



A dataset of plant communities invaded by *Acacia* sp. pl. and *Robinia pseudoacacia* in Italy

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Received: 7 October 2025 / Revised: 26 January 2026 / Accepted: 4 February 2026 /

Published online: 25 February 2026

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Abstract

The full extent of the ecological threat posed by non-native invasive leguminous N-fixing trees to Italian ecosystems has not been thoroughly documented at the national level. This study, conducted by the Working Group on Alien Species of the Italian Botanical Society, aims to develop a comprehensive dataset that provides information on invaded and non-invaded areas, supporting multi-scale ecological analyses on the impact of black locust (*Robinia pseudoacacia*) and different *Acacia* sensu lato species across Italy. We conducted paired vegetation surveys across 18 distinct invasion contexts, comparing invaded and non-invaded plant communities. These invasion contexts were selected opportunistically by the participating research groups, based on the availability of well-documented sites where the focal species were already established and exerting ecologically relevant effects. Overall, we conducted 342 vegetation surveys across 10 Italian administrative regions and identified 824 plant species. Our surveys highlighted areas affected by five invasive species, including *A. dealbata*, *A. mearnsii*, *A. saligna*, *Vachellia karroo*, and *R. pseudoacacia*. Most of the surveys focused on areas invaded by *A. saligna*. The plant formations investigated fall under 23 EUNIS habitat codes and 10 Natura 2000 habitats. The most frequently occurring vegetation types under the EUNIS code are temperate and Mediterranean-montane scrub, and the most frequently investigated habitat is priority habitat 2250*: Coastal dunes with *Juniperus* sp. pl. This dataset provides a robust baseline that can facilitate more detailed assessments of the impacts of these invasive species on native ecosystems.

Keywords Biological invasions · Ecological impacts · Invasive alien plants · Nitrogen-fixing invasive trees · Plant ecology · Vegetation

Introduction

Ecological research on biological invasions has significantly advanced our understanding of their widespread impacts (Carneiro et al. 2025). Despite extensive research on the effects of biological invasions on the natural environment, further investigation is needed to understand their differential impacts on various plant communities and their ecology (Vilà et al. 2024). The impact of plant invasions on ecological processes varies depending on the plant community in which they occur (Pyšek et al. 2012), and recognising this variation is crucial for developing more effective strategies to manage

invasions. Additionally, examining the effects of alien trees on various plant communities is critical in understanding the full extent of their ecological impact (Benesperi et al. 2012; Sádlo et al. 2017). In the Mediterranean region, non-native leguminous (Fabaceae) nitrogen-fixing (N-fixing) trees such as *Robinia pseudoacacia* L. and some taxa of *Acacia* sensu lato (including species of related genera such as *Vachellia* Wight & Arn.) are among the most aggressive and invasive tree species (Lazzaro et al. 2014; Souza-Alonso et al. 2017; Lorenzo and Morais 2024). These species are also considered among the most invasive and damaging in other Mediterranean and subtropical regions worldwide (Wilson et al. 2011; Botella et al. 2023). In Italy, *Acacia* sensu lato and *R. pseudoacacia* have a long history of colonisation and invasion and have been widely used for ornamental and forestry purposes (Lazzaro et al. 2014). Moreover, *A. saligna* (Labill.) H.L.Wendl. and *A. mearnsii* De Wild. are designated as species of Union concern on the Union list, established under Regulation (EU) No 1143/2014 on the prevention and management of the introduction and spread of invasive alien species and adopted under Commission Implementing Regulation (EU) 2016/1141. *Acacia saligna* was included by Commission Implementing Regulation (EU) 2019/1262, and it is noteworthy that *A. mearnsii* was a recent addition to this regulatory framework by Commission Implementing Regulation (EU) 2025/1422. However, they are now spreading rapidly in both human-altered and natural environments. This results in a loss of biodiversity (Pyšek et al. 2020), significantly impacts soil and native plant communities (Lazzaro et al. 2018; Tozzi et al. 2021) and incurs economic costs in attempts to control and eliminate them (IPBES 2023). These N-fixing species, which increase the N availability in the soil (including soils where the availability is naturally very low, such as sand dunes, see e.g. Skiba & Wainwright 1984), may favour some local native species (Vilà et al. 2024) or other neophytes. However, it has been shown that the presence of *Acacia* sp. pl. can reduce the population size of native species and threaten local biodiversity (Souza-Alonso et al. 2017), triggering allelopathic mechanisms (Lorenzo et al. 2011, Kato-Noguchi and Kato 2025) and altering the concentration of nutrients and organic matter in the soil (Lorenzo et al. 2010), finally inducing cascading impacts on ecosystem functioning (Juan-Ovejero et al. 2025). In the case of *Robinia*, in addition to its well-known effects on soil nitrification and acidification, it has been shown to reduce the presence of microarthropods and increase the abundance of bacteria (Lazzaro et al. 2018, Bury and Dyderski 2025). Accordingly, the invasion by *R. pseudoacacia* has a significant impact on forest plant diversity and species composition (Vítková et al. 2017). Although the impacts of some of these species have already been documented locally (*R. pseudoacacia*, *Acacia dealbata* Link, *A. pycnantha* Benth., and *A. saligna*, e.g., Lazzaro et al. 2020), assessing their impacts at the national level is essential to fully grasp their ecological impacts.

