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RISK ASSESSMENT OF THE IMPACTS DUE TO UNDERWATER ANTROPHOGENIC SOUND EMISSIONS

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***Ph.D. research funded by the
U.S Navy Office of Naval Reserach (ONR)***



**Doctoral Program
in Environmental and Infrastructure Engineering
XXVI Cicle**



In the management of the marine environment increasing concerns derived from the pressures consequent by human activities

European Union's Marine Strategy Directive

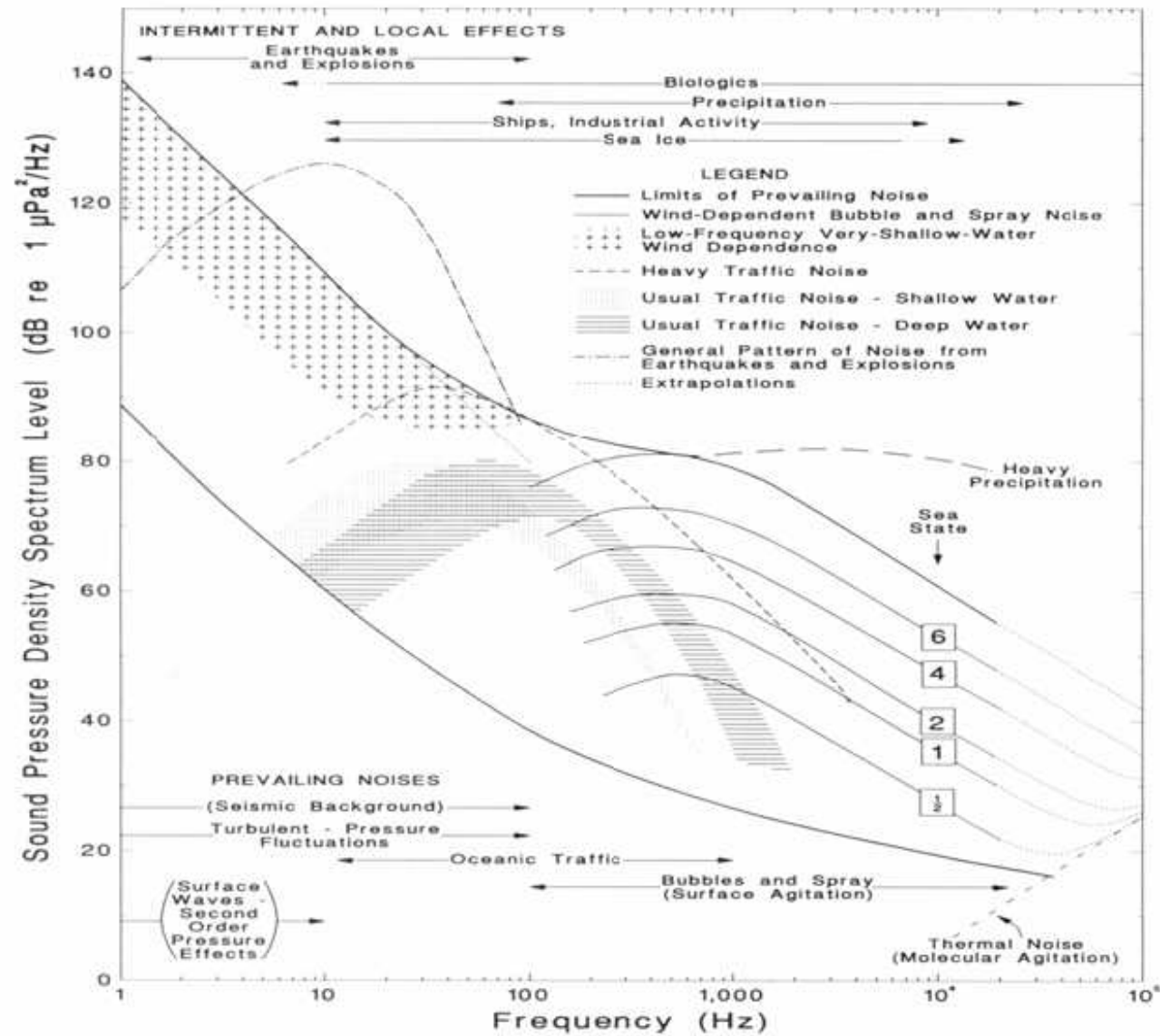
(Directive 2008/56/EC adopted in June 2008)

Aim to protect the marine environment across Europe from all the pressures derived by human activities.

Article 3(8) defines: '*pollution*'... "means direct or indirect introduction of substances or energy, **INCLUDING HUMAN- INDUCED MARINE UNDERWATER NOISE** , which results in deleterious effects such as harm to living resources and marine ecosystems.

Sources underwater noise (Wenz, 1962)

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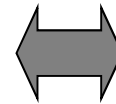


Anthropogenic sources of noise in the marine environment pose uncertain and poorly characterized threats to marine life, and in particular to marine mammals reducing the range over which they can communicate to temporal or permanent injury and mortality.

