{rokbox title=| (a) Measuring the maximum shell width in situ using an L-shaped ruler. (b) Photogrammetry module designed for this study, with a Blackmagic Pocket Cinema 4K digital camera as a main component. (c) Scientific diver recording pre-defined video transects inside the Foradada Siphon cave. :: Image: Authors|images/stories/ieo/imagenespublicaciones/centro-oceanografico-baleares-ieo-csic-underwater-photogrammetry-study-vazquezluis-2026-thumb-et-al.jpg|}images/stories/ieo/imagenespublicaciones/centro-oceanografico-baleares-ieo-csic-underwater-photogrammetry-study-vazquezluis-2026-et-al.jpg{/rokbox}

Elena Prado,Luis Rodríguez-Cobo,**Elvira Álvarez** and **Maite Vázquez-Luis** ,2026. **Underwater Photogrammetry for the Study of Vulnerable Benthic Species: The Case of Pinna rudis Linnaeus, 1758.**
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Abstract:The development of digital photogrammetry techniques has revolutionized the study of marine ecosystems, enabling the generation of high-precision three-dimensional models from conventional imagery. Structure from Motion (SfM) algorithms have become effective tools for mapping and monitoring underwater habitats, offering a non-invasive and cost-effective alternative to traditional methods. This study presents a pilot methodological validation of SfM-based underwater photogrammetry for the non-invasive morphometric monitoring of vulnerable benthic species, using Pinna rudis. The research focused on refining photogrammetric methodologies for marine conservation, addressing technical challenges such as variations in light conditions, water turbidity, and image acquisition complexity. The study area, the Cabrera Archipelago Maritime-Terrestrial National Park, is a pristine marine environment in the western Mediterranean, hosting diverse benthic communities, including an abundant Pinna rudis population. Data acquisition comprises sampling by scuba diving techniques at depths ranging from 26 to 31 m, performed during the July 2022 field campaign within a permanent demographic plot established in 2013 and the methodology applied involved generating three-dimensional models using SfM, allowing for direct measurements of the seabed and extraction of morphometric parameters of sessile species. The characterization of the Pinna rudis aggregation was based on specimen density and size structure, determined using maximum shell width. The 3D model of the pilot plot covers 86.1 m2, hosting 31 individuals. Morphometric measurements derived from SfM-based 3D models were validated against in situ diver measurements of maximum shell width. The results showed that the average maximum width obtained from 3D models (15.19 ± 3.23 cm) was consistent with in situ measurements (15.35 ± 3.48 cm). The mean difference between methods was –0.16 ± 0.82 cm, indicating a negligible systematic bias. The mean absolute error was 0.65 cm, corresponding to an average relative error of 4.34%, and a strong linear relationship was observed between both methods (r = 0.97). These results confirm that underwater

photogrammetry is a reliable and non-invasive tool for monitoring vulnerable benthic species, providing high-resolution spatial and morphometric data to support conservation strategies in marine protected areas and allowing the collection of additional data compared to in situ surveys.

Keywords:SfM photogrammetry,marine protected species,marine vulnerable species,biodiversity conservation.