



CIBRA



2005 - 2006



INGV

LIDO-ESONET/EMSO
SMO

ASPERA 25.05.2012

Bioacoustics

Advancing Acoustic Measurements

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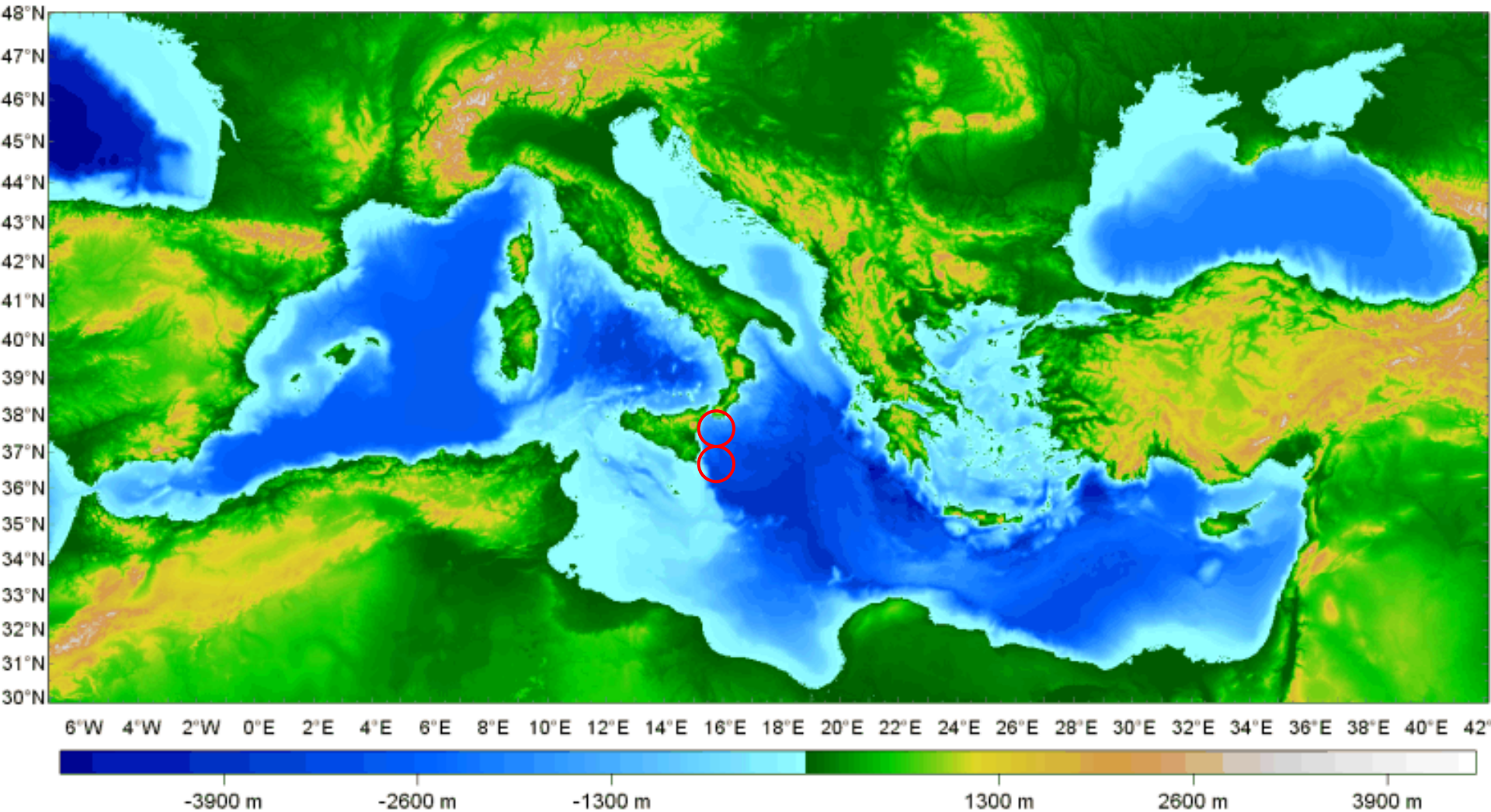
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<http://www.unipv.it/cibra>

<http://mammiferimarini.unipv.it>

The Mediterranean Sea, a laboratory for multidisciplinary research

Catania and Capo Passero locations



The Catania Test Site infrastructure

LNS-INFN Catania



Internet
Radio Link



LNS Test Site Laboratory
at the port of Catania

20 km

5 km

5 km

Test Site North



Test Site South



Installation at
2100 m depth



2 ROV operable
electro-optical
connectors to
shore



NEMO JB



4 ROV operable
electro-optical
connectors to
shore (380VAC)

SN1: Geo-hazards monitor



- Monitoring of volcanic and seismic activity in Sicily
- Development of Tsunami early warning systems

P. Favali and L. Beranzoli, Ann. Geophys. 49 (2006), 705

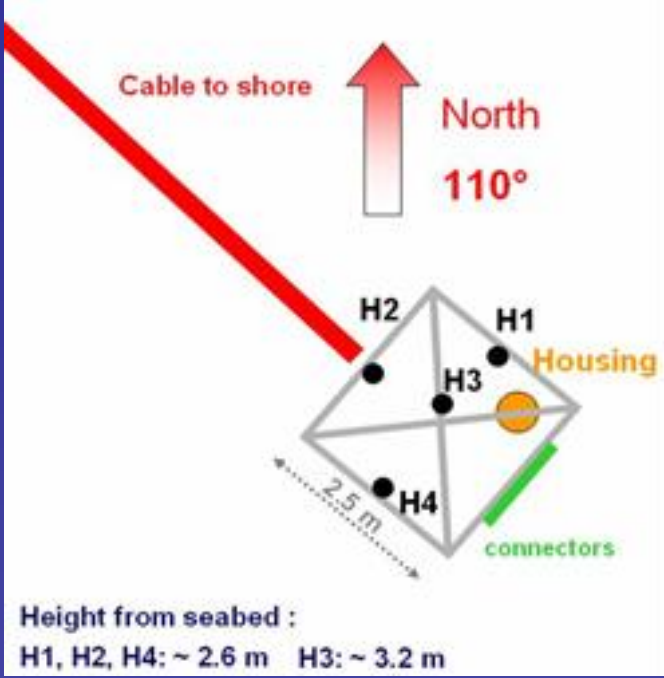
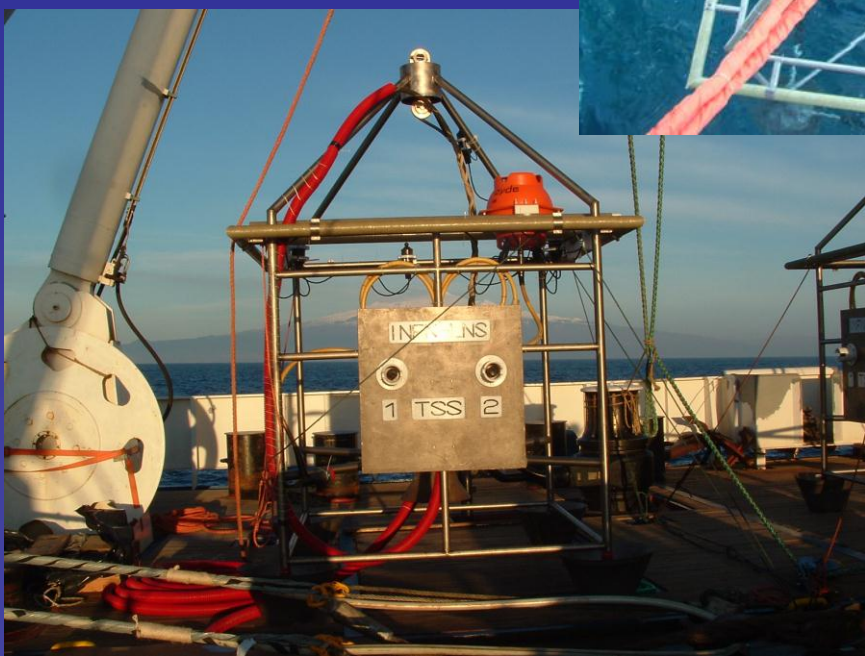
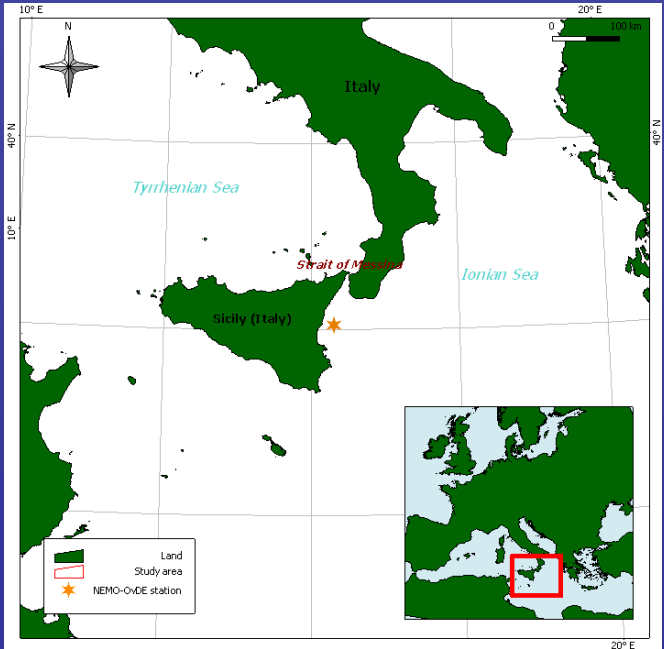
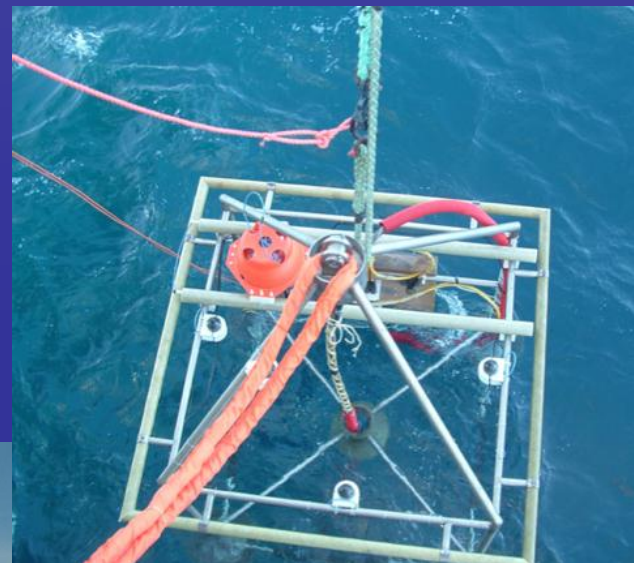
Sensor	Sampling rate
Three-component broad-band seismometer	100 Hz
Hydrophone (geophysics)	100 Hz
Gravity meter	1 Hz
Scalar magnetometer	1 sample / 10 min
Three-axes single-point current meter	2 Hz
CTD	1 sample / 12 min