Aim of my PhD research is:

Acoustic models

to evaluate the exposure for the population to specific sound sources



Species presence models

avoidance of habitat to reduce the potential impact

Risk map for management of the impact due to the introduction of underwater anthropogenic noise in the marine environment.

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SOURCES OF ANTHROPOGENIC UNDERWATER NOISE

Sources of **anthropogenic** underwater noise

ANNEX III lists the principal sources of underwater noise that create a "physical disturbance" to marine life.

- **MILITARY SONAR** (low-mid frequency active sonar: <1-10KHz)

European Parliament Motion B6-0089/2004.

Naval sonar European Parliament resolution on the environmental effects of high intensity active naval sonar.



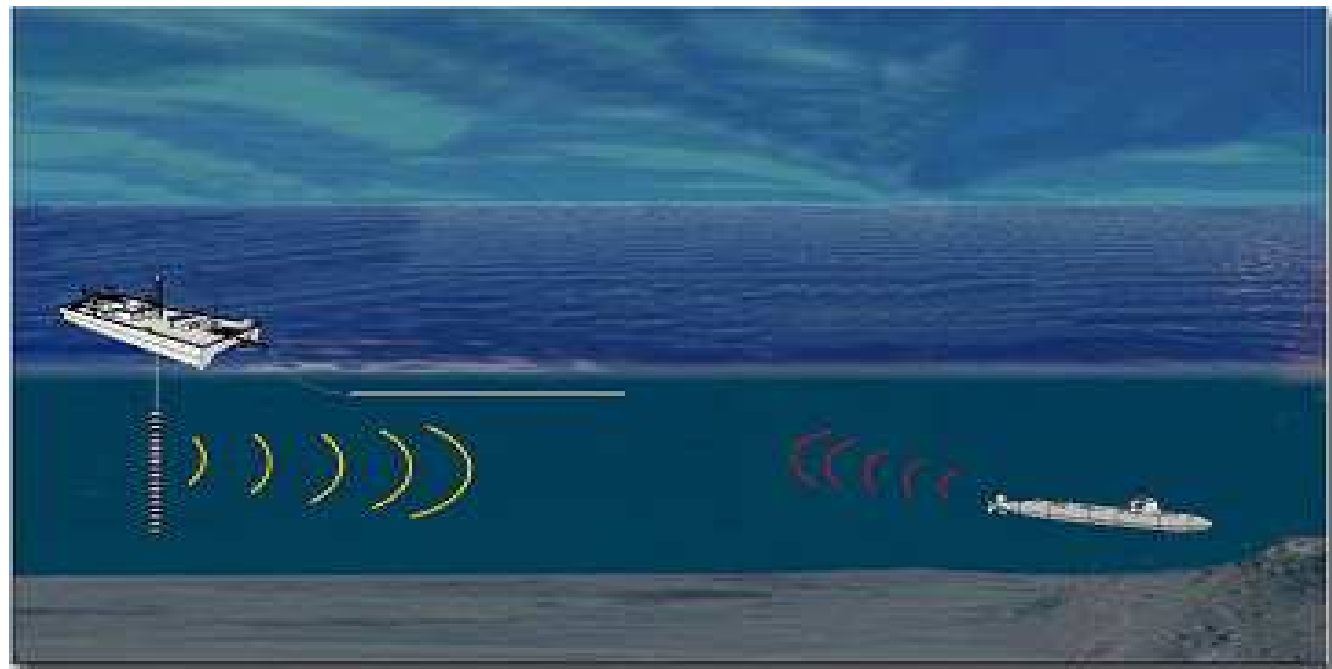
Military Sonar (low-mid frequency active sonar)

SURTASS-LFA (Surveillance Towed Array Sensor Sistem- Low Frequency sonar)

1 Array with 18 sound sources: Sound level: 215 dB re 1 μ Pa
Frequency: 100-500 Hz.

(U.S Navy – NATO) sea surveillance (anti submarine technology)

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Sources of anthropogenic underwater noise

- **MILITARY SONAR** (low-mid frequency active sonar- 1-10KHz)

European Parliament Motion B6-0089/2004.

*Naval sonars European Parliament resolution on the environmental effects
Of high intensity active naval sonars.*

- **SEISMIC SONAR** (seismic survey- air-guns, low- mid frequency)

Decreto Legislativo del 3 aprile 2006 n 152.