Here, we present a dataset on plant communities invaded by *Acacia* sp. pl., *R. pseudoacacia*, and *Vachellia karroo* (Hayne) Banfi & Galasso. This dataset comprises paired floristic vegetation surveys conducted in invaded and non-invaded contexts across various vegetation types across Italy, also including data on the vertical stratification and basal area of the woody surveyed formations. The aim is to provide data on which to build evidence on the ecological impacts of these naturalised/invasive alien species in Italy and start filling a significant knowledge gap by providing a systematic, national-level assessment of biological invasion impacts. Its purpose is to facilitate collaboration and inform the development of effective management and conservation strategies.

Methods

Sampling design

The data collection, conducted between 2021 and 2022, was based on the identification of invasion case studies, here defined as discrete invasion contexts. Each case study corresponds to a specific combination of (i) one invasive species (here restricted to alien nitrogen-fixing tree species of the family Fabaceae), (ii) one native vegetation type or habitat affected by that species, and (iii) one geographical area where paired invaded and non-invaded surveys were conducted. Because the aim of this dataset was to document vegetation communities in which biological invasions are already ecologically relevant, case studies were selected opportunistically in areas where ongoing or well-established invasion processes were known to occur. Site selection followed a mixed strategy: case studies were identified based on the presence of invasive alien species; invaded plots were located haphazardly within each case study; and corresponding non-invaded plots were selected within the same vegetation type and environmental context. All plots were georeferenced. Paired plots were established in both invaded and non-invaded stands. Each plot was assigned an “invasion level”, categorised as either ‘invaded’ (> 50% relative cover of the alien species) or ‘non-invaded’ (plots in which the alien species was absent or had a total cover below 5%). The upper threshold was adopted to ensure that invaded plots represented communities in which the focal alien tree was clearly dominant, whereas intermediate cover values were excluded because they may reflect early or transitional stages of invasion. Conversely, the lower threshold was adopted because plots were large and paired, and occasional seedlings of alien species may occur in the herbaceous layer of otherwise non-invaded areas. In fact, non-invaded plots were selected in vegetation types similar to those of invaded plots or in nearby stands representing the native vegetation that would typically occur in the absence of invasion.

Managed plantations were excluded, but naturally structured forests, including secondary stands derived from past plantations, were included if clear naturalisation processes had occurred. The plot dimensions differed according to the target species, reflecting the ecological characteristics of the invaded habitats. Specifically, we used 4 m×4 m plots for *Acacia* species, which primarily colonise Mediterranean scrub, coastal habitats, and dune systems. While for *R. pseudoacacia*, which typically invades forest ecosystems, we used 10 m×10 m plots. For *A. saligna* in Calabria, however, different plot sizes (5 m×5 m and 2 m×2 m) were used to match the area covered by uninvaded vegetation.

