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Research Article

Distribution of the invasive giant hogweed *Heracleum mantegazzianum* in Italy

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Abstract

Heracleum mantegazzianum, commonly known as giant hogweed, is a highly invasive plant species in Europe, included in the list of invasive alien species subject to regulation in the European Union. Native to the Caucasus Mountains in Southwest Asia, it has established itself in several temperate regions around the world, raising concerns due to its ecological impacts and risks to human health. In Italy, it was introduced in the late 19th century and has since escaped from cultivation and spread, but it has also disappeared from numerous sites, either because it failed to establish or was successfully managed. Consequently, information on its presence is inconsistent, and a comprehensive overview of its distribution is lacking. This study compiles and updates records from multiple sources—including field surveys, herbarium collections, and literature—to provide an overview of its distribution in the country. The results highlight that, despite recent control measures, *H. mantegazzianum* remains widespread in northern Italy, particularly across the Alpine region. This makes it a priority for monitoring and management strategies, especially as climate change may facilitate its range expansion to higher elevations, increasing the risk of invasion in mountain ecosystems rich in endemic species, which are both vulnerable and of high conservation value.

Key words: biodiversity conservation, biological invasions, climate change, high-elevation ecosystems, non-native flora, Regulation (EU) no. 1143/2014 on invasive alien species, vascular plants

Introduction

Heracleum mantegazzianum Sommier & Levier (Apiaceae), also known as giant hogweed, is one of the most problematic invasive species in Europe (Rumlerová et al. 2016; Vilà et al. 2024), to the extent that it has been included in the list of invasive alien species of Union concern since 2017 (European Commission 2025).

Native to the Greater Caucasus mountains in Southwest Asia, this exceptionally tall forb is well established across Northern and Central Europe, where it continues to expand its distribution, and it is also spreading in North America, Australia, and New Zealand (Cuddington et al. 2022; Müllerová 2024).

In Italy, seeds of this species were introduced by Sommier and Levier (1900) upon the return to Florence from their botanical expeditions in the Caucasus in 1890. In 1895 they named it after the anthropologist Paolo Mantegazza and sent the seeds to several European botanical gardens (Sommier and Levier 1895). In fact, *H. mantegazzianum* had already been introduced to Europe at the beginning of the 19th century (Jahodová et al. 2007), but it had not yet been described.

Since its first introduction, this large-sized species has been planted for scientific and ornamental purposes in both botanical and domestic gardens across Italy. It soon escaped from cultivation – initially only within botanical gardens, then it naturalized and became invasive, showing a dynamic invasion history: generally expanding, but occasionally contracting due to either natural failure of establishment or control measures. As a result, extensive information on the occurrence of giant hogweed in Italy has accumulated over the past 120 years. However, due to the long time span and the disappearance of the species from sites where it had been previously reported, which could also be related to its low persistence at historical locations (Pergl et al. 2012), a general review is needed to achieve a comprehensive overview of its distribution in the wild.

Indeed, a clear understanding of its distribution is crucial (Rajmis et al. 2016; Pergl 2017). First, because of its high dispersal potential and competitive ability, which make it a highly invasive species (Tiley et al. 1996; Pyšek et al. 2007), and also for the severe ecological and human health impacts it can cause (Nielsen et al. 2005; Müllerová 2024).

To address these threats, and identify management priorities, the present study aims to review and update the information on the occurrence of *H. mantegazzianum* in Italy, to provide a general overview of its distribution, as a basis for monitoring its future dynamics and supporting both scientific research and effective management strategies.

Materials and methods

Data acquisition

We collected data on the occurrence of *Heracleum mantegazzianum* from the extensive information on the distribution and invasion status of non-

native plant species in Italy compiled through a series of projects conducted since the early 2000s. In all these projects, data on the occurrence of the species were obtained through bibliographic sources (including previous floristic works and regional checklists of alien floras), from herbarium records, and from extensive field surveys.

