The bottlenose dolphin (*Tursiops truncatus*, Montagu 1821) is a Mediterranean cetacean listed as "vulnerable" in IUCN Red List. The Ligurian Sea and the Portofino coastal area are subject to intensive boat traffic. This kind of impact represents a serious threat, especially for cetaceans, as they communicate with sounds and orient by underwater sonar-waves. The main objective of the project is the improvement of the conservation status of the bottlenose dolphin in the MPA of Portofino. To facilitate management and conservation policies, to support scientific projects and promote public dissemination, we aim to: create a controlled area, make people aware of the presence of the dolphins, disseminate the appropriate code of conduct among tourists in the Ligurian sea (in accordance with ACCOBAMS and Pelagos Sanctuary guidelines), verify that the given rules are respected.

**THE ARION SYSTEM**

The detection units are composed by a network of hydrophones installed on two elastic beacons (Fig.2) in front of the Portofino MPA (Fig.1). The acquisition system communicates using a wi-fi bridge with an on-shore computer center housed inside Portofino’s lighthouse (Fig.3) to localize and track dolphins and boats in real time.

**GENERAL FUNCTIONING (Figures 4 - 5):**

- 4 hydrophones on each buoy collect underwater sounds
- Different sensors collect environmental data
- Raw data are filtered and transmitted on shore using a wireless bridge
- Dolphin’s whistles and other sound sources are identified in real time
- The position of a sound source (triangulated) is used to generate a track representing the route of the "target" (dolphins or boats)
- Raw data are stored for research purposes
- Information resulting from data analysis is transmitted to a web server and made available to the end users

**DOLPHIN TRACKING**

- Whistle identification is realized by a proper detection function applied to the spectrogram (Fig.6).
- TDOA (Time Difference Of Arrival) is calculated by cross-correlating the hydrophone signals: 6 configurations for 4 hydrophones to check for good events in plane-wave approximation. From TDOAs calculation it is possible to determine the direction of arrival of the sound emitted by an acoustic source (azimuth and elevation angle) corrected by nautical angles (roll-pitch-compass). Fig.7 shows some observed whistle types.

**BOAT TRACKING**

- Continuous listening of boat engine sound: fast and light tracking algorithm is needed.
- In the boat engine spectrogram (Fig.8) the signature at low frequencies is due to propeller rotation, at higher frequencies is due to cavitation.
- TDOA is calculated for 2 pairs of hydrophones mutually orthogonal in plane-wave approximation: in this way there is not any angular ambiguity and only one direction of arrival of sound emitted by a boat is calculated (Fig.9-10).

**TRIANGULATION**

- If each buoy detects the same acoustic source, both detection units will find a direction of arrival of sound.
- The real position of the source is found by triangulation (Fig.12-13)

**FIGURE 1:** Location and action range of the detection units

**FIGURE 2:** The detection units

**FIGURE 3:** Portofino’s lighthouse

**FIGURE 4:** Detection unit structure

**FIGURE 5:** ARION data flow

**FIGURE 6:** Spectrogram of a hydrophone signal

**FIGURE 7:** Spectrograms of some observed whistle types

**FIGURE 8:** Spectrogram of a boat signal

**FIGURE 9:** Cross-correlation of signals from 2 pairs of hydrophones

**FIGURE 10:** Bearing angle of a sound source for 2 pairs of hydrophones in plane-wave approximation

**FIGURE 11:** Cross-DEMEN spectrum of a boat over time

**FIGURE 12:** Left: both buoys detect the same whistle in the spectrograms. Right: the position of the dolphin is calculated by crossing the directions obtained from the two detection units and the hyperbola corresponding to the time delay between the buoys.

**FIGURE 13:** Boat tracking by triangulation process. The color gradient of the dot series corresponds to the time elapsed since tracking started (yellow: earliest tracking, white: lastest tracking).