Poster prepared for:

Tools for underwater noise monitoring, marine mammals' surveys, and acoustic risk mitigation policies' implementation

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Introduction

Concerns about noise effects on marine mammals has grown over the years, mainly with the use of low-frequency active sonars and seismic surveys. Whether in support of mitigation policies or in the larger field of marine mammal studies, passive acoustic techniques are today a qualifying point in environmental impact assessments.

Passive acoustics is a zero-impact powerful tool used for (a) expanding knowledge about marine mammals' behaviour, ecology and distribution; (b) monitoring underwater noise; (d) monitoring critical habitats; (e) evaluating the effects of sound exposure; (f) implementing mitigation policies by detecting animals approaching a sound exposure area.

Our experience

Since 1999 CIBRA co-operates with NATO Undersea Resarch Center within the SOLMAR Project, aimed at developing Marine Mammals Risk Mitigation Policies for NATO Navies and at defining and testing related tools.

Although "Dual Use" experiences provide excellent results studying low frequency sounds, limited bandwidth, high self noise, unsuitable interfaces for rapidly varying signals and expensive hardware, severely limits the effectiveness of standard ASW (antisubmarine warfare) equipment as a mitigation tool.

To support Mitigation Policies a PC based Sound Analysis Workstation was designed and extensively tested, assembling an affordable and flexible solution to collect, store and plot data resulting from combined acoustic and visual surveys (Pavan et al., 2004). Complimentary sensors have also been tested to set up a self contained, lightweight, easy to install and use, affordable equipment for passive acoustic research.

This system matches many aims, particularly those related with bioacoustic research and with the implementation of Risk Mitigation Policies in any field.

The workstation can be quickly installed on a wide range of platforms offering detection and processing capabilities when and where needed.

A multichannel approach allows to monitor different sensors at once, for example shallow and deep hydrophones or sonobuoy networks, while large bandwidth allows to detect signals that can't be detected with traditional equipment and which can often be the only signals revealing the presence of animals, as in the case of Cuvier's beaked whales (Johnson et al., 2004).

Wideband sensors, wideband arrays deployed at different depths, integration of signals gathered by a sparse array of sensors, and wideband beamforming are the possible hardware solutions for maximizing detection capabilities.

Software

Software includes 1) recording and analyzing signals from multiple sensors, 2) receiving, plotting and redistributing NMEA navigation data, 3) assisting logging and classifying acoustic contacts, 4) assisting logging visual contacts, 5) sharing data among networked PCs, 6) plotting on an oceanographic GIS.

Hardware

The core workstation provides high resolution spectrographic display and real-time beamforming capabilities on up to 8/16 input channels. Channels can be linked to a suitable array of hydrophones, giving beamforming capabilities, or to any wired or radio linked indipendent sensor. The bandwidth is 48 kHz or 100 kHz per channel, expandable to 400 kHz on single channels.

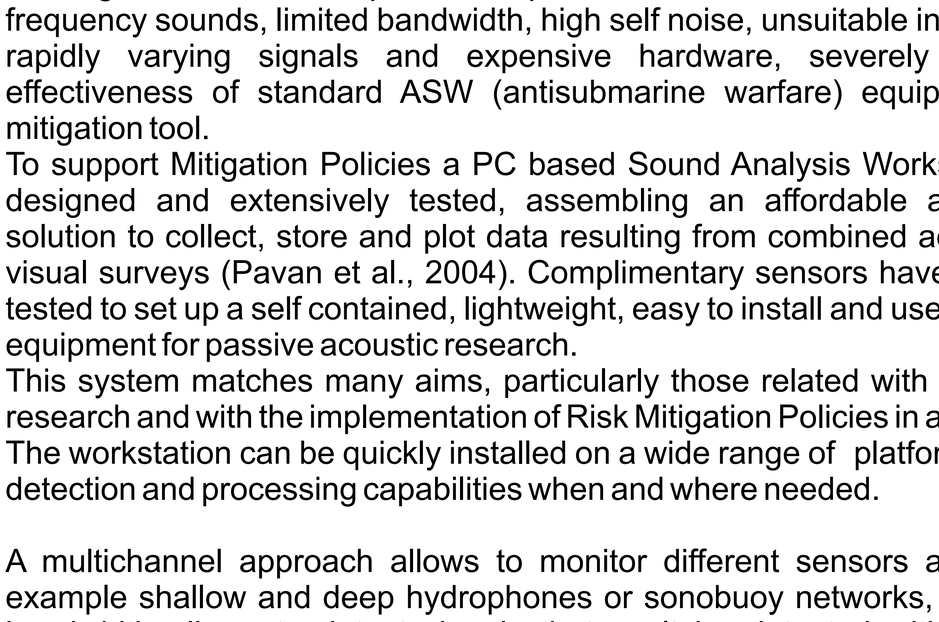
One PC dedicated to sound recording/analysis and one to GIS and navigation are required for optimal performance; additional networked PCs can be used to distribute processing, archiving and visualization tasks.

