



Data Paper

Integrating intraspecific functional trait data for 67 coastal plant species in central-northern Italy: the Priorcoast dataset*

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Abstract

Trait-based approaches are becoming pivotal in predicting vegetation changes and linking ecosystem structures to functions at varying geographical scales. Moreover, spatially explicit plant functional trait measurements for scarcely sampled species including intraspecific variation could be instrumental to better understand how plant functional traits mediate species' responses to changing environmental conditions. Here we present a dataset of four functional traits measured at the individual level for 67 plant species native to coastal habitats of Tuscany and Liguria (central-northern Italy) including fore- and back dunes, dune slacks, saltmarshes, rocky cliffs, and anthropized coastal environments. We followed standard protocols to make a total of 698 measurements. For each species, we measured traits including leaf area (LA), specific leaf area (SLA), leaf dry matter content (LDMC), and plant vegetative height (H) from multiple individuals to capture local intraspecific variability. This dataset adds to the valuable resources for studying plant strategies in Mediterranean coastal systems, assessing trait-environment relationships, and modeling plant community dynamics under environmental change. The data set is openly available for non-commercial purposes.

Keywords

Functional traits, intraspecific variation, LA, leaf traits, Mediterranean, SLA

Introduction

Functional traits are measurable plant features describing the structure, functions or ecological strategies that shape species responses to biotic and abiotic environments across spatial and temporal scales and different biological complexity levels (Violle et al. 2007; Adler et al. 2014; Bruelheide et al. 2018). Increasingly, functional traits are used to understand and map plant community properties and variation across space and time (Emery and La Rosa 2019; Vanneste et

al. 2019), for instance by computing communities' functional diversity. Compared to taxonomic diversity, functional diversity has been shown to have a higher explanatory power of the links between plant communities' ecological structure and ecosystem functioning (Tilman et al. 1997; Hillebrand and Matthiessen 2009; Díaz et al. 2013; Gonzalez et al. 2020).

Understanding the intra- and inter-specific variation in plant functional traits across space and different growth environments could provide key insights into plant species distribution patterns, community assembly mechanisms,

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evolutionary strategies, and ecosystem level potential responses to climate change (Westerband et al. 2021; Gremer 2023; Aguirre-Gutiérrez et al. 2025). Intraspecific trait variation is defined as the overall variability of trait values expressed by individuals belonging to the same species (Albert et al. 2011). To compute functional diversity metrics, it is widely assumed that intraspecific variation is negligible compared to that among species (Albert et al. 2012; Shipley et al. 2016), thus, averaged species-level functional trait values are commonly used (Palacio et al. 2025). However, especially at a local scale, intraspecific variation can account for more of the variation than interspecific trait variability (Kumordzi et al. 2014; Siefert et al. 2015). Consequently, intraspecific trait variation could be driving community structure and ecosystem function as much as interspecific variation (Bolnick et al. 2011; Govaert et al. 2016) and there is a growing need of incorporating such data in ecological studies or models (Funk et al. 2017).

There are multiple publicly available plant functional trait databases featuring an unprecedented amount of trait information globally, including the “Botanical Information and Ecology Network” (BIEN; <http://bien.nceas.ucsb.edu/bien/>, Enquist et al. 2016), the “Global Inventory of Floras and Traits for macroecology and biogeography” (GIFT, Weigelt et al. 2020) and TRY (Kattge et al. 2020). However, many species are still underrepresented in available data and information on intraspecific variation in trait values is scarce (Niinemets 2015; O’Sullivan et al. 2022). Often these species are difficult to find, highly specialized or hard to sample and/or measure due to intrinsic features or peculiar living conditions.

Coastal plant species must withstand naturally and anthropogenically driven stressful environments. Natural stressors, such as salinity, drought, soils with low oxygen and nutrient content, filter species based on their functional traits values and drive the coexistence of plant communities with strong functional trait identity (i.e., large variation in dominant traits values across different communities) (Calderisi et al. 2021). Moreover, the demanding living conditions of habitats with strong environmental constraints and high temporal or spatial variability could induce plant adaptation and/or acclimation by activating trait responses and plasticity (Trotta et al. 2025), leading to high local intraspecific variability (Lammerant et al. 2025). In this context, gathering data considering the trait variation of less frequently sampled species and making the data available could provide a significant contribution in addressing existing knowledge gaps (Westerband et al. 2021) but see Puglielli et al. (2024) and Chelli et al. (2025) for intraspecific trait variability datasets spanning a variety of habitats. Currently, the majority of European coastal habitats are at high or moderate risk from land use change (Seitz et al. 2014). In Italy, over the past 50 years, dunes have suffered a decline in habitat quality and half of the current area is now categorized as vulnerable (Gigante et al. 2018; Sarmati et al. 2025). Concerning the fragile plant communities of coastal environments, providing individual-level data on scarcely sampled species could allow for a more sound and productive application of functional