In each plot, we recorded floristic composition and vegetation structure, including all vascular plant species with visual estimation of absolute percentage cover, reported by vegetation layer (herbaceous < 0.5 m, shrub 0.5–3 m, tree > 3 m). For each layer, we recorded both total and species-specific covers, allowing vertical overlap. Taxonomic nomenclature follows the Portal to the Flora of Italy, version 2024.3 (<http://dryades.units.it/floritaly/>), whose data are derived from the Checklists of the native and alien floras of Italy (Bartolucci et al. 2024; Galasso et al. 2024) and their most recent updates. Furthermore, only in the case of *R. pseudoacacia* forest plots were all trees measured for diameter at breast height (DBH, measured at 130 cm). This measurement was collected exclusively in these forest invasion contexts because DBH is a standard and informative descriptor of stand structure in woodland ecosystems, whereas the *Acacia* case studies occurred predominantly in shrubland, scrub, or coastal habitats, where tree layers are

absent or poorly developed and plot size is smaller (4 m × 4 m); in these environments, DBH measurements would not provide meaningful structural information. Additionally, we counted stems < 4 cm DBH.

Fieldwork was conducted from late spring to early summer (April–June) in 2021 and 2022, which corresponded to the phenological optimum of most plant species in the study regions.

Data description

The dataset comprises 342 paired vegetation plots, equally distributed between invaded and non-invaded plots within each case study, and across target species and habitat types. The dataset focuses on multiple case studies covering five different invasive tree species (*Acacia dealbata*, *A. saligna*, *A. mearnsii*, *Vachellia karroo*, and *Robinia pseudoacacia*), various macrohabitat types (including forest, maquis, garrigue, and dunes) and 10 administrative regions (Calabria, Lazio, Liguria, Molise, Piedmont, Apulia, Sardinia, Sicily, Tuscany, and Trentino-Alto Adige, see Fig. 1). Each plot was assigned by an expert-based assessment to a level-3 EUNIS (European Nature Information System) Habitat Classification according to the 2021/22 revised EUNIS classification (<https://eunis.eea.europa.eu/habitats.jsp>), as well as to eventual corresponding European Habitats sensu 92/43/EEC (N2000 habitats) according “Italian Interpretation Manual of the 92/43/EEC Habitats Directive” (Biondi et al. 2009) and the Interpretation manual of European Union EUR28 (European Commission 2013).

Figure 2 summarises the number of plots for each target non-native species. Plots targeting *R. pseudoacacia* are predominantly located in forested habitats such as *Quercus* sp. pl. and *Carpinus betulus* L. lowland forests, *Castanea sativa* Mill. forests, *Populus* sp. pl. riparian forests, and *Quercus* sp. pl. thermophilous woodlands. In contrast, the plots targeting *Acacia* species are mainly found in coastal dunes (*A. saligna*), Mediterranean shrublands (*A. dealbata*) and *Alnus glutinosa* (L.) Gaertn. forests (*A. mearnsii*), while *V. karroo* invaded Mediterranean shrublands and *Pinus halepensis* Mill. forests. The dataset is presented in two parts: the first contains environmental and descriptive information (worksheet ENV of Siccardi et al. 2025), the second a floristic list with relative species abundance (worksheet SURVEYS of Siccardi et al. 2025) for each surveyed site. In ENV, for each plot, the dataset provides environmental and site-related information, including plot coordinates, plot invasion level, habitat type (EUNIS code and, where relevant, Natura 2000 code), sampling date, and the name of the contributing research group (Table 1). In addition, the dataset contains detailed vegetation information, with stratified cover estimates for each layer: herbaceous (< 0.5 m), shrub (0.6–3 m), and tree (> 3 m).