The NEMO-ONDE platform (2005-2006)

Ocean Noise Detection Experiment

4 wideband hydrophones
96 kHz 24 bit sampling
Real-time transfer to onshore lab by fiber optic cable to study uw noise sources



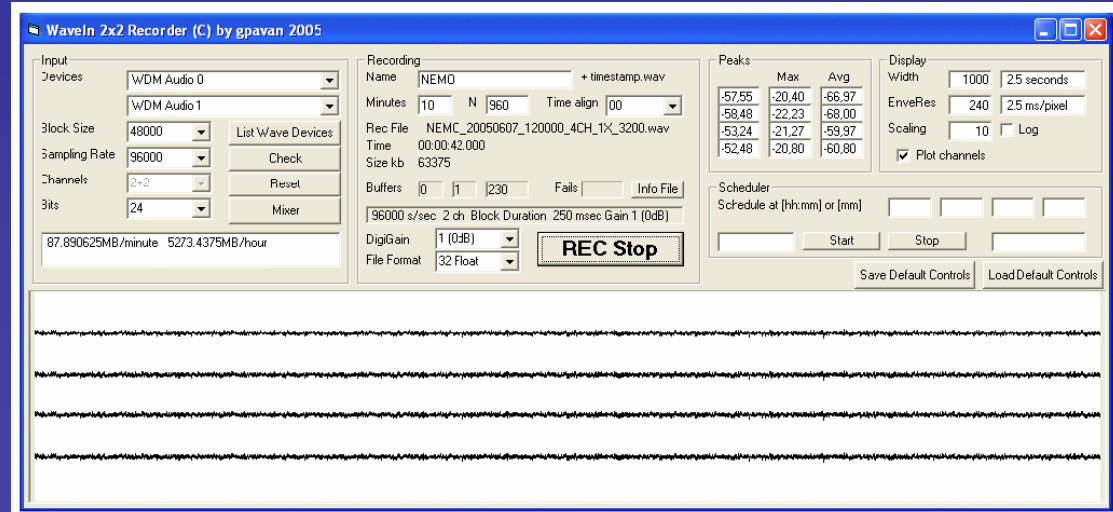
Data collection constraints and storage strategies

Evaluation of background noise and biological sources vs neutrino signature

4 wideband hydrophones sampled at 96 kHz with 24 bit accuracy produce 100Gbytes/day.

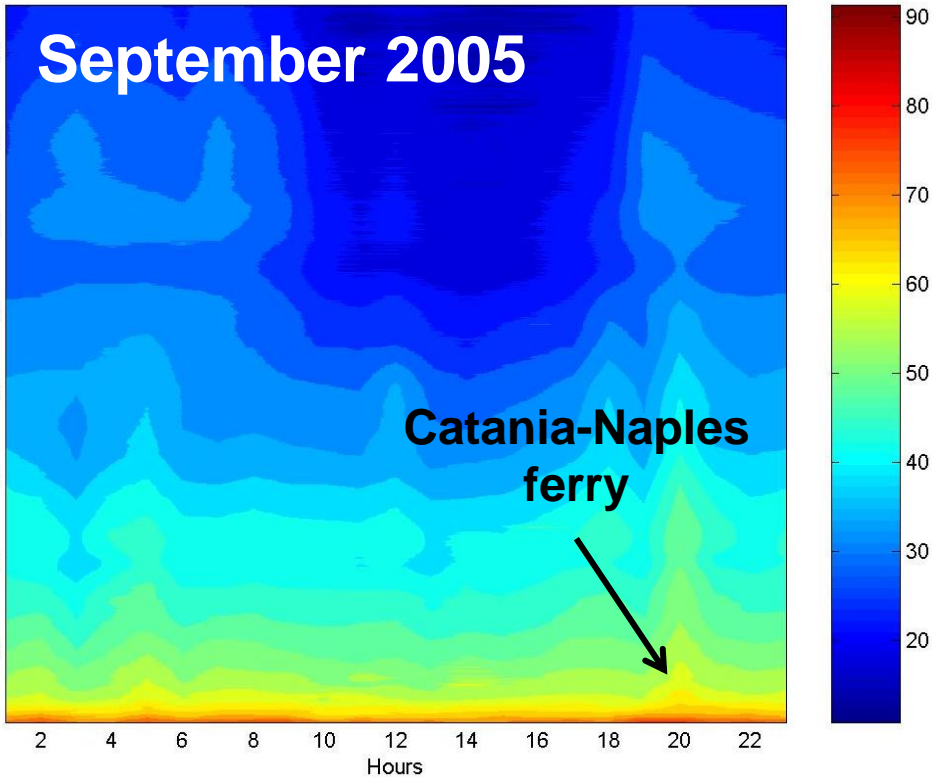
In 2005 it was quite prohibitive to record 24h/day continuously and it was decided to record 5 min every hour, a sampling scheme adequate for describing the presence and daily variations of biological sounds and of underwater noise.

Recording 5min/hour to 4ch wav files to allow an easy management and analysis with standard sound analysis software. However specific software was developed for the scheduled recordings and for the analysis and display, either in real-time and in post-processing.



