Multiscale Acoustic Sensing in the Western Ionian Sea: Distributed Acoustic Sensing and AI-Based Event Detection

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Distributed Acoustic Sensing (DAS) is rapidly transforming underwater acoustics by enabling standard fibre-optic telecom cables to operate as dense, kilometre-scale acoustic arrays. Within the VONGOLA project, funded under PNRR-NextGenerationEU and coordinated by CSFNSM, a DAS interrogator has been connected to two subsea cables offshore Eastern Sicily, part of the INFN-LNS marine infrastructure extending from the Port of Catania to 2,000 m depth and from Portopalo di Capo Passero to the KM3NeT site at 3,500 m. Operated continuously since January 2025, VONGOLA DAS provides unprecedented spatial and temporal coverage of the Western Ionian Sea soundscape.

The continuous recordings reveal a complex acoustic environment marked by persistent airgun activity during summer 2025, intense shipping traffic, recurrent geophysical signals linked to regional seismicity and volcanic structures, and the detection of a fin whale in February 2026. These observations confirm the biological richness of the basin and the growing anthropogenic pressures acting upon it, issues central to achieving and monitoring the EU Marine Strategy Framework Directive's *Good Environmental Status* (GES), particularly for underwater noise and marine mammal conservation.

A key innovation of VONGOLA is the first Mediterranean integration of DAS with cabled hydrophones, installed through the ITINERIS-PNRR and IPANEMA-ECCSEL projects, providing robust cross-calibration and enhancing the reliability of acoustic measurements. To address the massive data volumes produced by DAS, we developed an AI-driven classification framework based on a YOLO convolutional neural network. DAS time series are converted into spectrograms, enabling efficient identification of earthquakes, ships, fin-whale vocalisations, and unknown events while filtering irrelevant data.

This combined DAS-hydrophone-AI approach establishes a novel, scalable methodology for continuous, wide-area acoustic monitoring in the Mediterranean, supporting future real-time assessments of biological and anthropogenic sources essential for Marine Mammal Strategy implementation and long-term GES evaluation.