Discussion

Overall, our dataset provides a representation of non-native, nitrogen-fixing tree invasions in Italy across multiple species, habitat types, and geographic regions, and is suitable for further ecological analysis. By offering a systematic national assessment of the impacts of biological invasions, this study aims to fill a significant knowledge gap in Italy, thereby facilitating collaboration and informing the development of effective management and conservation strategies. Most of the surveys focused on areas invaded by *A. saligna* (Fig. 2), reflecting the regional availability of suitable invasion contexts rather than an effort to

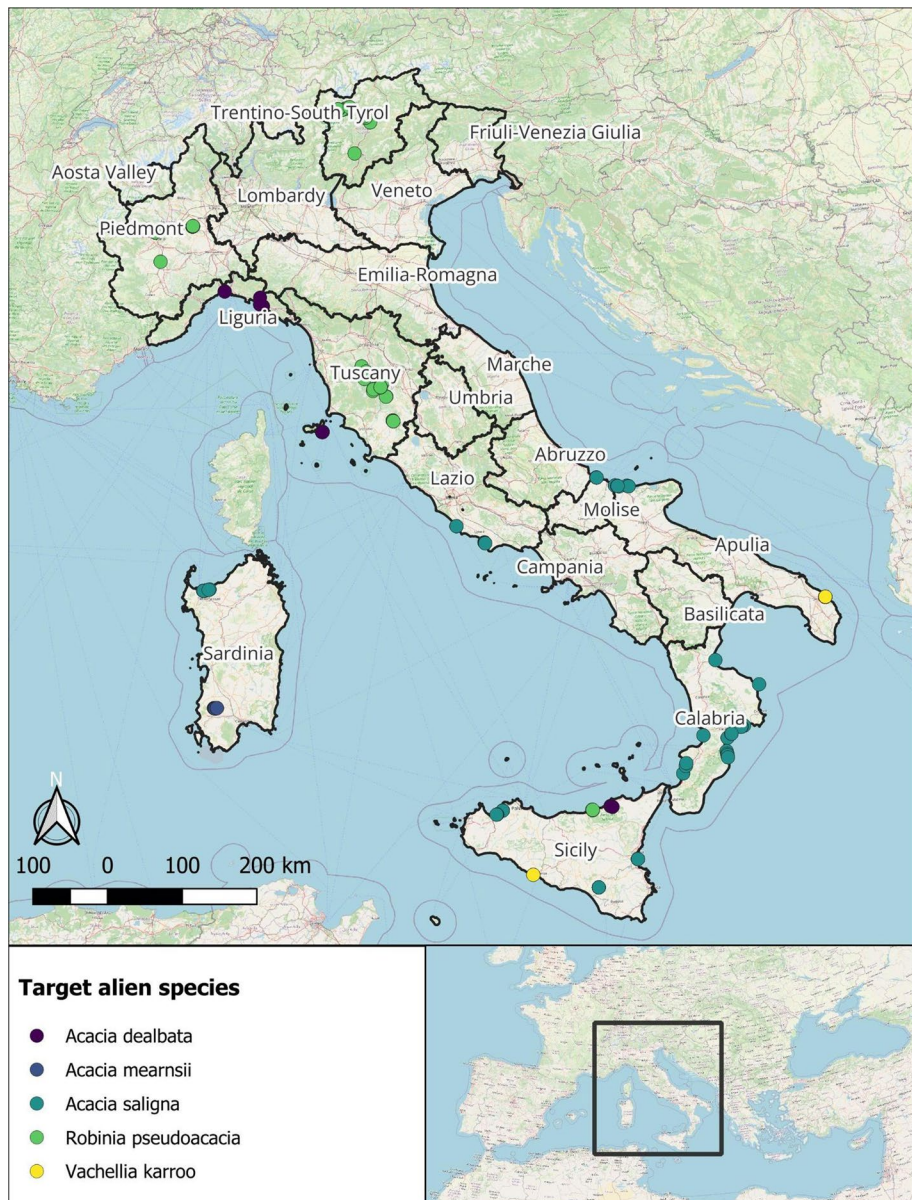


Fig. 1 Geographic distribution of all vegetation plots for the different target alien species. Administrative regions are delineated, and the map is displayed over an OpenStreetMap basemap (© OpenStreetMap contributors, CC-BY-SA)

portray the national distribution or relative abundance of the species. The vegetation types investigated fall under 23 EUNIS codes and 10 Natura 2000 habitats. The most frequently occurring vegetation under the EUNIS code is 'Temperate and mediterranean-montane scrub', and the most frequently investigated habitat is priority habitat 2250*: Coastal dunes

