ARION - Systems for Coastal Dolphin Conservation in the Ligurian Sea

M.Taiuti on behalf of the ARION Collaboration

THE PROJECT

ARION-LIFE+09 NAT/IT/190

- The ARION main objective is the creation of a virtual corridor for monitoring and surveillance of transient and resident bottlenose dolphins (*Tursiops truncatus*).
- Cofunded by EU, started on 1/10/2010 has been successfully completed 30/9/2015

Partnership

- Università di Genova (DIFI e DISTAV)
- SOFTECO SISMAT srl
- Area Marina Protetta di Portofino
- Direzione Marittima di Genova

Authors

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Objectives

- Conservation of the *Tursiops Truncatus* by means of three actions
  - Continuous surveillance of the project area to detect the presence of the bottlenose dolphins and concurrent human activities (boats)
  - Prompt risk reduction
  - Long term activity to define regulations and protected area boundaries

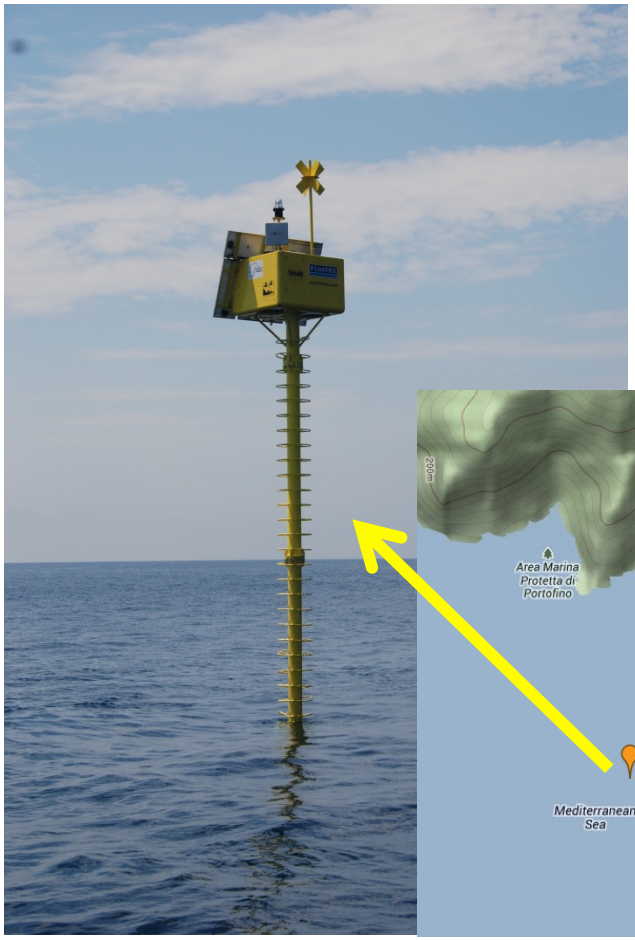
How?

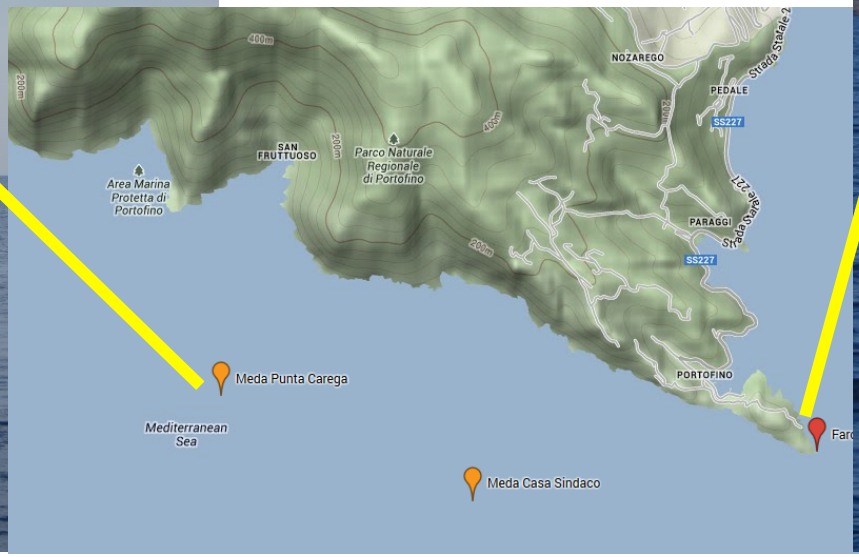
- We deployed in the Portofino MPA two detection units, based on a particular type of marine buoy (elastic beacon) each equipped with four hydrophones and an acquisition system which can record the typical "social communication whistles" emitted by the dolphins and the sounds emitted by boat engines.

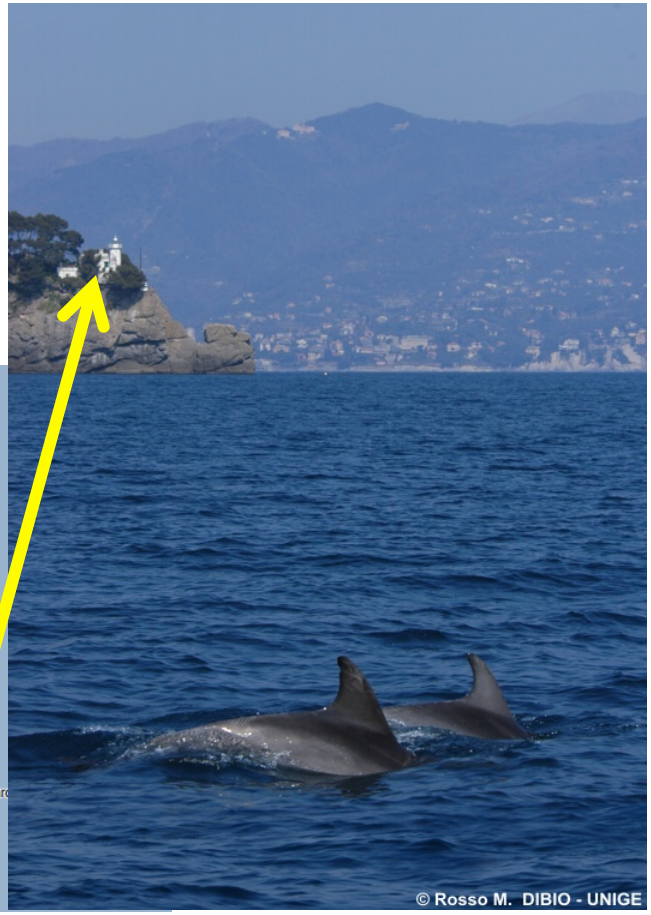
- Signals are pre-filtered and sent on shore, using a wi-fi bridge, where they are elaborated to get the position of dolphins and to track the boats in real-time.