characterization of species assemblages and, in turn, foster more effective coastal biodiversity protection frameworks. The main objective of this data paper was to gather functional traits data for under sampled dunes and salt marshes plant species, to enhance the geographical coverage of functional data for other coastal plant species and make the dataset (named “Priorcoast”) freely available.

Study area and methodology

The study area encompasses the coasts of Tuscany and Liguria (Figure 1), two administrative regions located in the northwest and central areas of Italy facing the Ligurian and Tyrrhenian Sea (Western Mediterranean). The climate is temperate, with hot and dry summers, and it is classified by the Köppen classification (Peel et al. 2007) as Csa (Hot-summer Mediterranean climate), typical for the Mediterranean area. The yearly precipitation is concentrated from late autumn to early spring; the summer is dry, and July is the driest month. The mean annual temperature is around 15°C, with the cooler months presenting a mean temperature higher than 7°C (Baroni et al. 2020). The coast includes both rocky and sandy shores, as well as coastal lagoons and salt marshes. The sampling was carried out at 11 localities (Figure 1), selected based on the presence of habitats of interest (dunes, salt marshes or dune slacks and rocky cliffs and coasts) and/or of target species based on expert knowledge. Detailed information on sampling localities, coordinates, and main types of coastal habitats can be found in the Priorcoast dataset.

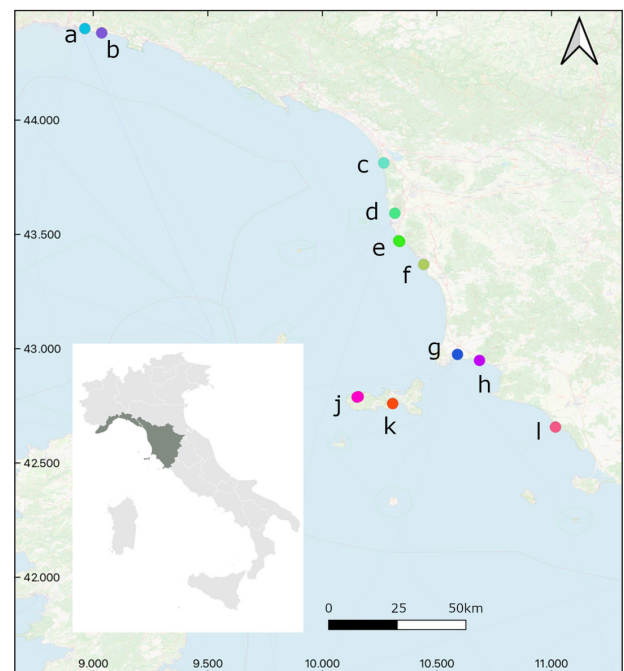


Figure 1. Map of the study area with each sampled locality highlighted in a different color. Base map from OSM (Open Street Map), elaborated in QGIS v. 3.28.1 (QGIS Development Team (2022)). Localities: a = Genova; b = Nervi; c = Torre del Lago; e = Calambrone; d = Calafuria; f = Rosignano; g = Orti-Bottagone; h = Carbonifera; j = Marciana; k = Lacona; l = Marina di Alberese.

Species selection

The 67 sampled species were selected based on the scarcity of their records (i.e., either their total absence, incomplete trait data available or lack of trait data sampled in mediterranean coastal environments) in publicly available databases (TRY, BIEN, BROT). Individuals were selected randomly in patches with local abundance of the target species, in order not to damage the local populations. Species names standardization followed FlorItaly – The portal to the flora of Italy (Martellos et al. 2020). Subspecies were identified and considered when possible, and the higher taxonomic level available was included in the dataset. The distribution of sampled species across Raunkiaer growth forms (Raunkiaer 1934), compiled from Acta Plantarum (Acta Plantarum 2025), and taxonomic families is visualized in Figure 2.