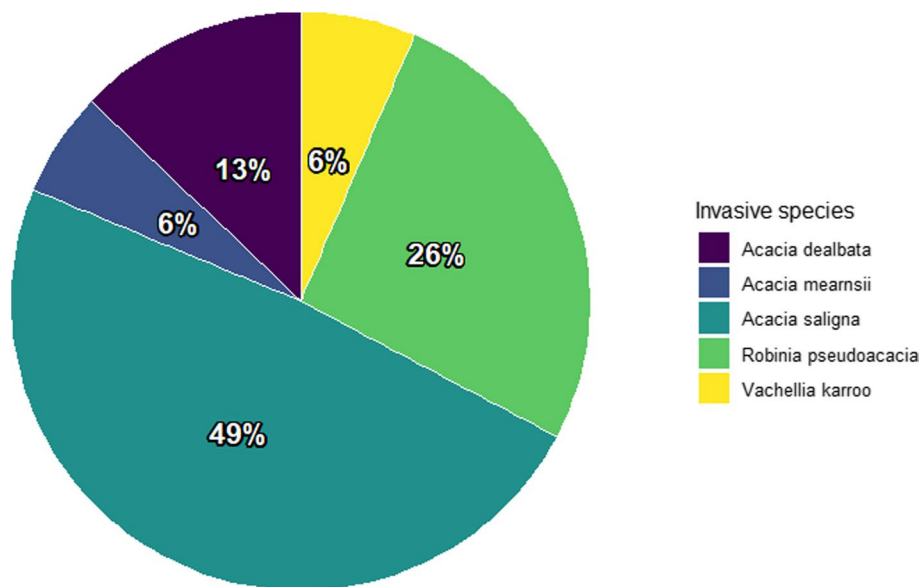


Fig. 2 Distribution of surveys among the target species, expressed as percentages of the total 342 surveys. For each species, the counts include paired surveys conducted in both invaded and non-invaded areas

with *Juniperus* sp. pl. (Fig. 3). However, 112 surveys remained unclassified, as they did not correspond to any habitat type recognised under the Habitats Directive. From a floristic perspective, 941 vascular plant species were identified in the 342 surveyed plots, excluding the five invasive species. For each surveyed plot, all species were recorded together with their abundance, estimated as percentage cover (proportion of ground surface covered by the canopy of each species) within each of the three vegetation layers. Table 2 lists the total relative frequency of the 5 target alien species and of 20 more frequent species in the dataset.

This study forms part of the collaborative project ‘Impacts of *Acacia* sensu lato and *Robinia pseudoacacia* (Fabaceae) in Italy’, which is coordinated by the Allochthonous Species Working Group of the Italian Botanical Society. The project involved 51 researchers from 23 institutions throughout Italy. This collaborative approach is increasingly recognised as crucial for tackling complex biodiversity challenges (Peruzzi 2018) and has proven particularly effective within the Italian botanical community. A prime example of this is the sustained success of the Italian Botanical Society’s Working Group for Floristics, Systematics and Evolution. The group’s extensive networks have played a pivotal role in achieving significant milestones, including the seminal Checklist of the Italian vascular flora (Conti et al. 2005), as well as its subsequent updates for native (Bartolucci et al. 2018, 2024) and alien (Celesti-Grapow et al. 2009; Galasso et al. 2018, 2024) flora. This collaborative spirit also extends to ecological research, as demonstrated by datasets such as ITV-net (Chelli et al. 2025).

To ensure data reliability and consistency, all surveys were carried out by trained botanists of the Allochthonous Species Working Group of the Italian Botanical Society, and the taxonomic identification of plant species was standardised according to national floristic references. Although the dataset has not yet been employed in peer-reviewed scientific publications, its quality is supported by expert validation and the use of a harmonised sampling

Table 1 Overview of the database fields describing plot-level information. Each field name is accompanied by a short description and, where needed, clarification of possible values.

