

Study of Low-Cost & Highly-Scalable Replantation Methods of *Posidonia oceanica*

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Abstract –This study investigates alternative, cost-effective methods for the regeneration of *Posidonia oceanica* in degraded marine habitats by germinating posidonia seeds and cuttings onto solid substrates, exploiting the plant's natural adherence to hard surfaces. Through three project phases, from seedling growth to in-situ trials and remote monitoring, this approach seeks to deploy plant/rock units from vessels, bypassing the need for manual planting by divers. Initial findings indicate successful seedling germination and favorable hydrodynamic behavior, paving the way for large-scale, diver-independent posidonia reforestation strategies.

Keywords – *Posidonia oceanica*, Seeds germination, Reforestation and Real-time monitoring

I. INTRODUCTION

Posidonia oceanica is a marine phanerogam exclusive to the Mediterranean Sea which plays a crucial role in providing indispensable ecosystem services [1]. These encompass safeguarding sandy sea-beds, mitigating beach erosion, establishing habitats for young fish, and sequestering carbon via its root system. Despite the regenerative capacity of deteriorated meadows, the process is slow, averaging a growth rate of 2-7 cm and 14 cm annually for vertical and horizontal roots, respectively [2]. In 2022, the enactment of Spanish Royal Decree 1057/2022 outlined the State Strategic Plan for Natural Heritage and Biodiversity up to 2030. This initiative aims to foster research for the large-scale cultivation of plants essential for the restoration of seagrass meadows. Additionally, restoration pilot tests for *Posidonia oceanica* meadows are expected to be conducted before 2024. A study published in 2021 highlighted the significant constraint posed by the expense of posidonia restoration projects, which typically ranged between €100,000 to €500,000 per hectare [2]. In most instances, re-plantation efforts were executed manually by diving teams. The analysis revealed that labor costs associated with divers responsible for seeding or implanting rhizomes constituted the predominant portion of the overall project expenses.

II. OBJECTIVE

This work aims to explore novel methodologies for the germination of *Posidonia oceanica* seeds and cuttings, specifically for reforesting degraded marine habitats. This endeavor leverages the innate tendency of posidonia plants to develop adhesive roots upon encountering solid substrates, enabling cost-effective and scalable implementation strategies.

The project will consist of three phases. The first phase comprises the growing of seedlings and cuttings onto small rocks of chalk (high in CaCO₃). The tendency of posidonia plants to grow sticky hairs when brought into contact with hard substrate will allow to prepare modules of plant/rock that can be launched from the sea surface from boats. The second phase of the project consists of in-situ trials to verify beneficial hydrodynamic behavior. The third phase of the project consists in remote monitoring of posidonia rooting in a controlled real environment.

Through this project, a new low-cost posidonia reforestation method will be evaluated, which does not require the assistance of a diver as the planting is done by launching rocks with attached seedlings or cuttings from a vessel and can be implemented on a large scale.

III. PROJECT STATUS

PHASE 1

Seeds were gathered in May 2023 in l'Ametlla de Mar. The seeds were germinated in small-size tanks onto rocks of varying size and shape (Fig. 1.A, B and C). Real-time monitoring made sure that the salinity and temperature was beneficial for growing conditions. A micronutrient mineral solution was applied once a week, especially to supplement the iron (Fe) required by the plants.

PHASE 2

In November 2023, a trial was realized using mock plant/rock modules to test the hydrodynamic falling behavior of the different rock/plant modules (Fig. 2.A). The trial took place in the OBSEA observatory, and the parameters that were tested were 1) spatial orientation during decent and post-settlement, 2) dispersion of the modules in low-current conditions, and 3) persistence of modules over the subsequent winter-storm season.

PHASE 3

In March-April 2024 the plant-rock units will be deployed in the sea floor in front of Sitges and Vilanova in la Geltrú (Fig. 2.B). The former launch site will be next to the OBSEA underwater observatory [3], at 20 meters depth. This sight has the benefit of ongoing monitoring from the OBSEA installations. Three additional launch sites are available in Sitges. These sites have the advantage of being within the area of previously existing Posidonia, with large areas of degradation. This type of substrate has shown to allow for high levels of success in previous restoration projects. The goal of phase two is to monitor the modules during the season of high vegetative growth (March-May and September-November) in the hope that the roots will develop sufficiently to prevent losses during winter storms.

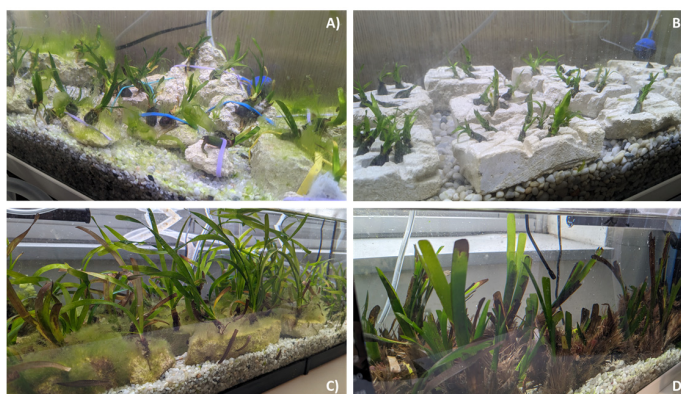


Fig. 1. A) - B) seeds germinating over rocks of chalk, C) Seedlings after 7 months and D) Rescued rhizomes following a storm - Nov 2023

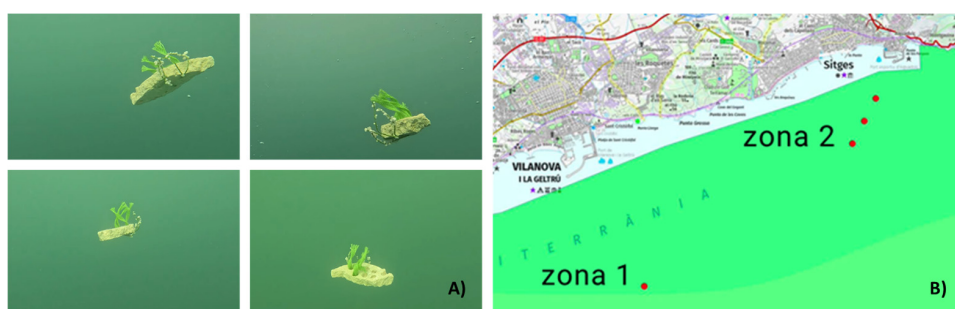


Fig. 2. A) Hydrodynamic falling behavior of mock rock/plant modules and B) Areas determined for PHASE 3 deployment

IV. CONCLUSIONS

Initial results from PHASE 1 showed that seedlings successfully germination occurred in 20% (70 plants from an initial stock of 356 seeds). Approximately half of the seedlings successfully attached to hard substrate, being the flat modules with indentations and holes the most successful and the loose pebbles the least.

Initial results from PHASE 2 showed that 100% of the modules fell and settled with the appropriate orientation, with roots below and leaves above; the amount of dispersion was approximately 2-3 meters at 20 meters depth; and several plant/pebble units have been lost to days of high currents, but the units with plant/rock remained in their place.

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