The first set of data was collected between 2002 and 2008 during the compilation of the national database on non-native vascular flora (Celesti-Grapow et al. 2009). Since then, information on the distribution of this species has been continuously updated, both at the regional scale (Galasso et al. 2018, 2024), and at the grid scale, particularly through recent projects specifically addressing invasive species of Union concern, supporting the implementation of the Regulation (EU) no. 1143/2014 on invasive alien species (Lozano et al. 2023).

Voucher specimens from representative populations located in all the invaded regions are deposited in the following herbaria: Civic Museum of Rovereto (ROV), Natural History Museum of Milan (MSNM), Sapienza University of Rome (RO), University of Trieste (TS) and University of Turin (TO). Herbarium codes follow the Index Herbariorum (2025; https://sweetgum.nybg.org/science/ih/).

In the present study, the distribution of *H. mantegazzianum* was defined at a finer scale than regional or grid-cell levels by mapping the location of individual records. Coordinates were obtained directly through field surveys (GPS) or calculated based on precise locality descriptions using GIS or Google Earth.

Each recorded population was assigned to a habitat type using the SynHab database (https://www.synhab.com/the-project), which contains information on the distribution of naturalised plant species in habitats worldwide (Kortz et al. 2025).

Data assessment

The dataset was reviewed and updated through recent field surveys, literature searches, and herbarium validations. To ensure data consistency and to provide a general overview of the recent distribution of the species, we assessed all records from the last 30 years (since 1994), excluding historical reports, in particular those from the early 1900s. We also excluded records referring to cultivated occurrences, considering only those documenting the species in the wild.

Results

The results of the survey are presented in Figure 1 and Supplementary material Table S1.

We recorded a total of 182 sites where *Heracleum mantegazzianum* occurs in the wild, spanning latitudes from 44.24° to 46.97° and longitudes from 6.96° to 13.35°. The data mostly derive from field surveys (177), with five