Sheet	Data	Description
ENV	REP	Unique identifier with an increasing number for each entry in the dataset
	GROUP_ID	Case study identifier: the first three letters indicate the invasive species investigated in the case study. ROB = <i>Robinia pseudoacacia</i> , DEA = <i>Acacia dealbata</i> , MEA = <i>Acacia mearnsii</i> , VAC = <i>Vachellia karroo</i> , SAL = <i>Acacia saligna</i>
	PLOT_NAME	Plot ID given by the authors at the time of the survey
	PAIR_NAME	Identification code for pairs of surveys within the same case study. Each code with the same number indicates a pair of surveys from the same case study, consisting of one invaded plot and one non-invaded plot
	SITE	Toponym where the survey was carried out
	ADM_REGION	Italian administrative region of the case study and survey
	DATE	Date on which the survey was carried out
	INVASION_LEVEL	Indication of whether the survey was carried out at an invaded site or at its uninvaded control
	INV_SPECIES_SHORT	Investigated invasive species, abbreviated nomenclature
	INVASIVE_SPECIES	Full name of the investigated invasive species, according to the nomenclature followed by the Portal of the Flora of Italy vers. 2024.3 (http://dryades.units.it/floritaly/)
	VEG_TYPE	Type of vegetation in which the survey was carried out
	EUNIS_VEG_TYPE	Label for vegetation type referring to the EUNIS code (ver. 2021)
	EUNIS_CODE	EUNIS code (ver. 2021) corresponding to the habitat type detected
	EUNIS_GROUP	EUNIS group at the second level
	EUNIS_2_LABEL	EUNIS label group
	N2K_CODE	Natura2000 habitat code
	N2K_LABEL	Natura2000 habitat label

Table 1 (continued)

Sheet	Data	Description
SURVEYS	COORDINATE E (X)	X coordinate, longitude according to the WGS84 (World Geodetic System 1984)
	COORDINATE N (Y)	Y coordinate, latitude according to the WGS84 (World Geodetic System 1984)
	PLOT_SIZE	Square plot size in meters, given as side length x side length (e.g. 4 x 4, 10 x 10)
	CANOPY_COVER	Tree layer coverage in percentage (%)
	SHRUB_COVER	Shrub layer coverage in percentage (%)
	HERB_COVER	Herb layer coverage in percentage (%)
	MEAN_CIRCUMFERENCE	The mean circumference of the trees in the plot with a diameter at breast height greater than 4 cm
	MEAN_DIAMETER	The mean diameter of the trees in the plot with a diameter at breast height greater than 4 cm
	N_IND_BELOW_4CM	Number of tree individuals with a DBH less than 4 cm
	AUTHORS	Names of surveyors who collected the plot data
	EMAIL_RESP	Email address of the main responsible author (contact person for the dataset)
	Layer	Vegetation layer (herbaceous < 0.5 m, shrub 0.6–3 m, tree > 3 m). For each layer, both total and species-specific covers were recorded, allowing vertical overlap
	Species	Full name of the identified vascular plant species, according to the nomenclature followed by the Portal to the Flora of Italy vers. 2024.3 (http://dryades.units.it/floritaly/)
	Layer_species	The species identified are associated with a vegetation layer. Each species can be found in one or more layers
	Columns from D to MG	Each column represents a single survey plot, identified by a unique ID in the header. The rows list the plant species found across all surveys. The value in each cell represents the relative cover (%) of a given species (row) in a given plot (column)