*(art.23, elenco A, Allegato III alla parte II, "Progetti sotto posti a VIA, punto 14)
devono essere soggette
a verifica di Valutazione di Impatto Ambientale (VIA) le
attività di estrazione in mare di petrolio e gas naturale a fini
Commerciali.."*



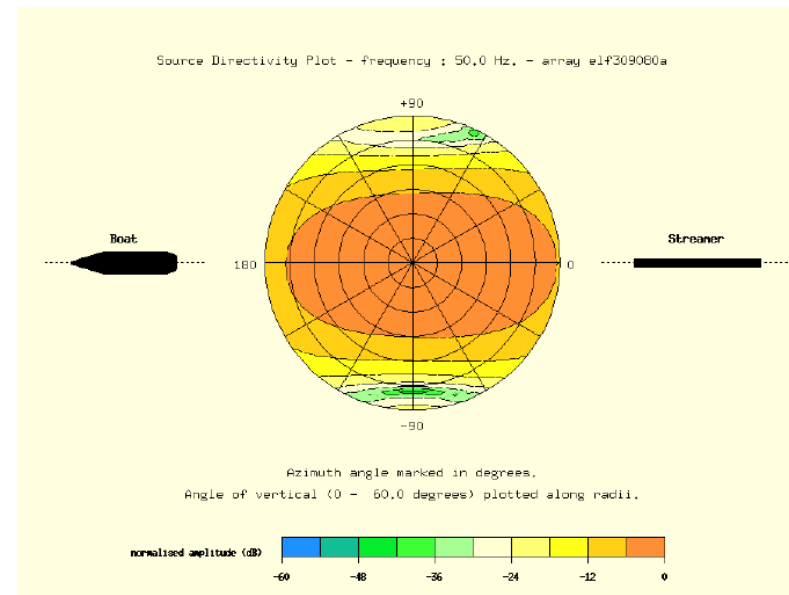
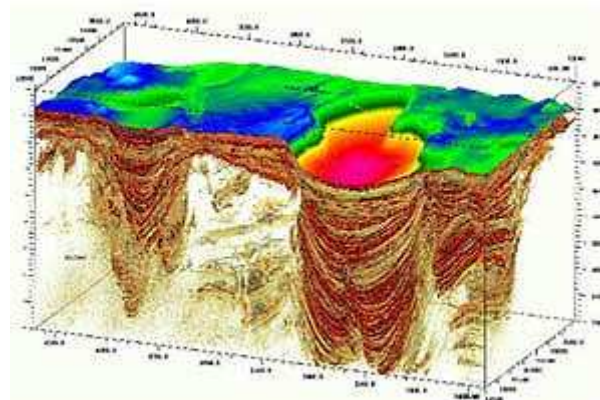
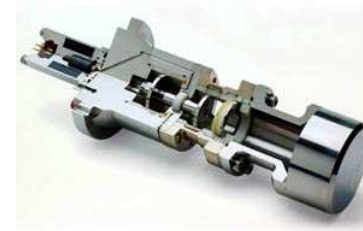
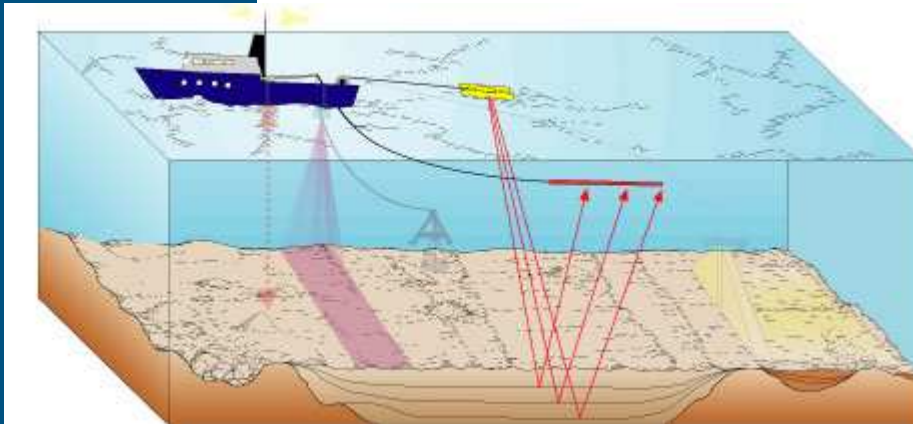
Seismic Sonar (air-guns, low- mid frequency)

Arrays Air-guns: Sound levels of individual air-gun 230 dB re 1 μ Pa

Frequency 100-1500 Hz

Airguns used for marine-based seismic exploration by the oil and gas industry

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Sources of anthropogenic underwater noise

- **MILITARY SONAR** (Military mid-high frequency)

European Parliament Motion B6-0089/2004.

*Naval sonars European Parliament resolution on the environmental effects
Of high intensity active naval sonars.*

- **SEISMIC SONAR** (air-guns, geosismic activity)

Decreto Legislativo del 3 aprile 2006 n 152.