Signals, plots, classification data and contacts are continuously recorded on a disk array to provide 24/24h data recording. Sounds are stored in standard formats in georeferenced time cuts. Logged data are stored in raw ASCII files to be easily imported in spreadsheets and in statistic analysis tools.

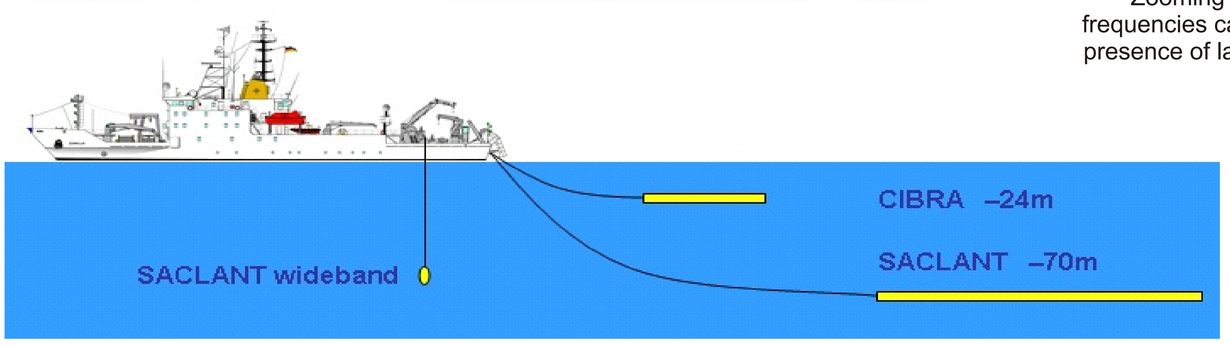
Sightings can be input with a database interface or by a graphic interface on a wireless tablet PC or hand held device (PocketPC). Localization of acoustic sources can be done by target motion analysis either with the beamformer or with time delay measures.

Navigation data, sightings and georeferenced acoustic events, categorized by human operators, are distributed by TCP/IP to be logged and plotted on the GIS and to be viewed/logged/processed by any computer on the network.

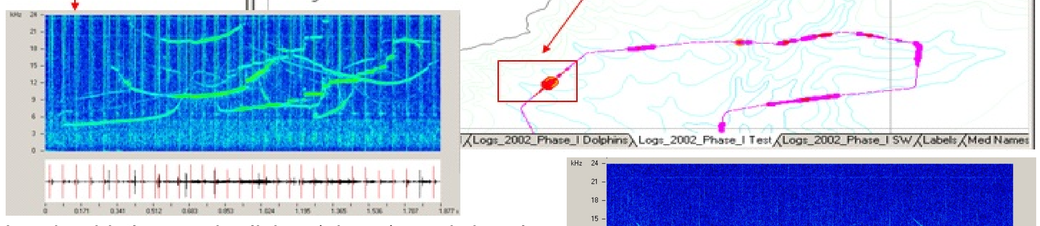
Data is overlaid on accurate bathymetric features (GEBCO vector dataset) and on remote sensing images or hindcast/forecast models (Mediterranean Forecasting System).



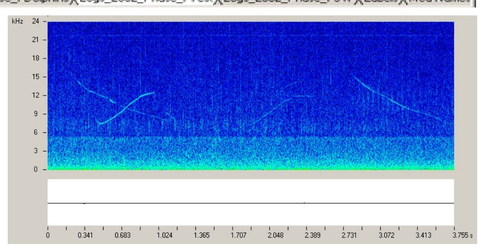
CIBRA array is equipped with a 160m towing cable, two groups of low-noise transducers with 48 kHz of bandwidth. It can be used from a small winch, though it can be easily moved, deployed and recovered by hand as well.



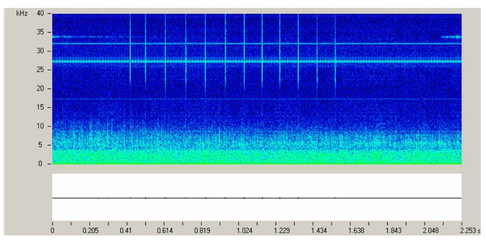
A multi-sensor configuration allows to maximize detection capabilities. The shown configuration has been extensively tested in four Sirena cruises in the Mediterranean Sea

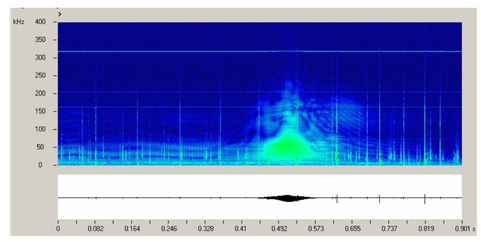


Loud whistles and clicks (above) and barely detectable ones (right); acoustic contacts are categorized and grouped in 1 minute time slots with navigation data. Each slot is georeferenced, thus allowing a direct link to a GIS for acoustic mapping.

