



Cetacean  
Sanctuary  
Research

*Report on the 1990-2020 Research and  
Conservation Activities in the Pelagos Sanctuary  
(North western Mediterranean Sea)*

Tethys Research Institute, February 2021



## **This report should be quoted as:**

Tethys Research Institute - Cetacean Sanctuary Research, 2021. Report on the 1990-2020 Research and Conservation Activities in the Pelagos Sanctuary (North western Mediterranean Sea). By Lanfredi C., De Santis V., Jahoda M. and Airoidi S. Tethys Research Institute. 2021 pp.56 + annex.

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Page 51 photo kindly provided by Liguria Whale Watching

Layout graphic design by Valentina De Santis

**In 2020 the CSR project was conducted in collaboration with:**



**and was supported by:**



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# TABLE OF CONTENTS

|   |    |
|---|----|
| <b>Executive Summary</b>  | 4  |
| <b>1. Cetacean Sanctuary Research Project</b>                           | 6  |
| 1.1 Overview of the Project   | 6  |
| 1.2 Projects' Study Area  | 7  |
| 1.3 CSR Target Species  | 10 |
| 1.4 Overview of research techniques                                     | 13 |
| <b>2. Summary of the Project's Results over 30 years</b>                | 16 |
| 2.1 Collaborations and Synergies (1990-2020)                            | 22 |
| <b>3. Conservation and Management Activities</b>                        | 23 |
| <b>4. Results of the 2020 Field Work Activity</b>                       | 27 |
| 4.1 Research Activity and Funding                                       | 27 |
| 4.2 Survey effort and sightings   | 28 |
| 4.3 Photo-identification  | 33 |
| 4.4 Collisions  | 35 |
| 4.5 Passive acoustic surveys and recordings                             | 37 |
| 4.6 Photogrammetry and acoustic allometry                               | 39 |
| 4.7 Faecal sampling   | 41 |
| <b>5. Reported encounters through the CFA citizen science programme</b> | 43 |
| <b>6. Peculiarities found during the 2020 season</b>                    | 45 |
| 6.1 Maritime traffic  | 45 |
| 6.2 Distribution of the animals   | 47 |
| <b>7. Education and Public Awareness</b>                                | 52 |
| 7.1 Digital Whales  | 52 |
| 7.2 Run for the Whales  | 53 |
| 7.3 Artists for Whales  | 53 |
| 7.4 PRESS Coverage and releases, blog                                   | 53 |
| 7.5 Social Media  | 54 |
| <b>Project personnel 2020</b>   | 55 |
| <b>Acknowledgments</b>  | 56 |
| <b>ANNEX I. Scientific contributions</b>                                | 57 |

# EXECUTIVE SUMMARY

The main aim of this document is to report the activities conducted by the Cetacean Sanctuary Research in the Pelagos Sanctuary area (North-Western Mediterranean Sea), with a detailed focus on the activities carried out during the 2020 research season.

Studies and monitoring, conducted in the Pelagos Sanctuary by the CSR Tethys project for over three decades, generated the longest time series and one of the largest datasets on Mediterranean cetaceans.

Between 1990 and 2020, the CSR spent more than 2,500 days at sea, covering about 140,000 km during summer seasons (May-October). This effort resulted in about 6,200 encounters of eight different species of cetaceans, in the development of photographic catalogues counting more than 1,500 individuals of seven different species and in a database of acoustic recording counting more than 1,400 files of cetaceans vocalizations.

During its 30 years operating in the Sanctuary area, Tethys has substantially contributed to increase the knowledge on the abundance, distribution, behaviour, health and conservation status of cetaceans species. A summary of the project results is presented in the first part of this report.

The pandemic caused by the worldwide Coronavirus disease (COVID-19) and the economic crisis linked to it, threatened the survival of the CSR project. However, thanks to the support of the MAVA Foundation, the CSR project kept conducting fieldwork even during this very difficult moment.

During the 2020 field season, the project conducted 54 days at sea, collecting more than 200 sightings of cetaceans belonging to six different species, 5,000 photos of cetaceans and 20 hours of acoustic recordings of cetaceans' vocalizations. Three cases of injured fin whales' individuals, showing clear evidence of severe collision marks, were also reported.

The project also reported 165 encounters of seabirds of five different species, 62 encounters of marine turtles and 111 encounters of fish of five different species. Detailed results of the 2020 field season are presented in the second part of the report.



Data collected in 2020, an unusual year, provided an essential contribution to the understanding of cetaceans ecology, presence, abundance, and distribution of cetaceans in the Pelagos Sanctuary. Interesting issues emerged by analysing the maritime traffic data provided by the Italian Coast Guard for the Pelagos Sanctuary area. An overall decrease of 20.3% in the number of vessels (mainly Passengers ships) was detected. Major changes occurred in the spring period, probably caused by the restrictions imposed by countries to contrast the virus diffusions. Finally, interesting peculiarities on fin whales distribution were highlighted by merging CSR sightings with opportunistic sightings data.

A great effort has also been devoted to public awareness. Details about education and public awareness activities undertaken by CSR are reported in the last part of this document.

Finally, the annex of this report contains a list of publications and conference presentations based on, or including, research conducted by Tethys in the western Ligurian Sea between 1990-2020.

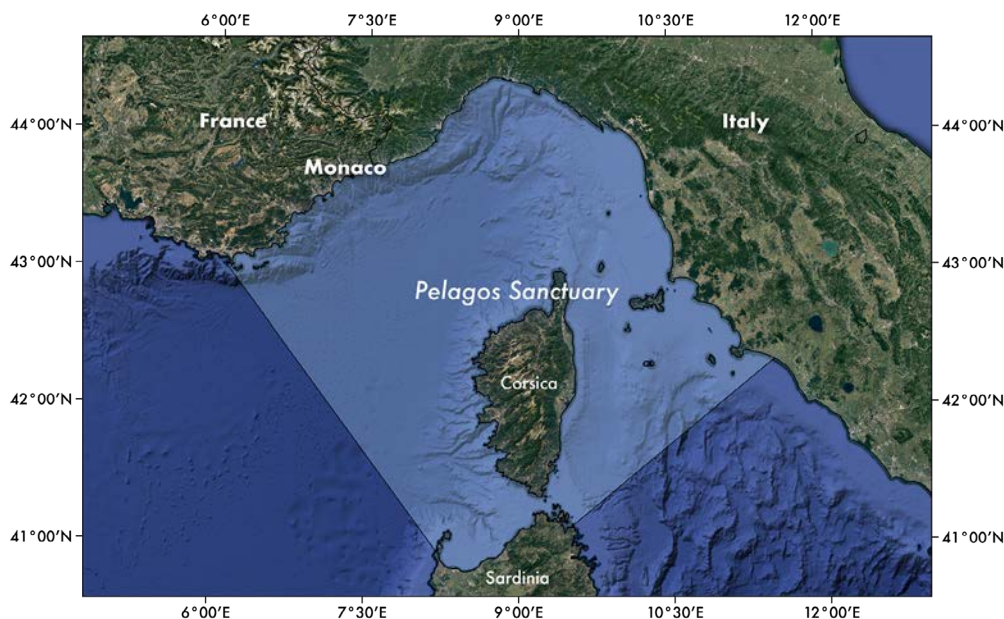


# 1. CETACEAN SANCTUARY RESEARCH PROJECT

## 1.1 Overview of the Project

The **Cetacean Sanctuary Research (CSR)**, established in 1990, is a long-term project of the Tethys Research Institute focused on the monitoring of all ecological aspects of the cetacean species living in the Ligurian Sea (North-Western Mediterranean Sea). The main aim of the project is to produce scientific knowledge to support the conservation of marine mammals.

The studies conducted in the 90's showed that this area is the most important habitat for cetaceans in the Mediterranean, given its high species diversity and its intense biological activity. This evidence led the Institute to play an active role in the creation of the "*Pelagos Sanctuary of Mediterranean marine mammals*" (Figure 1). The area contains deep-water and shelf-slope habitats suitable for foraging and breeding needs of all of the eight cetacean species regularly found in the Mediterranean Sea. It also accounts for one of the highest concentrations of cetaceans.



**Figure 1.** The Pelagos Sanctuary (enclosed within the black lines), of approximately 87,500 km<sup>2</sup>.

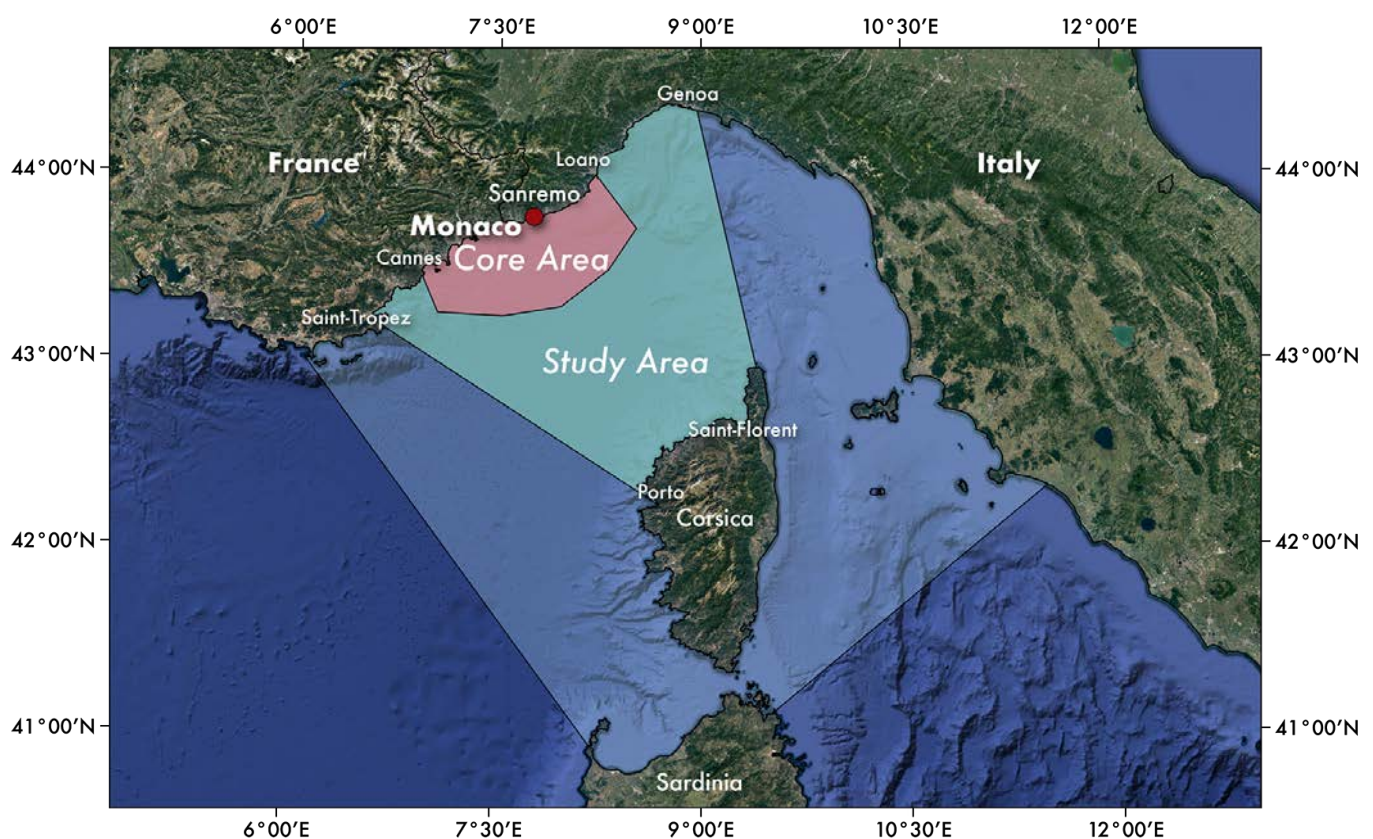
Studies and monitoring, conducted in the Pelagos Sanctuary by the CSR Tethys project for over 31 years (1990-2020), generated the longest time series and one of the largest datasets on Mediterranean cetaceans.

The CSR Project focuses on *population dynamics, spatial distribution, habitat preferences, ecology behaviour, bioacoustics and on the evaluation of long-term environmental changes and monitoring of anthropogenic pressures affecting the area.*

In order to provide a scientific basis for management recommendations to policy makers, the research is also focused on the potential impact of human activities on cetacean populations in the Sanctuary area. The aim is to provide a basic understanding of these complex interactions, also taking into account the variability of both environmental and anthropogenic factors over a three decades time period.

## 1.2 Projects' Study Area

The study area, of about 25,000 km<sup>2</sup>, is located in the western part of the Ligurian Sea, covering approximately a third of the entire Sanctuary area (Figure 2).

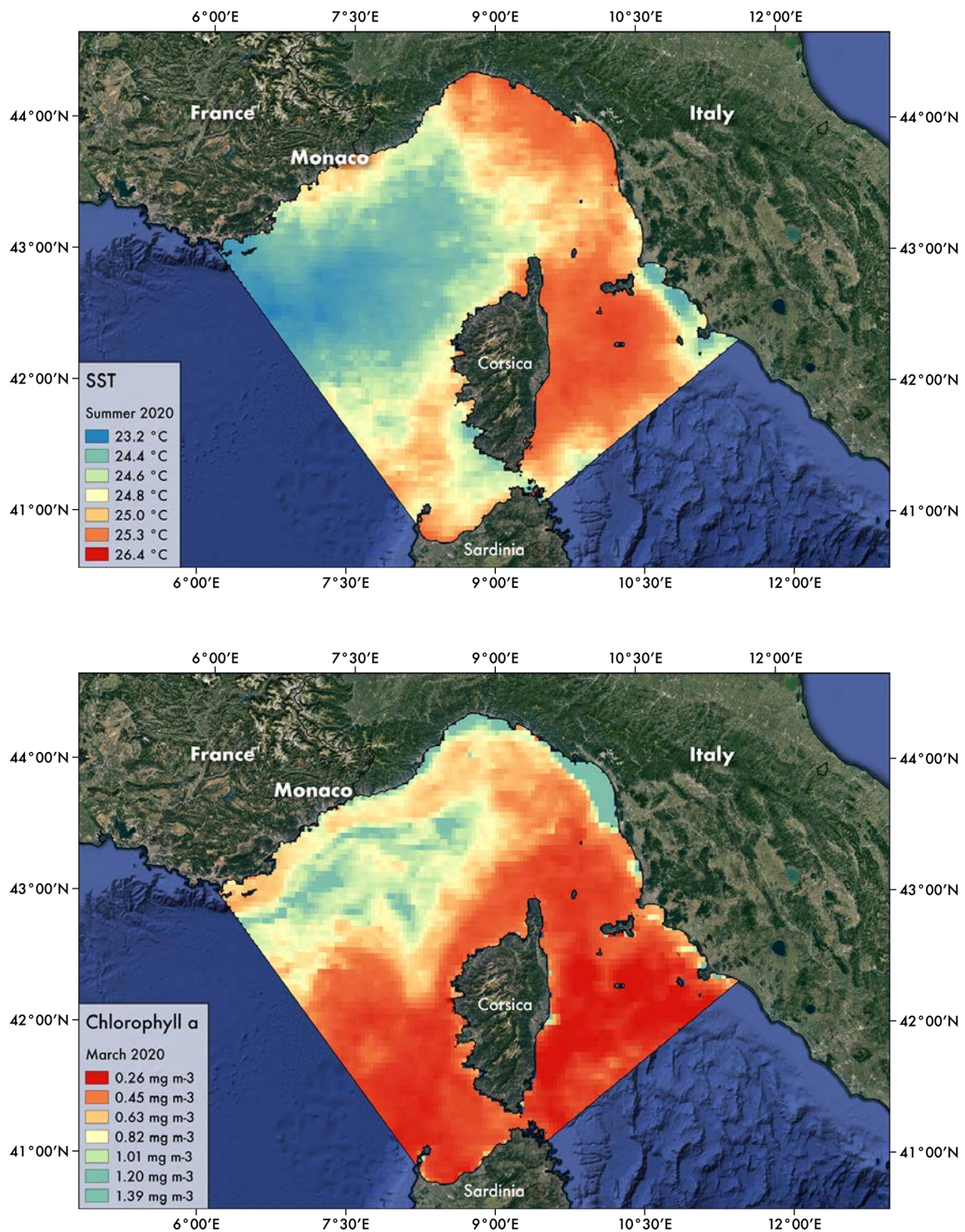


**Figure 2.** CSR study area (pastel turquoise) and core area (pastel coral - i.e. where most of the research effort is concentrated) within the Pelagos Sanctuary.

While most of the Mediterranean is considered an oligotrophic sea, the western Ligurian Sea is characterized by **high levels of primary productivity**, caused by the interplay of climatic, oceanographic and physiographic factors.



A dominant cyclonic (counter-clockwise) current, flowing north along Corsica and Tuscany and then reaching the coast of Liguria and mainland France in a westerly direction, creates a permanent frontal system which separates coastal and offshore waters (Figure 3). Intense biological activity is generated along this water mass boundary by the enhanced productivity and retention associated with this frontal system.



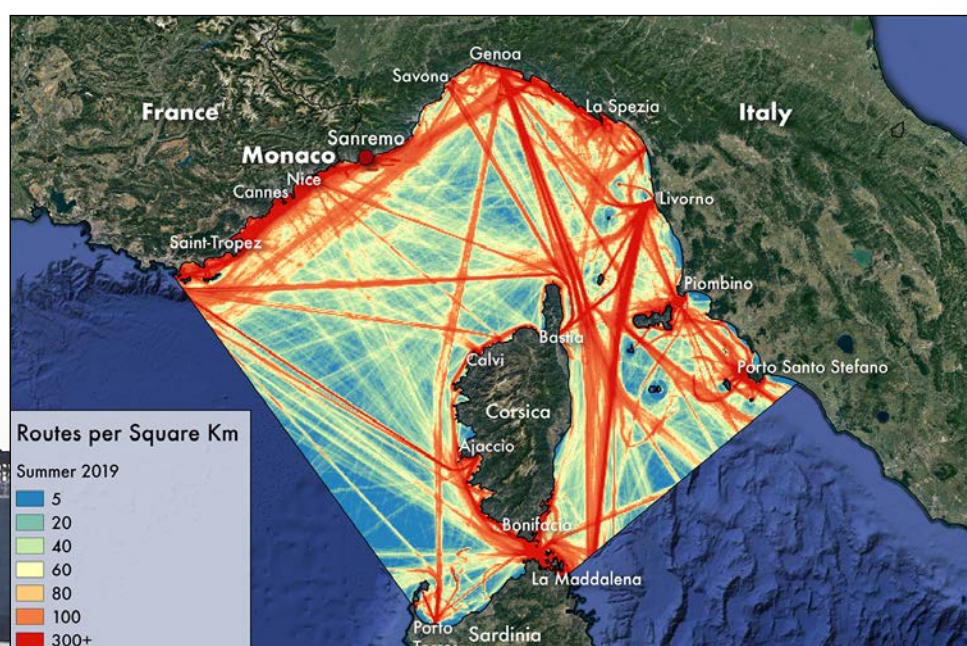
**Figure 3.** Remotely sensed Sea Surface Temperature (SST) during summer 2020 and chlorophyll-a concentration during March, observed in the Sanctuary area (©Giovanni.gsfc.nasa.gov - <https://giovanni.gsfc.nasa.gov/giovanni/>).



Such phenomena are intermittently and seasonally reinforced by vertical mixing and coastal **upwelling**, generated by the prevailing north-westerly wind ('*mistral*'). Deep nutrients and other organic substances contributed by rivers, most notably the Rhone, are then pumped into the euphotic zone, where they fertilize growing phytoplankton populations. Consequent high levels of primary production support a conspicuous biomass of highly diversified zooplankton fauna, including gelatinous macrozooplankton and swarming crustaceans – e.g. the euphausiid *Meganyctiphanes norvegica* known as northern krill. Zooplankton concentrations, in turn, attract various upper-trophic level predators to the area, including krill-eating, fish-eating and squid-eating cetaceans. In the study area, the continental shelf (0-200 m) is mostly narrow and dissected by steep, deeply cut submarine canyons, while the offshore portion consists of a uniform abyssal plain 2,500–2,700 m deep.

The area is interested by intense level of **human activities**. Most of the coastal areas, particularly on the mainland, are heavily populated and disseminated with large and medium-sized coastal cities, harbours of major commercial and military importance, and industrial areas. Additionally, the entire Sanctuary coastal zone contains popular tourist destinations, and is thereby subject to a considerable added human pressure during the summer months. Consequently, a range of diverse human activities exert several actual and **potential threats to cetacean populations** in the area.

These include *habitat degradation, regression and loss* caused by urban, tourist, industrial, and agricultural development, which is also associated with pollutant input in correspondence of largely populated areas and river mouths. *Disturbance from intense maritime traffic* (e.g. from passenger, cargo, military, fishing and pleasure crafts), which is particularly high in summer is another stress factor for cetaceans, as well as the growing whale watching business, military exercises, research activities at sea, and seismic oil and gas exploration. Furthermore, cetaceans are experiencing a growing *risk of collisions* with ships, also correlated with the increase of high-speed passenger transportation (Figure 4), and *mortality* caused by the accidental entanglement in fishing nets.



**Figure 4.** Route Density occurring in the Pelagos Sanctuary area during Summer 2019. Data from EMODnet portal (<https://emodnet.eu/en>).

### 1.3 CSR Target species

The CSR Project is focused on the data collection of **eight different species of cetaceans**: fin whales (*Balaenoptera physalus*), sperm whales (*Physeter macrocephalus*), striped dolphins (*Stenella coeruleoalba*), long-finned pilot whales (*Globicephala melas*), Risso's dolphins (*Grampus griseus*), common bottlenose dolphins (*Tursiops truncatus*), Cuvier's beaked whale (*Ziphius cavirostris*) and common dolphin (*Delphinus delphis*).