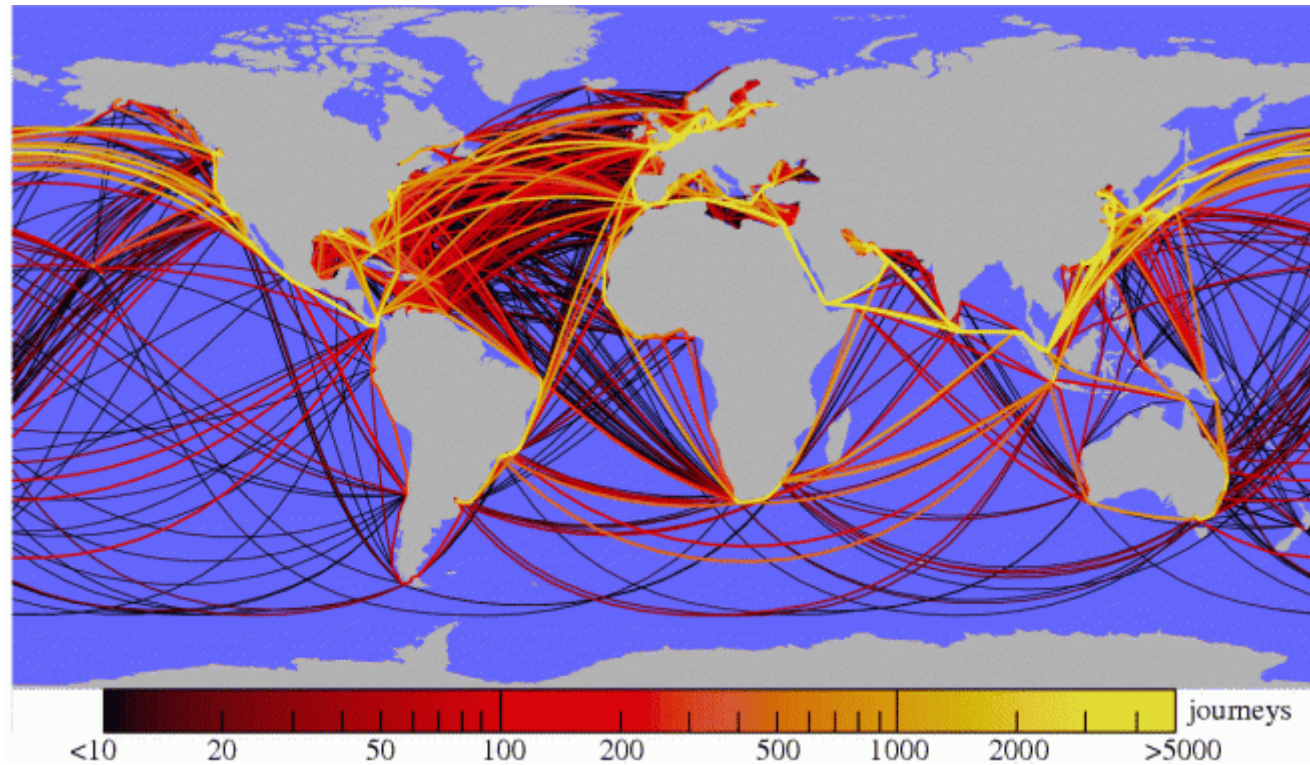
*(art.23, elenco A, Allegato III alla parte
II, "Progetti sotto posti a VIA, punto 14) devono essere soggette
a verifica di Valutazione di Impatto Ambientale (VIA) le
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Commerciali.."*

- **SHIPPING ACTIVITIES** (tankers, cargo ship, ferries..) **MARPOL 73/78**



SHIPPING ACTIVITIES

From 1950 increase of the ocean background noise of 10 to 20 dB



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Sources of anthropogenic underwater noise

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Commerciali.."*

- **SHIPPING ACTIVITIES** (tankers, cargo ship, ferries..) **MARPOL 73/78**

- **OFF-SHORE DEVELOPMENT** (Marine Renewable Energy Installations)

EU Strategic Environmental Assessment procedure (Directive 2001/42/EC)

- **COSTAL DEVELOPMENT** (on shore installations, pile-drivers, MREI)

Decreto Legislativo del 3 aprile 2006 n 152.