Noise spectrum correlation with ships and biological sources

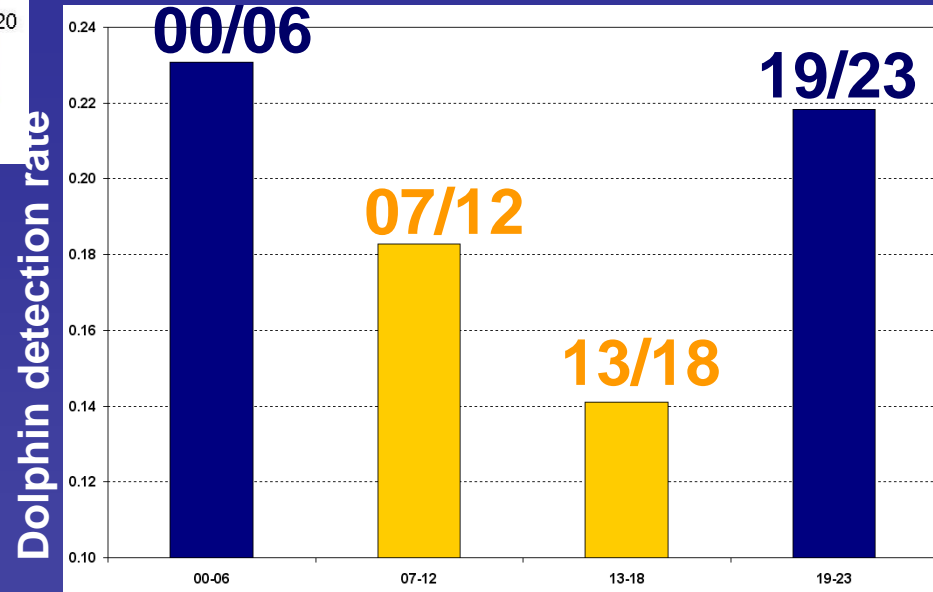
kHZ

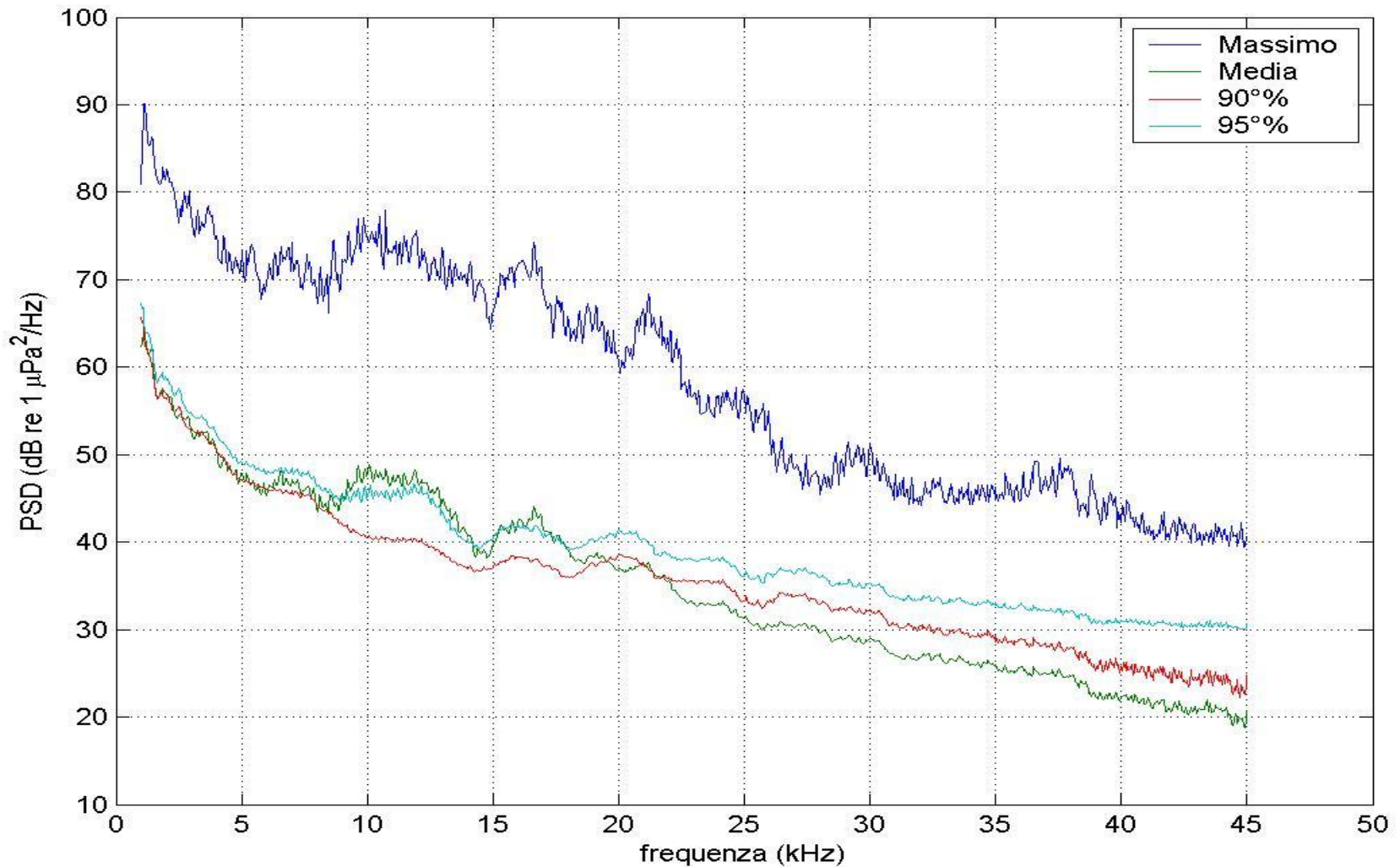


In the spectral region between 20 and 40 kHz we observe a day-night effect with upto 50% variations.
In this region dolphins give a strong contribution to noise

Preliminary

Independent CIBRA analysis:
Number of dolphins detected during day and night.
Night is the hunting time for dolphins
They emit both echolocation clicks (>20 kHz) and whistles.



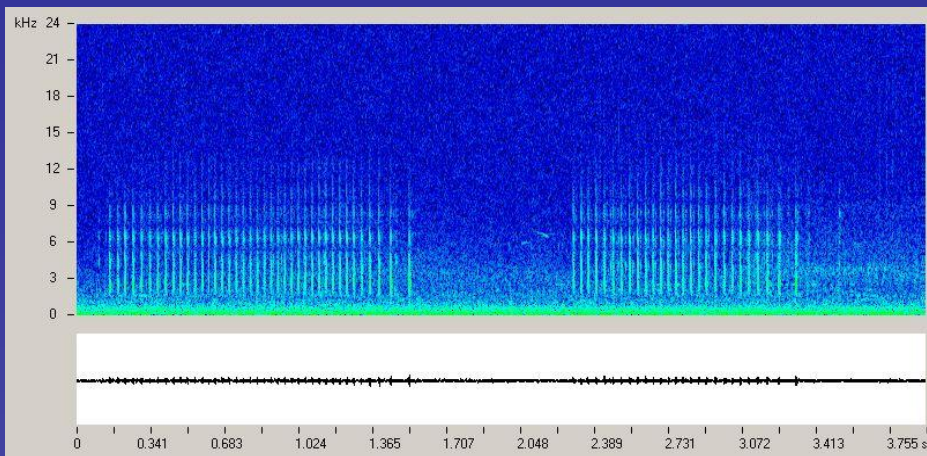
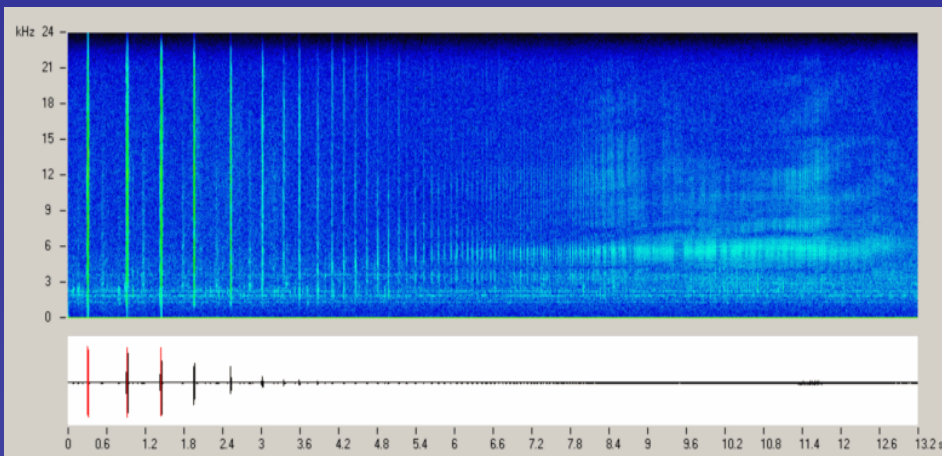
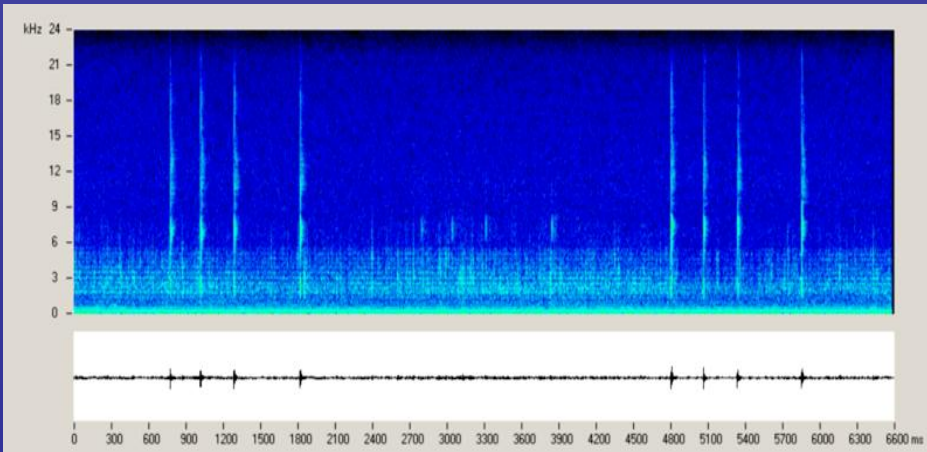
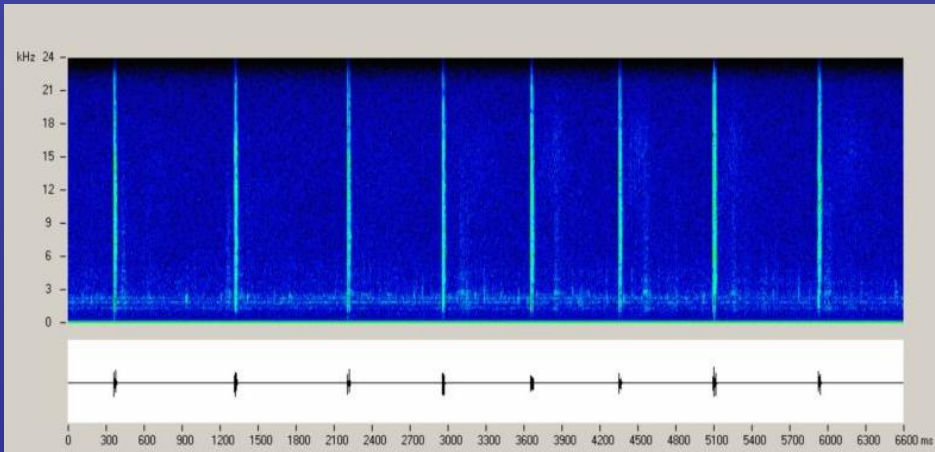


PSD spectra $\mu\text{Pa}^2/\text{Hz}$ on hydrophone H3, day 14.11.2006 at 23:30:

Average, Max, 90° & 95° percentiles.