The species are briefly presented based on the current Mediterranean assessment conservation status of the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species. However, in 2020 ACCOBAMS and IUCN promoted a re-assessment process, and these categories might change in a short time.

#### Endangered (EN) species

**S**perm whales are represented in the Mediterranean by a distinct population estimated to be smaller than 2,500 mature individuals, experiencing an inferred continuing decline in numbers. Entanglement in pelagic swordfish and tuna driftnets has been the main and very serious threat to this subpopulation. Their preferred habitat is usually the deep water of the continental slope, but they can also be found in deeper offshore waters, although to a lesser degree. The Pelagos Sanctuary area represents a pivotal habitat for sperm whales since they use the area mainly for foraging purposes, especially in the summer.



Sperm whale (*Physeter macrocephalus*)  
© Ventura F. / Tethys Research Institute



Common dolphin (*Delphinus delphis*)  
© Zanardelli M. / Tethys Research Institute

**C**ommon dolphins population have declined throughout the Mediterranean since the 1960s. The causes include prey depletion by overfishing, and incidental mortality in fishing gear. This species can be found in both coastal and offshore waters. It is rarely sighted in the Pelagos Sanctuary, but more frequent sightings are reported in the southern and eastern Mediterranean Basin.





Fin whale (*Balaenoptera physalus*)  
© Lodigiani E. / Tethys Research Institute

## Vulnerable (VU) species



**F**in whales, the only regular baleen whale in the Mediterranean, are a resident population separated from the Atlantic one. Fin Whales are regularly encountered throughout the western and central Mediterranean, with seasonal concentrations in the Pelagos Sanctuary, used as summer foraging ground. Although mainly found in deep waters (up to 2,500 m), fin whales may be sighted also over the shelf and slope. A sharp decrease in fin whale abundance in the Pelagos Sanctuary has been observed over the last decade. Ship strikes, a frequent cause of mortality, are the major concern in areas of heavy vessel traffic such as the North-Western Mediterranean.

**C**ommon bottlenose dolphins are the most coastal cetaceans of the Mediterranean Sea. The population is genetically differentiated from those of the contiguous eastern North Atlantic Ocean. These dolphins are regularly observed in the Pelagos Sanctuary and they are usually confined to the continental shelf within the 200 m isobath, with a preference for shallow waters less than 100 m deep. Incidental mortality in fishing gear, prey depletion caused by overfishing, habitat degradation and health effects caused by pollution are considered this species' main threats.



Common bottlenose dolphin  
(*Tursiops truncatus*)  
© De Santis V. / Tethys Research Institute



Striped dolphin (*Stenella coeruleoalba*)  
© Mao S. / Tethys Research Institute

**S**triped dolphins are the most abundant pelagic cetacean species in the Mediterranean. This species typically shows a preference for highly productive, open-waters beyond the continental shelf. It is also the most frequently observed cetacean in the Pelagos Sanctuary. Genetic studies strongly suggest that the Mediterranean population is genetically differentiated from the Atlantic one. A decline in the population has been observed in the past decades due to Morbillivirus epizootics. In addition, pollution and bycatch in pelagic drift fishing nets are also causes of concern.

**C**uvier's beaked whales are the only beaked whales regularly inhabiting the Mediterranean Sea which have been found associated with submarine canyons areas and slopes. A species hotspot within the Mediterranean has been identified within the Pelagos Sanctuary and particularly in the Genoa Canyon area, located in the Gulf of Genova (North-Eastern portion of the Ligurian Sea). Military sonars and possibly high-energy sounds from other anthropogenic sources have been associated with mass stranding and mortality events of Cuvier's Beaked Whales in the Mediterranean. Other concerns are bycatch in drift gillnets and the ingestion of plastic debris.



## Data Deficient (DD) species

**R**isso's dolphins are genetically different from those in the eastern Atlantic, too. This species shows a preference for deep pelagic waters, in particular steep shelf slopes and submarine canyons. Despite the increase in the knowledge on the distribution and abundance of the Mediterranean subpopulation, trends in abundance

| NOT EVALUATED | DATA DEFICIENT | LEAST CONCERN | NEAR THREATENED | VULNERABLE | ENDANGERED | CRITICALLY ENDANGERED | EXTINCT IN THE WILD | EXTINCT |
|---------------|----------------|---------------|-----------------|------------|------------|-----------------------|---------------------|---------|
| NE            | DD             | LC            | NT              | VU         | EN         | CR                    | EW                  | EX      |

are only estimated locally and particularly for the western part of the Pelagos Sanctuary, where regular monitoring studies on the species have been conducted since 1990. In the last decade a dramatic decline has been observed in this well-known population. Risso's dolphins are among the cetacean species most frequently found entangled in fishing gear.



**L**ong-finned pilot whales occur regularly only in the western Mediterranean Sea. As the other Mediterranean species, also long-finned pilot whales are genetically different from the Atlantic populations. Pilot whales are usually found in deep waters offshore. Once commonly found in large pods in the Ligurian and Tyrrhenian Seas, they are now rarely found in the Pelagos Sanctuary, although a few sightings occur every summer. Potential threats include by-catch, man-made noise, harassment during whale watching and toxic pollution.



## 1.4 Overview of the Research Techniques

**R**esearch surveys are conducted *ad libitum* in the study area during spring and summer months, between May and October, on a daily basis since 1990, using sailing and motorsailer vessels of about 15-21 m in length. All navigation data (position, speed, course) and environmental data (sea state, weather, visibility, cloud coverage) are systematically recorded on a dedicated database.



**V**isual effort, involving at least two observers, one at each side of the vessel at a height of approximately 3 m above the sea surface, is performed under 'favourable conditions' only (i.e. the vessel moving at an average speed of 5-11 km h<sup>-1</sup> in wind conditions corresponding to a Beaufort scale lower than three).



**A**coustic effort is performed even with less favourable sea state conditions and during the night by means of a stereo array including two hydrophones (frequency range 10 Hz to 15 kHz -3 dB) with two preamps (with high pass filters set to -3 dB at 100 Hz) towed on a 200 m cable behind the boat. The array is connected to a final amplifier, an external audio board and a personal computer allowing real-time visualisation and recording of sounds.



**F**or each cetacean sighting geographic position, group size and composition (number of adults, juveniles, calves and new-borns) are recorded. Dedicated acoustic recordings are made too, whenever possible, during sightings of cetaceans. Floating faeces are also collected for parasitological analysis.





**P**hotogrammetry technique is employed with sperm whales to determine the body length of the photographed individuals. These data can provide information on growth rate, stock structure and an estimate of population parameters as well. Data are collected through a digital camera and a Leica laser range finder.

**P**hoto-identification is used to catalogue individuals of all the cetacean species, except striped dolphins, to obtain information on their abundance, social organisation, movements, habitat use and reproductive success. Pictures are taken by means of a Canon digital camera equipped with image stabilized telephoto zoom lens (70–200 mm f2.8). Colour and black and white transparency film (ISO 100, 400) used to be employed in the early phases of this project, and later digital photography was systematically adopted. Patches, nicks, notches, scars, and other long-lasting marks on the dorsal fin for delphinids, caudal fin for sperm whales, or on the body for fin whales are used to identify individuals.

**C**etacean behaviour is investigated through a series of sampling techniques. Respiration patterns, directionality and presence of surface/aerial displays (i.e. breach, tail slap, head standing) are recorded. Underwater videos are taken from the boat (or tender) using GoPro cameras. A non-invasive Vertical Take-Off and Landing (VTOL) Unmanned Aerial System (UAS) is also employed to collect aerial photos and videos.

**D**iving behaviour of fin whales and long-finned pilot whales was studied in the past by applying velocity Time-Depth Recorder (TDR) sensors to the animals' body by means of suction cups.



**P**assive tracking, by means of a dedicated developed software and a Leica laser range finder, was used to highlight the reaction of fin whales to the disturbance possibly caused by the approach of boats.

The project carries out occasional collection of a limited number of tissue samples from some cetacean species obtained by means of the non-invasive “**skin swabbing**” and biopsy methods, using a pole for instance when dolphins are bow-riding. In the past, a crossbow was also used to collect fin whale samples of skin and blubber. The skin samples allowed us to perform genetic analyses, and to obtain important pieces of information on individual gender, stock identity and variability within and among population genetic philopatry. Toxicological analyses were performed on the blubber samples obtaining PCB, heavy metal and polycyclic aromatic compound concentrations in different cetacean species.

**H**uman activities are also monitored (i.e. counting all types of boats, ships and fishing gear in a radius of 3 nm from the ship). Systematic recordings of five minutes of background anthropogenic noise are made every 30 minutes during navigation, decreasing the boat speed to reduce self-generated noise. This data provided evidence for man-made noises within the Pelagos Sanctuary, such as air-guns used during seismic surveys, pile driving and sonars, known to alter cetaceans’ behaviour and to displace them from their usual areas.

Finally, the **presence of other marine animals**, including sea turtles, fishes (e.g. tuna, devil rays, sharks, swordfish, sun fish) and seabirds are reported on the database.



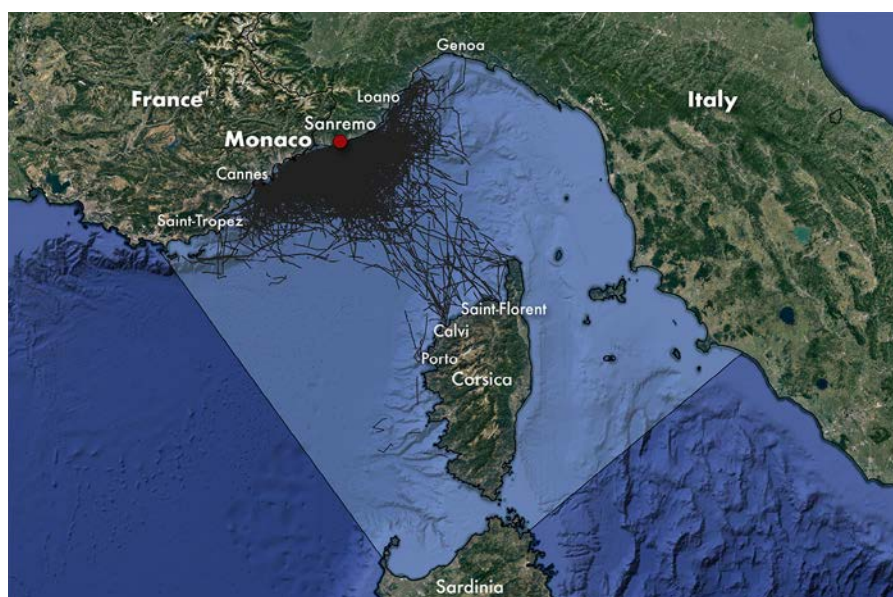
## 2. SUMMARY of the PROJECT's RESULTS over 30 years

For over three decades (1990-2020) the CSR Project has been collecting data in the study area every summer, generating one of **the longest time series and one of the largest datasets existing on Mediterranean cetaceans**. The results obtained by this intense research effort have been presented at national and international meetings and conferences, and also published in peer reviewed scientific publications.

The main results obtained in 30 years of activities are summarized below.

### SURVEY EFFORT

Between 1990 and 2020, the CSR spent more than 2,500 days at sea, covering about 140,000 km in standardized research conditions during summer seasons (Figure 5). This effort contributed to create the longest data series and one of the biggest databases of cetacean sightings of the Mediterranean Basin.



**Figure 5.** Survey tracks conducted between 1990-2020.



This effort resulted in about 6,200 encounters of cetaceans (Table 1).

The most frequently sighted species is the striped dolphin (about 4,300 sightings, 70%), followed by the fin whale (about 1,000 sightings, 17%) and the sperm whale (about 480 sightings, 8%), the Risso's dolphin (about 170 sightings, 3%), and the bottlenose dolphin (about 90 sightings, 1.5%). Occasionally also long-finned pilot whales (about 50 sightings, < 1%), Cuvier's beaked whales (about 47 sightings, < 1%) and common dolphins (8 sightings, < 1%) have been sighted.

**Table 1.** Research effort (km) and sightings collected by CSR Project between 1990-2020.

| Year  | Positive Effort (Km) | Sightings                 |                |                       |           |                         |                 |             |                 |       |
|-------|----------------------|---------------------------|----------------|-----------------------|-----------|-------------------------|-----------------|-------------|-----------------|-------|
|       |                      | Common bottlenose dolphin | Common dolphin | Cuvier's beaked whale | Fin whale | Long-finned pilot whale | Risso's dolphin | Sperm whale | Striped dolphin | Total |
| 1990  | 3566                 | 1                         | 0              | 0                     | 27        | 1                       | 5               | 1           | 97              | 132   |
| 1991  | 6214                 | 1                         | 0              | 0                     | 53        | 4                       | 7               | 2           | 106             | 173   |
| 1992  | 5794                 | 0                         | 1              | 0                     | 64        | 0                       | 4               | 0           | 123             | 192   |
| 1993  | 6898                 | 3                         | 0              | 0                     | 72        | 2                       | 9               | 0           | 185             | 271   |
| 1994  | 3611                 | 2                         | 0              | 0                     | 64        | 0                       | 3               | 2           | 80              | 151   |
| 1995  | 3952                 | 3                         | 0              | 0                     | 62        | 1                       | 5               | 2           | 123             | 196   |
| 1996  | 2920                 | 2                         | 1              | 0                     | 33        | 1                       | 5               | 1           | 77              | 120   |
| 1997  | 6051                 | 5                         | 0              | 3                     | 39        | 2                       | 14              | 1           | 110             | 174   |
| 1998  | 5411                 | 0                         | 1              | 2                     | 30        | 3                       | 16              | 4           | 101             | 157   |
| 1999  | 6484                 | 4                         | 0              | 0                     | 31        | 2                       | 12              | 9           | 104             | 162   |
| 2000  | 6286                 | 2                         | 0              | 3                     | 20        | 2                       | 9               | 9           | 99              | 144   |
| 2001  | 4141                 | 2                         | 1              | 0                     | 24        | 1                       | 12              | 6           | 114             | 160   |
| 2002  | 3918                 | 2                         | 0              | 1                     | 11        | 0                       | 5               | 7           | 87              | 113   |
| 2003  | 4850                 | 0                         | 0              | 4                     | 14        | 2                       | 3               | 18          | 100             | 141   |
| 2004  | 3652                 | 0                         | 0              | 3                     | 10        | 5                       | 12              | 4           | 136             | 170   |
| 2005  | 3497                 | 0                         | 0              | 2                     | 41        | 0                       | 10              | 4           | 172             | 229   |
| 2006  | 3249                 | 2                         | 0              | 1                     | 16        | 0                       | 5               | 4           | 140             | 168   |
| 2007  | 2785                 | 2                         | 1              | 0                     | 21        | 2                       | 7               | 30          | 150             | 213   |
| 2008  | 4246                 | 3                         | 0              | 5                     | 14        | 4                       | 8               | 27          | 127             | 188   |
| 2009  | 4161                 | 0                         | 1              | 3                     | 10        | 1                       | 4               | 27          | 174             | 220   |
| 2010  | 4498                 | 0                         | 1              | 3                     | 44        | 2                       | 5               | 32          | 208             | 295   |
| 2011  | 5224                 | 3                         | 0              | 3                     | 20        | 4                       | 3               | 39          | 235             | 307   |
| 2012  | 3673                 | 4                         | 0              | 0                     | 40        | 0                       | 0               | 40          | 179             | 263   |
| 2013  | 4997                 | 2                         | 0              | 3                     | 45        | 1                       | 3               | 27          | 147             | 228   |
| 2014  | 4935                 | 2                         | 0              | 7                     | 9         | 0                       | 1               | 36          | 127             | 182   |
| 2015  | 4331                 | 5                         | 0              | 2                     | 44        | 5                       | 0               | 28          | 155             | 239   |
| 2016  | 5465                 | 10                        | 0              | 2                     | 18        | 2                       | 0               | 19          | 174             | 225   |
| 2017  | 3463                 | 10                        | 0              | 0                     | 57        | 3                       | 0               | 29          | 210             | 309   |
| 2018  | 3165                 | 12                        | 0              | 0                     | 33        | 0                       | 0               | 12          | 131             | 188   |
| 2019  | 4550                 | 6                         | 1              | 0                     | 36        | 1                       | 0               | 32          | 182             | 258   |
| 2020  | 3406                 | 6                         | 0              | 0                     | 13        | 3                       | 3               | 27          | 151             | 203   |
| Total | 139393               | 94                        | 8              | 47                    | 1015      | 54                      | 170             | 479         | 4304            | 6171  |

Most of the CSR dataset is accessible online at <http://seamap.env.duke.edu/> through the Ocean Biogeographic Information System Spatial Ecological Analysis of Mega-vertebrate Populations (OBIS-SEAMAP), a spatially referenced online database which collects marine mammal, seabird, sea turtle, ray and shark observation data from across the globe.

## HABITAT PREFERENCE AND SPATIAL VARIABILITY

The habitat preferences of the different species living in the area were defined thanks to the long-term time series produced by the project.

The Ligurian and Provençal waters host a wide variety of habitats, where a narrow continental shelf, deeply cut by several submarine canyons, is followed by offshore waters deeper than 2,500 meters. Fin whales and long-finned pilot whales were found to be associated with very deep offshore waters; sperm whales, Cuvier's beaked whales and Risso's dolphins with the continental slope and submarine canyon systems, while common bottlenose dolphins are usually found in shallow, coastal waters. Striped dolphins, the most abundant species, are found in both off-shore and continental slope areas.

Since the Pelagos area represents a foraging ground for most of the aforementioned species, the variability of the foraging habitat has been investigated over the years. Particularly for fin whales, that concentrate in the area for feeding during spring-summer, a spatial variability of the foraging site has been observed over the years. The analysis of sperm whale vocalizations recorded over the years allowed to identify the slope area as the predominant foraging site for this species, however foraging occurred also in off-shore areas.

## TEMPORAL VARIABILITY AND ABUNDANCE

Long time series of data, as the one owned by the CSR project, allowed us to evaluate and detect changes in the species presence. Changes in relative and absolute abundance during the last 30 years were observed.

The analysis of the CSR's data highlighted a decreasing trend of fin whales from the 90' and the increase of presence of sperm whales and bottlenose dolphins in the western Ligurian Sea in the last ten years.

The data series on Risso's dolphins is among the longest, and one of the most important of its kind in the world, has also allowed us to highlight a dramatic decline of this species in the study area (Western part of the Pelagos Sanctuary), up to the point it has never been spotted from 2015 to 2019.

The analysis of the frequency of occurrence of the individuals over time, and of the photographic catalogues, allowed us to estimate the population size for most of the cetacean's species in the Pelagos Sanctuary as well.

## INDIVIDUAL IDENTIFICATION

Most cetacean species present natural, long-lasting features that enable individual recognition. By taking pictures of these morphological characteristics, (i.e. the trailing edge of dorsal fins or flukes, or the scars on dorsal fins and on body) CSR's researchers developed photographic catalogues with more than 1,500 individuals of different species.

The application of this technique allowed to monitor the habitat use and site fidelity for the area at individual level for three decades.

Details by species are reported in Table 2 below:

**Table 2.** Overall number of animals by species, photo identified between 1990-2020.

| Period             | Species                   | Catalogue |
|--------------------|---------------------------|-----------|
| 1990-2020          | Common bottlenose dolphin | 183       |
|                    | Common dolphin            | 15        |
|                    | Cuvier's beaked whale     | 27        |
|                    | Fin whale                 | 738*      |
|                    | Long-finned pilot whale   | 164       |
|                    | Risso's dolphin           | 282       |
|                    | Sperm whale               | 182       |
| * 1990-2007 period |                           |           |

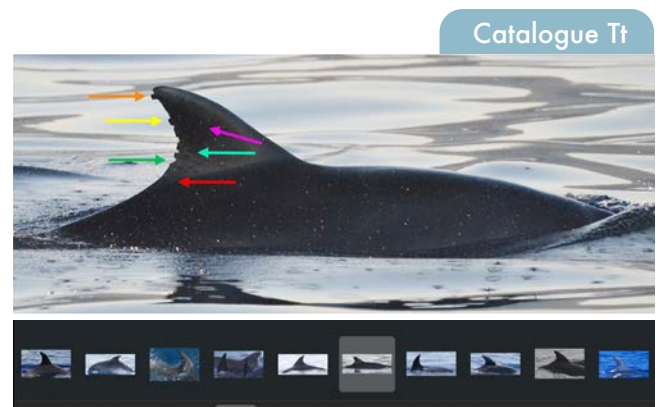
The fin whale, sperm whale, Risso's dolphin, Cuvier beaked whale and common bottlenose dolphin image catalogues, starting from 1990 and complete with relative sighting (geographic position and group composition) and effort data, were shared with other institutes carrying out research in the Pelagos Sanctuary and in other areas of the Mediterranean Sea.

The final goal was to merge all data in a unique, international and comprehensive catalogue of all photo-identified individuals, in order to reach the critical mass needed for applying advanced statistical analyses.

Both sightings and photographic data of most of the species are available, upon request, on the INTERCET database developed to facilitate cooperation between parties engaged in cetacean research (<http://www.intercet.it/>) in the Pelagos Sanctuary area.



"Depa" sighted in July 2020. © De Santis V. / Tethys Research Institute



Female of common bottlenose dolphin called "Depa" and sighted for the first time in 2015. © De Santis V. / Tethys Research Institute

## MOVEMENTS

The analyses and the photographic catalogue shared among institutes allowed to study both short and long-term movements of whale and dolphin individuals in the western Mediterranean.

