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Posidonia oceanica and its threats

Posidonia oceanica is an endemic Mediterranean seagrass species forming extensive underwater meadows that underpin coastal ecosystem functioning and services (Pergent-Martini et al., 2024). These meadows occur from shallow coastal waters down to ~40 m depth and are composed of dense rhizomatous networks stabilising sediment, cycling nutrients, and sheltering a high diversity of marine taxa (Boudouresque et al., 2021). *P.oceanica* contributes substantially to carbon sequestration, storing organic carbon in persistent below-ground structures called *matte*, (Serrano et al., 2016; Monnier et al., 2019). In some Mediterranean regions, seagrass carbon storage has been estimated at rates comparable to peatlands and mangroves (Monnier et al., 2019). Furthermore, *P.oceanica* reduces coastal erosion by dampening wave energy and trapping sediments (Personnic et al., 2014). With this wide range of ecosystems services provided, the economic value of *P.oceanica* has been estimated to be in the range of 25.3 – 45.9 million €/year (Campagne et al., 2015). As such, decline of these meadows thus represents considerable ecological and socio-economic loss.

Despite their importance, *P.oceanica* meadows have suffered long-term recession in extent and health across the Mediterranean Basin, largely driven by local anthropogenic pressures — coastal urbanisation, eutrophication, turbidity, trawling, anchor damage, fish farming and pollution — and global stressors including warming seas and invasive species (Boudouresque et al., 2021; Boulenger et al., 2025, Pazzaglia et al., 2020).

Conservation of _Posidonia oceanica_

Conservation efforts for *P.oceanica* span threat reduction, protected area management, and active restoration. Mitigation of direct disturbances such as anchoring through seagrass-friendly moorings and exclusion zones forms a foundational strategy. Marine Protected Areas (MPAs) have been implemented where *P.oceanica* meadows are priority habitats, where regulated boating and mooring have been shown to support meadow stability. Protection alone, however, may be insufficient where meadows are severely degraded (Boudouresque et al., 2021; Serrano et al., 2016; Pansini et al., 2025). Active restoration techniques seek to reintroduce seagrass *P.oceanica* propagations into degraded habitats through transplantation of rhizome cuttings or fragments, use of anchoring substrates, or facilitating natural regeneration pathways (Boudouresque et al., 2021; Pansini et al., 2022). Transplant studies have shown that *P. oceanica* cuttings can establish and contribute to meadow recovery under suitable conditions, although success rates vary widely depending on method and site (Boudouresque et al., 2021; Ferretto et al., 2021; Passini et al., 2021; Pansisni et al., 2025; Pergent-Martini et al., 2024).

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Conservation barriers

Life history strategies of *P.oceanica* present inherent barriers to restoration. The slow growing species relies primarily on clonal growth, with sexual recruitment rare and poorly understood, leading to low genetic diversity in many meadows and limited natural recovery after disturbance (Pergent-Martini et al., 2024). This biology underpins the urgency for effective active restoration when natural rates of recovery cannot keep pace with loss.

Human pressures persist as major conservation barriers. Anchor damage and boat traffic physically fragment meadows, while eutrophication exacerbates seagrass decline by reducing light availability essential for photosynthesis (Pazzaglia et al., 2020). Climate change intensifies thermal stress and may facilitate the spread of invasive seagrass species such as *Halophila stipulacea*, which has a competitive advantage under predicted warming scenarios (Nguyen et al., 2020). Although invasive species are not currently a threat at this study site, the intensity of storm events caused by climate change has been noted to cause extensive damage to meadows. Such stressors complicate restoration since planting efforts may fail if interactions with underlying environmental conditions are not fully understood.

Aim of the Silba Project

The Silba Posidonia project aims to evaluate whether artificial substrates constructed from repurposed fishing trap frames can enhance the survival and growth of Posidonia oceanica rhizomes in degraded meadow areas. Through a controlled field-based experimental design, students will assess the potential of these structures to provide stable foundations for seagrass meadow restoration. Identifying optimal conditions for their deployment and recommend methodological improvements for future initiatives. Utilising SCUBA diving, students will monitor to *P.oceanica* ramets transplanted onto artificial frames at varying depths and degradation gradients. Environmental variables such as light attenuation, sediment type, temperature and water quality may also be collected to contextualise outcomes. Analysis will aim to compare performance across frames and sites. Consideration should also be given to assessing functional ecosystem recovery of sites, an area highlighted for future study (Personnic et al., 2014; Pergent-Martini et al., 2024; Pansini et al., 2025).

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