Trait selection and measurement protocols

We selected measured traits based on their ecological significance (Díaz et al. 2016) and documented relationship and variation in response to typical coastal environmental

constraints such as salinity, wind, drought and water availability, and solar radiation (Bricca et al. 2023 and references therein). Higher plant height is both associated with competitiveness for light and, in coastal environments, with a reduced tolerance to environmental stressors such as wind, and often with deep root systems that help consolidate mobile dunes (García-Mora et al. 1999). In coastal environments, a smaller leaf area is typically related to increasing salinity (Qiu et al. 2007; De Battisti 2021) and solar radiation and is also considered as an adaptation to wind induced dehydration (Shiba et al. 2025). A higher leaf dry matter content relates to lower leaf water availability (Wang et al. 2022) and enhances stress-tolerance (Ciccarelli 2015). Lastly, specific leaf area (SLA) typically relates to growth rate, and to resources and water availability (Li et al. 2005; Pérez-Harguindeguy et al. 2016), with high SLA values correlating with acquisitive strategies and low SLA with conservative ones (Díaz et al. 2016).

Trait definitions and trait units of measurement follow those of the TRY database standardized values for four numerical plant traits. Plant traits sampling was carried out between April 2023 and May 2025 following an opportunistic sampling design meaning that target species were sampled when encountered at sampling localities, in an amount that would have not damaged the local population. All trait data in our dataset were obtained from individuals growing in natural vegetation, following the protocol by Perez-Harguindeguy et al. (2016). Furthermore, traits were always measured in adult individuals, never in seedlings or saplings. Plant vegetative height (H) was measured in the field with a meter, not considering reproductive structures. Leaf traits were quantified from exposed mature leaves in the plant canopy or upper layer of leaves that were collected and immediately stored in sealable plastic bags filled with deionized water and stored in the fridge at 4 degrees for 12 h before being dried with absorbent paper and weighted. Leaf area (LA) was obtained by scanning (using an EPSON Perfection V370 Photo at 300 dpi) the adaxial surface of the lamina of at least 3 fresh leaves from 3 different individuals and measuring their area using the software ImageJ (Schneider et al. 2012). Leaves were then oven-dried for 48 h at 72°C, and then, leaf dry weight was measured using an analytical balance with an accuracy of 0.01 mg (AS 60/220.R2, Radwag). Leaf dry matter content (LDMC) was calculated as the ratio between leaf fresh weight and dry weight with this formula:

$$\text{LDMC} = \text{Leaf dry weight (mg)} / \text{Water-saturated fresh weight (g)}$$

Finally, specific leaf area (SLA) was calculated as the ratio between fresh leaf area and its dry weight with the formula:

$$\text{SLA} = \text{Leaf area (mm}^2\text{)} / \text{Leaf dry weight (mg)}$$

To provide an example overview of the data for the species collected across multiple localities, and asses intraspecific

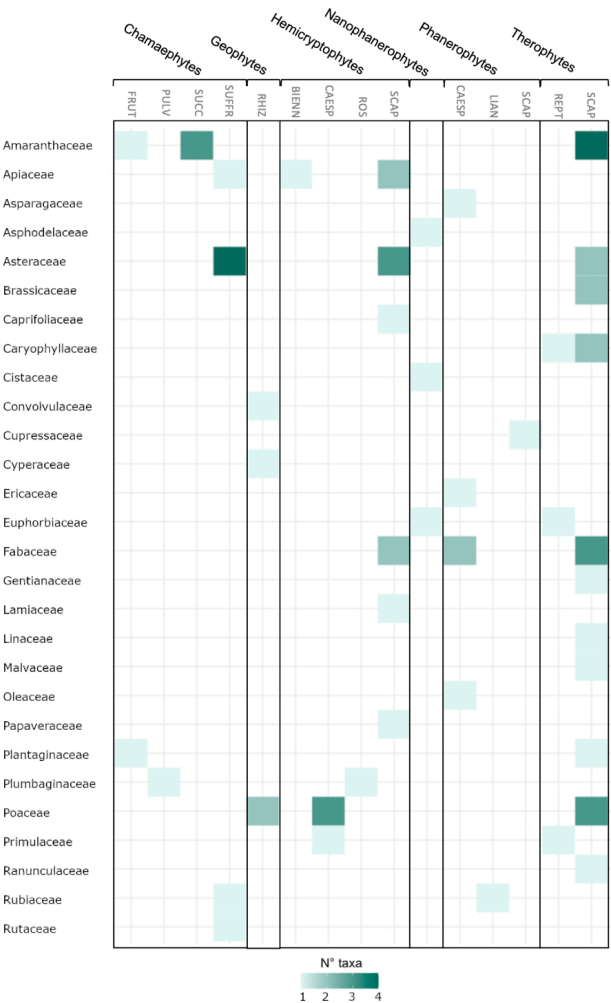


Figure 2. Sampled species by family and life forms.

variation, we visualized and tested for significant differences in trait values between species from different localities by performing an analysis of variance (ANOVA).