A first evaluation of movement patterns, distribution, abundance, individual residency and habitat preferences for these species in the Sanctuary has been performed for some species, such as common bottlenose dolphins, Risso's dolphins, Cuvier's beaked whales and sperm whales. For instance, it has been observed that Risso's dolphins and common bottlenose dolphins can cover hundreds of kilometres, and sperm whales over a thousand kilometres, moving from the Strait of Gibraltar to the Ligurian Sea.

## VOCAL REPERTOIRE

Since 2005, cetacean vocalizations are regularly recorded, obtaining an important acoustical database of different species and allowing dedicated studies on the characterization of their vocal repertoire (Table 3).

**Table 3.** Overall number of recordings by species collected during 2005-2020.

| <i>Period</i> | <i>Species</i>            | <i>N Recordings</i> |
|---------------|---------------------------|---------------------|
| 2005-2020     | Common bottlenose dolphin | 24                  |
|               | Cuvier's beaked whale     | 18                  |
|               | Fin whale                 | 5                   |
|               | Long-finned pilot whale   | 58                  |
|               | Risso's dolphin           | 39                  |
|               | Sperm whale               | 1100                |
|               | Striped dolphin           | 220                 |
| <i>Total</i>  |                           | 1464                |

The acoustic analysis of parameters of sperm whale vocalizations (such as the "clicks" they produce during their dives) and the analyses of the photogrammetry data, allowed us to estimate the overall body size of the animals. Since 2008, we have been able to estimate the body length and individual growth of about 100 animals. Such size estimates gave important information on the populations, suggesting for instance that the area is used mainly by subadult male sperm whales, which are larger than females.

The analysis of the vocalizations correlated to the feeding activity (such as "creaks") suggested foraging as the main activity performed by sperm whales in the study area, particularly on the slope areas; however high level of creak rates occurs also in the pelagic environment. Sperm whales also produce non-click sounds with a possible communication function (such as "trumpets"). The CSR project collected one the largest dataset currently available worldwide on this particular sound.



## DIVING BEHAVIOUR

Fin and long-finned pilot whales diving behaviour was investigated through the application of velocity TDR, providing evidence of deep diving performances by both species in the Mediterranean Sea. The maximum depth, over 400 m, reached by fin whales in our study area was never directly recorded before for any other species of baleen whales elsewhere.

## INTERACTION WITH HUMAN ACTIVITY

The behaviour of the species, particularly fin whales, has been investigated to understand the potential impact of human activities such as commercial whale watching.

The disturbance caused by these activities has been measured in terms of behavioural reactions of the whales to the presence of boats. These results are a basis for the development of specific guidelines for boats approaching the animals.

The influence of maritime traffic (i.e. traffic density, collision rate, fishery pressure) has been investigated in the Pelagos Sanctuary to understand how this activity can influence the presence, the habitat use and survival of marine mammals in particular large whales such as fin and sperm whales but also Cuvier's beaked whales.

## HEALTH STATUS AND GENETICS

Several studies on ecotoxicology have been conducted in collaboration with other research institutes.

The level of contamination by persistent pollutants (i.e. DDT, PCB) has been evaluated for different species, considered sentinel species of the marine ecosystem status, by analysing tissue samples.

The samples allowed also to carry out genetic studies in collaboration with several universities, identifying differences in the Mediterranean populations of seven species, in respect to the Atlantic ones. Cetaceans are also exposed to a variety of pathogenic microbes, infectious diseases and a wide range of parasites. All of these factors are also under investigation.

## 2.1 Collaborations and Synergies (1990-2020)

With over 30 years of activity, the project has many longstanding and profitable collaborations with national and international organizations and research institutes across the Mediterranean Region. The main active collaborations are here reported.

### NATIONAL INSTITUTIONS

- Italian Ministry for the Environment Land and Sea, Italy
- Institute for Environmental Protection and Research (ISPRA) Italian Coast Guard, Italy
- Milan Civic Aquarium, Italy
- Natural History Museum, Milano, Italy
- Italian Environment Fund (FAI)
- Regione Liguria/Regional authority of the Liguria Region
- Several Italian Municipalities
- Istituto Zooprofilattico Sperimentale Del Piemonte Liguria e Valle D'Aosta

### INTERNATIONAL INSTITUTIONS

- Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS)
- Pelagos Sanctuary Agreement
- Specially Protected Areas Regional Activity Centre (SPA/RAC)
- International Union for Conservation of Nature (IUCN)
- International Whaling Commission (IWC)
- Joint Research Center of the European Commission

### UNIVERSITIES

- Duke University, USA
- Interdisciplinary Center for Bioacoustics and Environmental Research (CIBRA), University of Pavia, Italy
- University of Siena, Italy
- Politecnico di Milano, University of Technology, Italy
- University of Natural Sciences of Milan, Italy
- Sapienza University of Rome, Italy
- University of Foggia, Italy
- University of Padua, Italy

### RESEARCH INSTITUTE, NGOs and Whale Watching operators

- VerdeAcqua, Italy
- CIMA Research Foundation, Italy
- Fondazione Acquario di Genova, Italy
- Costabalena, Italy
- Liguria Whale Watching, Italy
- Marevivo, Italy
- CETUS, Italy
- Greenpeace ITALIA, Italy
- WWF Mediterranean Marine Initiative (WWF Med)
- WWF ITALIA, Italy
- WWF France
- SeaMe Sardegna, Italy
- Battibaleno, Italy
- Oceanomare Delphis, Italy
- Miraceti, France
- EcoOcean, France
- GECEM, France
- Submon, Spain
- Asociacion Tursiops, Spain
- Cetacea recerca, Spain
- Alnitak, Spain
- CIRCE, Spain
- Pelagos Cetacean Research Institute, Greece
- Whale & Dolphin Conservation, U.K.
- International Fund for Animal Welfare, U.K.





### 3. CONSERVATION and MANAGEMENT ACTIVITIES

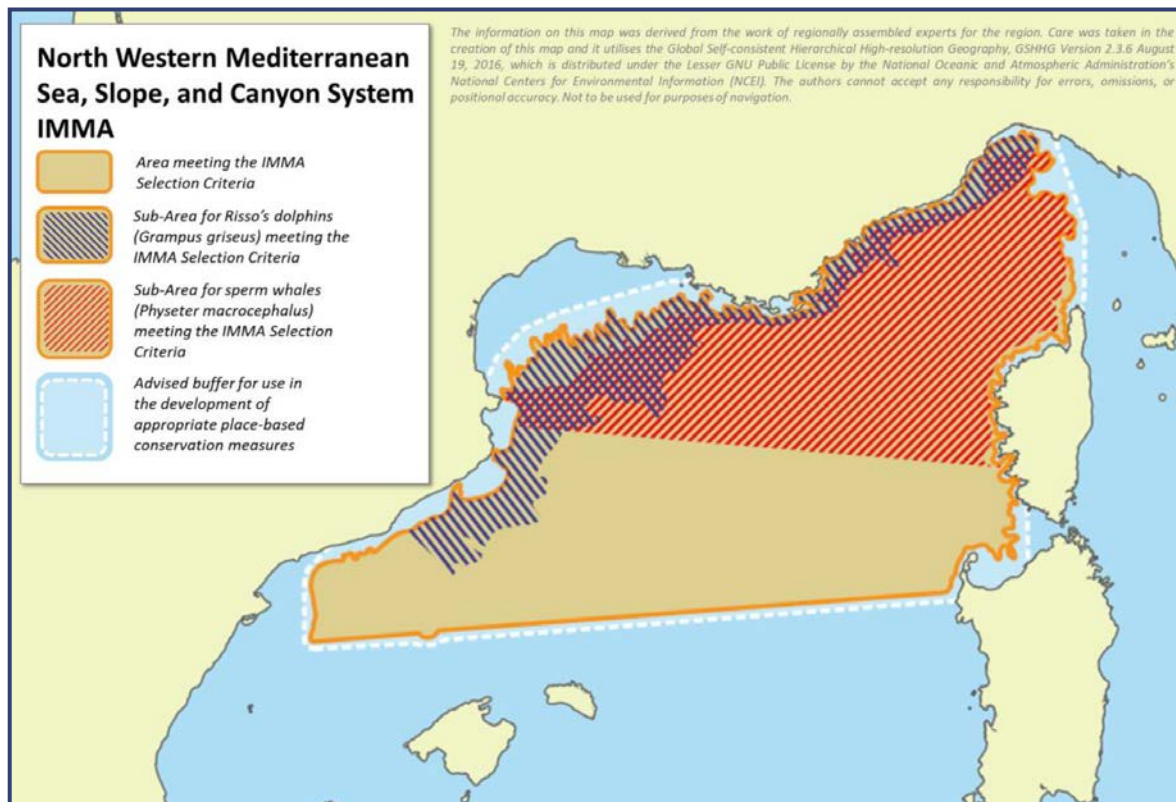
Tethys Research Institute played a crucial and active role in the development and institution of the *Pelagos Sanctuary for Mediterranean marine mammals*.

Data collected by Tethys in the 90s supported the evidence that the area, interested by intense biological activity, hosts a high species diversity and important habitats for a number of pelagic species, including cetaceans.

Hence, Tethys proposed to establish a marine Biosphere Reserve with the support of Prince Ranieri III and the European Association Rotary for the Environment. In 1993, a joint Declaration was signed by Italy, France and Monaco for the creation of a **Mediterranean Sanctuary for Cetaceans**. Six years later (1999) the Agreement was signed and the protected area, of approximately 87,500 km<sup>2</sup>, was enlarged from the original proposal to a large part of the Western Mediterranean, between Toscana, the continental French coast, Corsica and the northern part of Sardinia, including waters with the legal status of maritime internal waters, territorial seas and high seas (today also ecological zones). Following the ratification by Monaco (2000), France (2001) and Italy (2002), the Sanctuary Agreement entered into force on the 21<sup>st</sup> of February 2002. Although to this day the area has seen little changes in terms of management, the agreement represents an important step forward towards the final goal of ensuring protection to cetaceans living in the area.

In 2001, the Sanctuary has also been added to the list of **Specially Protected Areas of Mediterranean Importance** (SPAMIs), under the framework of the Barcelona Convention. This made the Pelagos Sanctuary the first and only international and high seas protected area in the world (<https://www.sanctuaire-pelagos.org/en/>).

The results obtained by the CSR project contributed to the identification of two IMMAs located in the North western part of the Mediterranean region entitled “the North West Mediterranean Sea, Slope and Canyon System IMMA” (Figure 6) and “the Western Ligurian Sea and Genoa Canyon IMMA” (<https://www.marinemammalhabitat.org/immas/imma-eatlas/>). **Important Marine Mammal Areas** are defined as “areas that have potential to be delineated and managed for conservation” by the IUCN Marine Mammal Protected Areas Task Force.



**Figure 6.** North West Mediterranean Sea, Slope and Canyon system IMMA (Map extracted from: IUCN-MMPATF (2017) North West Mediterranean Sea, Slope and Canyon system IMMA Factsheet. IUCN Joint SSC/WCPA Marine Mammal Protected Areas Task Force, 2017).

CSR researchers also promoted the subscription of the partnership with the Pelagos Sanctuary to many coastal municipalities of the Liguria Region, which have thus committed to implement practical measures in favour of marine mammals, to promote awareness of the Sanctuary among the general public and to include local authorities in the Sanctuary's **educational and awareness-raising efforts**.

In March 2019, Tethys signed a Protocol of Understanding with the **Italian Coast Guard**; together they conducted several activities in Italy, aimed at raising awareness on the conservation of the Mediterranean among the general public, especially boaters and children.

Since 2019, the CSR Project Manager has held a series of lectures on the ecology, threats and conservation of Mediterranean cetaceans to Italian Coast Guard officers as part of their training courses.

**Data sharing** represents an important action toward the development of efficient conservation strategies. Along with the intense network of collaborations, CSR made most of its dataset available to the scientific community through open access databases such as OBIS-SEAMAP portal (<http://seamap.env.duke.edu>) or dedicated research portals such as INTERCET (<http://www.intercet.it/>).

In 2018, within the framework of the 32nd annual European Cetacean Society the CSR team organized and coordinated a workshop entitled “**Mediterranean Grampus Project 2.0: Improving knowledge and conservation of the Mediterranean population of Risso’s dolphins through effective partnerships**”. More than 30 Mediterranean experts and representatives of ACCOBAMS and the Pelagos Sanctuary Secretariat attended the workshop. The final goal was to consolidate and expand the network of researchers created in 2012 within the Mediterranean Grampus Project 1.0 and take stock of the new available information about the Mediterranean population of Risso’s dolphins as a whole.

CSR researchers are involved in the **IUCN assessment of the conservation status of Mediterranean cetaceans**, and in the development of dedicated **Conservation and Management Plan (CMP)** for cetaceans species promoted by ACCOBAMS for the Mediterranean region.

The collaboration with FAI Fondo Ambiente Italiano (Italian Fund for the Environment) and the Italian Coast Guard allowed the development of the project entitled **Cetacei FAI Attenzione - CFA** (“Be aware of cetaceans”), both a public awareness and a citizen science project carried out since 2018. The goal of the project is to spread information among the public, mitigate the disturbance to cetaceans possibly caused by pleasure boats and acquire georeferenced data on whale and dolphin sightings along the entire coast of Italy.

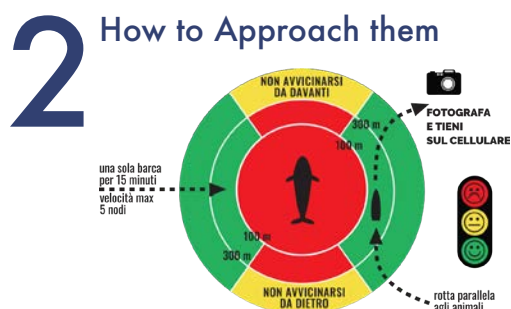
One of the main target species of the CFA project is the Risso’s dolphin. The decline of the encounters in the CSR study area from 2015, brought researchers to look for the “disappeared” dolphin population at larger scale. Together with a well-established network of collaborating research institutes, the CFA citizen science project also contributed to the identification of new areas of occurrence for said species.

Cetaceans encounters can be reported by different sea users (sailors, whale watching operators, fishermen, etc) by means of a dedicated website (<https://www.cetaceifaiattenzione.it/>), where sighting data, pictures and videos can be uploaded.

**1 How to Find them**  
Can indicate the presence of cetaceans:  
a part of the animal back or a dorsal fin;  
a blow, high and narrow in the case of the fin whale and lower in the sperm whale;  
splashes if there are jumping dolphins.

**3 Data to be Collected**  
Day  
Time  
Latitude/Longitude  
or other indication of the Position

**5 Count the Animals**  
Try to count the animals and look if and how many calves and/or newborn (half of an adult or less) there are.



**4 Take Photos and Videos**  
Always in full compliance with the code of conduct.



**6 Report the Sighting!**  
Go to  
[www.cetaceifaiattenzione.it](https://www.cetaceifaiattenzione.it)





Two dedicated posters and a leaflet about the Mediterranean species, also presenting a code of conduct for boaters to apply when coming across cetaceans, have been produced. 2,200 posters and 30,000 leaflets have been distributed and are now displayed in the port authority offices of the main Italian harbours and marinas. Both posters and leaflets are also available for download from the CFA website (Figure 7).



## CETACEI, **FAI** ATTENZIONE!

### VEDI BALENE O DELFINI? SEGNA LA L'AVVISTAMENTO



I mari italiani ospitano 8 diverse specie di cetacei e l'Istituto Tethys, organizzazione non-profit per la conservazione del mare, li studia e li monitora da oltre trent'anni.

**Andando per mare potete aiutarci!**  
Se incontrate cetacei, avvicinateli nel rispetto delle regole e inviate foto o brevi video (con data, ora, posizione e numero di animali), sul sito [www.cetaceifaiaattenzione.it](http://www.cetaceifaiaattenzione.it)

Dalla forma della pinna dorsale si possono riconoscere individui già avvistati e ricostruirne gli spostamenti.

**Grazie del vostro aiuto!**



### COME COMPORTARSI CON I CETACEI

I mammiferi marini sono oggi minacciati da catture nelle reti, plastica, inquinamento, diminuzione delle prede, rumore, collisioni. Anche piccole barche possono essere fonte di stress.



**COME AVVICINARSI?**  
Tra 300 e 100 m DI DISTANZA:  
• mantenere una **rotta parallela** a quella degli animali  
• **non avvicinarsi da davanti né da dietro**  
A 100 m DI DISTANZA:  
• non avvicinarsi di più, a meno che non siano loro a venire spontaneamente

**CHE VELOCITÀ TENERE?**  
• quella dell'animale più lento, e in ogni caso **non superare i 5 nodi**  
• **attenzione**: oltre a quelli in vista, altri animali possono trovarsi nelle vicinanze e potrebbero **non essere visibili** in superficie

**COSA FARE?**  
• **spegner** eco-scandagli e fishfinder  
• **non separare** mai degli animali dal gruppo  
• **una sola barca** può trovarsi nella fascia dei 300 m, lasciare il posto ad altre in attesa dopo 15 minuti

**E SE SONO LORO AD AVVICINARSI?**  
• **non tentare di toccarli**, né con le mani, né con oggetti  
• **non gettare cibo**  
• **non entrare in acqua**  
• **non puntare mai verso il gruppo** con l'intenzione di far avvicinare i delfini alla prua: se si sentono al sicuro lo faranno di loro iniziativa

*I cetacei sono **protetti a livello nazionale e internazionale**, le trasgressioni sono sanzionate dalla legge italiana*

### LE SPECIE DEL MEDITERRANEO

Ideato e proposto da Tethys, il Santuario Pelagos, una vasta area protetta a livello transnazionale, è una delle zone più ricche di balene e delfini del Mediterraneo, eletta tra i Luoghi del Cuore del FAI - Fondo Ambiente Italiano.





Sul sito [www.cetaceifaiaattenzione.it](http://www.cetaceifaiaattenzione.it) le chiavi per il riconoscimento delle specie







Cetacei, FAI attenzione! è realizzato da  
ISTITUTO TETHYS ONLUS - www.tethys.org  
Tempo condivide ricerche in mare  
e sul campo può partecipare  
Info: [www.biancamaria.org](http://www.biancamaria.org)

Concept campagna coordinamento: **Salvatore Amato**  
Concept sviluppo: **Stefano Madonia**  
Zoonomia e grafica: **Caterina Lanfredi**  
Foto: **Indira Tethys ONLUS**  
Disegni: **Massimo Benvenuto**  
Impaginazione grafica: **Stefano Ruggiero CRISA Officina**

Figure 7. CFA poster posted in all Italian harbours and marinas.

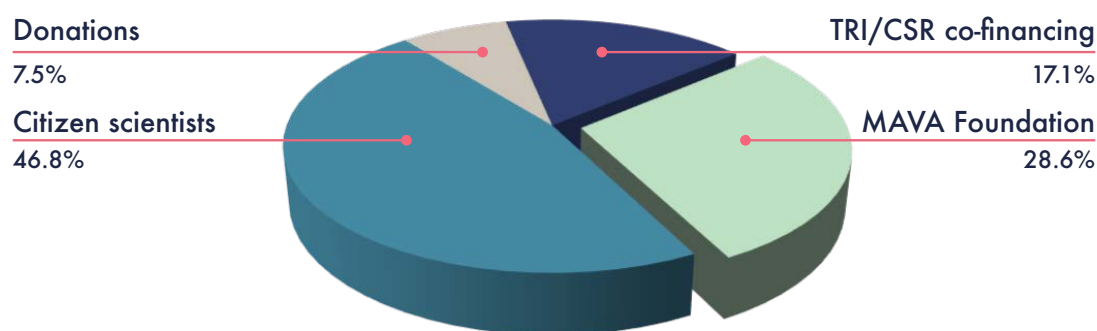
## 4. RESULTS of the 2020 FIELD WORK ACTIVITY

### 4.1 Research Activity and Funding

In past years the CSR project has spent on average 17 weeks at sea per year, collecting data from the end of May to the beginning of October. The participants of the CSR citizen science program are the main source of funding.

The pandemic caused by the worldwide Coronavirus disease (COVID-19) and the economic crisis linked to it, threatened to drastically reduce the attendance to the project and, subsequently, the data collection period.

Thanks to the support of the MAVA Foundation, the CSR project conducted 13 weeks of summer field work research activity (between the end of June and the beginning of October), limiting the loss of the research effort to only 4 weeks corresponding to a reduction of 23% in effort coverage (in term of kilometres conducted at sea) compared to the previous years (Figure 8). The received funds also allowed to comply with the contract for the use of the research platform, for 2020 and future years.



**Figure 8.** Pie chart showing the main funding sources and relative contribution (%) to support CSR Project 2020 activity.