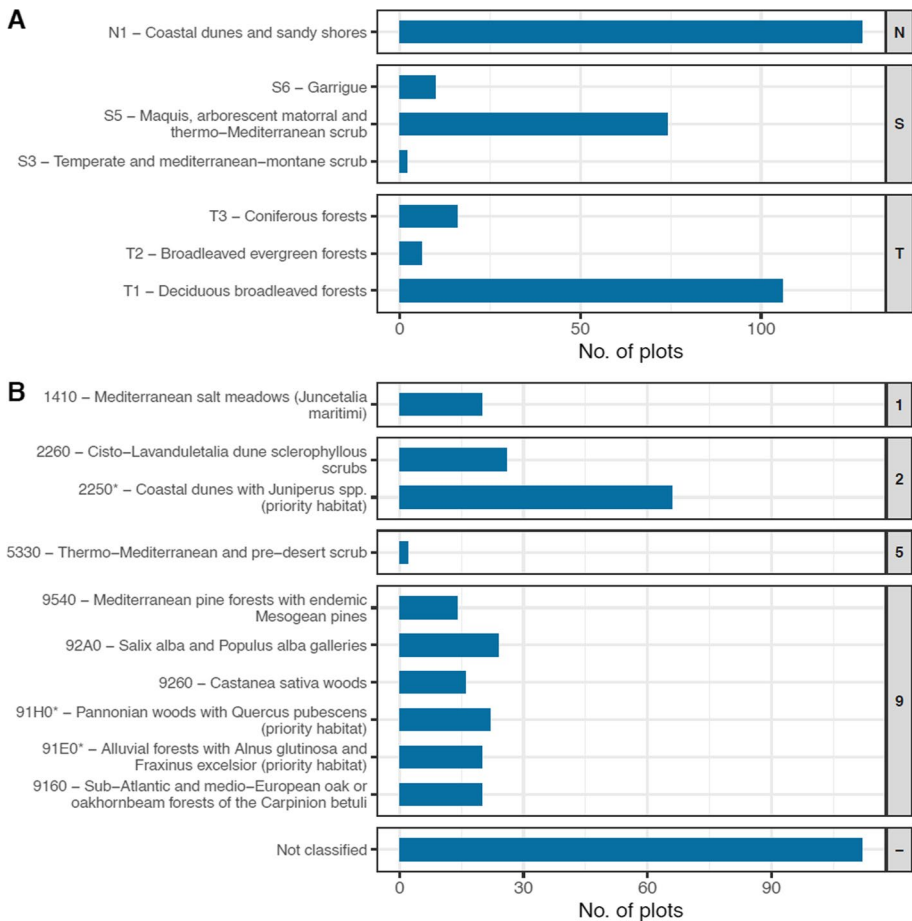


Fig. 3 Distribution of sampling plots by habitat classification. **(A)** Classification based on the EUNIS (ver. 2021/22) system (level 2), with habitats grouped into level 1 macro-categories (EUNIS groups: N “Coastal habitats”, S “Heathland, scrub and tundra”, and T “Forest and other wooded land”). **(B)** Classification based on the Habitats Directive 92/43/EEC (Natura 2000 level 1: 1 “Coastal and halophytic habitats”, 2 “Coastal sand dunes and inland dunes”, 5 “Sclerophyllous scrub (matorral)” and 9 “Forests”). The “Not classified” category represents plots in vegetation not identifiable as a Natura 2000 habitat

protocol across case studies. The dataset has been deposited in the open-access repository Zenodo, which was selected for its long-term preservation policy, DOI assignment, and compliance with FAIR principles (Findable, Accessible, Interoperable, Reusable). Metadata were carefully structured to facilitate integration with other vegetation databases and to ensure reusability for ecological analyses and conservation planning at different spatial scales.

Despite its comprehensiveness, this dataset has some limitations. First, it does not cover the complete national distribution or relative abundance of the target invasive species, as surveys were conducted opportunistically in areas with well-established or ongoing invasions. Second, the dataset does not include impact assessments, such as EICAT evaluations, which could provide further insights into the ecological consequences of the invasions; such analyses are beyond the scope of this Data Note. Finally, 112 surveys could not

Table 2 Frequency of the five target invasive alien species and the 20 most frequent native species. The table shows the total frequency in the dataset ($N=342$ plots, 171 invaded and 171 non-invaded) and the relative frequency within the three main EUNIS habitat groups (ver. 2021/22): N (Coastal habitats, $N=128$ plots, 64 invaded and 64 non-invaded), S (Heathland, scrub and tundra, $N=128$ plots, 64 invaded and 64 non-invaded), and T (Forest and other wooded land, $N=86$ plots, 43 invaded and 43 non-invaded)