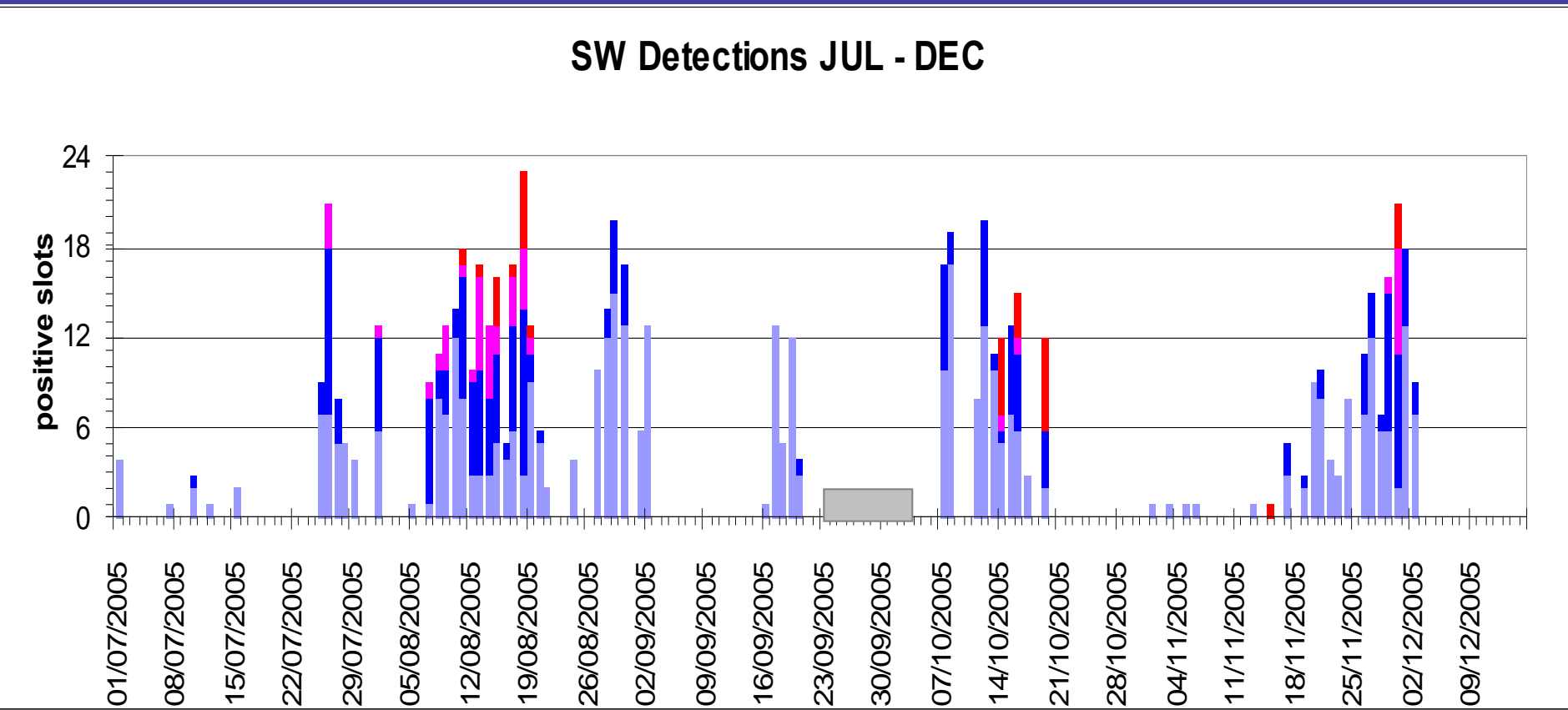
The Max profile is strongly influenced by impulsive sounds (clicks) made by sperm whales (they “occupy” less than 5% of the time).

Sperm whales' sound categories



The Neutrino and the whale. Nature 462, December 2009

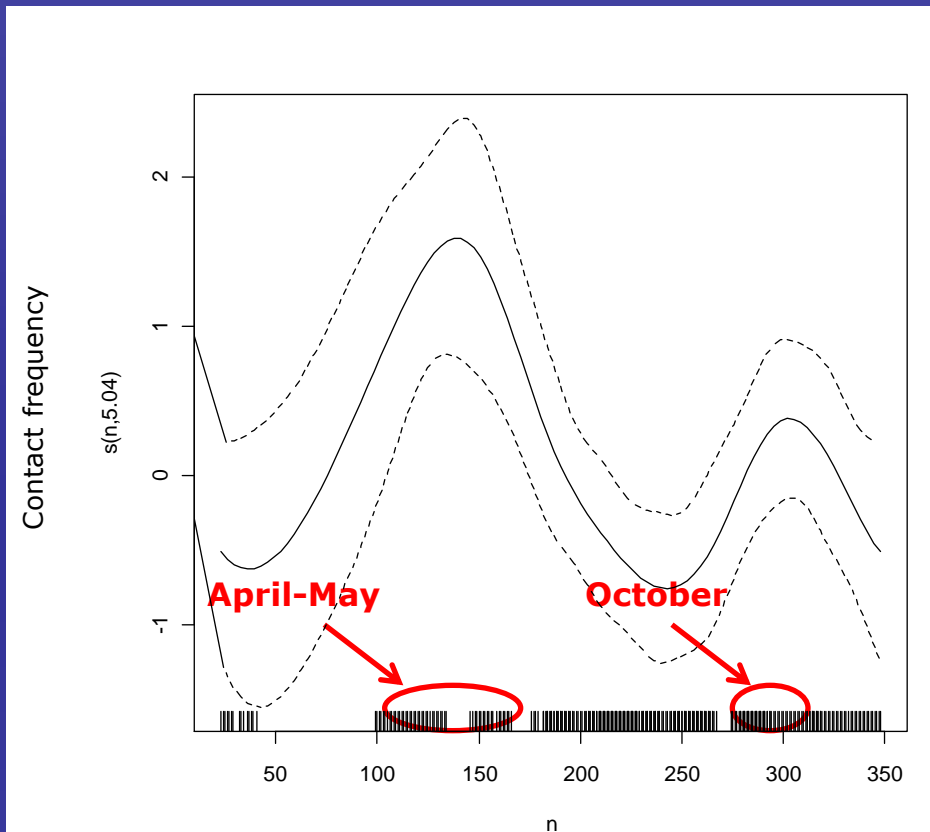
Daily & seasonal presence of sperm whales in the detection range



- 1 animal detected
- 2 animals detected
- 3 animals detected
- 3 or more animals detected

Development of reliable sperm whales' automatic detectors.