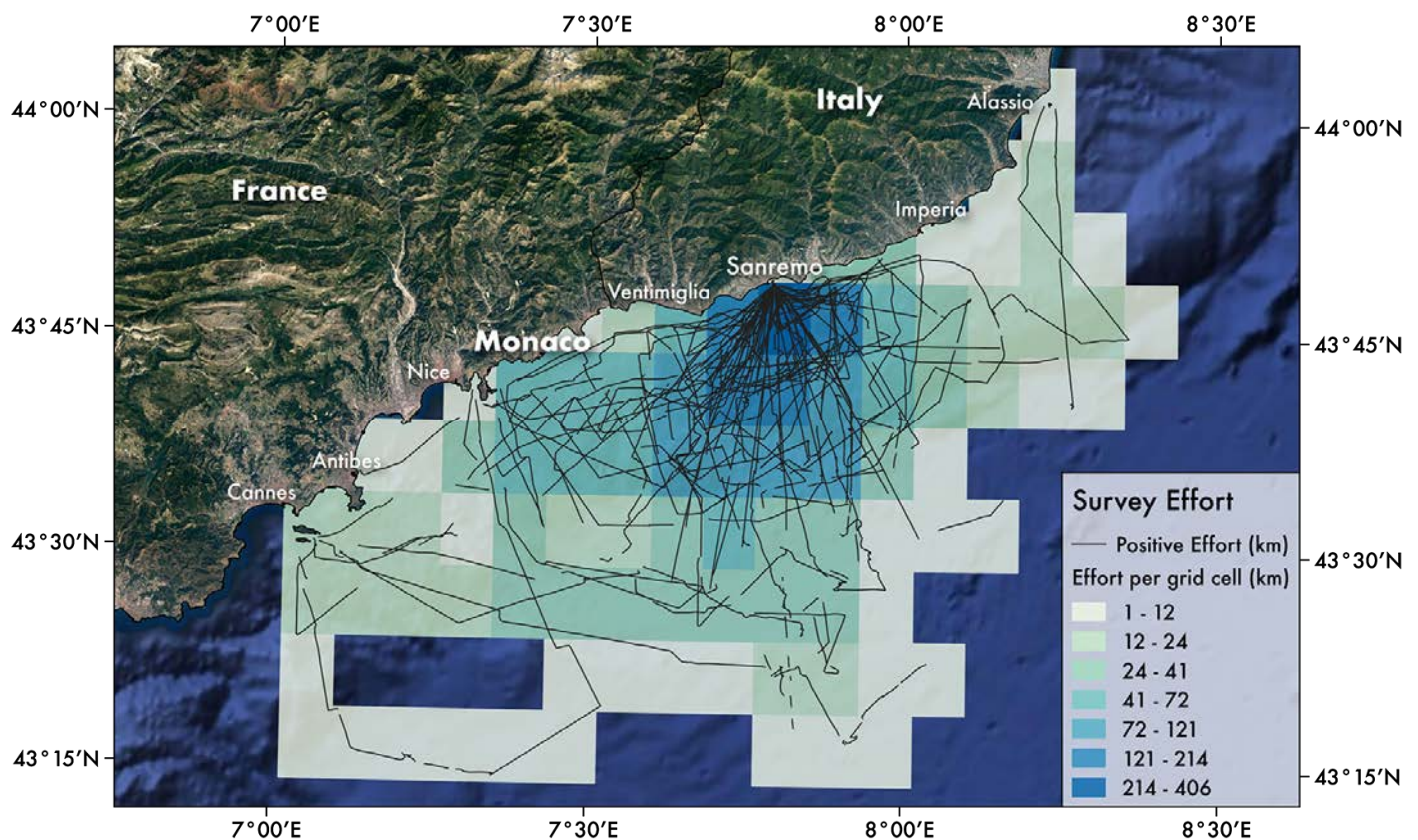
Without the MAVA Foundation support, the CSR project would have most likely stopped collecting data in the field, after 30 years of uninterrupted activity. The risk of not being able to renew the rental agreement for the use of the research platform, continuously employed in the last 15 years, was also averted because of the MAVA Foundation support. In the best-case scenario, without any external support, the project would have been able to carry out only eight weekly cruises, reducing research effort by 53% compared with previous years.

In the 13 weeks, 54 days were spent at sea, collecting important information on the species presence and distribution.

## 4.2 Survey Effort and Sightings

The 2020 research survey has been conducted in an area of approximately 29,000 km<sup>2</sup>. The 21 m motor-sailer “Pelagos RV” was used as the research platform. Survey transects were not predesigned and data were roughly collected along North-to-South transects opportunistically surveyed at a mean cruising speed of about 6 knots. Standardized fieldwork protocols were employed and all of the observations were made under good sea and weather conditions, defined as “favourable conditions”; the searching effort ceased when wind exceeded Beaufort 3 (wind speed higher than 5,4 m s<sup>-1</sup>).

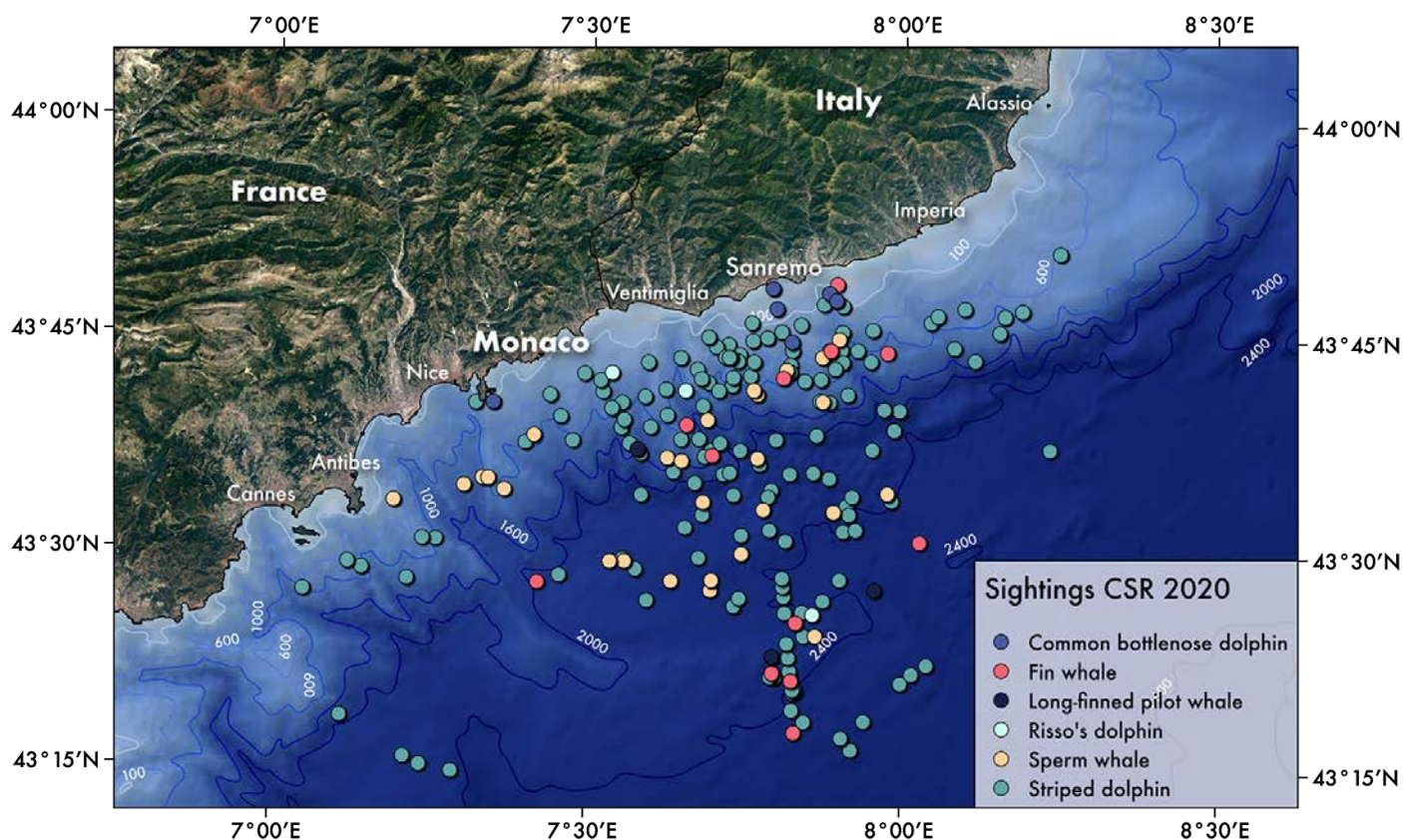
A total of 3,406 km has been covered under favourable conditions (Figure 9).



**Figure 9.** Map showing survey traks conducted in 2020 (thick lines) and the searching effort per grid cell (darker the color higher the number of km surveyed per cell).



A total of 203 sightings of cetacean species were recorded: 74.4% of them were striped dolphins, 13.3% sperm whales, 6.4% fin whales, 3.0% common bottlenose dolphin, and 1.5% for Risso's dolphins and long-finned pilot whales individually (Table 4, Figure 10).



**Figure 10.** Map showing the position of cetaceans' sightings collected during 2020 field season.

**Table 4.** Overall number of sightings by species and average group size with standard deviation (SD).

| Year  | Species                   | N sightings | Group Size (SD) |
|-------|---------------------------|-------------|-----------------|
| 2020  | Common bottlenose dolphin | 6           | 23.2(14)        |
|       | Fin whale                 | 13          | 1.91(1.62)      |
|       | Long-finned pilot whale   | 3           | 35.3(24.5)      |
|       | Risso's dolphin           | 3           | 6.3(7.5)        |
|       | Sperm whale               | 27          | 1.4(1)          |
|       | Striped dolphin           | 151         | 19.4(17.44)     |
| Total |                           | 203         |                 |

During the 2020 season, the presence of other marine animals has been monitored as well. The most frequently sighted categories were seabirds (n. 165, 46%), fish (n. 111, 31%) and marine turtles (n. 62, 17%). In particular, five species of seabirds and five species of fish were observed (see respectively Table 5 and 6 and Figure 11 and 12).

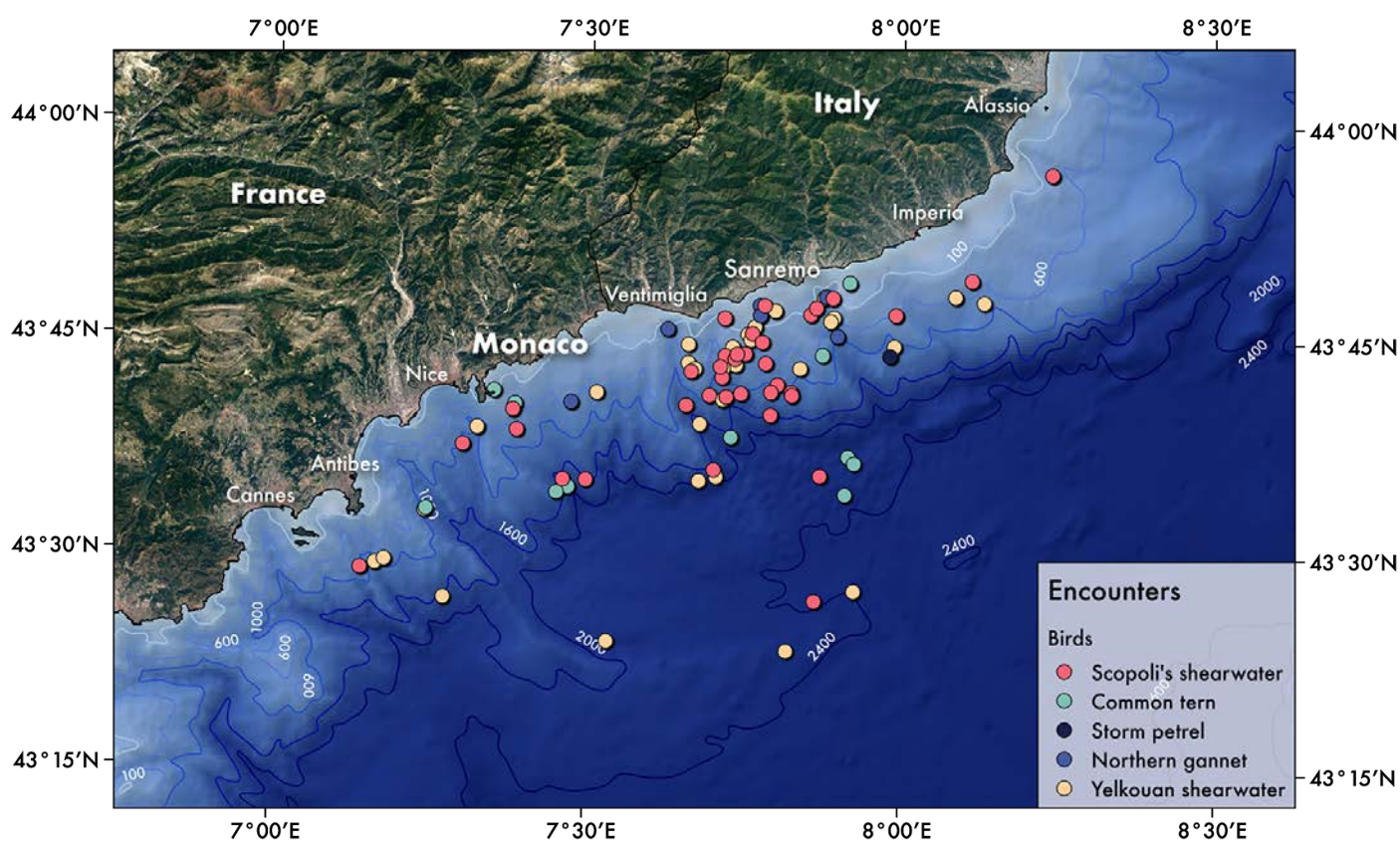




Among seabirds the most sighted species are yelkouan (*Puffinus yelkouan*) and Scopuli's (*Calonectris diomedea*) shearwaters.

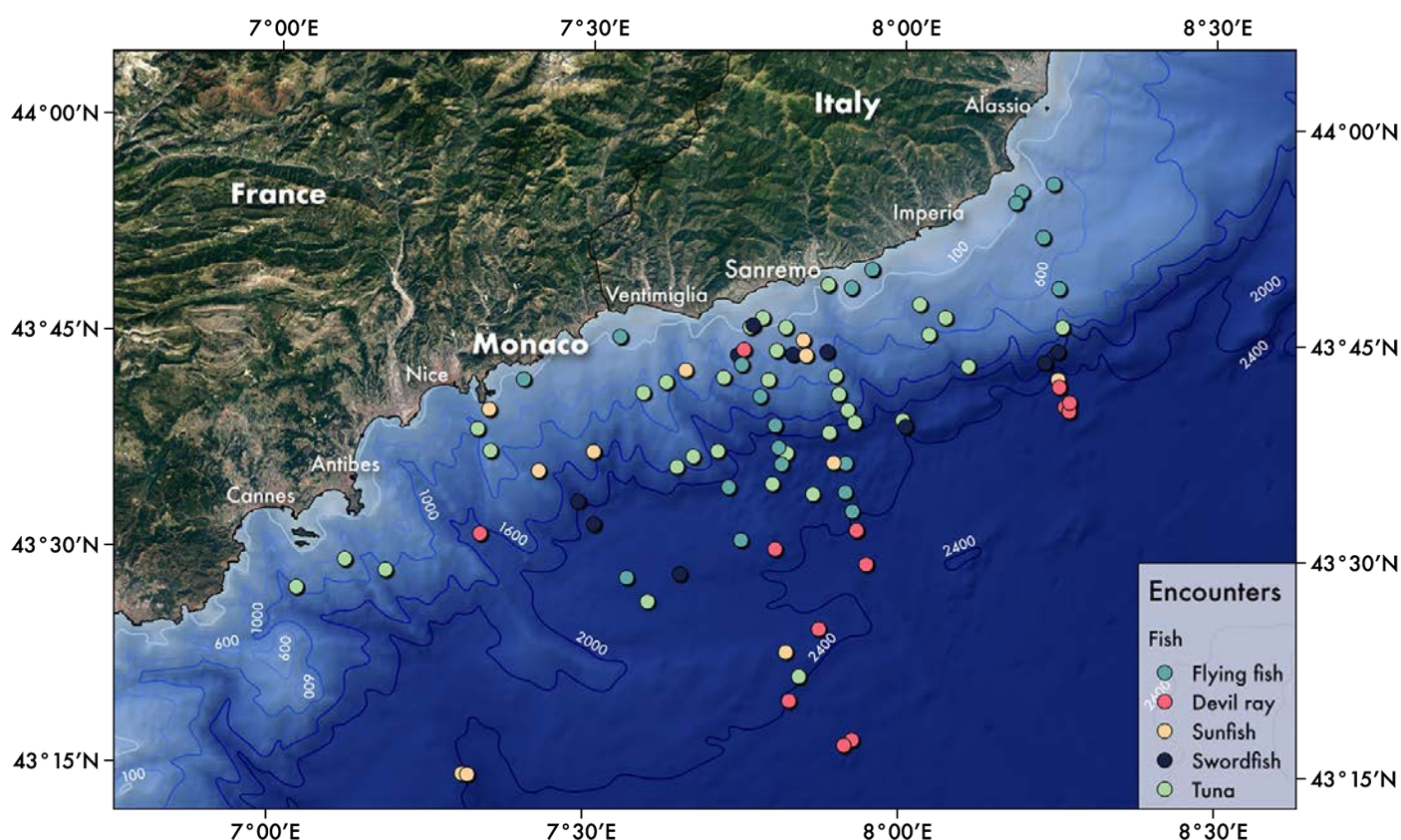
**Table 5.** Overall number of seabirds by species encountered during 2020 field season.

| Year         | Species              | N encounters |
|--------------|----------------------|--------------|
| 2020         | Common tern          | 18           |
|              | Northern gannet      | 12           |
|              | Others               | 15           |
|              | Scopoli's Shearwater | 59           |
|              | Storm petrel         | 1            |
|              | Yelkouan Shearwater  | 60           |
| <b>Total</b> |                      | <b>165</b>   |



**Figure 11.** Map showing the position of seabirds encounters collected during 2020 field season.





**Figure 12.** Map showing the position of fish encounters collected during 2020 field season.



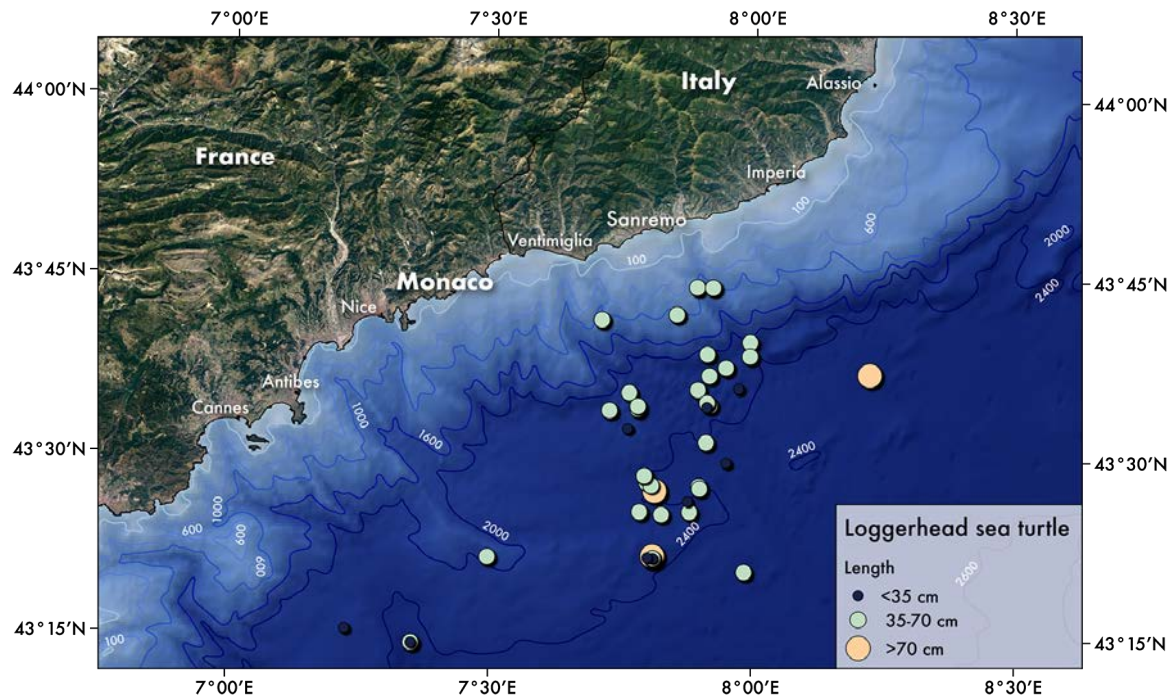
**Table 6.** Overall number of fish by species encountered during 2020 field season.

| Year  | Species     | N encounters |
|-------|-------------|--------------|
| 2020  | Devil ray   | 18           |
|       | Flying fish | 27           |
|       | Others      | 10           |
|       | Sunfish     | 11           |
|       | Swordfish   | 10           |
|       | Tuna        | 35           |
| Total |             | 111          |

Regarding fish, tuna (different species belonging to the *Scombridae* family) is the most sighted category followed by flying fish (*Cheilopogon heterurus*) and devil ray (*Mobula mobular*).

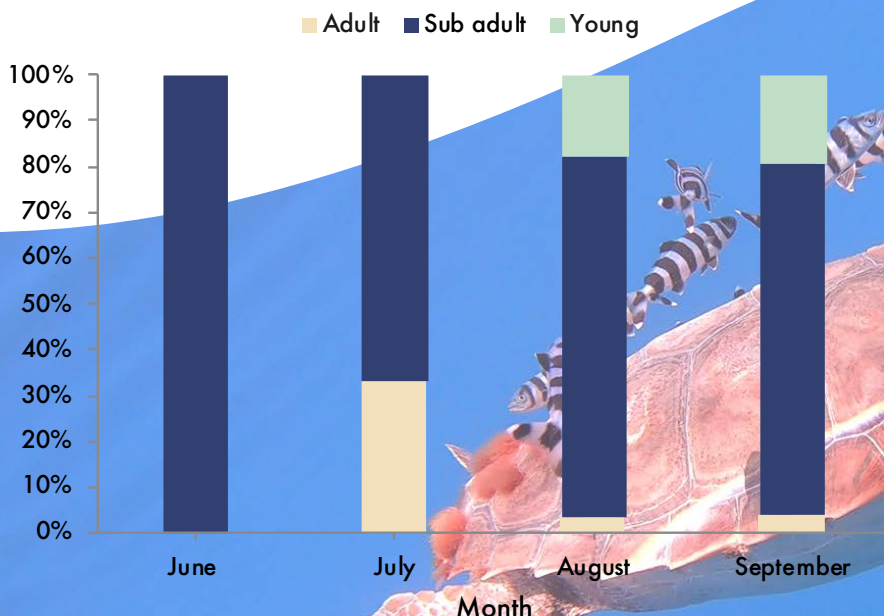


Regarding sea turtles, the only reported species was the loggerhead sea turtle (*Caretta caretta*). The highest prevalence was reported in August with 28 turtles sighted, with September closely following with 26 turtle sightings. Most of the turtles were apparently in a healthy state (n. 57) if compared with the observed turtles in distress (n. 5) for the investigated months. During the season, four adults (estimated length of caparace from notch-to-tip >70 cm), 48 sub-adults (estimated length ≤70 cm - >35 cm) and ten young (estimated length ≤35 cm) turtles were observed. The results clearly showed that the higher prevalence are sub-adult turtles (Figure 13, Figure 14).



