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A meta-analysis reveals a positive correlation between genetic diversity metrics and environmental status in the long-lived seagrass *Posidonia oceanica*

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Abstract

The seagrass *Posidonia oceanica* is a key engineering species structuring coastal marine systems throughout much of the Mediterranean basin. Its decline is of concern, leading to the search for short- and long-term indicators of seagrass health. Using ArcGIS maps from a recent, high-resolution (1–4 km) modelling study of 18 disturbance factors affecting coastal marine systems across the Mediterranean (Micheli *et al.* 2013, http://globalmarine.nceas.ucsb.edu/mediterranean/), we tested for correlations with genetic diversity metrics (allelic diversity, genotypic/clonal diversity and heterozygosity) in a meta-analysis of 56 meadows. Contrary to initial predictions, weak but significantly *positive* correlations were found for commercial shipping, organic pollution (pesticides) and cumulative impact. This counterintuitive finding suggests greater resistance and resilience of individuals with higher genetic and genotypic diversity under disturbance (at least for a time) and/or increased sexual reproduction under an intermediate disturbance model. We interpret the absence of low and medium levels of genetic variation at impacted locations as probable local extinctions of individuals that already exceeded their resistance capacity. Alternatively, high diversity at high-impact sites is likely a temporal artefact, reflecting the mismatch with pre-environmental impact conditions, especially because flowering and sexual recruitment are seldom observed. While genetic diversity metrics are a valuable tool for restoration and mitigation, caution must be exercised in the interpretation of correlative patterns as found in this study, because the exceptional longevity of individuals creates a temporal mismatch that may falsely suggest good meadow health status, while gradual deterioration of allelic diversity might go unnoticed.

Keywords: anthropogenic disturbance, genetic diversity, local extinction, meadow resistance, *Posidonia oceanica*, seagrass, temporal mismatch

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Introduction

Recent biodiversity conservation actions and mitigation measures are aimed at reducing the impact of anthropogenic activities on the natural environment, for example the Aichi targets of the Convention for Biological Diversity (CBD), the European Marine Strategy Framework Directive (MSFD) and Water Framework Directive (WFD) and the Ecosystem Approach of the Mediterranean Action Programme (UNEP-MAP). A major concern is the high rate of species-level extinctions, often equated with loss of biodiversity, as well as extinctions of local populations (Allendorf *et al.* 2013). Especially in the marine environment, where connectivity is generally higher, actual species extinctions appear to be relatively rare, whereas local population declines or local extinctions of species are more

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