Dataset structure and content

The dataset Priorcoast is available as a supplementary Microsoft Excel .xlsx file (Suppl. material 1) containing three separate sheets: “single leaf traits”, “individual traits”, and “metadata”. The “single leaf traits” hosts traits measured for each sampled leaf and contains eight columns: “Species”, compiling the species level names of sampled entities following FlorItaly (Martellos et al. 2020); “Individual” and “Leaf”, with the information on sampled individual and leaf, respectively; “Fresh_weight.g” with water saturated weights expressed in grams; “Dry_weight.g”, with oven-dried dry weights expressed in grams; “Leaf_Area.mm²”, with leaf areas measurements expressed in mm²; “LDMC.mg.g” with leaf dry matter content values expressed in mg/g; “SLA.mm².mg” with SLA values expressed in mm²/mg. The second sheet, “individual traits” hosts traits either measured for the whole individual (as in the case of height) or leaf traits values averaged to the individual level. It contains 13 columns: “Species”; “Individual”; “Height.cm”, with vegetative height values expressed in cm; “avg_Fresh_weight.g”; “avg_Fresh_weight.g_n”; “avg_Dry_weight.g”; “avg_Dry_weight.g_n”; “avg_Leaf_Area.mm²”; “avg_Leaf_Area.mm²_n”; “avg_LDMC.mg/g”; “avg_LDMC.mg/g_n”; “avg_SLA.mm²/mg”; “avg_SLA.mm²/mg_n”. The columns ending with “_n” indicate the number of replicas (i.e., leaves) used to calculate averaged trait values. Lastly, the “metadata” sheet contains six columns: “Species”, “Individual”, “date”, “locality”, “lat”, and “long” compiling the sampling date, locality and decimal latitude and longitude following coordinate system EPSG 4326, respectively. Throughout the dataset some missing data for dry weight, SLA or LDMC (around 3.5% of

all entries at leaf level) can be found due to lack of adequate material left after drying to carry on leaf trait measurements.

Dataset coverage

The dataset includes 698 trait records for four functional traits (LA, SLA, LDMC, and H) (plus fresh and dry weights of leaves) of 67 coastal species belonging to 61 genera and 28 taxonomic families (Table 1). At the individual level, leaf trait data, including fresh and dry weights, make up 83.1% of the dataset, followed by whole plant trait (i.e., vegetative height) (16.9%, respectively). All observations have geographic coordinates.

Table 1. Measured traits, units, and the number of individual measurements per trait for 67 coastal species.

Trait	Unit	Individual measurement
Dry weight	g	661
Fresh weight	g	698
LDMC	mg/g	660
LA	mm ²	694
SLA	mm ² /g	658
Height	cm	213

Differences of trait values across localities

Several species displayed significant differences across localities (Figures 3, 4, 5, 6), especially *Arthrocaulon macrostachyum* and *Salicornia perennans*, which showed significantly different values for all measured traits between localities. Highlighted differences while representative of a small geographical and ecological gradient support the need for more intraspecific trait data for coastal environments and in particular, for salt marshes.