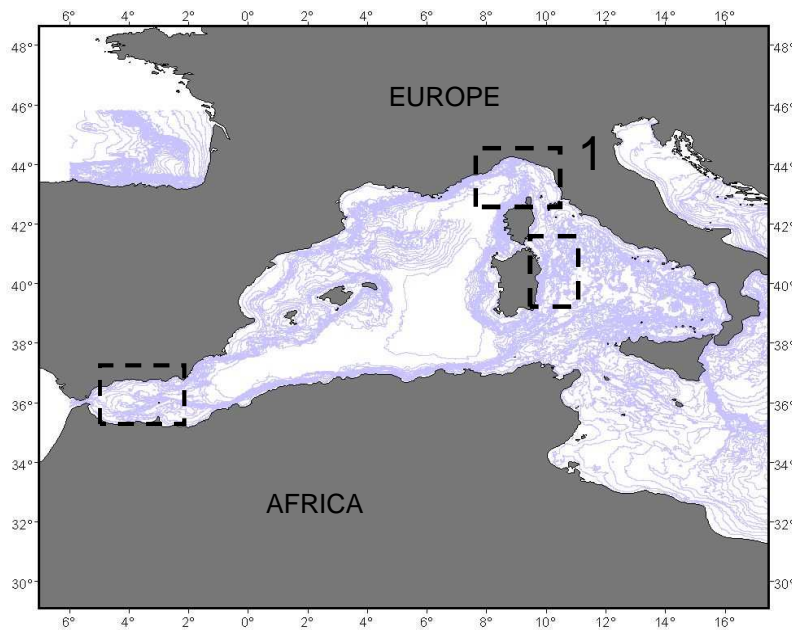


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DATA COLLECTION

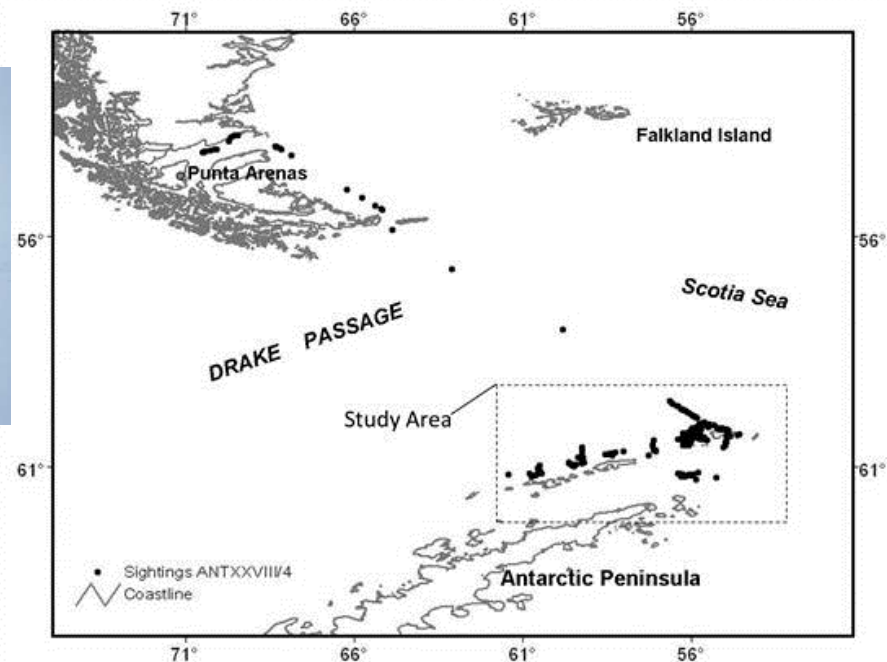
MEDITERRANEAN SEA Data set



NATO

"Research Vessel Alliance"

SOUTHERN OCEAN Data set



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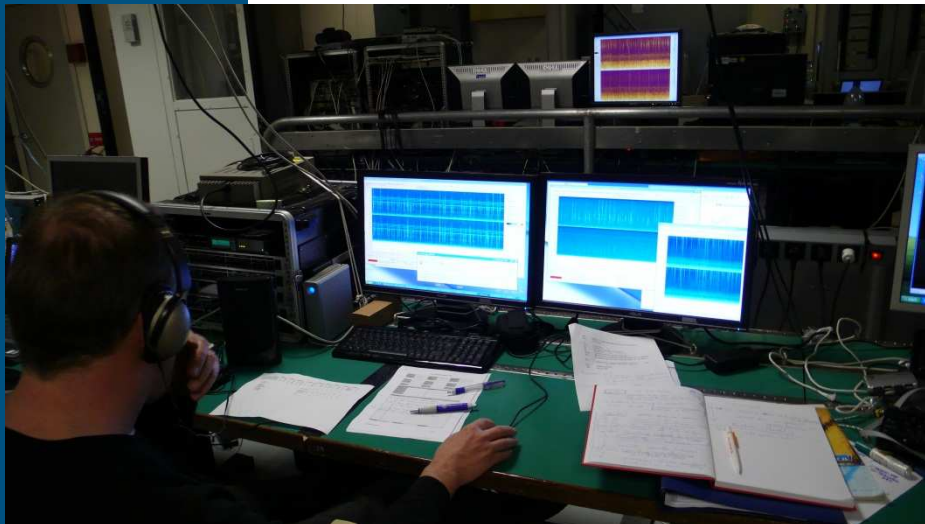


AWI
"Research Icebreakers
Polarstern"

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Biological data



Acoustic data



Oceanographic data

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RESULTS



Static Predictors (depth slope) for evaluating the Exposure



ELSEVIER

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Risk mapping for sensitive species to underwater anthropogenic sound emissions: Model development and validation in two Mediterranean areas

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^a Politecnico di Milano, University of Technology, DIIAR Environmental Engineering Division, Piazza Leonardo da Vinci 32, 20133 Milano, Italy