Presence / absence by day



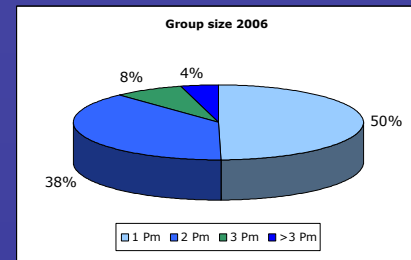
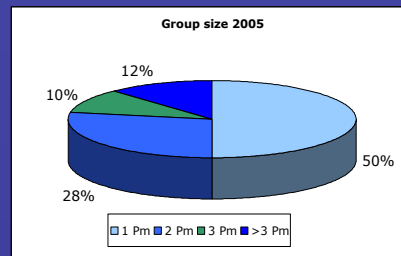
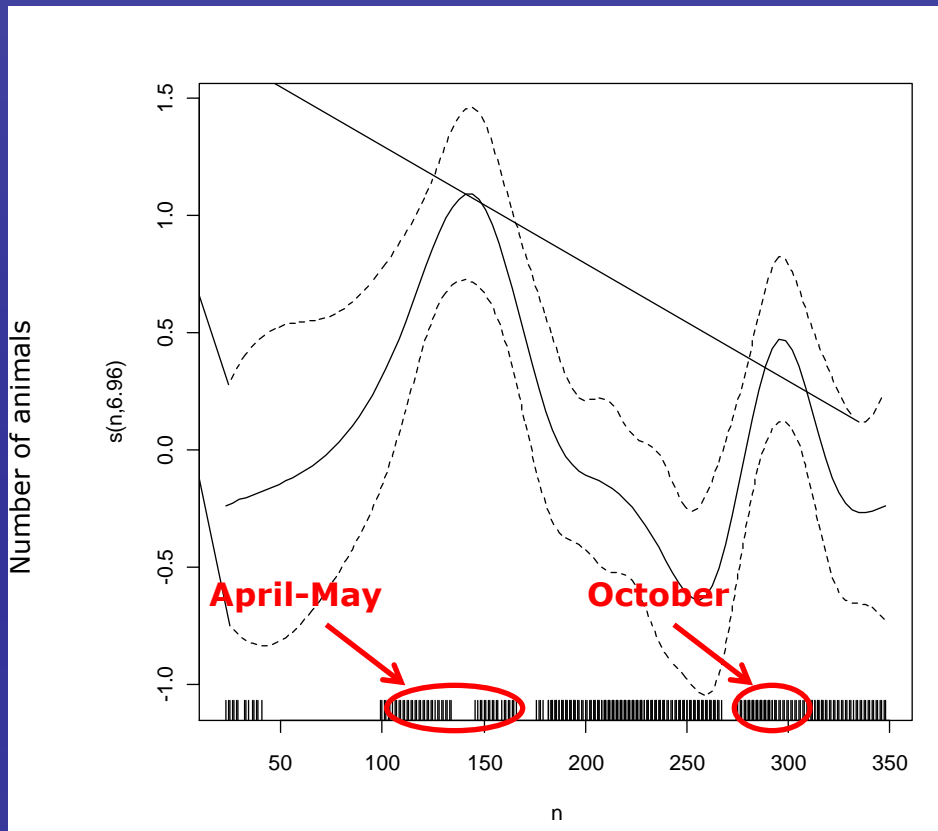
GAM - Examined factors: day of the year, year; quasi-binomial error distribution.

Significant relationship with day of the year
($p < 0.001$)

Presence peaks in **Spring** and **Autumn**

This results confirms the hypotheses on seasonal migration patterns

Group size variation



GAM - Examined factors: day of the year, year; quasi-Poisson error distribution.

Significant relationship with day of the year
($p < 0.001$)

They move in **groups**, the two peaks match the presence/absence peaks and support the hypotheses about their migration pattern.

They move among Easter and Western Med basins.

Detailed analysis of signal details to assess sperm whale sizes

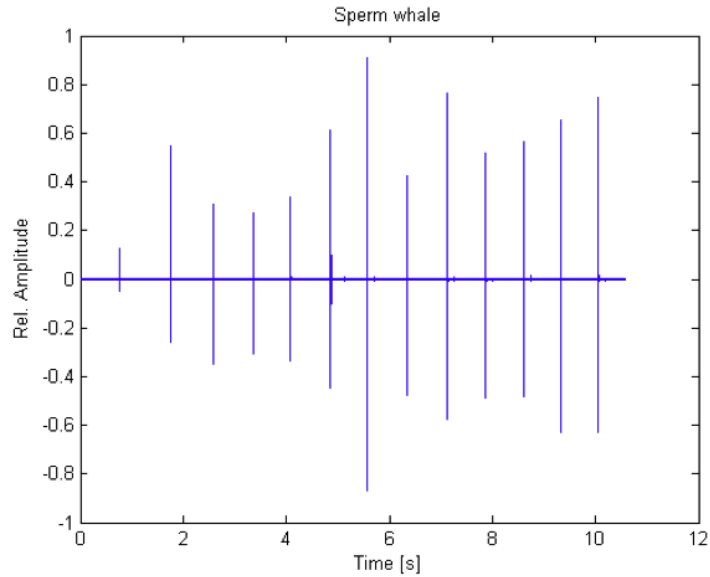


Figure 2.5 Sperm whale click train

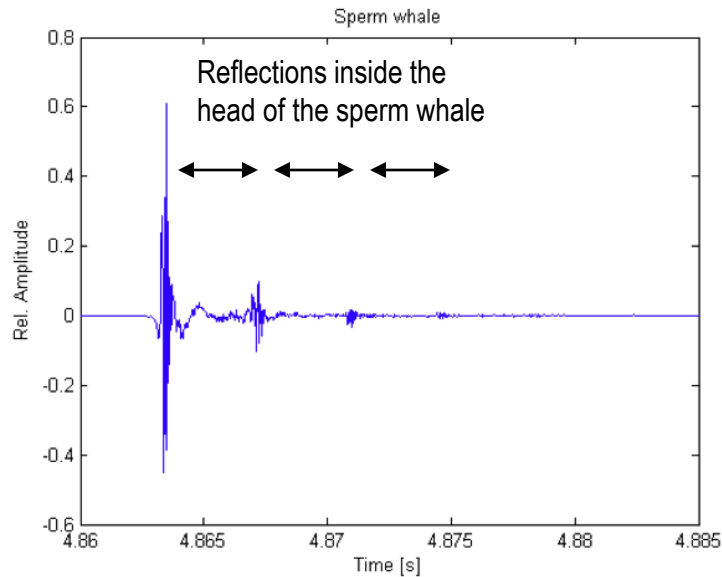
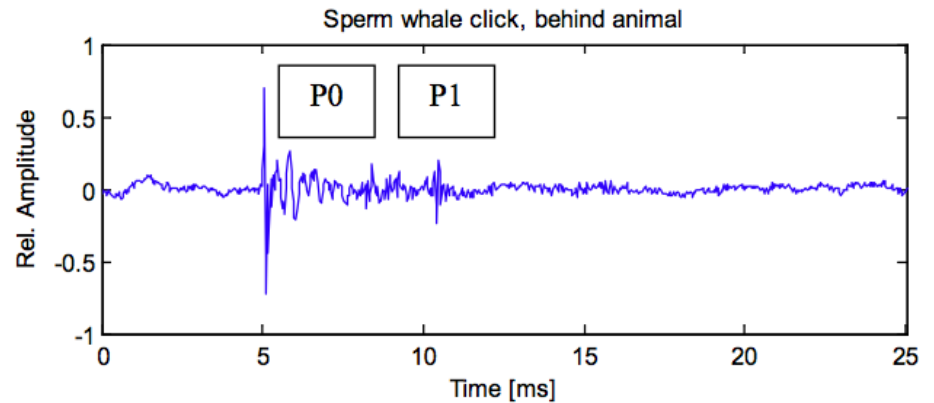
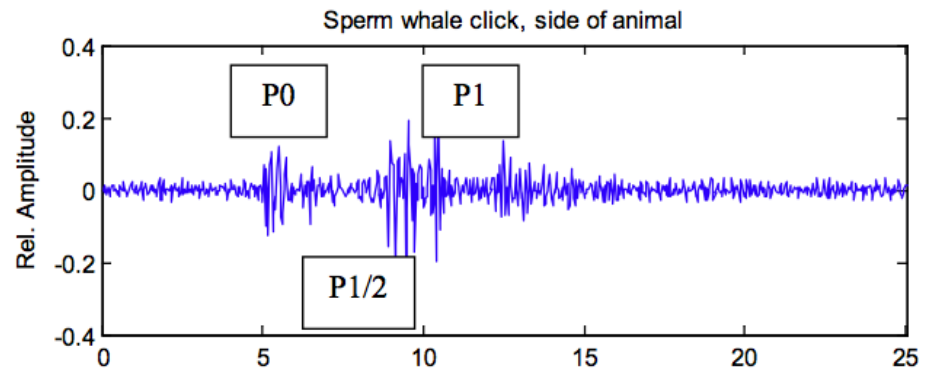
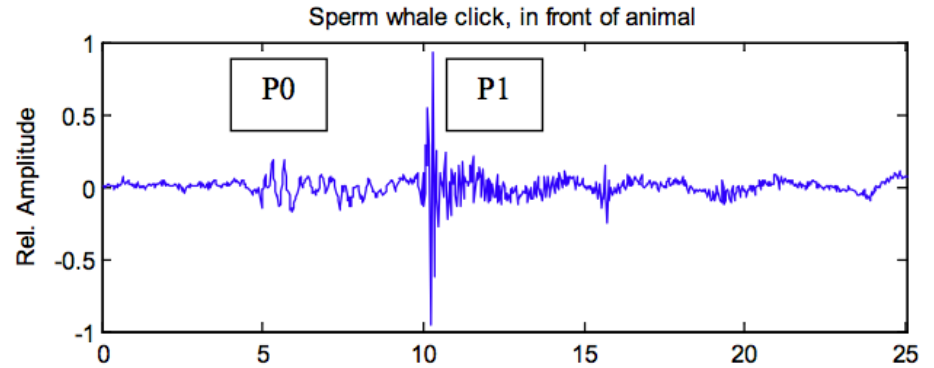
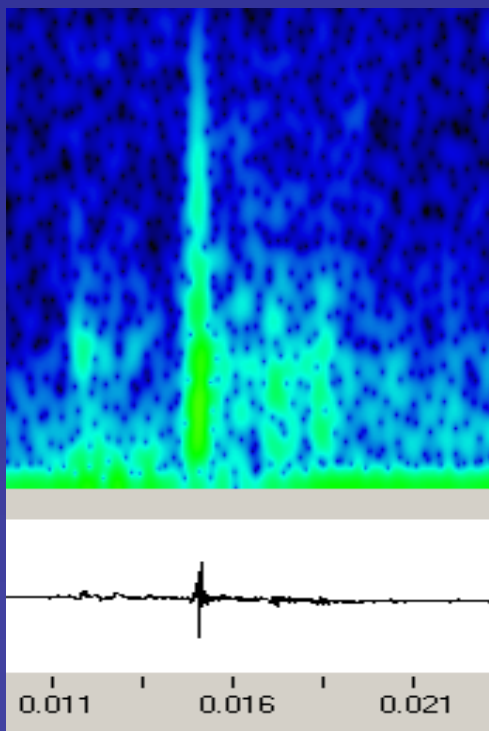
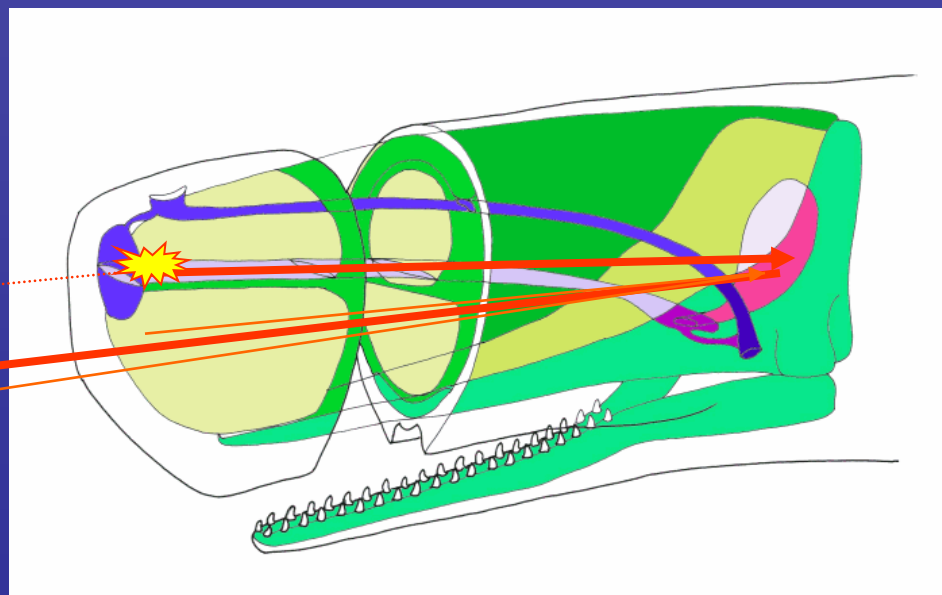
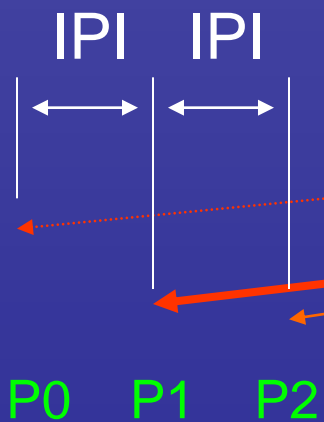