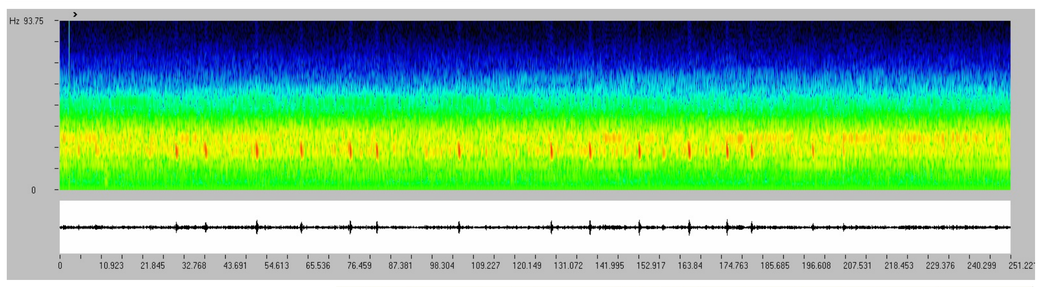


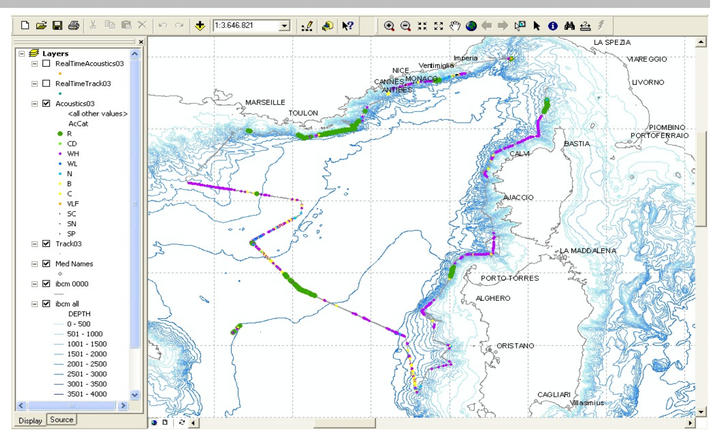
Echolocating dolphins revealed by wideband detection and display (horizontal lines are electronic interferences).



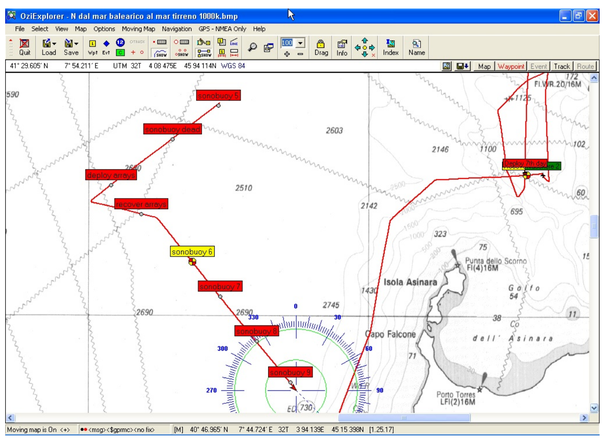


Zooming into very low frequencies can reveal the presence of large whales.

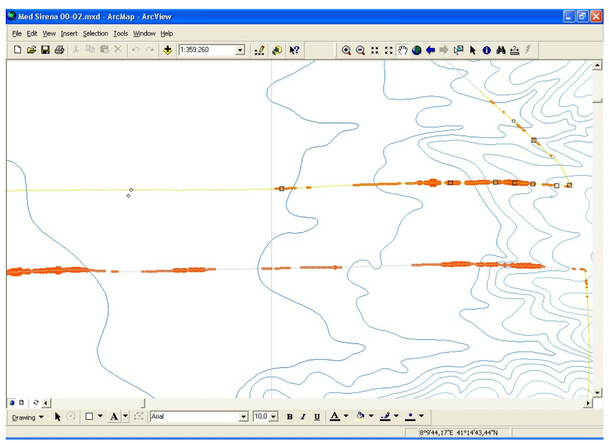




GIS overview of acoustic contacts in a cruise.



A navigation software can be used to assist simple logging operations.



Detailed view of acoustic contacts (red) and sightings (black); the daylight track is shown in yellow .

References

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