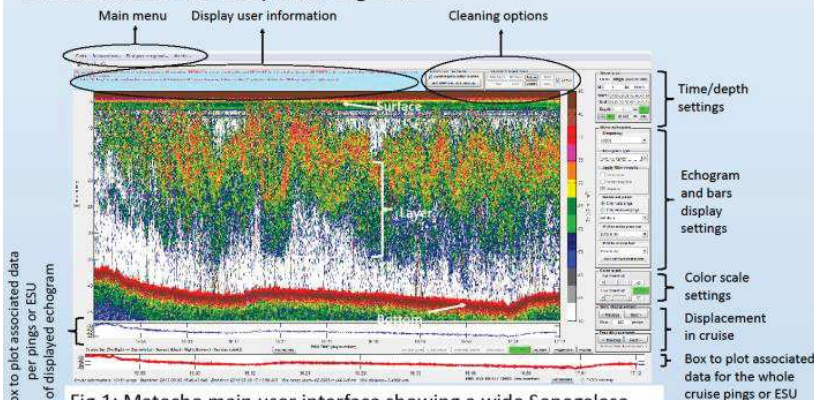


Fig. 1: Matecho main user interface showing a wide Senegalese scattered layer at 70 meter depth (data: Ecoao survey on-board FRV Antea, IRD), main options are displayed on the right panel.

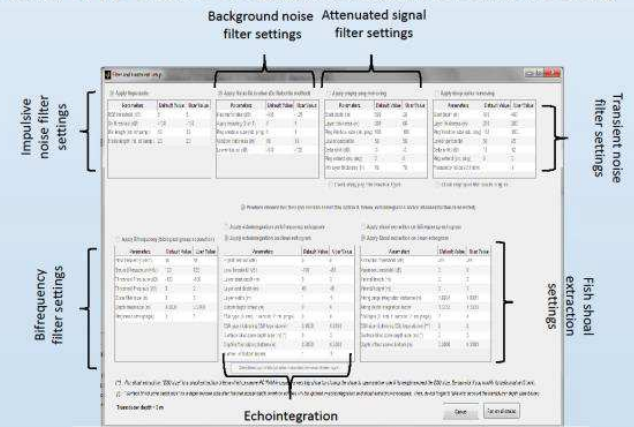


Fig. 2: User setting for automatic filters, bi-frequency, echointegration and shoal extraction processing from various fisheries acoustics data formats.

## Matecho description

Matecho is a friendly automatized processing method to extract information and perform echo-integration. The initiative in open source allows update fostering collaborative works and technological transfer. Matecho supports old and recent formats. The procedure allows applying semi-automatic echogram data cleaning and application of automatic data filters. Echo-integration processing is executed per depth layers and integrates their characteristics per elementary sampling unit. Scattered layers are automatically detected by segmentation from echo integrated echogram and shoals are extracted from an iterative process of aggregation of filtered echogram echoes which allows, in both cases, to calculate *ad hoc* parameters describing morphological, spatial location and acoustic characteristics of scattered layers and shoals. Finally Matecho is realized for experts as open source code and for end-users as a free executable.

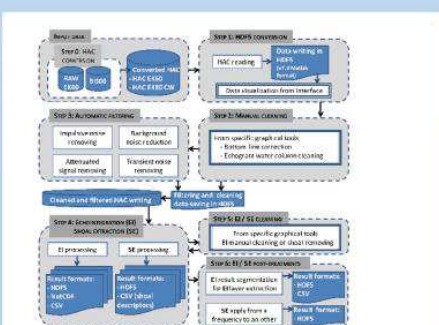


Fig. 3: Scheme of Matecho treatment chain, step by step. HAC: ICES format for the exchange of fisheries acoustics raw and edited data.

Table 1. Characteristics of the surveys processed using Matecho in the framework of Preface and AWA projects. Hac: international standard format for the exchange of fisheries acoustics raw and edited data; CW: continuous waveform signal.

Echogram/ Data format	Survey/Ship Names	Year(s)	Frequencies (kHz)	Geographical Area	High seas/ Coastal
EK60/ Hac or EK60/RAW	Epure/Antea	2013	38, 70, 120, 200	Morocco	Coastal
	Ecoao/Antea	2013	38, 70, 120, 200	Senegal	Coastal
	Awa2014/Thalassa	2014	18, 38, 70, 120, 200, 333	Senegal	Coastal
	Pirata/Thalassa	2015, 2016, 2017	18, 38, 70, 120, 200, 333	Gulf of Guinea	High seas
	Mesop/Antea	2009, 2010	38, 70, 120, 200	Indian Ocean	High seas
EK500/BI500 or EK500/LSS	Microton/Antea	2010	38, 70, 120, 200	Indian Ocean	High seas
	La Perouse/Antea	2016	38, 70, 120, 200	Indian Ocean	High seas
	Mad-Ridge/Antea	2016	38, 70, 120, 200	Indian Ocean	High seas
EK500/BI500 or EK500/LSS	18 Cruises/Dr Fridtjof Nansen	1995 to 2002, 2003 to 2015	38, 70, 120, 200	West African coasts	Coastal

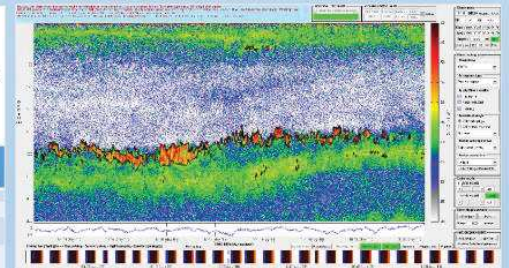


Fig.4: Illustration of a Matecho graphical output of an echointegration result showing the diel (sunrise in orange and sunset in blue; black: night, white: day)vertical migrations of a scattered layer displayed in green (data: Pirata 2017).

The acoustic data treatments from these numerous surveys allowed validating the Matecho treatment chain – which leans on algorithms and libraries of Movies3D– for different platforms and acquisition systems, in different environments and marine ecosystems. It can be used in routine to process ecosystemic acoustic surveys data from raw data files until echo integration, shoal and/or scattered layer extraction. Matecho HDF5 output files in comma-separated values or NetCDF can be used easily to apply specific analysis from classical development software. In the near future, the Matecho treatment chain will be adapted to be able to treat the Simrad EK80 wideband fisheries acoustics data. In the near future, several Matlab programs for specific analysis of treated acoustic data will be interfaced with Matecho.

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