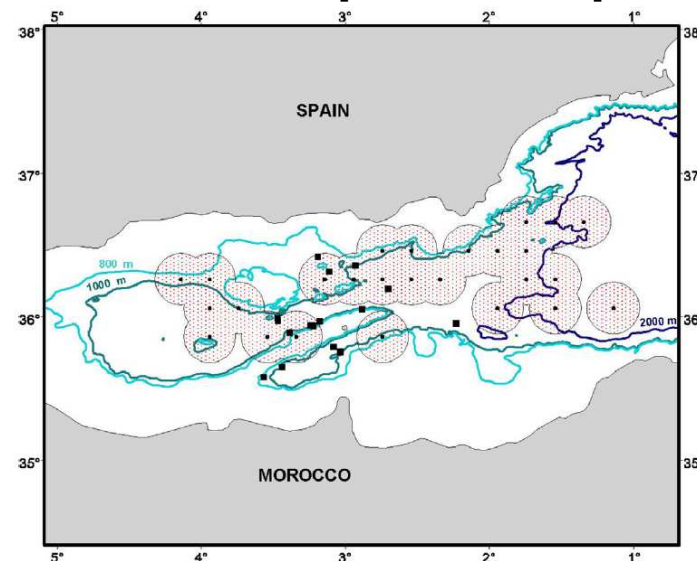
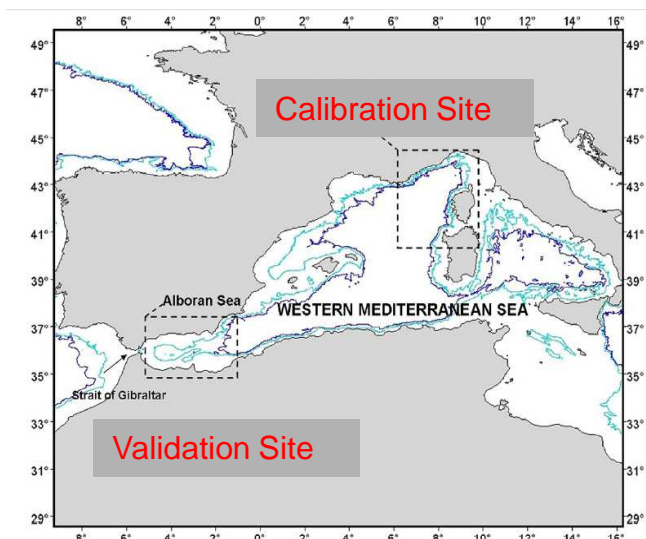
^b Space and Naval Warfare Systems Center Pacific, 53560 Hull Street, San Diego, CA 92152-5001, USA

^c CIBRA, Centro Interdisciplinare di Bioacustica e Ricerche Ambientali, Dept. of Animal Biology, Università di Pavia, Via Taramelli 24, 27100 Pavia, Italy

^d Museum of Natural History of Milan, Vertebrate Zoology Department, C.so Venezia 55, 20121 Milano, Italy

^e NATO Undersea Research Centre, V.le San Bartolomeo 400, 19126 La Spezia, Italy

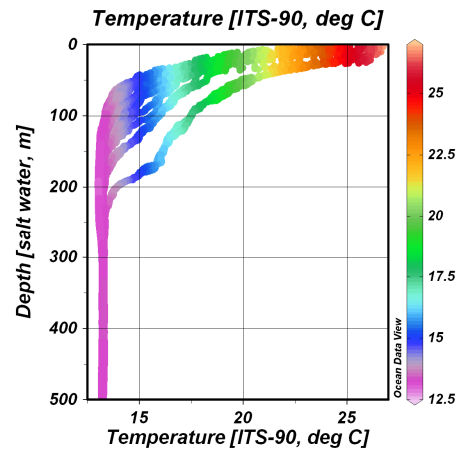
Risk exposure map



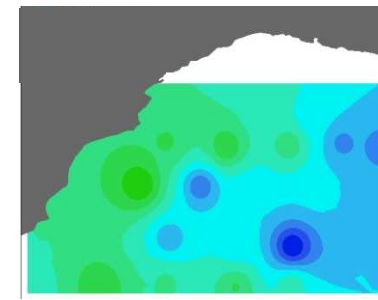
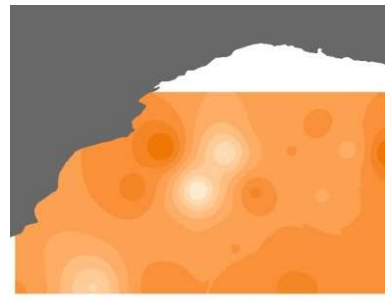
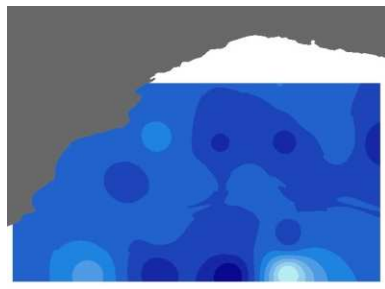
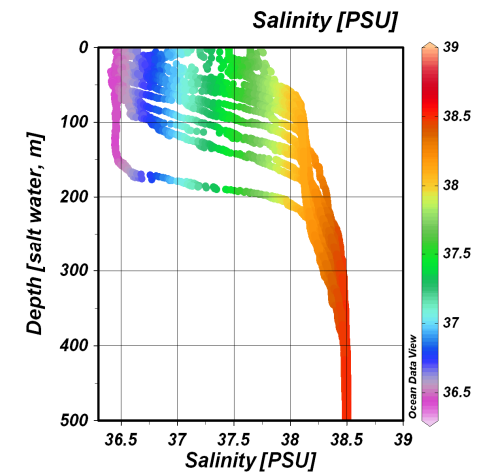
Dynamic Predictors (CTD) for evaluating the Exposure