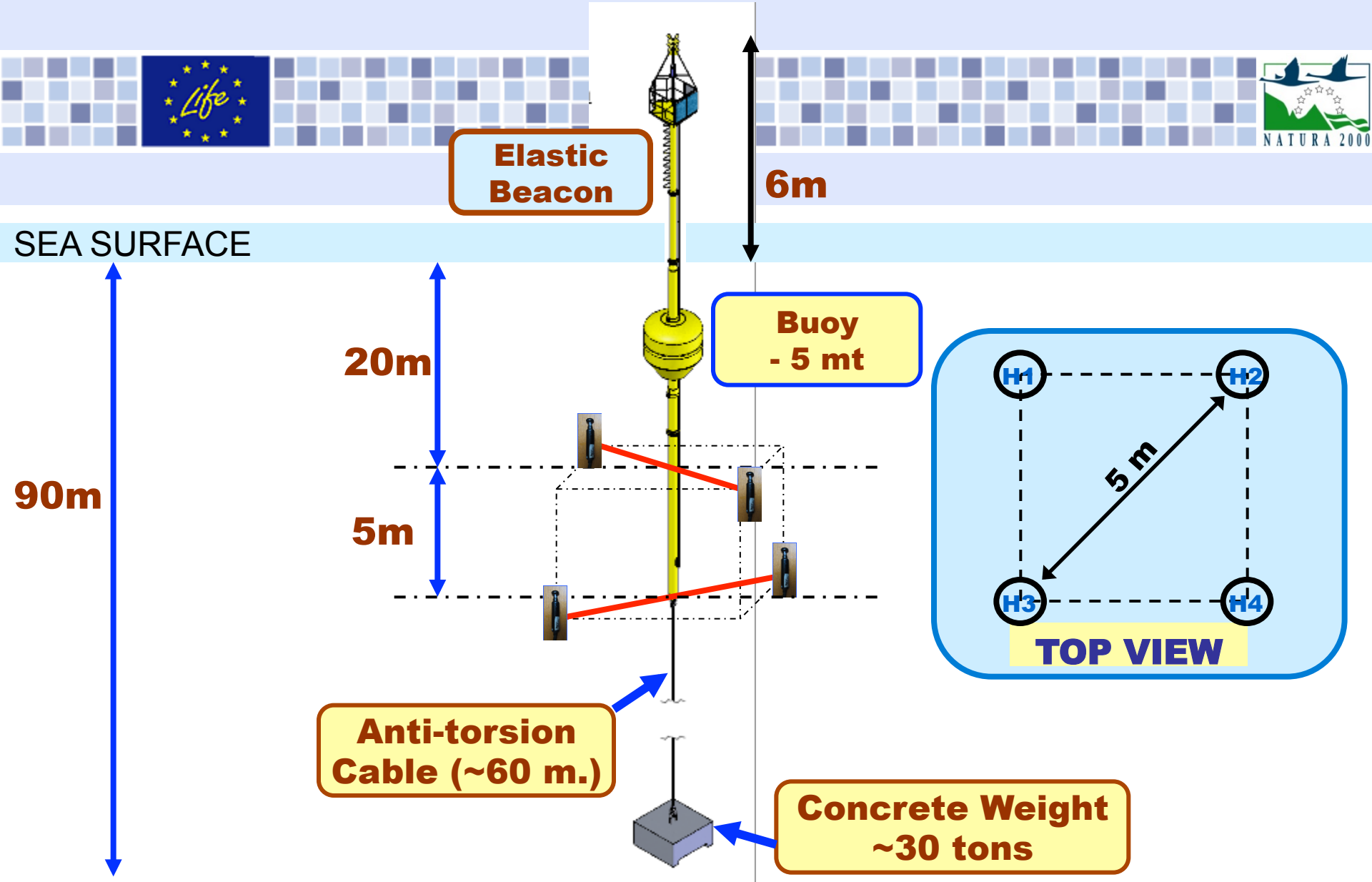
THE INFRASTRUCTURE

A permanent marine infrastructure for bottlenose dolphins and boats detection and tracking



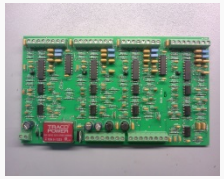





Elastic Beacon
6m
SEA SURFACE
90m
20m
5m
Buoy - 5 mt
H1
H2
H3
H4
5 m
TOP VIEW
Anti-torsion Cable (~60 m.)
Concrete Weight ~30 tons
SEA BOTTOM