Figure 2.6 Details of a sperm whale click. Zoom into Figure 2.5





The geometry of the sound producing system is quite complex and produces multiple pulses we can use to assess whales' size and also their orientation and behaviour while diving at 1000m depth.

IPI and size estimate by manual measures

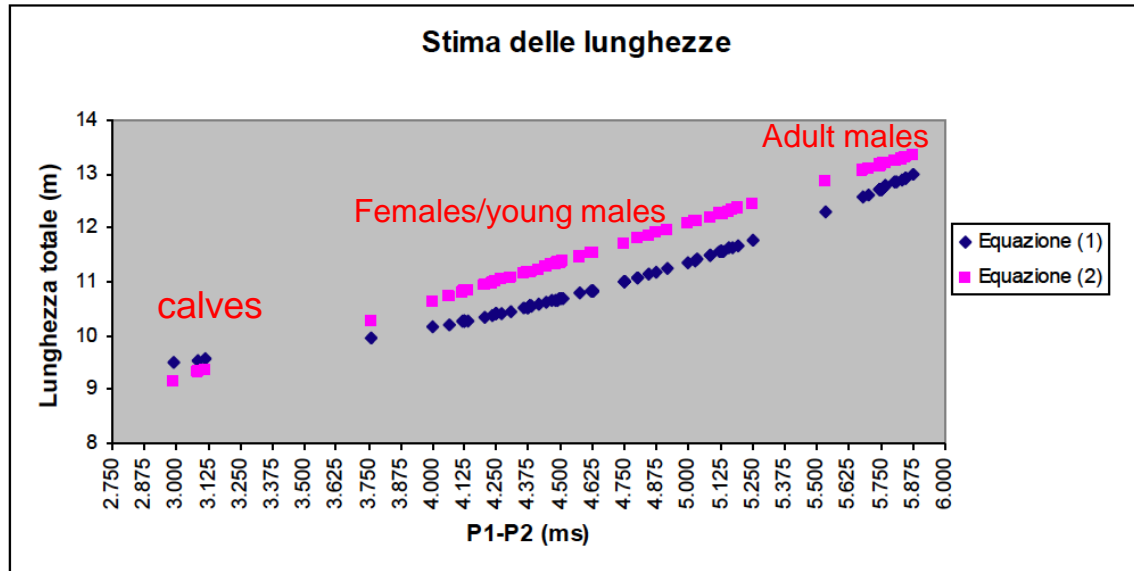
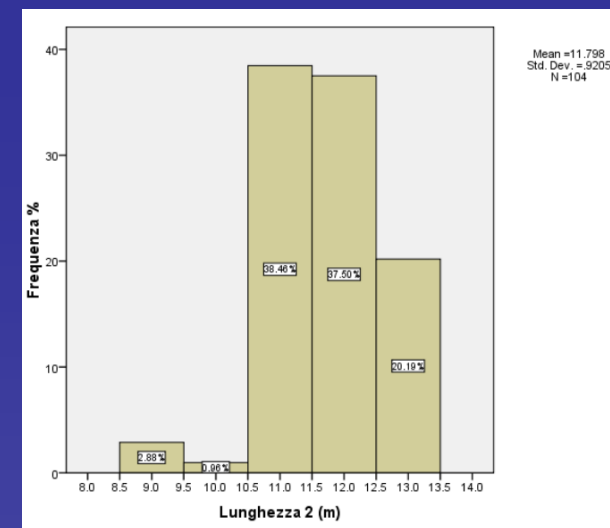
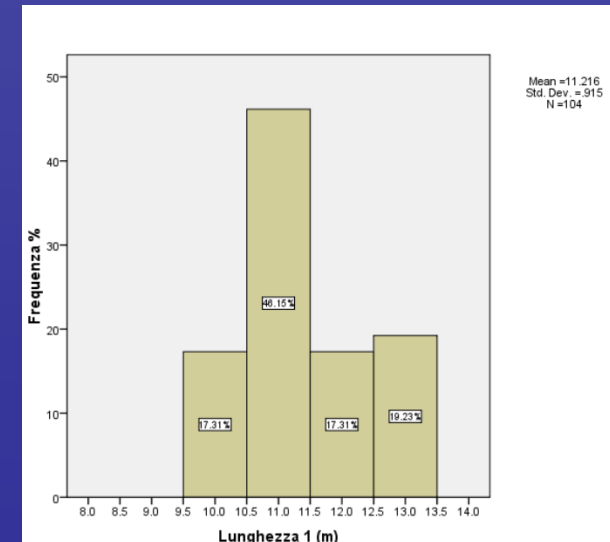


Grafico 5 - Confronto delle lunghezze totali (in m) dei capodogli ottenute con le equazioni (1) e (2), proposte da Gordon (1991).