Oceanographic parameters measured as a function of depth using sensors installed on a CTD (Conductivity, Temperature, Depth) with Rosette Frame:

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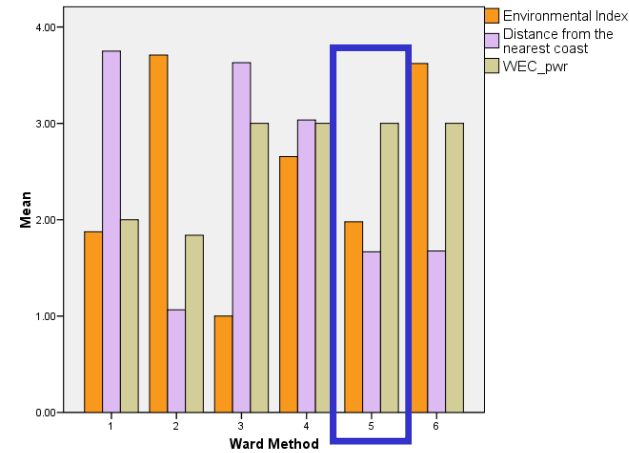
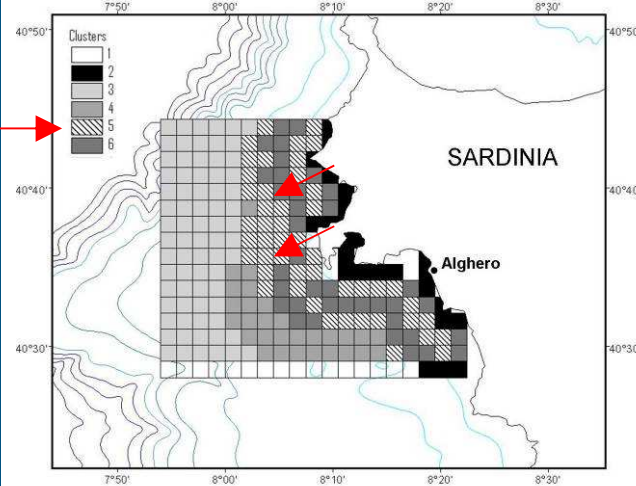
Conductivity (mS/cm)
Temperature (deg C)
Fluorescence (ug/l)
Dissolved Oxygen (ml/l)
Sound Velocity (m/s)
Turbidity (FTU)



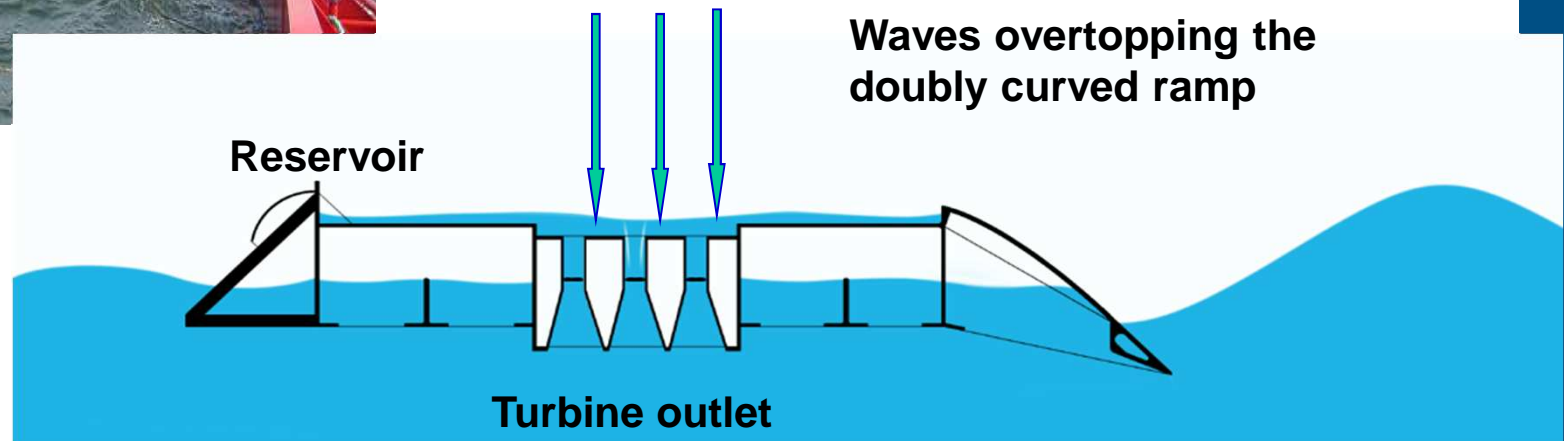
Lanfredi C. et al. Does dissolved oxygen play a role in Cuvier's beaked whale habitat selection? A comparison between three study areas in the western Mediterranean Sea. XXVth Annual Conference of the European Cetacean Society Cadiz, Spain, March 21-23, 2011