**Figure 13.** Map showing sea turtle encounters collected during 2020 field season (points are categorized by turtle estimated length).

**Figure 14.** Bar chart showing the position of sea turtle encounters by age classes and month collected during the 2020 field season.



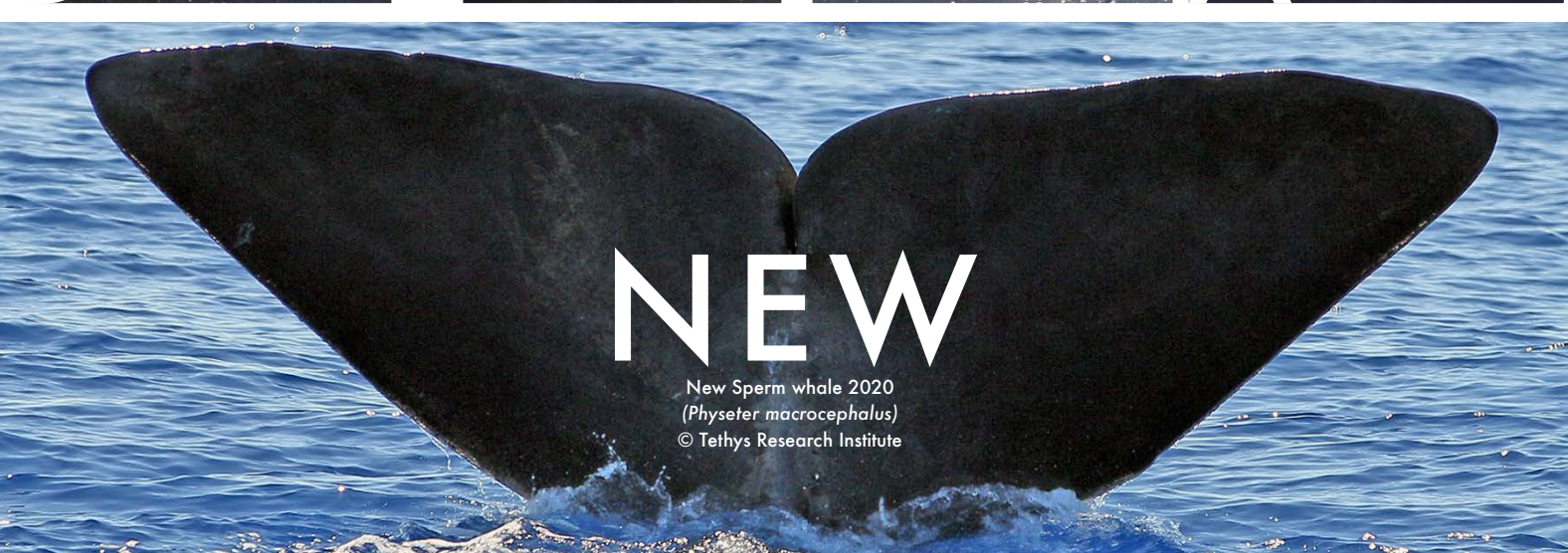
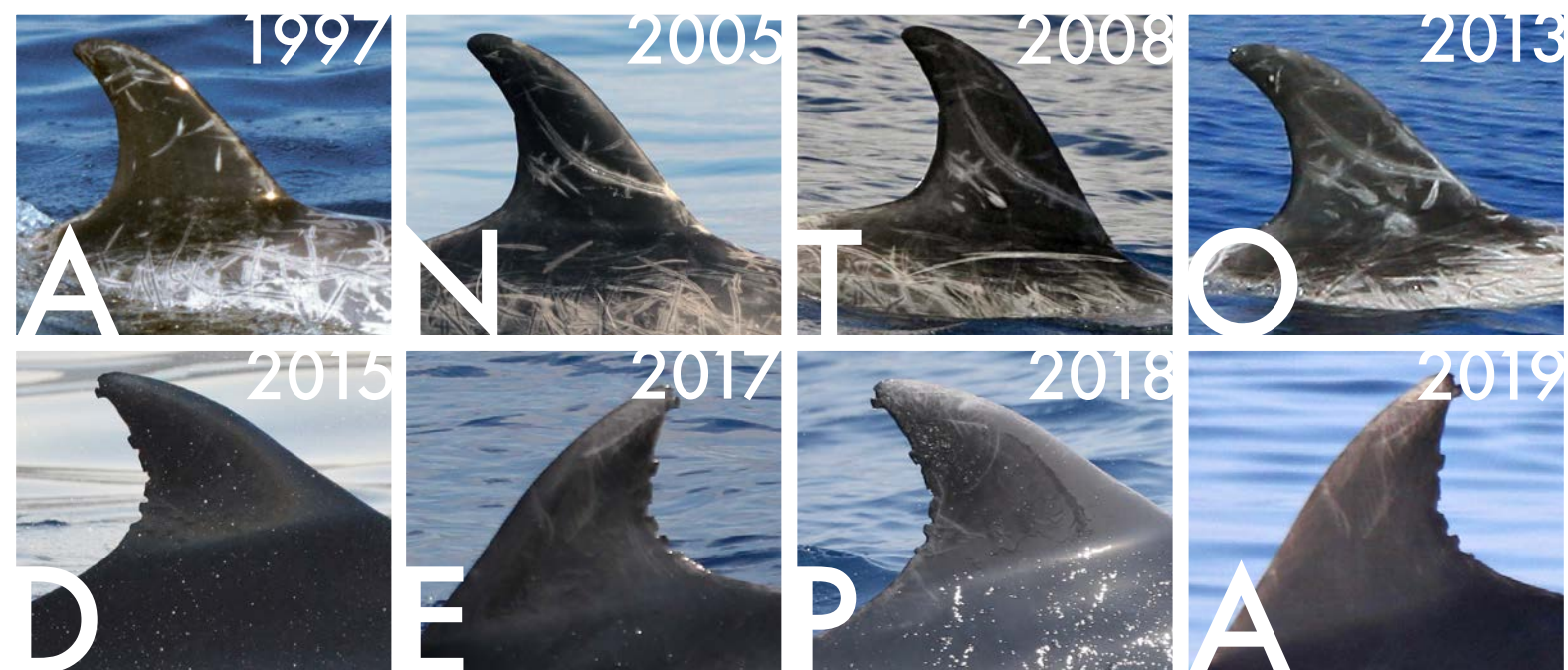


## 4.3 Photo identification

Individual identification is a powerful technique, which can be used to obtain important ecological information on animal populations. Photo-identification techniques were applied to all of the cetacean species mentioned before, except for striped dolphins. This technique was performed in 2020 by using Canon digital camera (EOS 7D) equipped with 70-200mm f2.8 zoom lenses. A total of 5,064 photos of 5 different species have been collected during the season.

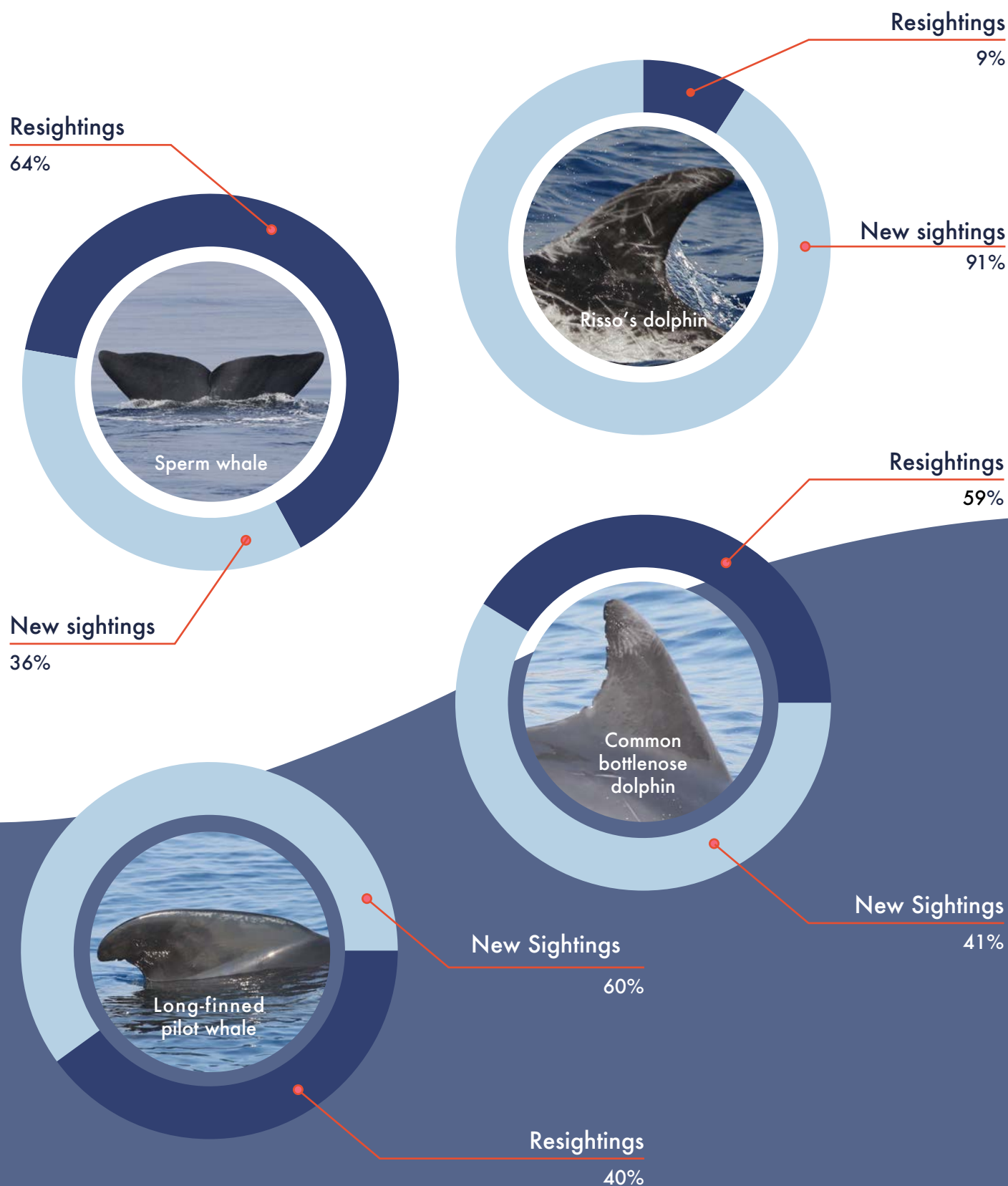
Most of the digital photos collected were then cropped around the dorsal fin, fluke and visible part of the body, and selected using consistent criteria (e.g. entire fin/tail visible, right angle, appropriate sharpness and resolution). From the analysis of the photo emerged that 51 common bottlenose dolphins, 28 sperm whales, 11 Risso's dolphins, and 25 long-finned pilot whales, were photo identified during the 2020 season.

The comparison between the collected images and those contained in the historical catalogues (matching) was performed for most of the species (Table 7). Regarding the total number of sperm whale individuals which were photo-identified, 35.7% of them were new individuals, while the remaining 64.3% were re-sightings of individuals already known (i.e. already present in the historical catalogue).



**Table 7.** Summary of the overall number of images taken during the 2020 season and results of the matching (as the number of photo-identified individuals, resighted individuals and new individuals).

| Species                   | N Pictures taken | N PhotoID   | N Resighting | N New |
|---------------------------|------------------|-------------|--------------|-------|
| Common bottlenose dolphin | 889              | 51          | 30           | 21    |
| Fin whale                 | 431              | In progress |              |       |
| Long-finned pilot whale   | 829              | 25          | 10           | 15    |
| Risso's dolphin           | 632              | 11          | 1            | 10    |
| Sperm whale               | 2283             | 28          | 18           | 10    |





## 4.4 Collisions

The waters of the Pelagos Sanctuary host high densities of both cetaceans and marine traffic. Cetaceans are very susceptible to vessel strikes, which usually end in serious injury and even death for the cetaceans. Many studies have shown that while all vessel types are implicated in vessel-cetacean collisions, those which are large and fast-moving have a more severe impact and pose a higher risk of mortality for cetaceans.

Recently, CSR project provided photo-id data to contribute to a dedicated project, financed by the Permanent Secretariat of the Pelagos Agreement, to develop and evaluate mitigation strategies to reduce the risk of ship strikes to fin and sperm whales in the Pelagos Sanctuary. From the analysis of the CSR historical catalogues (1990-2018), it emerged that 30 different sperm whales and 53 fin whales reported collision marks.

During the 2020 field season, only one injured sperm whale (already present in the catalogue under the name “Freddy”) was reported among the 28 photo-identified animals. Three fin whale individuals showed clear evidence of collision marks too.



Two of the three fin whales with amputations, certainly due to human activities, recorded this year had never been encountered in the study area before. Thus, they were added to the individuals with collision marks catalogued from 1990.

This year’s most striking case was “Codamozza” (“chopped tail”, also called “Fluker”), that left with its flukes completely severed, by an accident which probably happened right within the Pelagos Sanctuary. The individual had already been photo-identified by Tethys back in 1996, with half of its flukes already missing. However, the whale used to be re-sighted in the Sanctuary on a regular basis by CSR and other research or whale-watching organizations for over 20 years. The second accident involving “Codamozza”, which led to the total loss of the flukes, probably occurred off the French coast between the second half of September and the first week of October 2019. Nevertheless, and despite appearing skinny, the animal travelled a large part of the Mediterranean for almost a year, touching Greece, Syria, southern Italy and then returning back to the Pelagos Sanctuary in June 2020. In early July, “Codamozza” was sighted for the last time south of Toulon (France), her condition apparently worsened, and there are fears that she may not have survived.

In late August, the CSR researchers spotted in front of Sanremo, again inside the Sanctuary, a second whale in very similar conditions, with almost its entire fluke missing. Having only a thin stripe left, the individual was named “Mezza Coda”, meaning literally “half fluke” in Italian. This animal also appeared emaciated and was never sighted again.



A third case was recorded at the end of July: a fin whale whose dorsal fin was amputated was spotted by CSR researchers. As for the causes of all three cases, either a collision with a ship or an entanglement in a fishing gear have been hypothesized.

The first reported event, "Codamozza", was intensively featured in many Italian and foreign media, together with the case of two sperm whales entangled in illegal driftnets in Sicily. On the bright side, these stories contributed to raise awareness about the multiple threats to Mediterranean cetaceans and their survival. In the wake of the case of the two entangled sperm whales, Tethys wrote a letter together with Greenpeace to the Italian Minister of Agricultural, Food and Forestry Policies, Bellanova, denouncing the illegal use of driftnets and asking for their total ban as proposed by the EU.





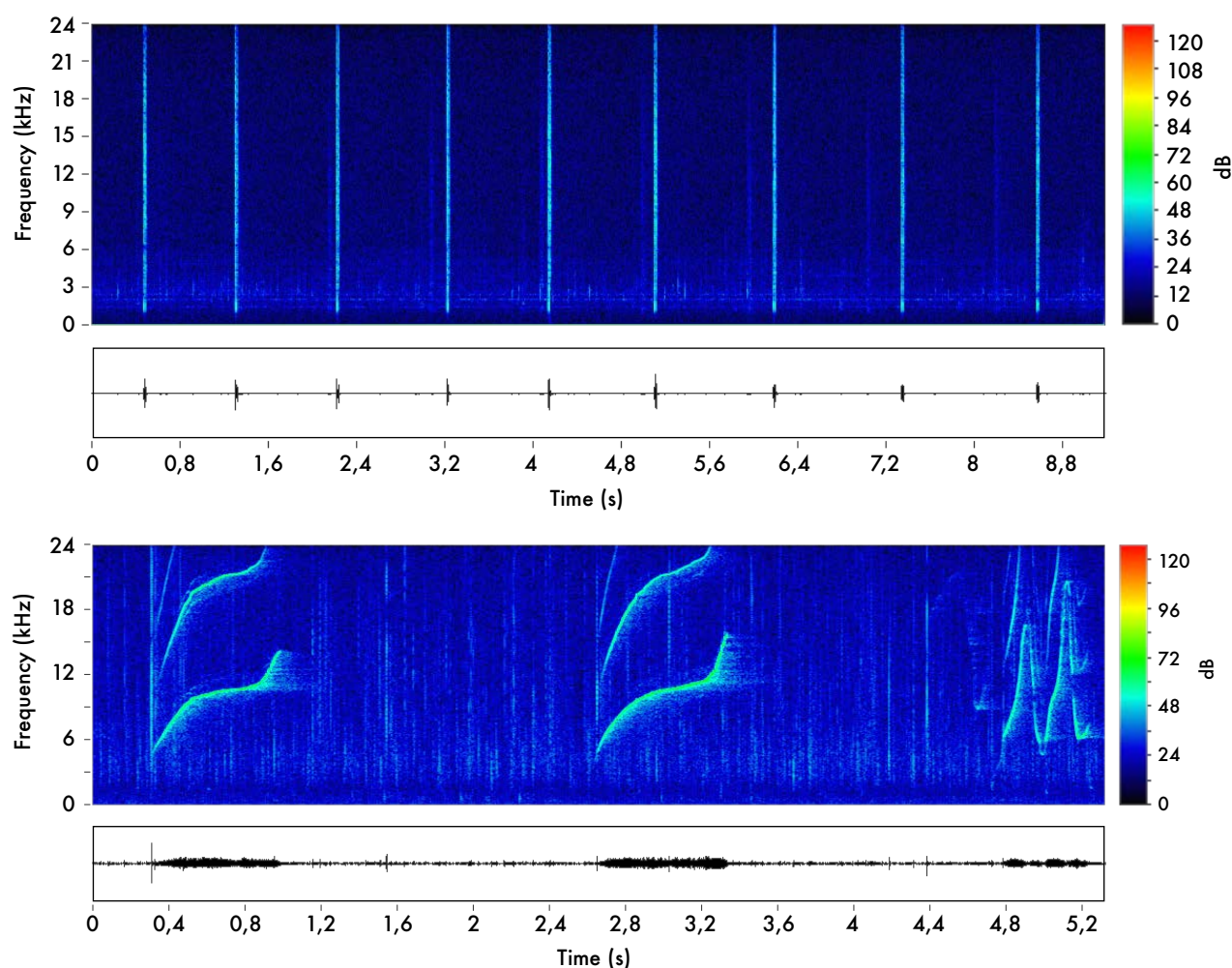
## 4.5 Passive acoustic surveys and recordings

Passive Acoustic Monitoring (PAM) was also carried out concurrently to visual surveys. A horizontal array of tow hydrophones was towed 200 metres behind the boat. The array was connected to a final amplifier, an external audio board and a personal computer allowing real-time visualisation and recording of sounds. The system allows the detection and the recording of both cetacean presence and background noise (Figure 15).

A total of 63 dedicated acoustic recordings files resulting in approximately 20 hours of recordings were made by using Sound Emission Analyzer Pro (SeaPro, developed by Interdisciplinary Center for Bioacoustics and Environmental Research (CIBRA)) during cetaceans' encounters, to feed the acoustical data base, systematically compiled by the Tethys Research Institute (Table 8).

**Table 8.** Number of recordings and overall duration of the recordings by species collected during the 2020 field season.

| Year  | Species                   | N recordings | Duration |
|-------|---------------------------|--------------|----------|
| 2020  | Common bottlenose dolphin | 3            | 02:30:27 |
|       | Long-finned pilot whale   | 8            | 04:28:03 |
|       | Risso's dolphin           | 2            | 01:43:29 |
|       | Sperm whale               | 50           | 10:57:13 |
| Total |                           | 63           |          |



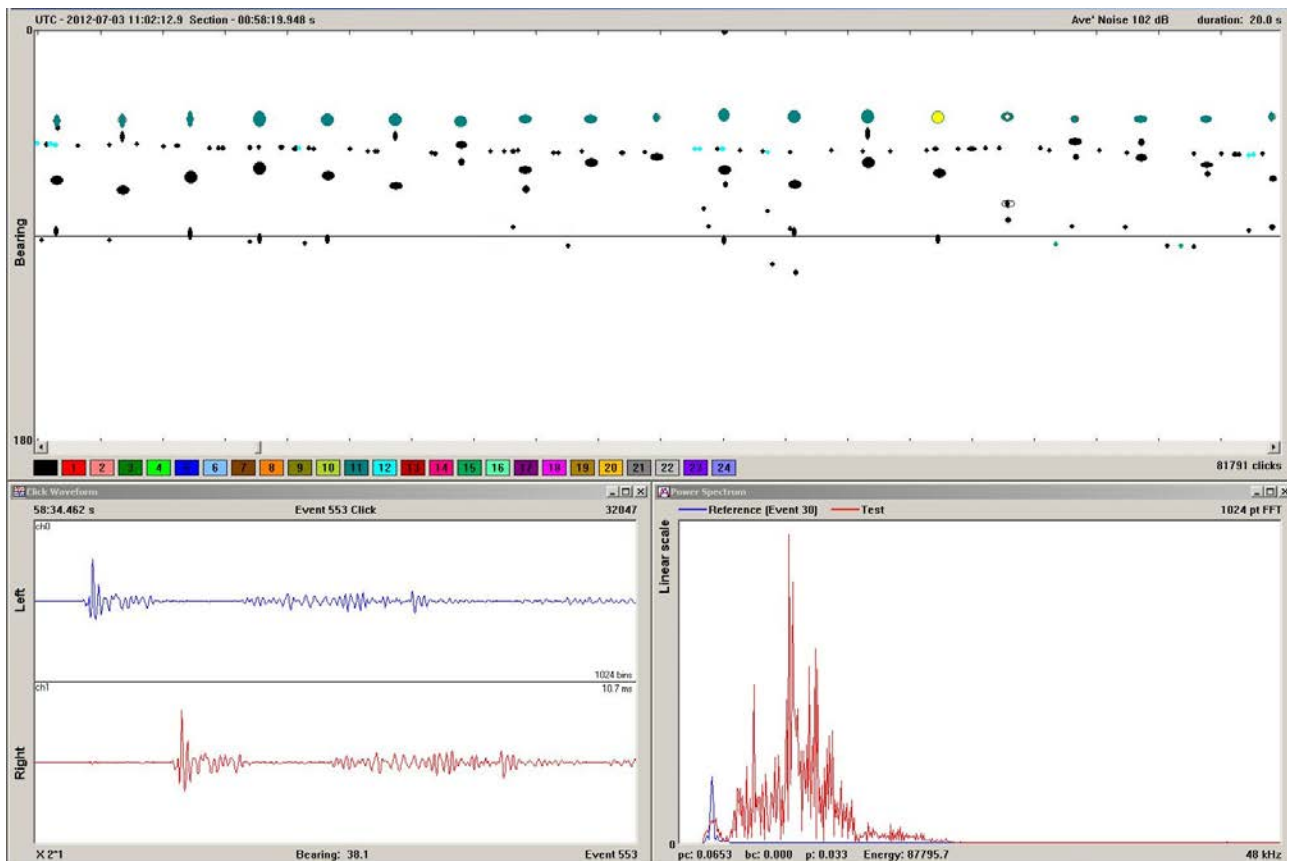
**Figure 15.** Spectrogram of sperm whale regular clicks (a) and common bottlenose dolphin whistles and echolocation clicks (b).