water-tight instrum box

data acq digitaliz

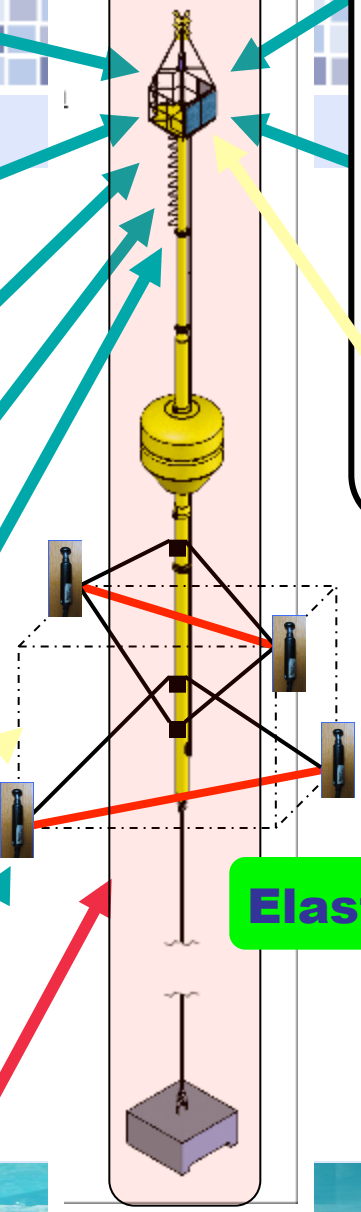


filter-amplif board

tilt-heading

batteries & ch reg

GSM remote switch



transm. radio WiFi

photov. panel ~43 W

meteo station

outdoor instrum

Elastic Beacon

underwater instrum

current-wave meter

hydrophones

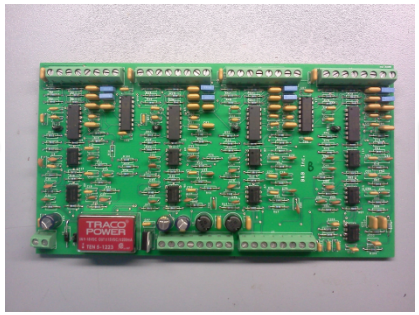
water param

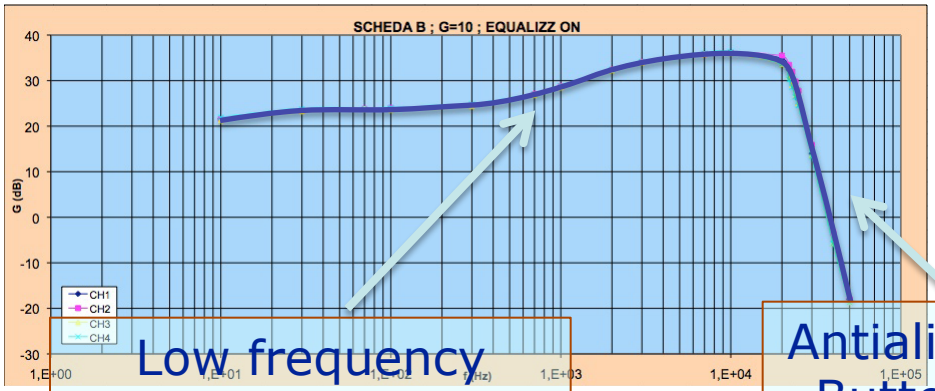
Hydrophone properties

- GP0280 by COLMAR

- Working band: 5 – 90.000 Hz
- Sensitivity differential output: -165 dB re 1V/μPa @5 kHz
- Directivity: spherical, omnidirectional
- Max working depth: 1000 m
- Gain @5 kHz: 36 dB (differential output)
- Input acoustic equivalent noise: 34 dB re 1μPa/√Hz @5 kHz

Acquisition System





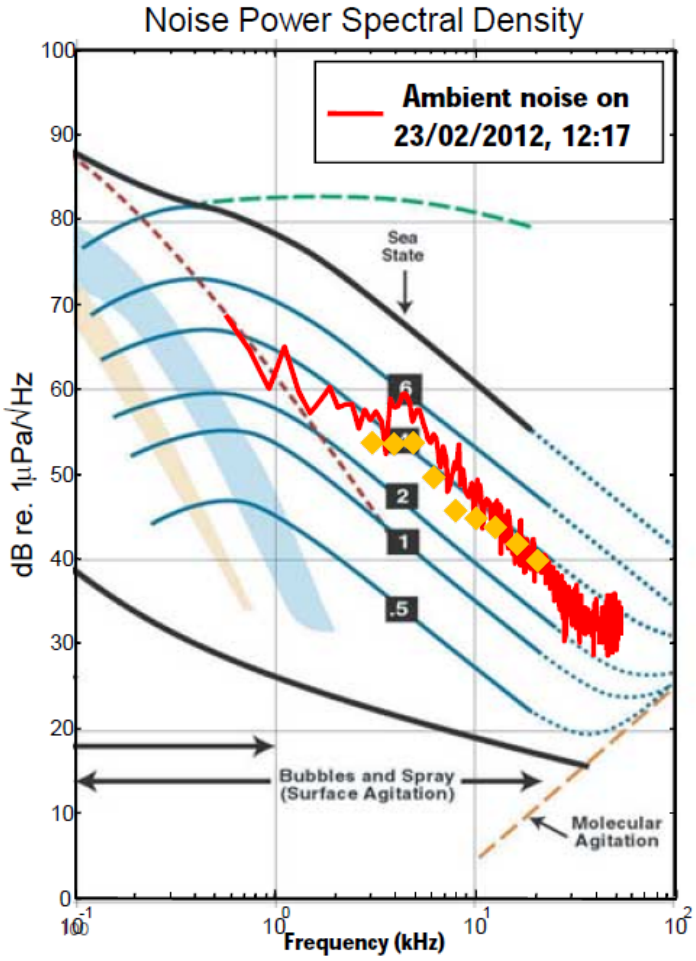
4-channel
16 bit ADC
Single clock
Up to 100 kS/s

Low frequency noise reduction filter (< 3kHz)