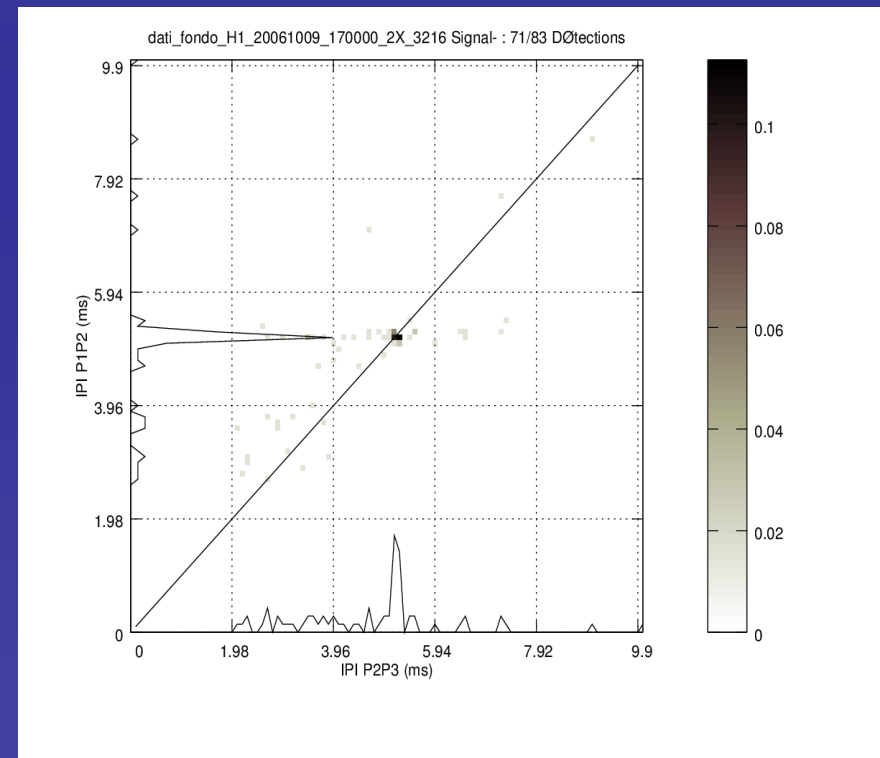
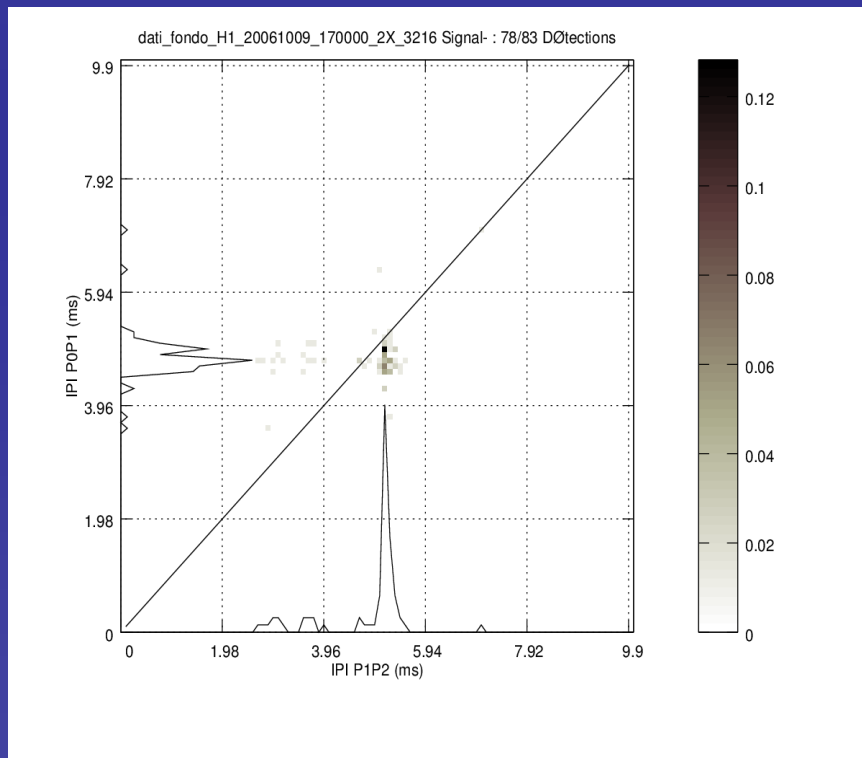
Estimating the whales' size allows to monitor the structure of the population and to monitor changes due to direct and indirect anthropogenic impacts.

This is fundamental for tuning long term conservation strategies.

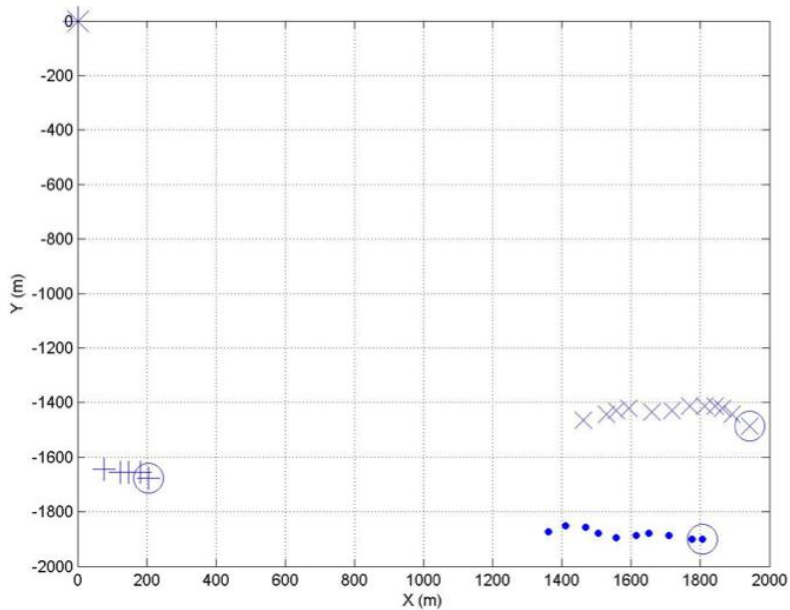


Accurate IPI and size estimation by unsupervised P0 P1 P2 P3 pulse identification

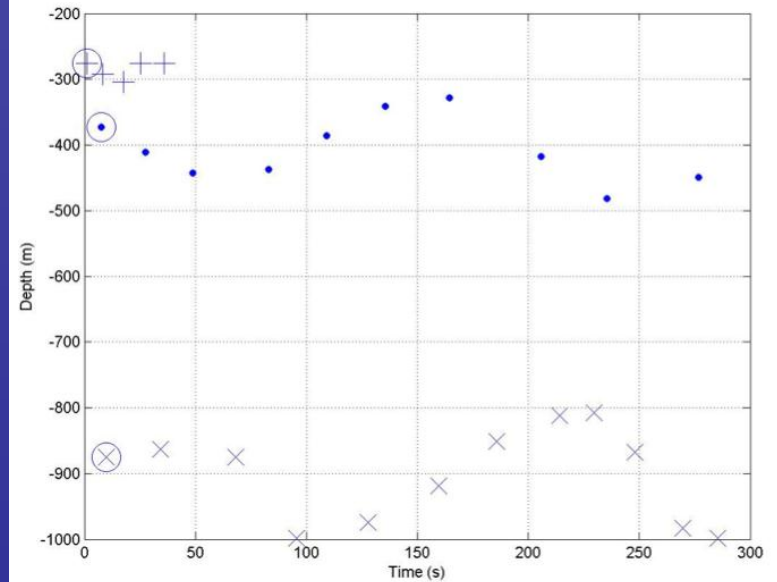
Work done with new algorithms developed at Toulone Univ. LSIS
Abeille, Glotin, Giraudet, Pavan, *submitted*



