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Restoration of seagrass meadows through a nature-based solution in the Caleri Lagoon (Po River Delta, Italy)

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Seagrass meadows are pivotal Blue Carbon habitats that support biodiversity, coastal protection, provide vital ecosystem services while mitigating anthropogenic CO_2 emissions through carbon sequestration. Globally, they are increasingly regressing due to the combined effects of climate change and human activities. In this context, restoration initiatives facilitate the reintroduction of seagrass meadows to sites where they were formerly present.

This study focuses on a nature-based restoration initiative in the Caleri lagoon, located in the Po River Delta (Italy) where the dwarf eelgrass *Zostera noltei* was transplanted to restore a depleted habitat.

A total of 135 sods, with a diameter of approximately 15 cm, were transplanted from the donor site in the Venice lagoon in autumn 2022 and late spring 2023.

On field monitoring of seagrass growth was carried out during August 2023 by means of UAV surveys and in June 2024 by means of ground surveys. The UAV survey was conducted employing a lightweight drone equipped with a high-resolution RGB camera. Visual inspection of the high-resolution orthomosaics, combined with prior knowledge of the transplantation sites, enabled precise mapping and identification of the transplanted seagrass sods. Measured diameters ranged from a minimum of 3 cm (indicative of a decrease in leaf density of the sod) to a maximum of 66 cm (indicative of a growth in leaf cover of more than 4 times). Ground measurements taken in June 2024 provided a rough estimate of the eelgrass meadow extent of 60 m² with continuous meadow patches with diameters ranging between 1.5 and 3 m.

Additionally, the biota sampling and analysis showed clear positive signs of recovery of the benthic community. The diversity and evenness values of the 115 benthic species showed slightly higher values in the transplant site respect to the control site. A higher frequency of epifaunal predators

and herbivores, and of organisms with longer life spans and larger body sizes was observed in the macrobenthic community.

The restoration of *Z. noltei* in the Caleri lagoon exemplifies successful restoration practices that contribute to the mitigation of anthropogenic impacts, reinforcing the role of coastal vegetated ecosystems as buffers against environmental pressures. In addition, this case study underscores the critical importance of interdisciplinary approaches and continued monitoring to optimize restoration efforts and inform blue carbon policy development. In this context, high-resolution, non-intrusive UAV data collection supports monitoring activities by enabling frequent, repeatable surveys, thereby enhancing efficiency in time-sensitive studies.