Antialiasing 8-poles Butterworth filter Sallen-Key type

Performances

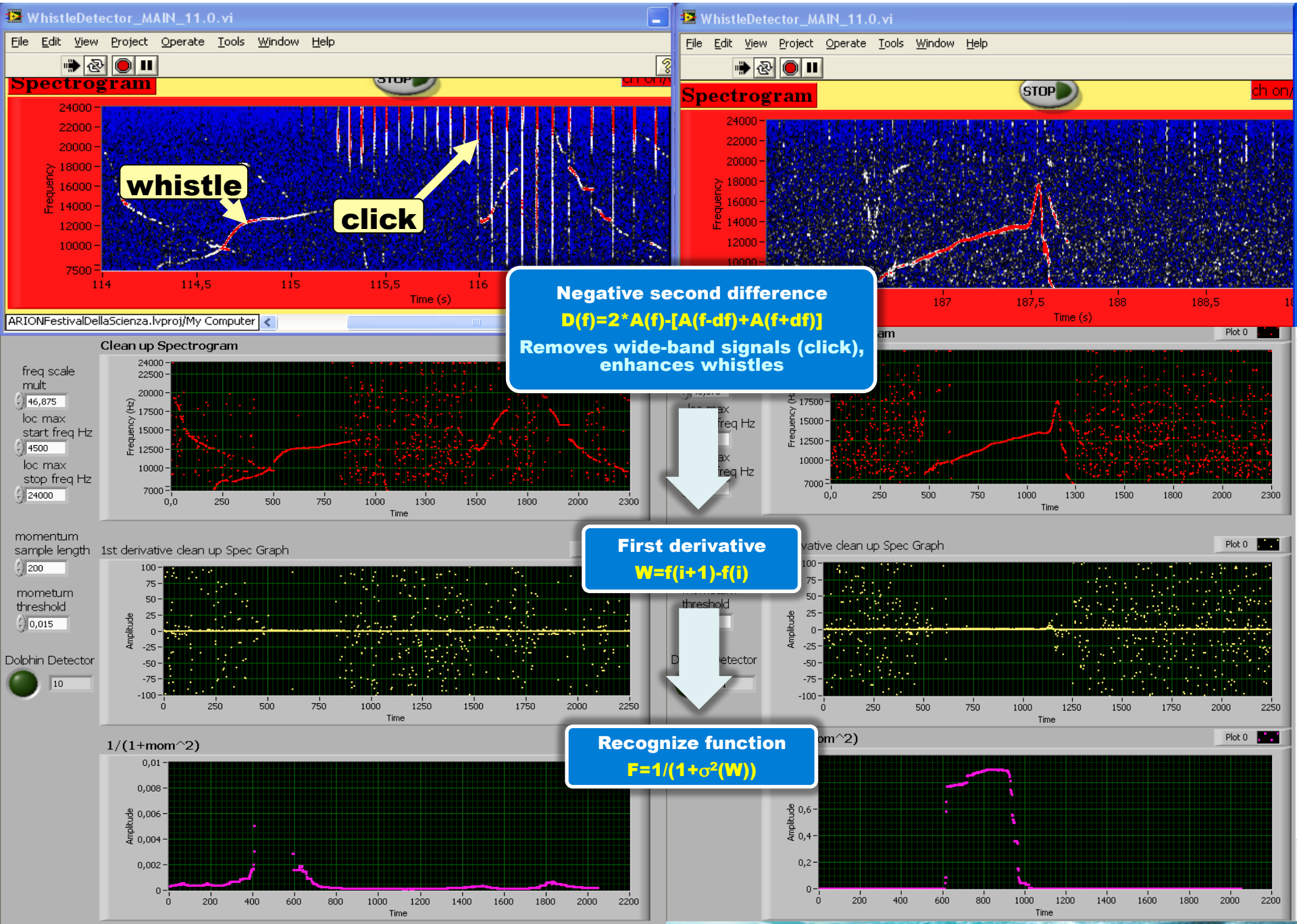
- Hydrophones absolutely calibrated
  - Ambient noise (Wenz curve)
  - Measurement with calibrated hydrophone shows noise higher than theoretically expected
  - Our system provides similar results
- Up-time 89%



from [Ainslie, 2011]

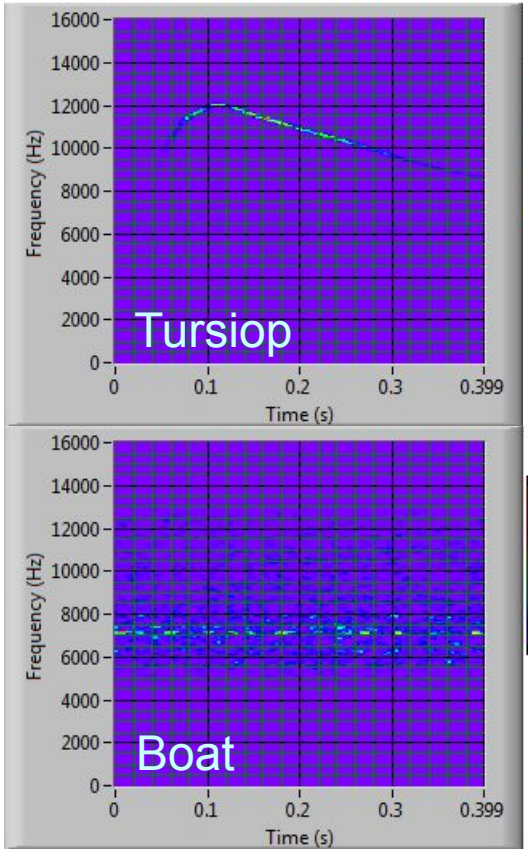
On-line analysis

- Whistle identification – W.Zimmer algorithm
- Noise reduction – boats mis-identification
- Sound heading calculation
- *Sound source localization*
- Boat tracking


WhistleDetector_MAIN_11.0.vi
File Edit View Project Operate Tools Window Help
Spectrogram
STOP
whistle
click
Frequency
Time (s)
ARIONFestivalDellaScienza.lvproj/My Computer
Clean up Spectrogram
freq scale mult
46,875
loc max start freq Hz
4500
loc max stop freq Hz
24000
momentum sample length
200
momentum threshold
0,015
Dolphin Detector
1st derivative clean up Spec Graph
1/(1+mom^2)
Amplitude
Time
Negative second difference
D(f)=2*A(f)-[A(f-df)+A(f+df)]
Removes wide-band signals (click), enhances whistles
First derivative
W=f(i+1)-f(i)
Recognize function
F=1/(1+σ²(W))
Plot 0