Sperm whales are the main target species of the CSR acoustic monitoring.

During sperm whale acoustic detections, the animals were tracked by using Rainbow Click software (developed by International Fund for Animal Welfare (IFAW)).

The aim was to approach them at the end of the dive, after the individual surfaced and is breathing, in order to collect photo-ID, photogrammetry and behavioural data (such as respiration pattern) or to collect both underwater and aerial images (Figure 16).

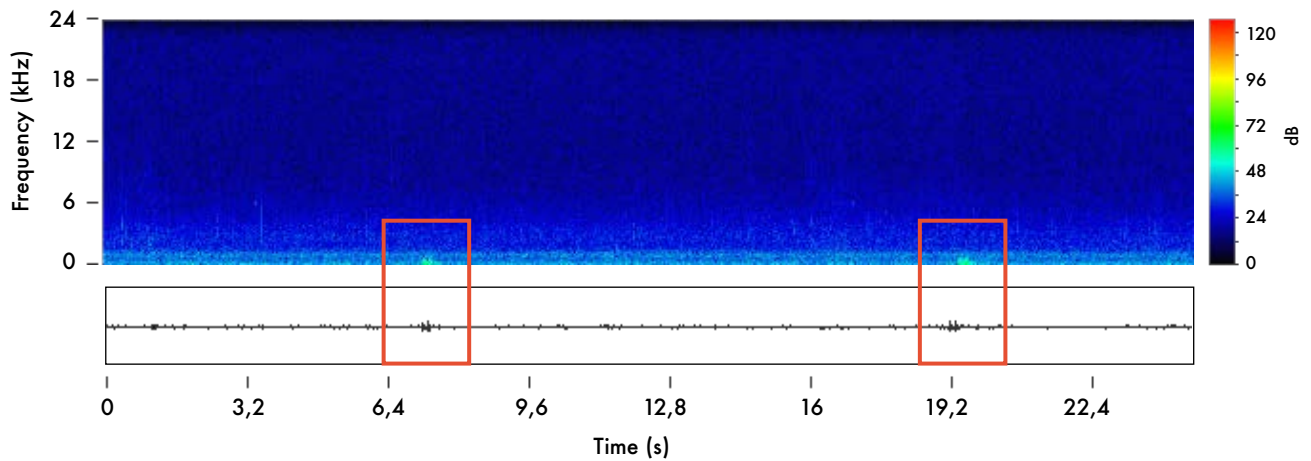


**Figure 16.** RainbowClick software main screen with real time sperm whale tracking.

At the beginning of a new dive after the surface period (i.e., when the whale fluked-up), acoustic recordings were continuously collected for each dive. For 25 different sperm whale sightings, a total of 50 recordings were collected during the 2020 season.

During the 2020 surveys, background noise recordings, five minutes each, were systematically collected every 30 minutes, totaling 334 recordings. On some occasions, impulsive sounds from human-made sources were also recorded, such as airguns used during seismic surveys, known to have a potential impact on marine mammals (Figure 17).

As happened last year, the results of the analyses on the anthropogenic sounds recorded inside the Pelagos Sanctuary in 2020 will be sent to the Italian Ministry of the Environment and to the Permanent Secretariat of the Sanctuary.

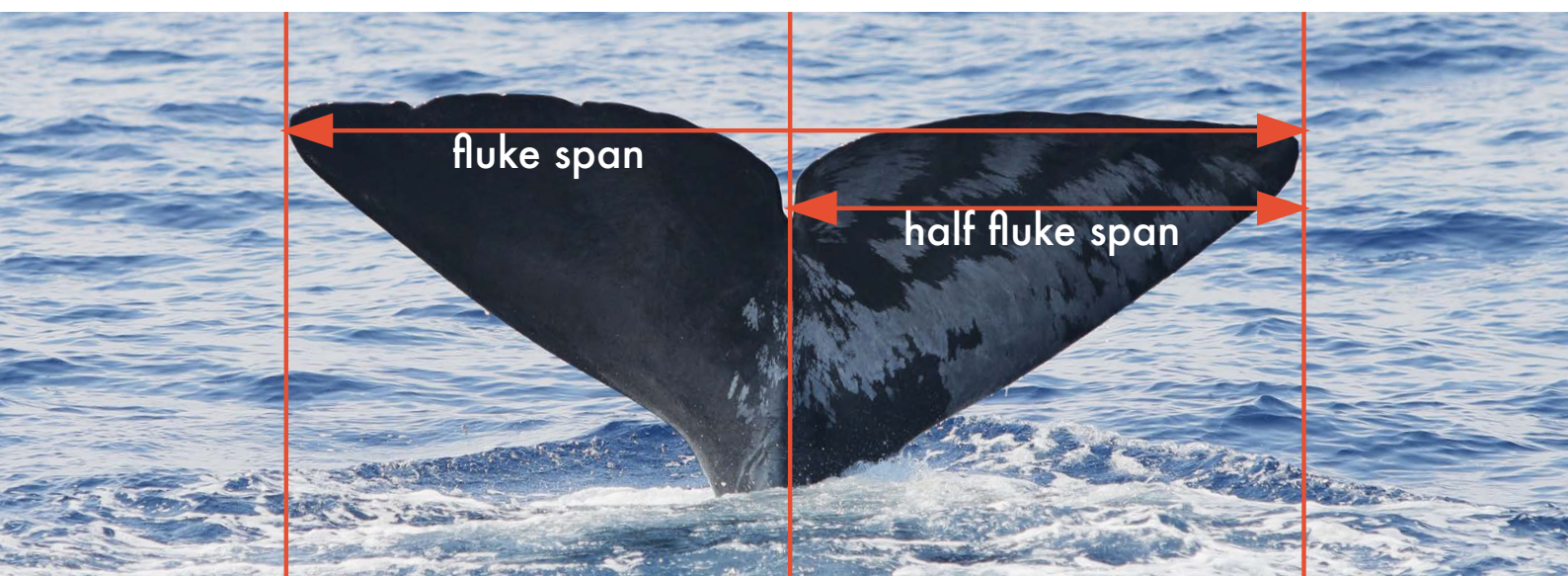


**Figure 17.** Spectrogram of a series of airgun pulses recorded during the 2020 field season.

## 4.6 Photogrammetry and acoustic allometry

Photogrammetry is a technique which allows to derive information on the geometrical properties of an object directly from photographs while acoustic allometry allows for the understanding of how animal vocalizations reflect animals' body size. The sperm whale is the largest of the toothed whales and the most extreme sexually dimorphic species of cetaceans in terms of body length and weight. For photogrammetric studies we derive animals' body length from pictures of the tail of each individual taken during the fluking (Figure 18). From these pictures we can obtain a measurement of the real-life fluke-span and, based on established allometric equations, we can relate this to the animals' body length. Since 2008, we have been able to estimate the body length and individual growth of about 100 animals with longest individuals reaching almost 13.5 meters and growing roughly 10 cm per year on average with the fastest measured growth of 21 cm per year recorded for younger animals.

Photogrammetry data have been collected in 85% (n. 23) of the sperm whale sightings. Analysis of the data is still in progress.

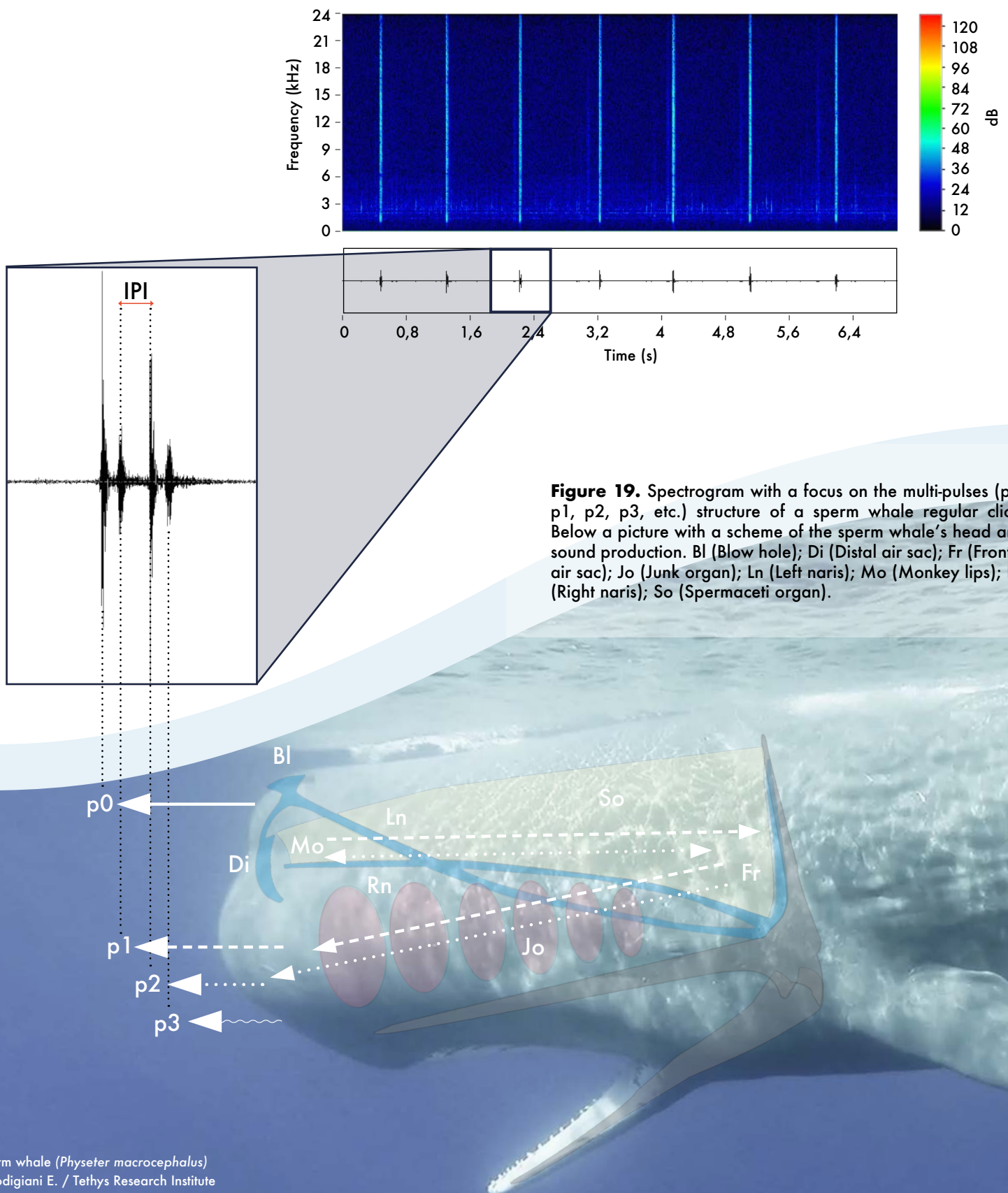


**Figure 18.** Photogrammetry measurements used to estimate the total length of the animal.



During sperm whale dives, we continuously monitor and record the vocalisations emitted by the animals. The multi-pulse structure of sperm whale “clicks” offers a unique non-invasive and non-lethal way to investigate individuals body length by looking at the intimate structure of each single click and by measuring the so called Inter Pulse Interval (IPI) of hundreds of single clicks for each encountered animal (Figure 19).

The analysis of the IPI from the 50 recordings collected during the 2020 season is currently in progress.



## 4.7 Faecal sampling

The health assessment of cetaceans can be used to indirectly monitor marine ecosystem quality, making cetaceans valid sentinel species for marine ecosystem status.

During 2020 surveys a non-invasive sampling method was used to collect new information to better understand sperm and fin whales' health status.

Floating faeces were collected from individual whales using a fine nylon mesh net. A total of three faecal samples from three different sperm whales were collected. Each faecal sample was subjected to microscopic investigation by using a flotation solution of ZnSO<sub>4</sub> (specific gravity 1360) and a Mini-FLOTAC® technique in combination with Fill-FLOTAC® slightly modified. Faecal samples found positive for parasite eggs/cysts and/or adult worms by microscopic analysis were also subjected to DNA genomic extraction and molecular assay in order to identify and genetically characterize parasites identified by microscope. Eggs of parasites, most likely nematodes (Figure 20A) were identified in the faecal samples of two out of three sperm whale samples by microscopic examination.

In order to genetically characterize the species, the two faecal samples were then subjected to DNA extraction. DNA samples will be subjected to molecular assay and sequencing in order to identify and determine the parasites species. Cysts of parasites were already reported and identified in faecal samples of fin and sperm whales collected in the 2019 season.



**Figure 20.** A) Image of the parasites eggs found in sperm whales samples. B) Image showing the faecal sampling and microscopic analysis on board Pelagos RV.



Floating faeces of sperm whale  
(*Physeter macrocephalus*)  
© Iacopini M. / Tethys Research Institute



Faecal samples of a Cuvier's beaked whale stranded in September on the Ligurian coast were also collected and subjected to coprological analysis. Preliminary results showed a massive infestation with adult parasites. Future analysis will be planned in order to characterize the species identified by microscope.

During the research season and in particular from the 10<sup>th</sup> to 23<sup>rd</sup> of August 2020, researchers and the guests on board were actively involved in the faecal sampling and microscopic analysis. An optical microscope was kept on board and the faecal samples collected were analysed in real time, after being given a presentation regarding cetacean parasites and methodological assay (Figure 20B). The guests enjoyed the lesson and were directly involved in preparing the samples for microscopic analysis.



**Figure 21.** Necropsy of the Cuvier's beaked whale stranded in September 2020 performed by Zooprofilattico Institute of Imperia.





## 5. REPORTED ENCOUNTERS through the CFA Citizen Science programme

During the first two years of activity (2018-2019) the **Cetacei FAI Attenzione - CFA** ("Be aware of cetaceans") initiative collected about 1,400 reports of sightings of all the regular Mediterranean cetacean species.

In 2020, during the spring "lockdown" (March-May) the CSR team used the CFA web portal and database to collect cetaceans' encounters reported by the Coast Guard and fishermen or those posted on the web (i.e. social networks, YouTube).

In summer, sightings were also reported from owners of pleasure boats, whale watching platforms and other organisations operating at sea.

A total of 644 encounters of 12 different cetacean species (Figure 22) have been reported from January to December 2020.

The most frequent species were striped dolphins (189 sightings, 29.3%) followed by fin whales (136 sightings, 21.1%) and common bottlenose dolphins (128 sightings, 20%).

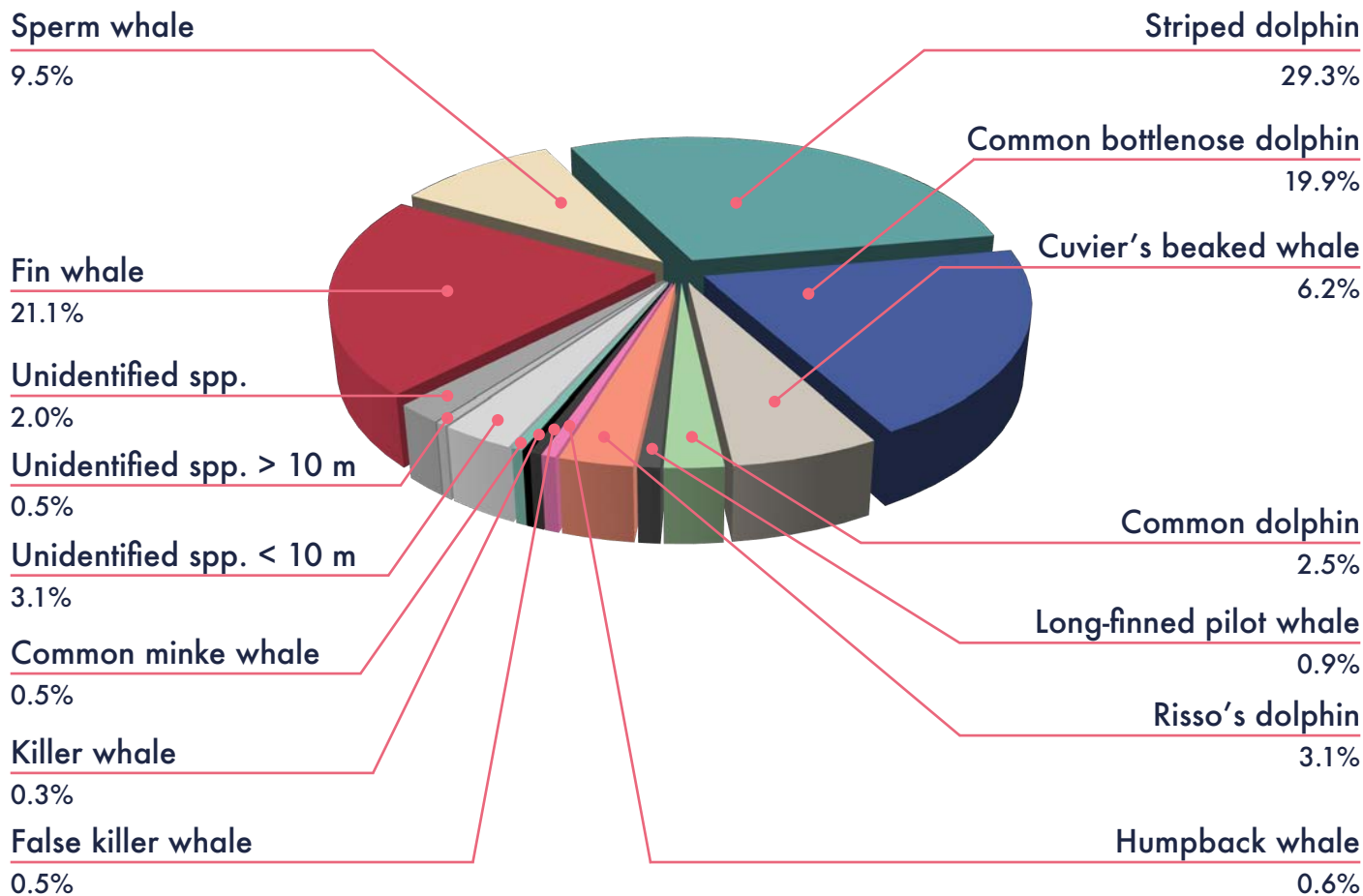
20 sightings (3%) of Risso's dolphins have been reported in 2020 in the Ligurian Sea, Southern Tyrrhenian Sea and in the Strait of Sicily (Figure 23).

In addition, 12 encounters of Mediterranean "occasional" species belonging to false killer whales (n. 3), killer whales (n. 2), humpback whales (n. 4) and also common minke whales (n.3) have been reported (See Paragraph 6.2).

