

LISTENING TO THE WADDEN SEA: SOUNDSCAPES IN A DYNAMIC COASTAL MOSAIC

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Soundscape ecology explores the interactions between abiotic, biotic, and anthropogenic sounds within habitats. This acoustic environment is important as underwater sound is crucial in biological processes such as mating, orientation, prey detection, and predator avoidance for marine mammals, fish, and invertebrates. However, increasing human-generated noise from shipping, vessel traffic, and coastal development disrupts these natural soundscapes, potentially causing harmful ecological effects (Duarte et al., 2021). To address this, the European Union's Marine Strategy Framework Directive (MSFD) includes Descriptor 11 (D11), which focuses on underwater noise to support the achievement of Good Environmental Status (GES) in marine environments. While efforts to monitor and regulate underwater noise are ongoing, direct measures for shallow coastal waters remain limited.

The Wadden Sea is one of the last remaining large-scale, intertidal ecosystems where natural processes continue to function largely undisturbed. This system spanning the Netherlands, Germany, and Denmark, is valuable to its inhabitants and migrating guests due to its mosaic-like habitat structure. Establishing a baseline for natural soundscape diversity in this dynamic coastal ecosystem is challenging but essential for effective noise monitoring and management.

This study presents a workflow for recording and analyzing soundscapes in subtidal Wadden Sea habitats. The recordings were conducted alongside simultaneous field campaigns involving active hydroacoustic surveys for sediment/ habitat classification, and benthic investigations. Underwater recordings from nine distinct sediment habitats, including sand and reef environments, reveal unique soundscapes influenced by tidal cycles and anthropogenic noise, which may reduce natural variability. Our findings contribute to the collective understanding of underwater noise and provide practical suggestions on how management strategies can be improved. We recommend strategically placing monitoring stations across habitats and ensuring continuous recordings to capture tidal variations.

Duarte CM, Chapuis L, Collin SP, et al. (2021) The soundscape of the Anthropocene ocean. *Science*, 371:6529, eaba4658. doi:10.1126/science.aba4658