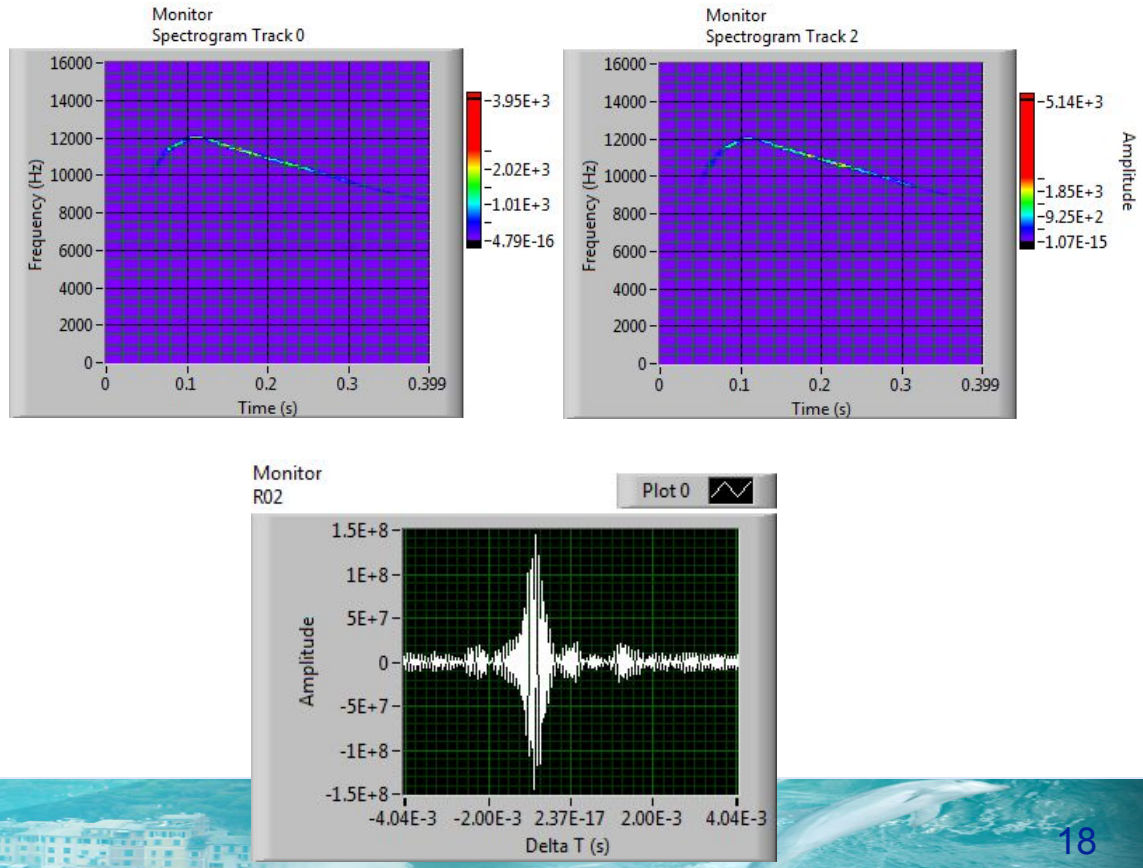
Noise Reduction

- The algorithm is not sufficient
- Boats mimic the bottlenose dolphin signal
- Check on signal duration and slope
- 90% efficiency with <5% contamination



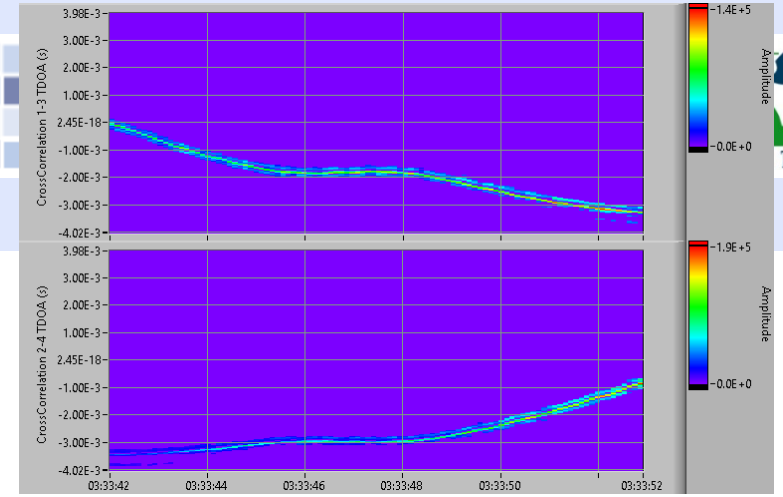
Sound Heading Calculation

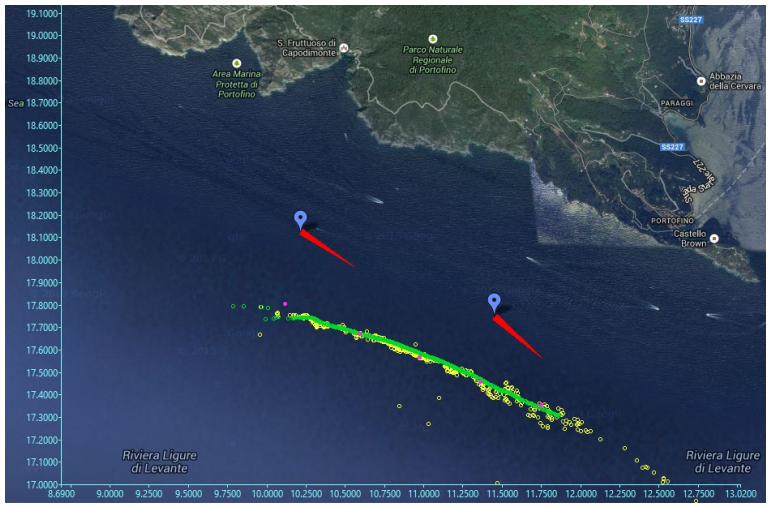
- Based on cross-correlation
- Average angular resolution: 1°

