



## Listening to the Sea: Soundscape as Sentinel of Mediterranean Marine Conditions

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Assessing the ecological status of marine biodiversity and habitats requires innovative, non-invasive tools capable of capturing ecosystem dynamics across multiple scales. Passive acoustic monitoring and soundscape analysis have emerged as powerful proxies for monitoring biodiversity, habitat health, and the impact of environmental pressures. This synthesis integrates multi-year research conducted in the Mediterranean Sea, within the framework of the National Biodiversity Future Center, to estimate the effectiveness of ecoacoustics in evaluating responses to either local and global stressors at species, community, and habitat levels.

By analysing the soundscapes of *Posidonia oceanica* meadows and coralligenous reefs, we have explored the relationship between acoustic metrics, habitat condition and biodiversity. At the habitat level, soundscape analysis seems to be an effective tool for assessing the structural complexity of meadows and the success of seagrass restoration. At the community and species level, we have examined how biological sounds reflect the presence and behaviour of key soniferous species, including mammals, fish and invertebrates. Our framework specifically addresses the influence of local stressors, such as the pervasive impact of boat traffic and noise pollution, which induces plastic changes in acoustic signals and suppresses biological output, alongside the role of the thermal environment, where rising temperatures and heating events alter the acoustic activity of marine communities. The results confirm that soundscapes effectively reflect the dynamic interaction between habitat structure, biological processes, and anthropogenic disturbance.

Integrating passive acoustic monitoring and soundscape analysis into monitoring strategies provides a holistic view of marine ecosystem health, offering a complementary tool for the management and protection of vulnerable Mediterranean habitats and species. Ultimately, these findings highlight that the soundscape should be integrated into conservation strategies as a key functional attribute of marine ecosystems.