

EGU25-10978, updated on 23 Mar 2026

<https://doi.org/10.5194/egusphere-egu25-10978>

EGU General Assembly 2025

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Future Scenarios of Blue Carbon Sequestration in Italian *Posidonia oceanica* Meadows

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Marine coastal ecosystems play a vital role in carbon storage and sequestration, making a significant contribution to climate change mitigation. However, their accessibility and location in shallow coastal waters make them particularly vulnerable to human activities such as habitat destruction and water pollution. While recent estimates of ecosystem services have been conducted in some Italian regions, spatially explicit research on the blue carbon potential of *Posidonia oceanica* remains limited.

This study analyzed carbon sequestration using a spatially explicit approach, employing various modeling methods in line with the tiered framework proposed by the IPCC. Among the most promising tools, the InVEST Coastal Blue Carbon (InVEST CBC) model (<https://naturalcapitalproject.stanford.edu/invest/>) was applied to quantify carbon dynamics in coastal and marine ecosystems under present conditions and future scenarios. The model evaluated pressures contributing to carbon emissions and accumulation over time, providing spatially detailed outputs in raster format.

The InVEST CBC model was informed by:

- The spatial distribution of *Posidonia oceanica* in Italian coastal waters, recently updated by ISPRA as part of the implementation of the Marine Strategy Framework Directive.
- Ecological parameters of *Posidonia oceanica* (e.g., distribution, density, foliar and rhizome production, and ecological status) derived from field data and existing literature.
- Maps of current pressures affecting carbon storage, such as boat anchoring, coastal engineering, aquaculture, urban effluents, land use, coastal population density, and fishing

activities in Italian coastal areas.

The study evaluated blue carbon sequestration under three future scenarios:

- Business-as-usual: Assumed no significant improvements in environmental factors, maintaining current levels of human impacts that contribute to meadow regression.
- Sustainable future: Envisioned significant reductions in anthropogenic pressures compared to the business-as-usual scenario, promoting the conservation of seagrasses by 2050. This scenario also examined the role of sustainable mooring systems in mitigating anchoring impacts from recreational boating.
- Non-sustainable future: Projected increased human pressures, resulting in significant losses of seagrasses compared to the business-as-usual scenario by 2050.

The sustainable future scenario was specifically assessed in marine protected areas, including the Archipelago of La Maddalena National Park, Asinara National Park, and Cilento, Vallo di Diano e Alburni National Park. In these areas, state-of-the-art mooring fields were implemented as part of the Sea Forest Life project (LIFE17 CCM/IT/000121; <https://www.seaforestlife.eu/en/>).