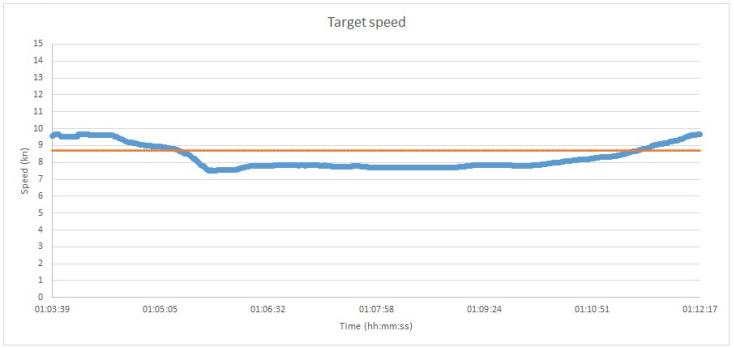


Boat tracking

- Joint analysis of the reconstructed sound direction (cross-correlograms)
- Kalman filter applied
- Comparison with AIS data
- Velocity measurement accuracy: 20%







BOTTLENOSE DOLPHINS OBSERVATION

Mammalian Biology 76 (2011) 180–189

Contents lists available at ScienceDirect

Mammalian Biology

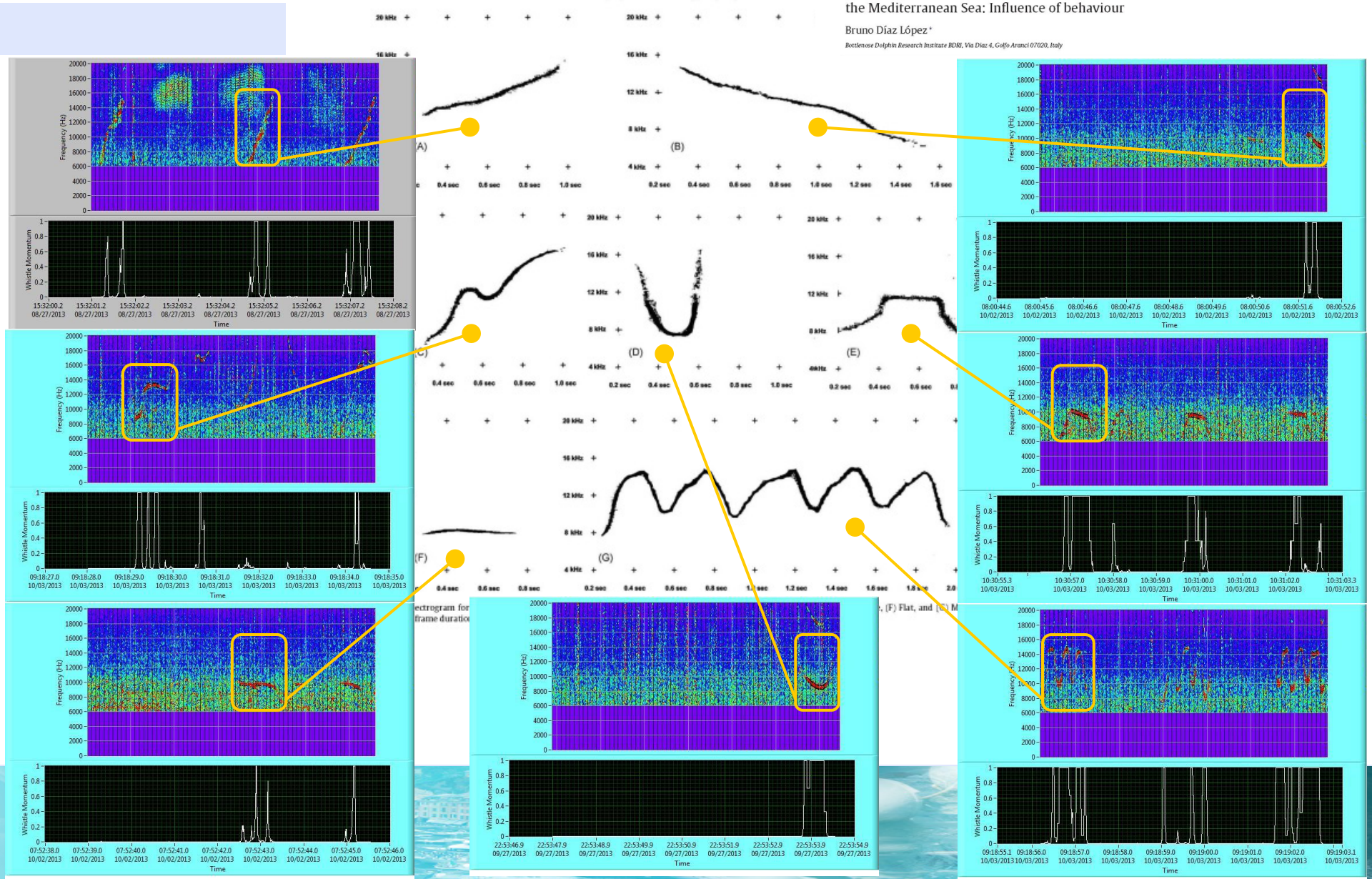
journal homepage: www.elsevier.de/mambio