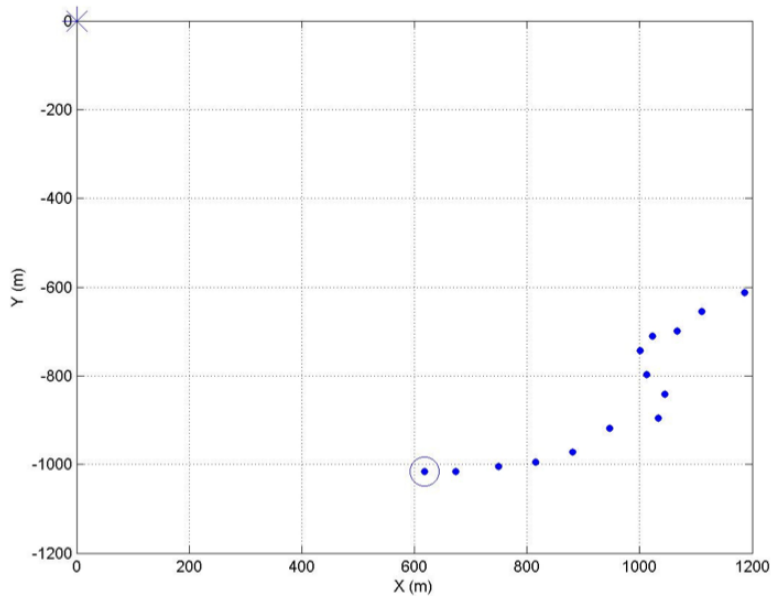
Plan view



Diving profile

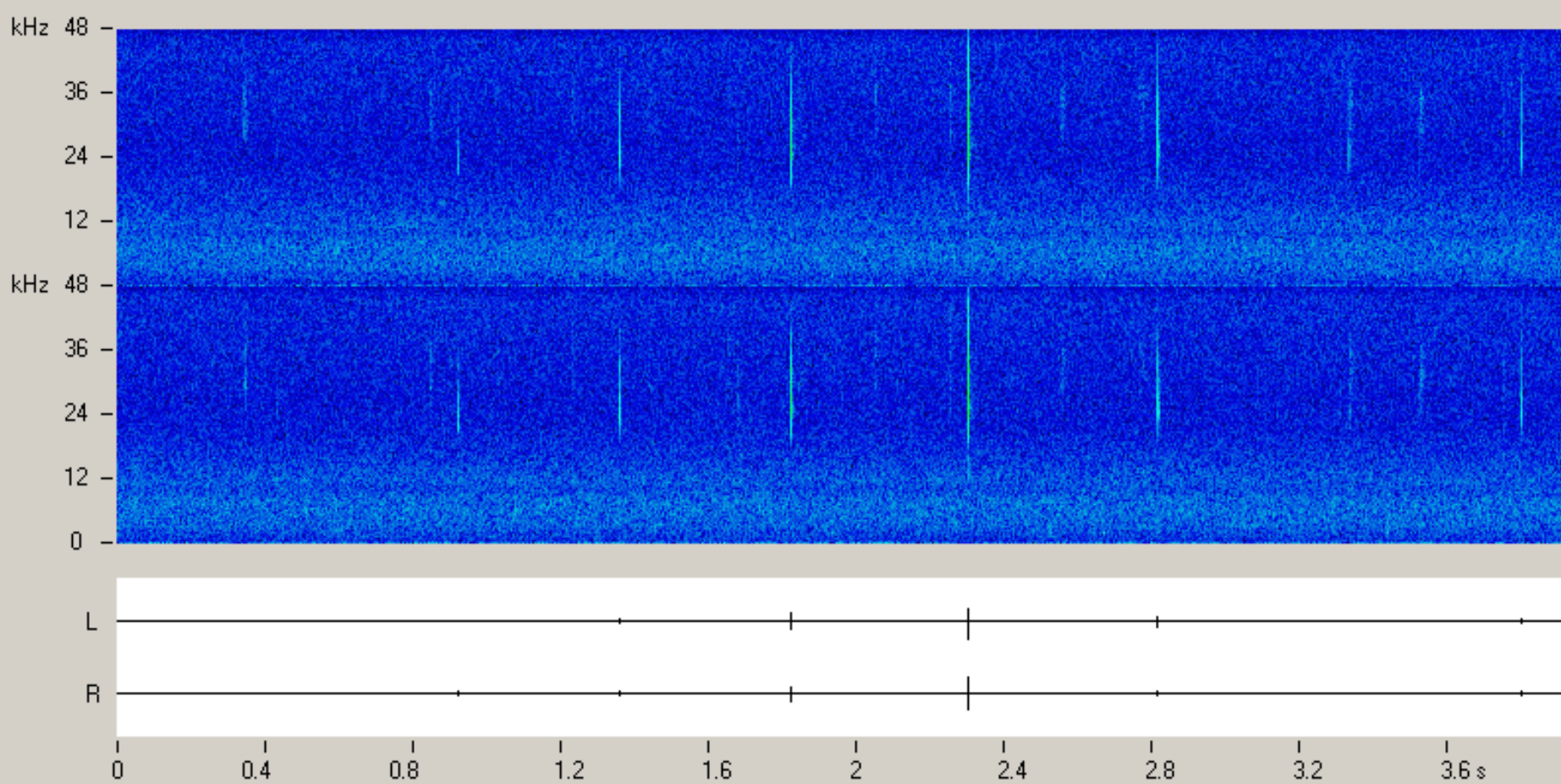


Plan view



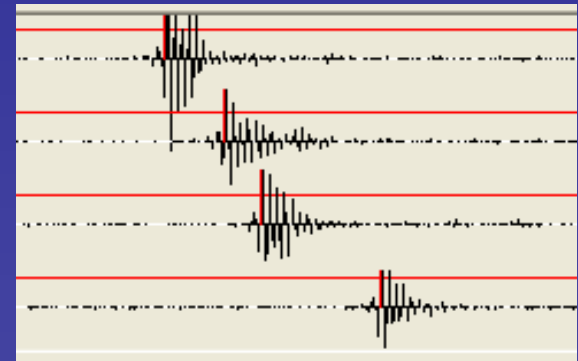
Tracking of sperm whales developed on ONDE data by H.Glotin et al. at LSIS (Toulon Univ.)

To be implemented in real time on next acoustic observatories



Detection of elusive/rare species such as Cuvier's beaked

Two channels spectrographic display of a series of clicks spaced 400-480ms, 300 μ s long, emitted by a pair of Cuvier's beaked whales, a key species in current research projects on the impact of noise on marine mammals.



New advanced acoustic sensors
and continuous recording / storage of selected
hydrophones

Catania (planned June 2012):

ONDE2 - 4 hydrophones 70kHz bw
192kHz sampling with gps timestamp

SN1 - 4 hydrophones 96kHz

Capo Passero (end 2012):

SMO - 14 hydrophones
192kHz sampling with gps timestamp

Field-work to be granted by other projects...



Long term goals :

Ocean noise statistics (natural, shipping, sonars, sparkers, etc)

Study marine mammals population trends and correlate with external factors (climate changes, noise, ship traffic, other impacts)

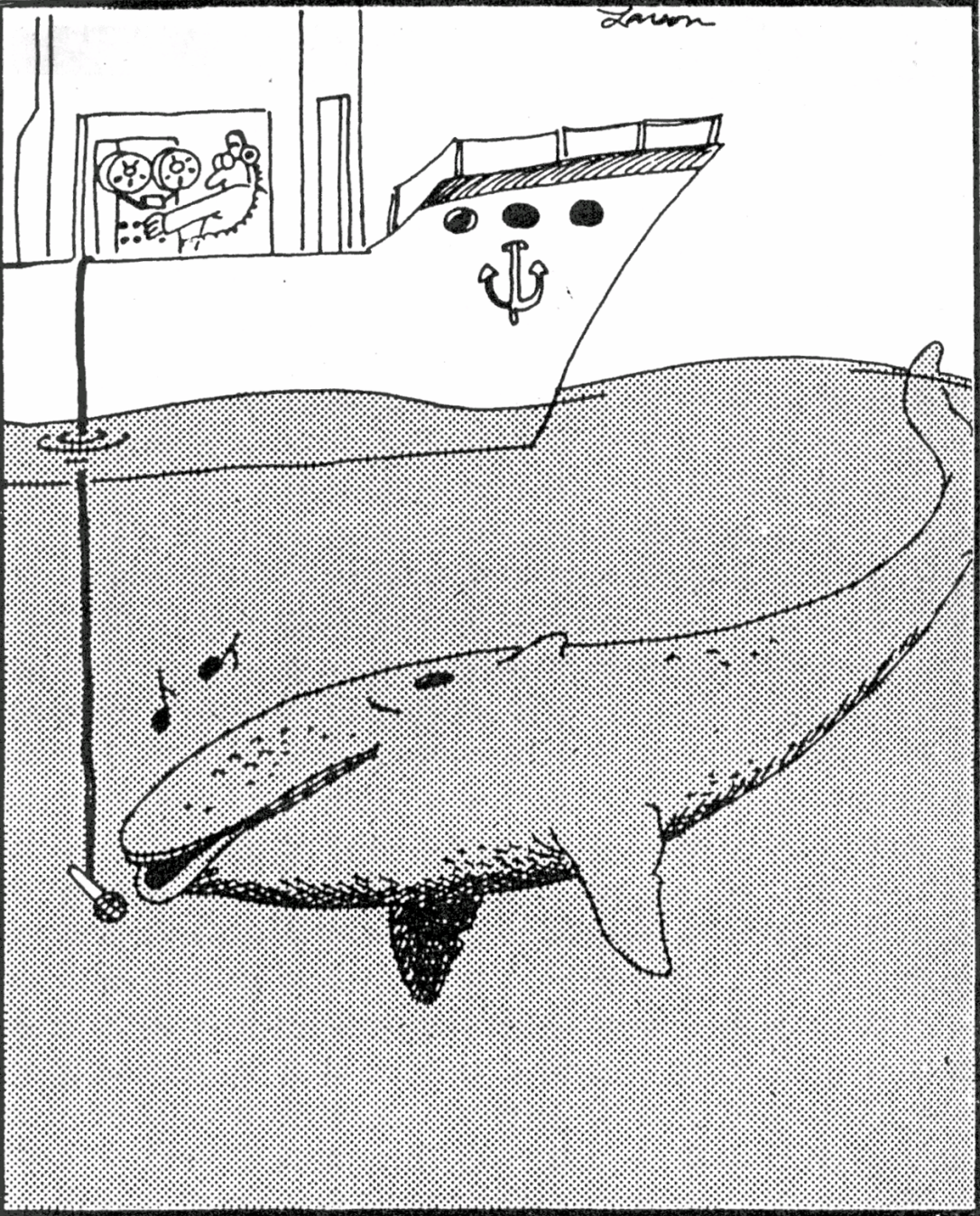
Improve detection and tracking technologies for instantaneous and continuously moving sound sources (e.g. to confirm migration)

Improve technologies for long term acoustic monitoring, data recording, data distribution and processing

Improve technologies for acoustic data classification

Integrate and correlate multiple data (oceanographic, AIS, etc)

Larson



Thanks

"A Louie, Louie . . . wowoooo . . . We gotta go now . . ."