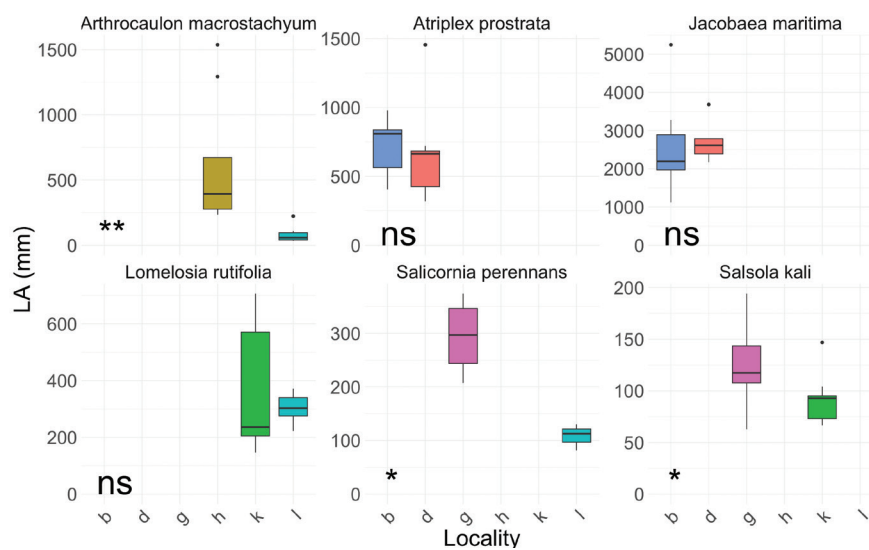


Figure 3. Differences in leaf area (LA) values by species across localities. Displayed species were selected on the basis of the presence of more than 1 individual in more than one locality. Statistical significance is displayed at the bottom-left of each boxplot with the following symbols: ns = $p > 0.05$; * = $p \leq 0.05$; ** = $p \leq 0.01$; *** = $p \leq 0.001$. Different localities are indicated by the corresponding letters: b = Nervi; d = Calafuria; g = Orti-Bottagone; h = Carbonifera; j = Marciana; k = Lacona; l = Marina di Alberese.

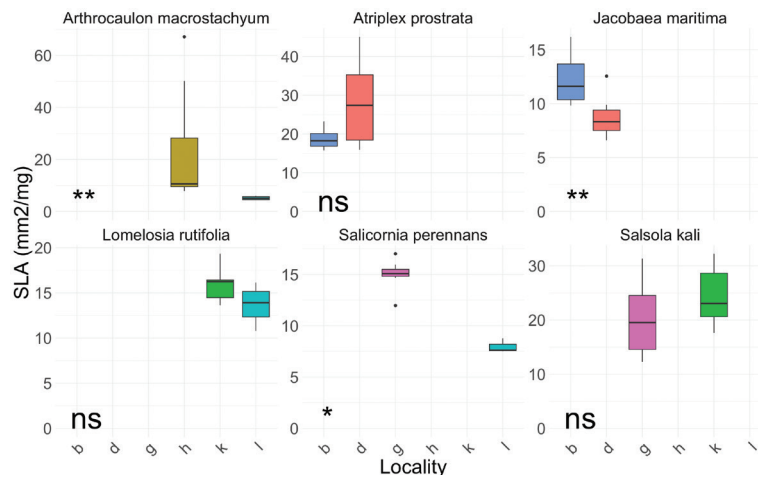


Figure 4. Differences in specific leaf area (SLA) values by species across localities. Displayed species were selected on the basis of the presence of more than 1 individual in more than one locality. Statistical significance is displayed at the bottom-left of each boxplot with the following symbols: ns = $p > 0.05$; * = $p \leq 0.05$; ** = $p \leq 0.01$; *** = $p \leq 0.001$. Different localities are indicated by the corresponding letters: b = Nervi; d = Calafuria; g = Orti-Bottagone; h = Carbonifera; j = Marciana; k = Lacona; l = Marina di Alberese.

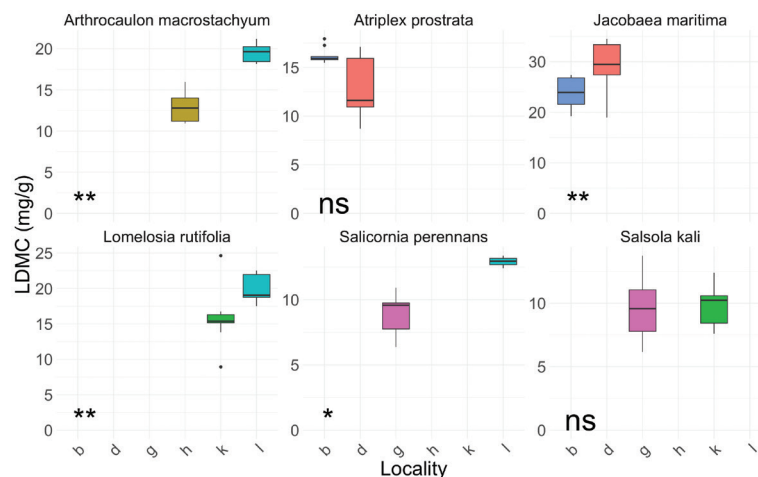


Figure 5. Differences in leaf dry matter content (LDMC) values by species across localities. Displayed species were selected on the basis of the presence of more than 1 individual in more than one locality. Statistical significance is displayed at the bottom-left of each boxplot with the following symbols: ns = $p > 0.05$; * = $p \leq 0.05$; ** = $p \leq 0.01$; *** = $p \leq 0.001$. Different localities are indicated by the corresponding letters: b = Nervi; d = Calafuria; g = Orti-Bottagone; h = Carbonifera; j = Marciana; k = Lacona; l = Marina di Alberese.