Multicriteria Analysis for the selection of the best technologies and the identification of optimal sites for wave-farms in two areas (Alghero, Sardegna)

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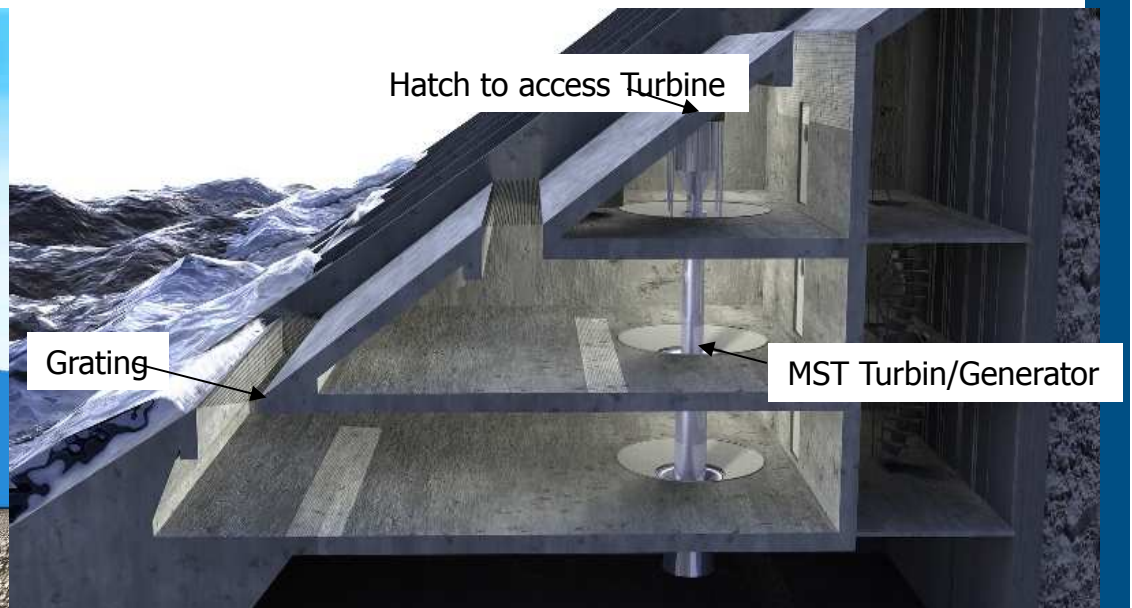
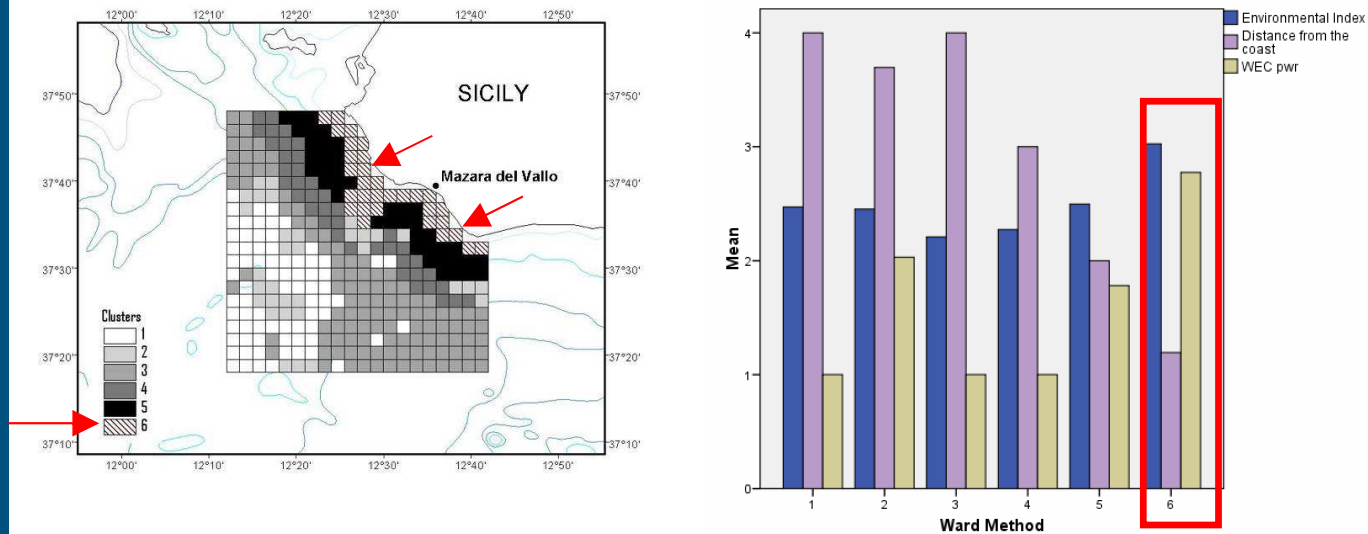


OFF SHORE ALTERNATIVE





Multicriteria Analysis for the selection of the best technologies and the identification of optimal sites for wave-farms (Mazara, Sicily).



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**THANK YOU
FOR YOUR ATTENTION**