


RESEARCH ARTICLE

# Long-term response of *Posidonia oceanica* meadow restoration at the population and plant level: implications for management decisions

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In recent years, numerous efforts to transplant *Posidonia oceanica* have been carried out in the Mediterranean Basin for experimental and large-scale restoration purposes. However, data on the long-term outcomes of these initiatives remain scarce. This study aims to address this gap by investigating the long-term response of transplanted *P. oceanica* at both the population and plant level in comparison to adjacent natural meadows. We report on two large-scale transplantation sites in Italy: Santa Marinella in the Central Tyrrhenian Sea and Ischia Porto in the Southern Tyrrhenian Sea, assessing their progress 14 and 10 years after transplantation, respectively. Descriptors of the meadows and of individual plants were investigated through field and laboratory activities. Sampling was conducted in both transplanted and adjacent control areas within the natural *P. oceanica* meadow. After about a decade, shoot density in the transplanted areas equaled that of the natural ones. Nevertheless, phenological and lepidochronological descriptors in the transplanted areas still did not match those of the natural meadows. Our work provides crucial information into the restoration process of *P. oceanica*, with implications for managing this habitat in line with recent EU marine legislation.

**Key words:** habitat management, long-term transplant, *Posidonia oceanica*, restoration, seagrass transplantation

## Implications for Practice

- Research studies on *Posidonia oceanica* transplants are still limited to a modest number of mostly recent cases.
- After about a decade, shoot density in the transplanted areas can equal that of the natural ones.
- Phenological and lepidochronological descriptors in transplanted areas do not always match those of natural meadows, even after 10 or more years.
- Results highlight the importance of long-term monitoring for detecting key patterns in the restoration dynamics of *P. oceanica* transplants.

## Introduction

*Posidonia oceanica* (L.) Delile meadows are facing severe decline across the Mediterranean Basin, particularly in heavily urbanized coastal areas (Duarte et al. 2008). Over the past 50 years, coastal human activities have led to the loss of between 11 and 52% of the originally documented area occupied by *P. oceanica* (Marbà et al. 2014; Telesca et al. 2015). However, according to some authors, this decline is not generalized (de los Santos et al. 2019).

Seagrasses such as *P. oceanica* are slow-growing species, with natural recovery processes taking decades to centuries (González-Correa et al. 2005). Moreover, low flowering rates (Díaz-Almela et al. 2006), coupled with high fruit abortion

rates and predation (Balestri & Cinelli 2003), further hinder the resilience of this species. Given the decline of *P. oceanica* meadows and the unique biology of the species, it has become increasingly acknowledged that, while protection measures to reduce human impacts are crucial to prevent further regression, transplanting cuttings could accelerate natural regeneration processes in areas where suitable conditions for

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