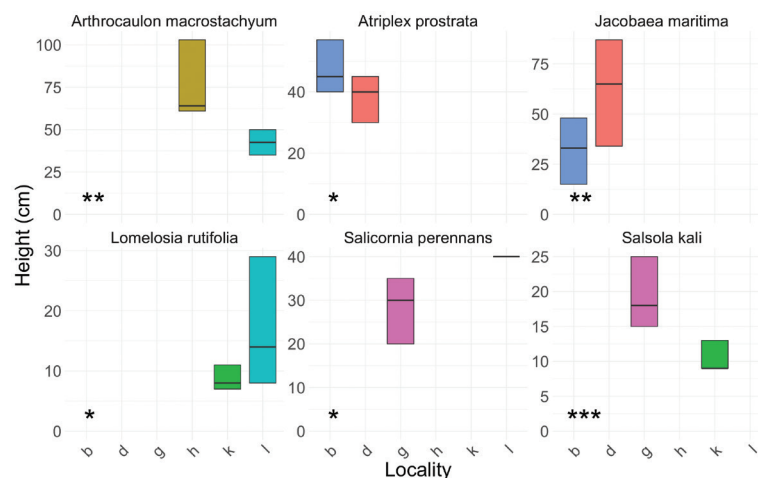


Figure 6. Differences in height values by species across localities. Displayed species were selected on the basis of the presence of more than 1 individual in more than one locality. Statistical significance is displayed at the bottom-left of each boxplot with the following symbols: ns = $p > 0.05$; * = $p \leq 0.05$; ** = $p \leq 0.01$; *** = $p \leq 0.001$. Different localities are indicated by the corresponding letters: b = Nervi; d = Calafuria; g = Orti-Bottagone; h = Carbonifera; j = Marciana; k = Lacona; l = Marina di Alberese.

Applications and future perspectives

The presented Priorcoast dataset contributes to furthering the knowledge of intra- and inter-specific variability in leaf functional traits and plant height of central-northern Italy coastal plants, representing a valuable resource for future meta-analysis or ecological studies addressing functional composition and diversity of coastal plant communities. The spatial and ecological scale at which intraspecific variability can be inferred from this dataset is certainly limited. However, the dataset still provides relevant information on scarcely sampled species that is suitable to be included in trait-based modeling efforts and thus functional-based conservation planning. Understanding how species are locally adapted or could adapt to changing environmental conditions based on their relative intraspecific variation could aid in assessing their resistance to global change, especially in heavily anthropized and threatened coastal systems (Kichenin et al. 2013). We are aware that our trait selection could be enhanced to include, e.g., traits related to dispersal strategies or below-ground organs that are overall scarcely studied and even more scarcely represented in available databases (Laliberté 2017; Saatkamp et al. 2019) but see La Bella et al. (2024) and Ciccarelli et al. (2023). However, even though we sampled a limited number of traits, these were selected based on well-known correlations with plant ecological strategies (Díaz et al. 2016) and are informative on how plants respond to their environment and influence ecosystem properties.

Additional information

Conflict of interest

The authors declare that they have no conflict of interest. Daniele Viciani and Lorenzo Lazzaro are part of the Editorial Review Board in Vegetation Ecology and Diversity but took no part in the peer review or decision-making process for this manuscript.

Ethical statement

No ethical statement was reported.

Use of AI

No use of AI was reported.

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Author contributions

Mariasole Calbi: Conceptualization; methodology; data curation; formal analysis; visualization; writing – original draft, review, and editing. Michele Mugnai: Conceptualization; data curation; writing – review and editing. Eugenia Siccardi: Data curation; writing – review and editing. Virginia Amanda Volanti: Data curation; writing – review and editing. Lorenzo Lazzaro: Conceptualization; data curation; writing – review and editing. Hamid Gholizadeh: Data curation; writing – review and editing. Claudia Angiolini: Data curation; writing – review and editing. Simona Maccherini: Project administration; data curation; writing – review and editing. Daniele Viciani: Project administration; resources; data curation; writing – review and editing.

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Data availability

The data is available as supplementary material.

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Supplementary material 1

The Priorcoast dataset

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Data type: xlsx

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