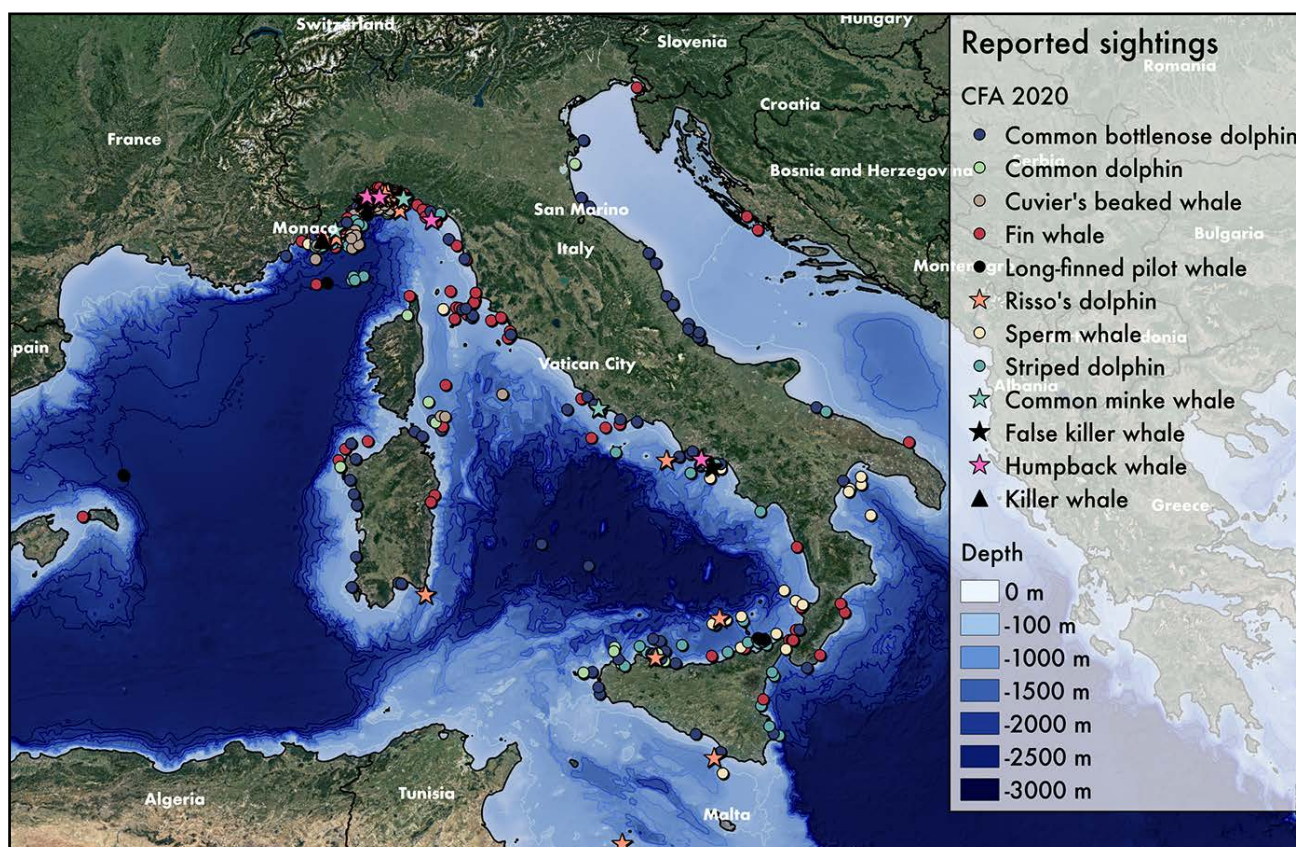
The programme contributed to achieve a crucial engagement with the public adding to the ocean literacy and marine citizenship.

Furthermore, and together with a consolidated network of collaborating partners, new areas of occurrence of the species were identified.





**Figure 22.** Pie chart showing the reported encounters by the CFA network during 2020.



**Figure 23.** Map showing the location of the 644 cetacean's encounters reported in 2020 by the CFA network.

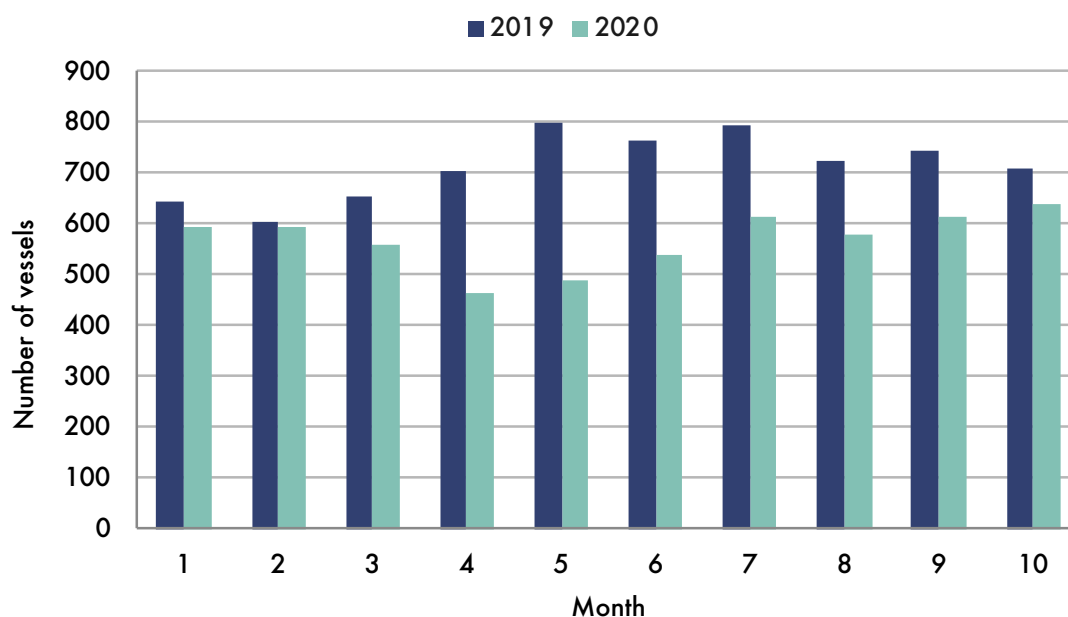
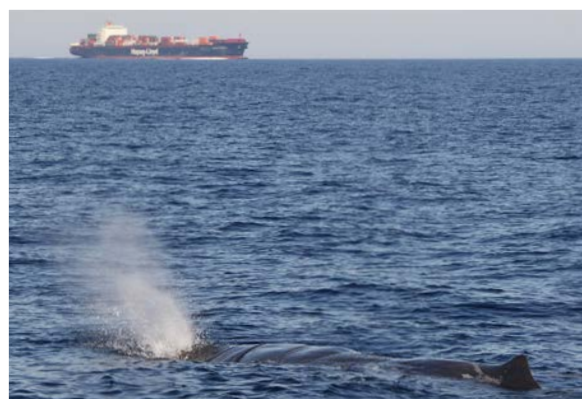




## 6. PECULIARITIES EMERGED DURING 2020 SEASON

### 6.1 Marine Traffic

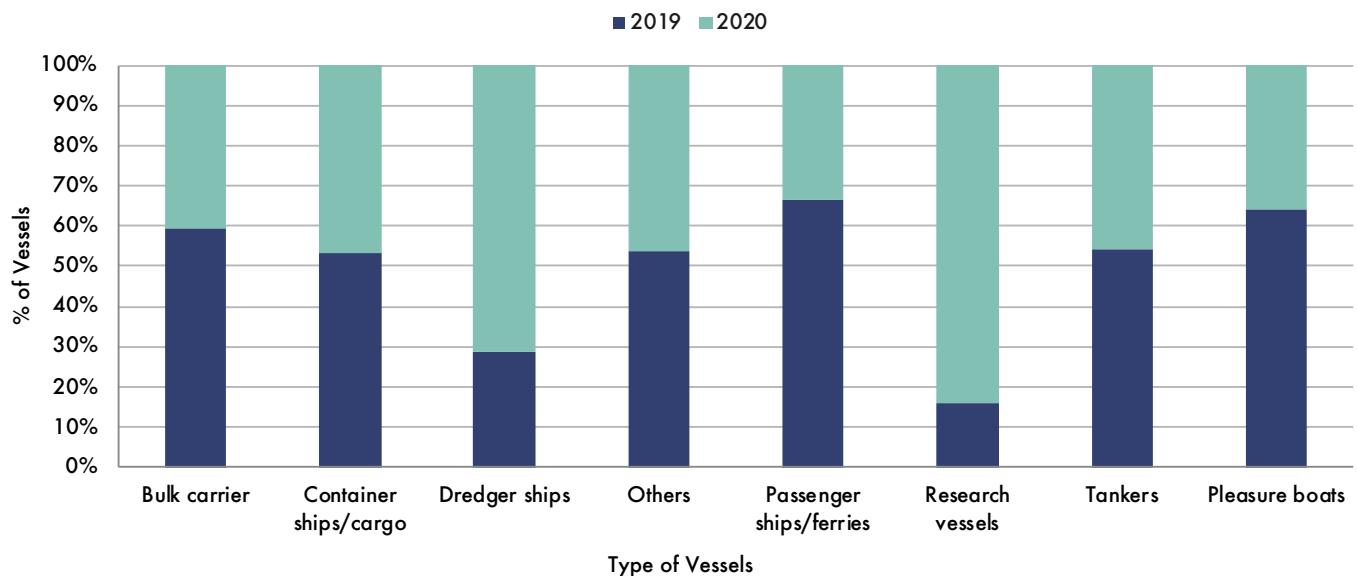
Monthly averages of ship types transiting in the Ligurian Sea between January and October 2019, and in the same period in 2020, have been provided by the Italian Coast Guard. A total of 7,143 vessels of 56 different types have been registered in 2019. In 2020, an overall decrease of 20.3% in the number of vessels has been observed (n. 5,693, 54 vessel types). Main differences in the monthly maritime traffic involve the spring season (March-May, -30%), in coincidence with the beginning of the Italian "lock-down" period and the beginning of the related restrictions (Figure 24). The overall ship traffic increased again in summer (June-September), but well below the usual traffic density. Between June to September 2020 a reduction of 22.3% of the maritime traffic has been recorded compared to the same period in 2019.



**Figure 24.** Bar chart showing the monthly overall number of vessels transiting in the Ligurian Sea in 2019 and 2020. Data provided by the Italian Coast Guard.

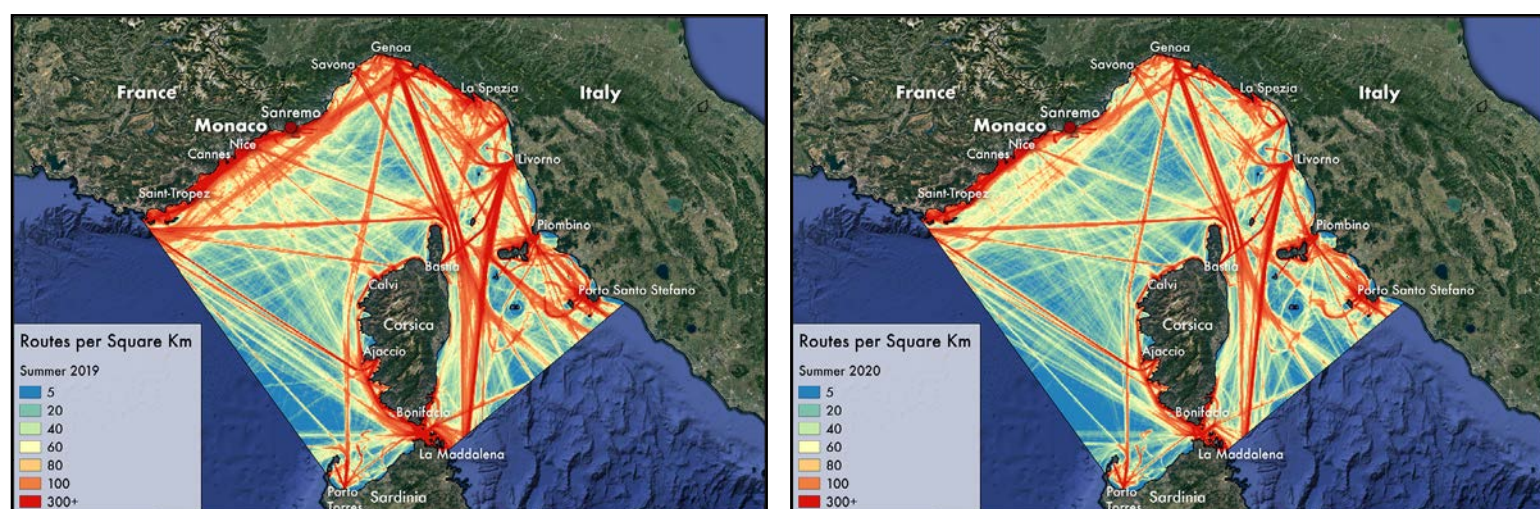


Vessel types have been merged into 8 macro-categories (Bulk carrier, Container ships/cargo, Dredger ships, Passenger ships/ferries, Research vessels, Tankers, Pleasure boats and Others). In both the years considered, Container ships/cargo is the most representative category covering 50% of the maritime traffic registered. Tanker is the second most representative category. The comparison of vessel categories between 2019 and 2020 values show a small drop in the number of Container ships/cargo (-12%) and Tankers (-15%). A marked reduction of Passenger ships/ferries of almost 50%, followed by Pleasure boats (-44.20%) and bulk carriers (-31.30%), has been observed (Figure 25).



**Figure 25.** Barchart showing the comparison of the 8 macro categories registered in the Ligurian Sea in 2019 and 2020.

Route density data extracted from the EMODnet portal clearly show a decrease in the summer maritime traffic density in the Pelagos Sanctuary area in 2020 (Figure 26).



**Figure 26.** Route Density occurring in the Pelagos Sanctuary area during Summer 2019 (on the left) and Summer 2020 (on the right) in the Pelagos Sanctuary. Data from EMODnet portal (<https://emodnet.eu/en>).

The effects of maritime traffic range from disturbance due to underwater noise (i.e. masking of communication) to lethal effects due to the collision with large vessels. The data presented here suggest a potential reduction of the noise frequency component introduced by Passenger ships/ferries of 50%, while the component of noise induced by Container ships/cargo/Tankers have potentially not undertaken substantial changes. In addition, it can be speculated that the observed decrease in shipping traffic may have potentially reduced the risk of collisions with large whales.

However, further analysis will be conducted to correlate the maritime traffic density and the observed presence of cetaceans in order to contribute to the understanding the potential effect of this anthropogenic pressure on cetacean habitat use and distribution.

## 6.2 Distribution of the animals

Peculiarities in cetacean species occurrence and distribution have been observed in 2020:

- *fin whales have been largely sighted in areas that are different compared to their usual habitat;*
- *Risso's dolphins have been documented in the study area after six years of absence;*
- *"occasional" Mediterranean species have been observed within the Pelagos Sanctuary area.*

**F**in whales: The analysis of the CSR long-term dataset clearly indicates the fin whales' preferred habitat as the deep pelagic area of the central and western part of the Pelagos Sanctuary at depths of about 2000 m or higher. This area is in fact known to be a "critical habitat" for fin whales, considered an important summer foraging ground for the species.

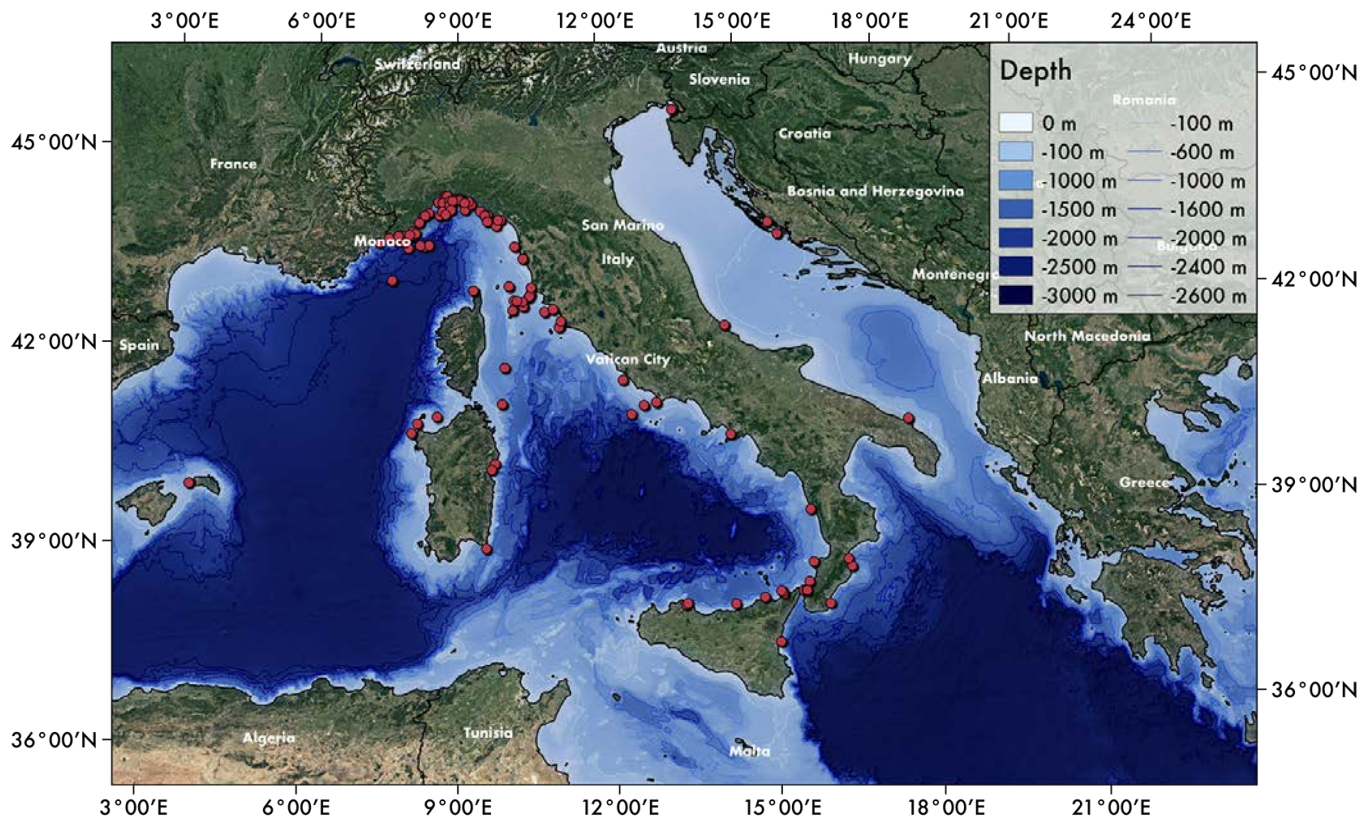
Differences in fin whale distribution have been observed in the CSR study area in 2020.

Over the total number of sightings collected during the 2020 fieldwork season (n:13), two fin whale encounters (15%) occurred in very coastal waters (about 40 m of depth) while the others occurred in pelagic waters (at an average depth of 1,800 m). The limited number of sightings collected with respect to previous seasons raises some concern, however further analyses are needed to assess whether this apparent decrease of the species relative abundance is statistically significant.





It's interesting to report here that the fin whales 2020 data reported by the "Cetacei Fai Attenzione" (CFA) network (a citizen-science collection of opportunistic sightings data, see Paragraph 5 for further details) showed a marked increase of fin whales encounters (+148%; n. 134 in 2020) that have been reported in coastal waters.



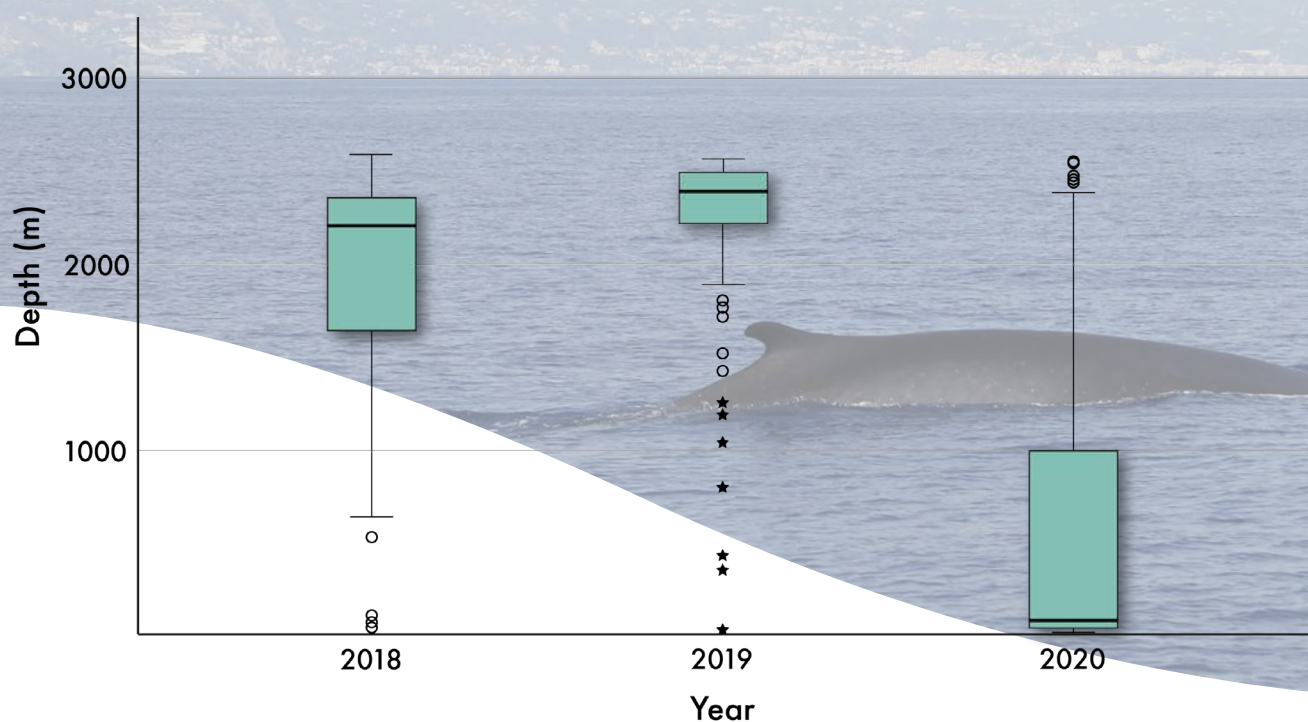
**Figure 27.** Map showing the position of fin whales encounters reported by the CFA network in 2020.

The highest number of fin whale encounters was in the Ligurian Sea (62%), it concerned mostly the summer period (90% of the sighting occurred between June and October), and they were at an average depth of about 410 meters (N. 83; SD: 721 m), well below their usual depth range.

CFA and CSR data collected between 2018-2020 were combined to test the hypothesis that fin whale sightings in 2020 occurred at a much shallower depth than in the previous years. The analysis confirmed that the difference was statistically significant (Kruskal Wallis Test, H: 101; df: 2; P-level < 0.001) (see Table 9 and Figure 28).