Original Investigation

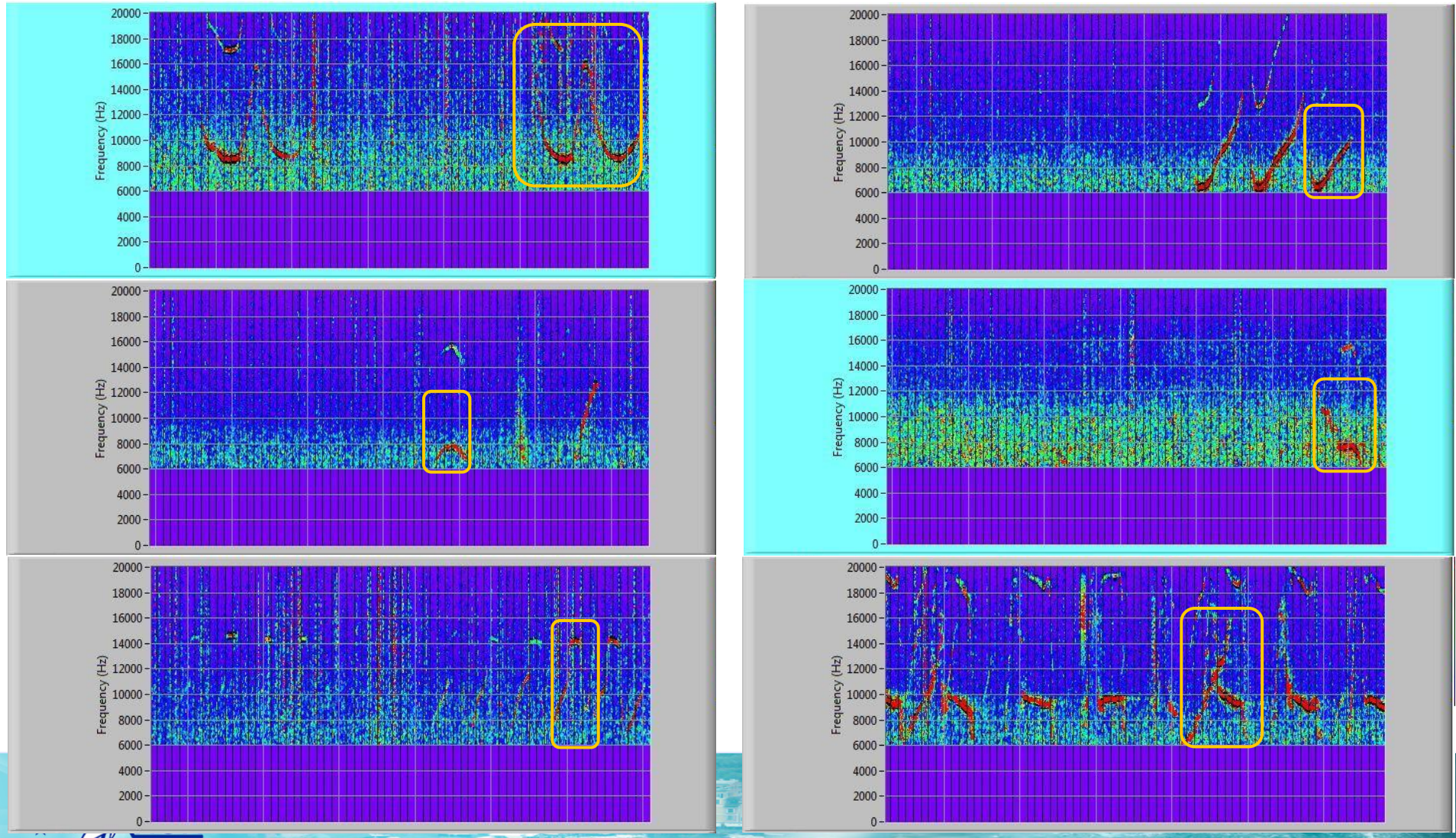
Whistle characteristics in free-ranging bottlenose dolphins (*Tursiops truncatus*) in the Mediterranean Sea: Influence of behaviour