Species	Total relative frequency in the dataset	Relative frequency in S plots	Relative frequency in T plots	Relative frequency in N plots
<i>Acacia dealbata</i> Link	0.140	0.375		
<i>Acacia mearnsii</i> De Wild	0.029		0.116	
<i>Acacia saligna</i> (Labill.) H.L.Wendl	0.351	0.180	0.070	0.711
<i>Robinia pseudoacacia</i> L.	0.310	0.016	1.198	0.008
<i>Vachellia karroo</i> (Hayne) Banfi & Galasso	0.070	0.047	0.209	
<i>Asparagus acutifolius</i> L.	0.275	0.273	0.035	0.438
<i>Smilax aspera</i> L.	0.263	0.188	0.267	0.336
<i>Rhamnus alaternus</i> L. subsp. <i>alaternus</i>	0.234	0.344	0.151	0.180
<i>Rubus ulmifolius</i> Schott	0.231	0.211	0.581	0.016
<i>Rubia peregrina</i> L.	0.213	0.273	0.186	0.172
<i>Pistacia lentiscus</i> L.	0.193	0.164	0.256	0.180
<i>Quercus pubescens</i> Willd. subsp. <i>pubescens</i>	0.184	0.086	0.593	0.008
<i>Fraxinus ornus</i> L. subsp. <i>ornus</i>	0.164	0.055	0.570	
<i>Hedera helix</i> L.	0.155	0.016	0.593	
<i>Lotus cytisoides</i> L.	0.140	0.086		0.289
<i>Rubus caesius</i> L.	0.140		0.558	
<i>Cistus salviifolius</i> L.	0.137	0.297	0.093	0.008
<i>Daucus carota</i> L.	0.137	0.102	0.081	0.211
<i>Phillyrea latifolia</i> L.	0.135	0.117	0.349	0.008
<i>Lagurus ovatus</i> L.	0.132	0.016	0.035	0.313
<i>Phillyrea angustifolia</i> L.	0.129	0.102		0.242
<i>Oloptum miliaceum</i> (L.) Röser & H.R.Hamasha	0.129	0.125	0.093	0.156
<i>Acer campestre</i> L.	0.126		0.500	
<i>Brachypodium sylvaticum</i> (Huds.) P.Beauv. subsp. <i>sylvaticum</i>	0.126	0.039	0.442	
<i>Galium aparine</i> L.	0.126	0.023	0.419	0.031

be classified under any habitat type recognised by the EU Habitats Directive, which may limit certain habitat-specific analyses. Nevertheless, the dataset provides a robust baseline for future ecological research, monitoring, and management planning.

Author contributions LL conceived the research network idea. LL, ES, and AM conceptualised the study and wrote the first draft of the manuscript. AM, ES, and LL organised and managed the data. ES, AM, ATRA, CA, DA, GBac, SB, EB, GBaz, MEB, GBon, GBru, SCam, MLC, SCas, LC-G, AC, DD, MCF, LS, GD, EF, TF, AG, LG, GPGG, EK, VLAL, ML, VL, FM, GM, PM, CM, MM, CMM, EVP, MP, LP, GR, FR,

SS, GS, AS, GT, CT, AT, MV, DV, RPW and LL participated in drafting the common sampling protocol, provided the data and contributed to the critical revision of the manuscript to produce the final version.

Funding Open access funding provided by Università degli Studi di Firenze within the CRUI-CARE Agreement. MM acknowledge the support of NBFC to the University of Florence, funded by the Italian Ministry of University and Research, PNRR, Missione 4 Componente 2, “Dalla ricerca all’impresa”, Investimento 1.4, Project CN00000033. CA, GBo, EF, CM, were funded under the National Recovery and Resilience Plan (NRRP), Mission 4 Component 2 Investment 1.4 – Call for Tender no. 3138 of 16 December 2021, rectified by Decree no. 3175 of 18 December 2021 of the Italian Ministry of University and Research funded by the European Union – NextGenerationEU; Award Number: Project code CN_00000033, Concession Decree no. 1034 of 17 June 2022 adopted by the Italian Ministry of University and Research, CUP B63C22000650007, Project title “National Biodiversity Future Center – NBFC”.

Data availability The dataset is stored in the Zenodo repository at the following link: <https://doi.org/10.5281/zenodo.17249125> (Siccardi et al. 2025). The dataset is under the Creative Commons Attribution 4.0 International license.

Declarations

Competing interests The authors declare no competing interests.

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Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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