**Table 9.** Descriptive statistics of the depth of the fin whales encounters reported in the Ligurian Sea between 2018 and 2020.

| Year | N (CSR+CFA) | Min | Max  | Median      | SD    |
|------|-------------|-----|------|-------------|-------|
| 2018 | 58 (33+25)  | 43  | 2594 | 2164.0      | 694.3 |
| 2019 | 83 (36+47)  | 22  | 2566 | 2372.5      | 532.9 |
| 2020 | 96 (13+83)  | 11  | 2551 | <b>80.0</b> | 852.1 |



**Figure 28.** Comparison between the depth statistics of the fin whales encounters between 2018-2020 (Depth derived from GEBCO Digital Atlas <https://www.gebco.net>)

The low number of fin whale sightings reported in the study period (n. 13) by the CSR project, and a large number of reported encounters in coastal waters in 2020, suggest that the species may have used a different habitat from its usual one.

Chlorophyll-a (Chl-a) data are largely used as a proxy of fin whales foraging habitats, with higher values highlighting potential foraging sites.

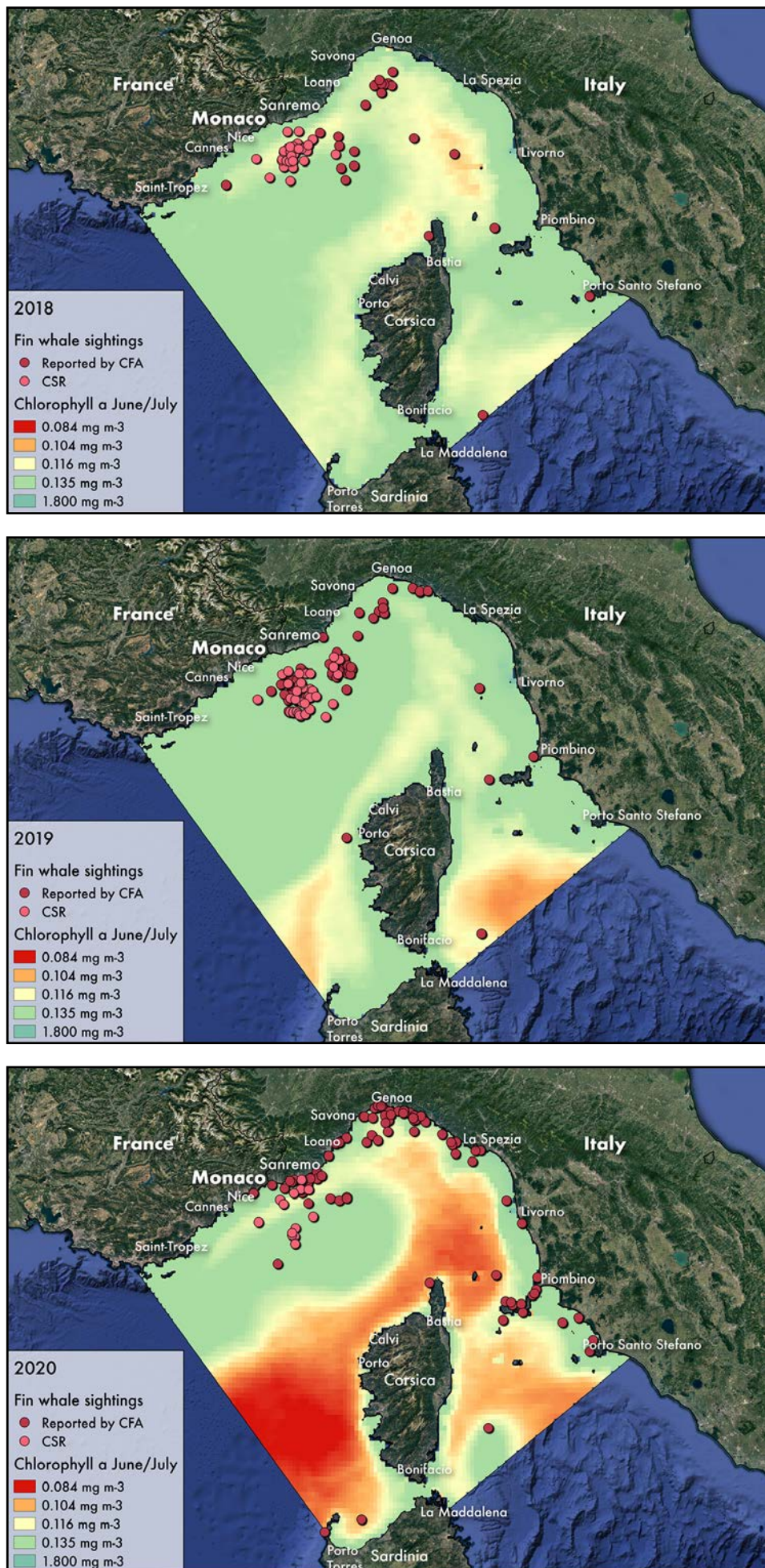
Therefore, Chl-a concentration averaged maps for summer 2018, 2019, and 2020, generated by the NASA Ocean Biology Processing Group (OBPG) through the Giovanni system (<http://disc.sci.gsfc.nasa.gov/giovanni/>), were considered (Figure 29).

A different spatial pattern of Chl-a concentration has been observed in 2020.

However, the productivity level of the Ligurian Sea in 2020 appears to be comparable to the averaged values registered in the foregoing years (J.N. Druon pers comm).

Further analyses are needed to better understand the potential causes of the fin whale observed distribution in coastal waters.



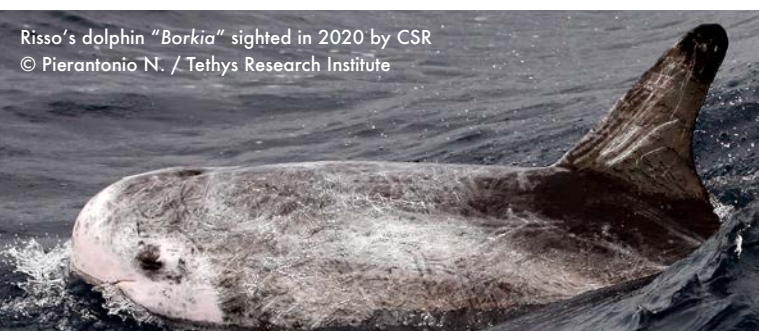


**Figure 29.** Maps showing the Chlorophyll-a concentration extracted from <http://disc.sci.gsfc.nasa.gov/giovanni/> and fin whales reported encounters by CSR project and by CFA network in 2018 (a) 2019 (b) and 2020 (c).

**Risso's dolphins:** The presence of Risso's dolphins has been extensively reported in the western Ligurian Sea since 1990. This population is the most studied one within the Mediterranean Sea area and the CSR project owns the biggest photographic dataset on this species. This long-time series of data allowed us to estimate Risso's dolphins' trends in abundance in the area. Despite the continuous research effort, a dramatic reduction in numbers of individuals has been observed in the last decade. Particularly, the encounter rate has dramatically decreased in the area, with no Risso's dolphin sightings reported since 2015.

In 2020, three sightings of Risso's dolphins occurred after 6 years of this species being absent from the study area. The first sighting, at the beginning of July, was a group of 15 individuals with 2 calves. From the comparison between the photo-id data collected and the historical Risso's dolphin catalogue (272 individuals), emerged that the group was entirely composed by new individuals never sighted before in the area, since no positive matching was found.

On the contrary, a known individual (called "*Borkia*") already sighted within the Sanctuary area, was found in both the second and the third sighting at the beginning of September. *Borkia*, which doesn't belong to the CSR catalogue (western portion of the Sanctuary), was sighted by two Whale Watching (WW) companies operating in the eastern side of the Pelagos Sanctuary (Genoa Canyon area) in the last 3 years (2018-2020). *Borkia* was sighted by WW on August 16th and then by CSR three weeks later, at the beginning of September. This match allowed us to follow the movements of the animal and to estimate the linear distance covered, from the Eastern to the Western side, in more than 100 kilometres (about 60 nm).



**Occasional species:** In 2020, four different occasional species of cetaceans have been reported within the Pelagos Sanctuary area by WWs companies or research groups. In particular humpback whales, killer whales, false killer whales, and common minke whales were reported in eastern part of the Pelagos Sanctuary.

All of these species have been very rarely sighted in the Sanctuary area in the past decades. Occasionally, these species enter the Mediterranean Sea as visitors from the Atlantic Ocean. Sighting and stranding events have been recorded throughout the Mediterranean and particularly in the Algero-Provencal and Tyrrhenian subregions.

The increase in the reported sightings of occasional species could be perhaps due to a combination of greater attention for cetaceans by the public and the media in recent years and possible increases in populations frequenting the north-east Atlantic Ocean.



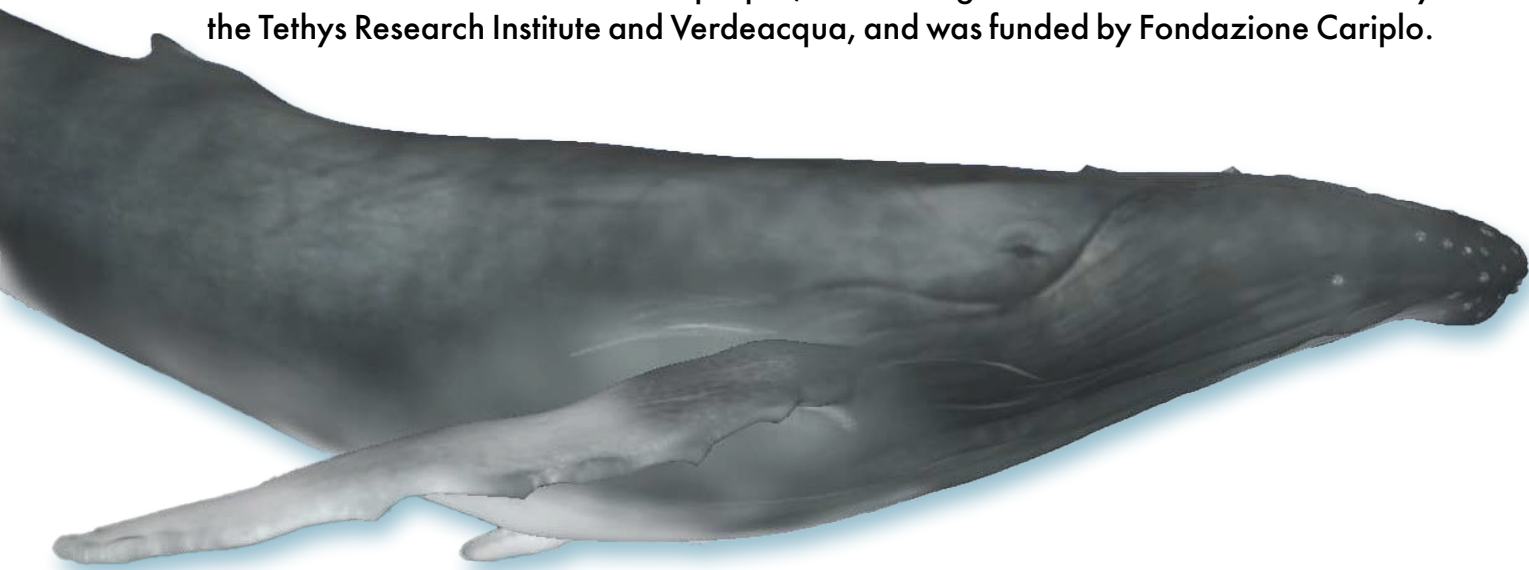
## 7. EDUCATION and PUBLIC AWARENESS

A great effort has been devoted also to public awareness about all research activities conducted by Tethys in this area. In over thirty years over 3,200 people, from different countries, have participated in the CSR citizen science program, supporting researchers during the field data collection.

The work conducted by Tethys within the CSR project has been featured in several popular articles published in Italian and European magazines and a large number of lectures and public presentations on cetacean research and conservation issues were given in the last 31 years. Several lectures were also given in primary and secondary schools involving hundreds of local students and children and particularly those living in the area of the Pelagos Sanctuary, enhancing the awareness about cetacean conservation in the Mediterranean Sea. In addition, seminars for University students are regularly conducted by CSR/TRI researchers.

### 7.1 Digital Whales

A public awareness project centered around the Pelagos Sanctuary, with a special focus on the activities of the CSR, was launched at the Civic Aquarium of Milan from September 2019 to December 2020. The project, called "Digital Whales" was carried out by the Tethys Research Institute and Verdeacqua, and was funded by Fondazione Cariplo.



Six flagship species, custom-designed by a digital media artist were on life-size display in augmented-reality, together with around 150 “nuggets” of information and stories in the form of short multimedia presentations and additional downloadable material.

Three conferences, held by CSR researchers, were also part of the project. It was originally designed for the visitors of the Aquarium, to be enjoyed by means of tablets and smartphones, but due to the COVID-19 emergency lockdown, all of it was made available online as well, for free.

## 7.2 Run for the Whales

Since 2016 CSR researchers organized a series of running races (half marathon, 10 km and family run) in Sanremo, called “Run For The Whales”, which was attended by over 2000 participants. During the sporting events, conferences and meetings were held and informative material was distributed for raising awareness of the impact of anthropogenic pressures on cetaceans.

## 7.3 Artists for Whales

In 2017 an art exhibition was organized in Sanremo in the suggestive Santa Tecla fortress (18<sup>th</sup> century), hosting artworks dedicated to the larger Mediterranean whales. With this exposition, 30 international artists expressed their concern about the different threats marine mammals are facing.

## 7.4 PRESS Coverage and Releases, Blog.

Tethys people authored hundreds of popular science articles in newspapers and magazines, several books, and give talks and lectures on a regular basis.

This year many interviews or articles on the CSR project have been published in magazines/newspapers, televisions (i.e. Italian main TV channels such as RAI and Mediaset and local broadcasting). The 2020 press coverage scores around 50 stories quoting the work of Tethys and of the CSR, in Italy but also in other countries as UK (New Scientist, the Guardian, Daily Mail online, the Telegraph). Five press releases have been issued during the summer 2020 season, plus one more together with Greenpeace on the illegal driftnets in the Mediterranean. Articles are posted on a regular basis in the website's news section, both in Italian: <https://whalesanddolphins.tethys.org/it/news/> and in English <https://whalesanddolphins.tethys.org/news/>.





## 7.5 Social Media

A fundamental aspect of Tethys' contribution to marine conservation is communication on social media: the CSR posts mainly on Facebook and Instagram, and occasionally on Pinterest, YouTube and Vimeo.

Live streaming has been performed both on Tethys' and on other organisation's Facebook pages.

The Facebook account has over 11,400 followers; Instagram, implemented for the last 2 years, over 2,300.

During summer 2020 (May 1<sup>st</sup>–September 30<sup>th</sup>) the "reach" (number of people who saw any content from the page or about the page, including posts, stories, ads, social information from people who interacted with the page) on Facebook ranged between 1,630 and 112,496.

Among the most successful posts were those about the flukeless whale ("Codamozza"), which averaged a reach of 12,164 people (no paid advertisements were made).



**Figure 30.** Descriptive statistics of social media.

## Project Personnel 2020

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**Vice Project Manager:** *Caterina Lanfredi*

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**Researchers** (in alphabetical order): *Eleonora Barbaccia, Mario Gabualdi, Laia Garrobé, Marianna Marangi, Lisa Picatto, Jessica Picozzi, Martina Saccomani, Francesca Soster, Veronica Zampieri*

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**Marine Conservation, Education and Public Outreach:** *Sabina Airoidi, Maddalena Jahoda*

**Communication:** *Maddalena Jahoda*

**Participant Coordinator - Booking Management:** *Adriana Geraci, Sabina Airoidi*

**Administrative Manager:** *Adriana Geraci, Margherita Zanardelli*

**Webmaster:** *Elena Politi*





## Acknowledgments

The work conducted by the project in the western Ligurian Sea was possible thanks to the commitment and dedication of a great number of people that collaborated during these 30 years of activity. We are deeply grateful to Giuseppe Notarbartolo di Sciara, Founder of the Tethys Research Institute, Margherita Zanardelli, first CSR project manager, all past and present collaborators (all the Tethys' researchers, administrative, research assistants, collaborators, participants to the citizen science programme, under and post-graduate students) and friends for contributing to the CSR field work data collection and data analysis.

In particular, we would like to thank the skippers of the vessels operated by Tethys Research Institute: Giorgio Barbaccia, Lucio Lessini, Ignazio Cavarretta, who provide invaluable support until 2005 and Roberto Raineri and Paolo Pinto, who are supporting the project with passion and dedication since 2006.

Thanks to Lanfranco Ferraiolo and Raffaella Galli for the assistance provided during summer 2020.

Thanks to the Milan Civic Aquarium, the International Fund for Animal Welfare (IFAW) for providing us the softwares LOGGER and RAINBOW CLICK, which were used for both data logging and species acoustic detections; St. Andrews University for PAMGuard Software and to the Interdisciplinary Center for Bioacoustics and Environmental Research (CIBRA) who provided the SeaPro acoustic software. Thanks to Michele Manghi (NAUTA s.r.l.), who provided technical assistance with the hydrophone array.

Thanks to Jean-Noël Druon for the inputs and comments about the fin whale foraging habitat.

Special thanks to the Italian Coast Guard for their constant collaboration, in particular to General Commandant Vice Admiral Giovanni Pettorino, Rear Admiral Nunzio Martello, Rear Admiral Aurelio Caligiore, Rear Admiral Sergio Liardo, Captain Cosimo Nicastro and Lieutenant Commanders Santo Altavilla, Sabrina Di Cuio, Angelo Gonnella.

Thanks to all the organizations that supported the project in three decades of activity.



## ANNEX I. Scientific contributions

Publications and presentations are based on, or including research conducted by Tethys in the western Ligurian Sea between 1990-2020.

### Peer-reviewed publications

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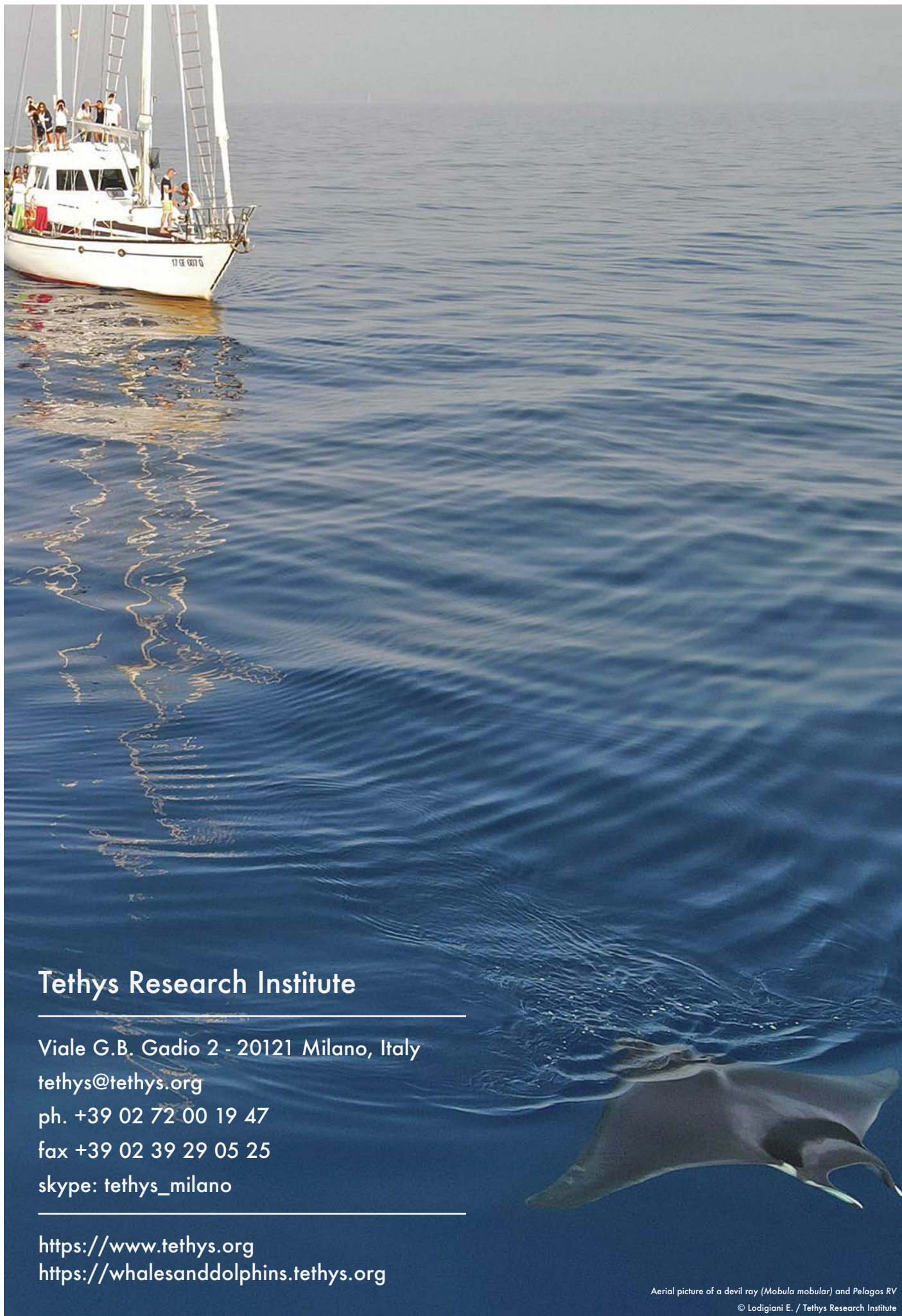
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Aerial picture of a devil ray (*Mobula mobular*) and Pelagos RV

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