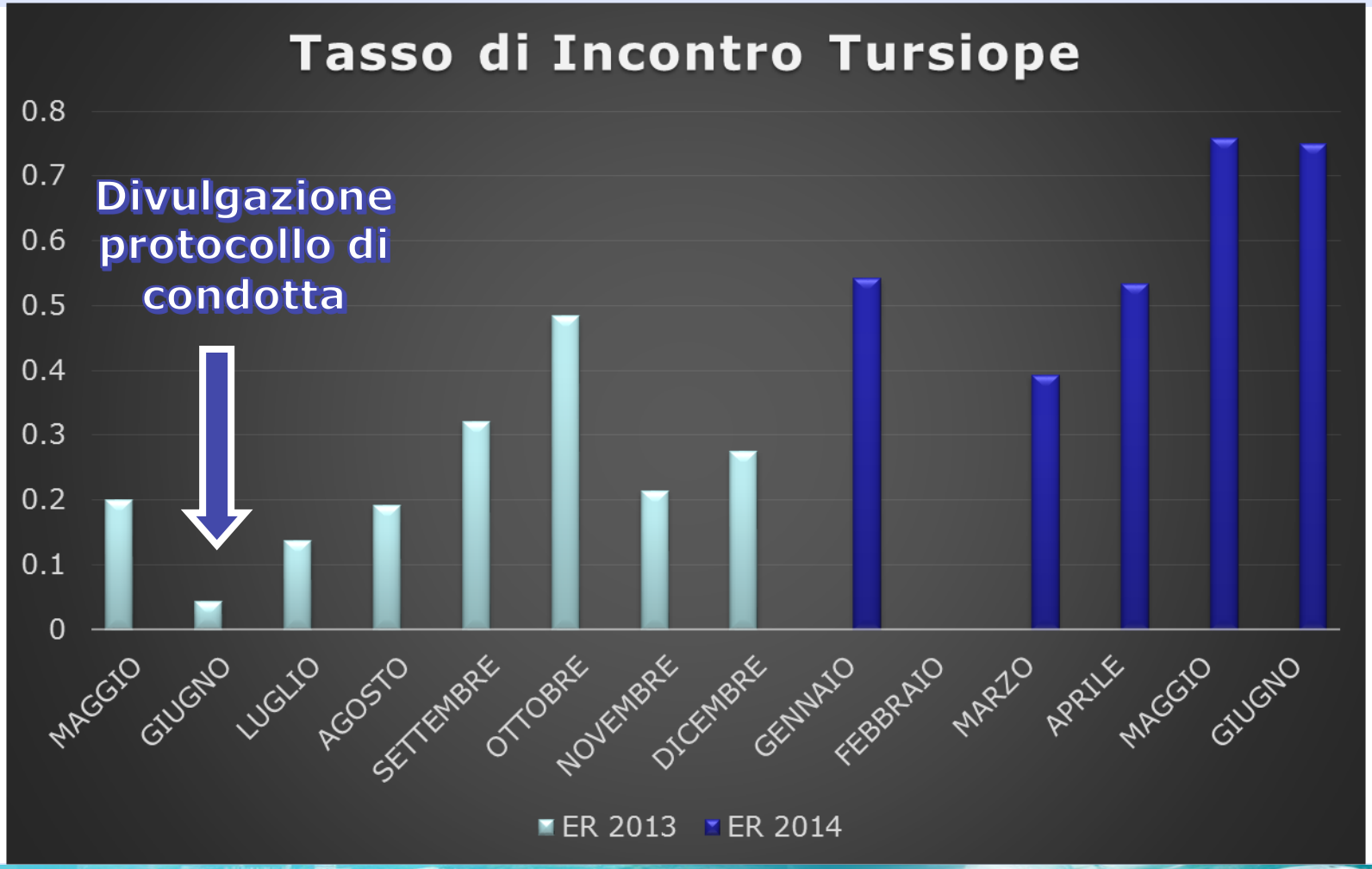
Bruno Díaz López *

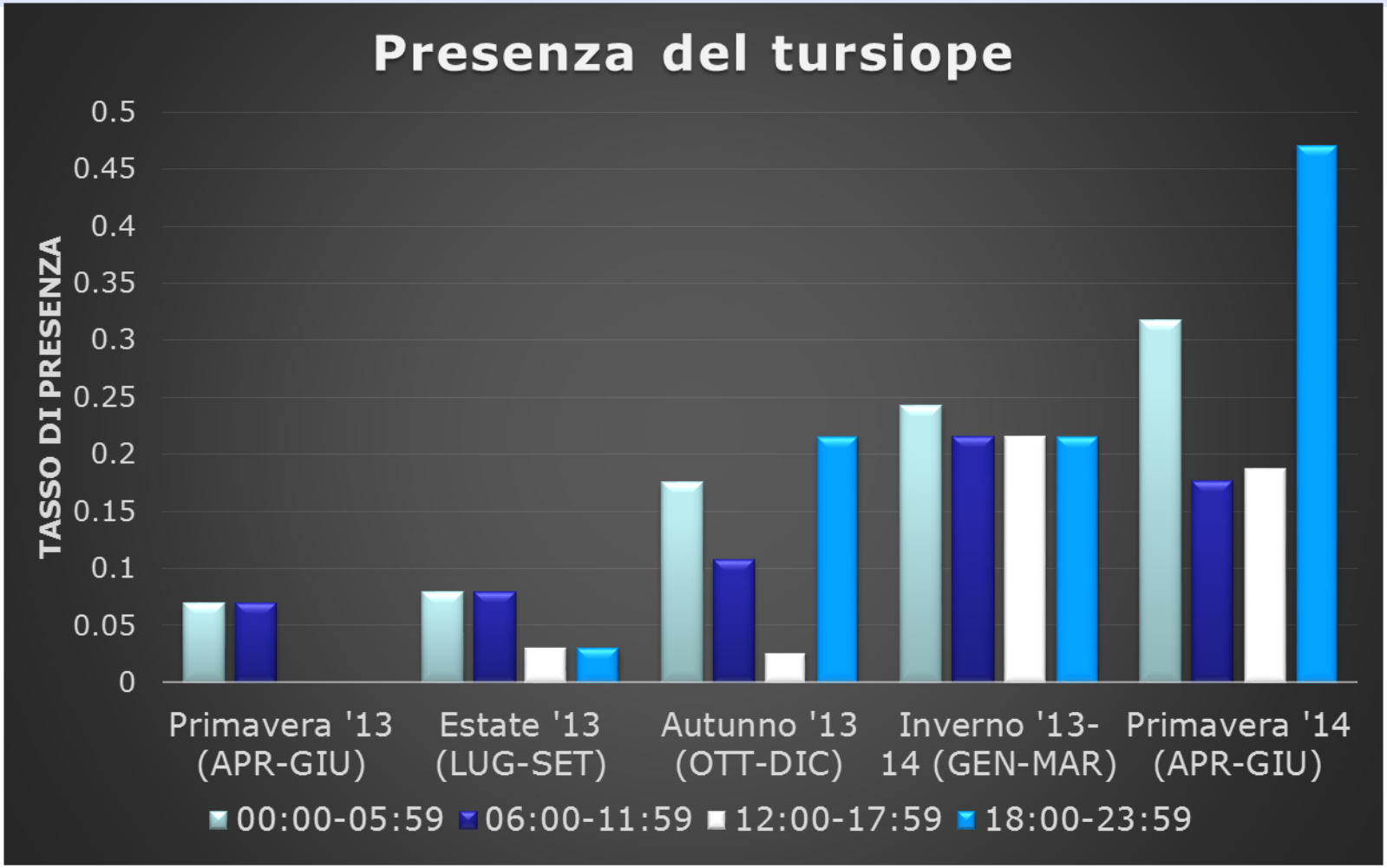
Bottlenose Dolphin Research Institute BDRI, Via Diaz 4, Golfo Aranci 07020, Italy



- Observed several additional signals not common in the Mediterranean Sea


Frequency (Hz)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0


Tasso di Incontro Tursiope
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Divulgazione protocollo di condotta
MAGGIO
GIUGNO
LUGLIO
AGOSTO
SETTEMBRE
OTTOBRE
NOVEMBRE
DICEMBRE
GENNAIO
FEBBRAIO
MARZO
APRILE
MAGGIO
GIUGNO
ER 2013
ER 2014


Presenza del tursiope
TASSO DI PRESENZA
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Primavera '13 (APR-GIU)
Estate '13 (LUG-SET)
Autunno '13 (OTT-DIC)
Inverno '13-14 (GEN-MAR)
Primavera '14 (APR-GIU)
00:00-05:59
06:00-11:59
12:00-17:59
18:00-23:59

SUMMARY

- ARION succesfully completed in 2015 and we are replicating it in the Savona area (WHALESAFE)
- It provided a two-years observation period of interactions between tursiops and anthropic activities
- It provided evidence of effectiveness of best practice
- However longer term investigation is required to better quantify the results