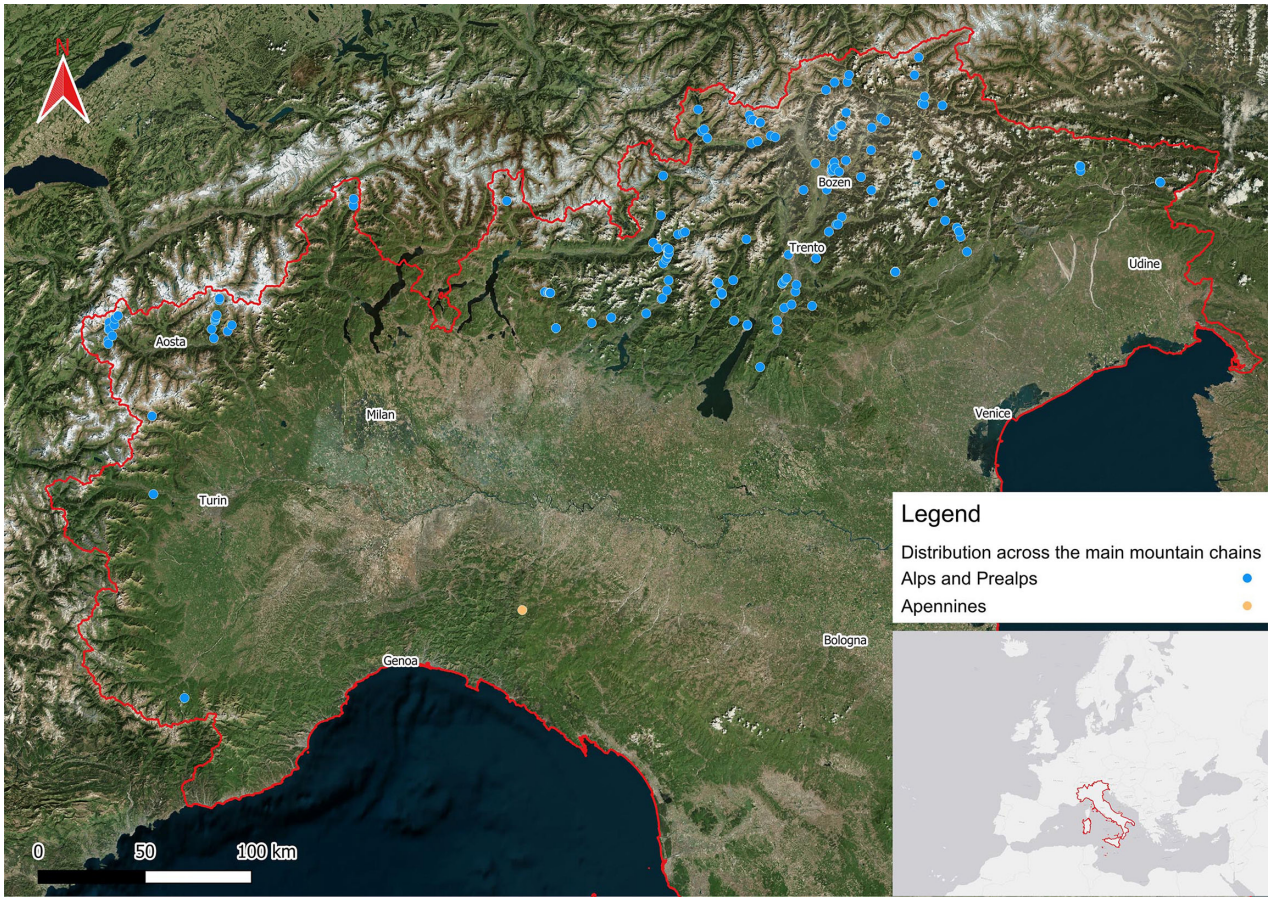

Figure 1. Distribution of *Heracleum mantegazzianum* in Italy (basemap: Bing Satellite). Blue dots indicate all recorded occurrences; the yellow dot indicates the occurrence on the Apennine mountain slopes.

records from the literature. Giant hogweed is distributed along the Alpine range, with only one recorded occurrence on the northern slopes of the Apennine Mountain range (Id 182 in Table S1 and the yellow dot in Figure 1).

The habitat types where the populations were detected (Table S1) were mainly riparian (89 records), ruderal (68), and human-maintained grasslands (21), followed by habitat types represented by far fewer populations: wetlands (4), open forests (4), scrub (3), natural grasslands (2), and agricultural areas (1). The total number of habitat types recorded exceeds the number of sites because some populations extended over more than one habitat type.

Discussion

Our study provides a general overview of the recent distribution of *H. mantegazzianum* in Italy. Overall, the results indicate that the species is widely distributed, spanning from east to west across the northern part of the country, with most occurrences in the Alpine region (Figure 1; Table S1).

This finding is relevant for several reasons. First, due to the well-documented social and health impacts of the species (Nielsen et al. 2005; Pyšek et al. 2007; Müllerová 2024). *Heracleum mantegazzianum* produces

phototoxic furanocoumarins that can cause severe phytophotodermatitis when its sap comes into contact with human skin and is subsequently exposed to sunlight (Tiley et al. 1996; Denness et al. 2013; Flanagan et al. 2021).

Several groups of people are at greater risk, including gardeners and forest workers, who are more likely to come into contact with the plant's sap due to mechanical damage during vegetation management (Klimaszyk et al. 2014; Rzymski et al. 2015). Similarly, individuals involved in recreational activities in invaded areas—such as those aiming to access riverbanks, which are often densely colonized by this species—may also be exposed to these risks (Müllerová 2024). This is all the more relevant in many of the surveyed sites (Figure 1), which are located in the Alpine region, a popular destination for outdoor recreation that attracts numerous visitors during the summer months.

Besides the health risks, the widespread presence of *H. mantegazzianum* detected in this study is alarming considering the extensive control efforts undertaken over the past two decades. Since the early 2000s, awareness of the risks posed by this species has increased in Italy across the regions where it had established, leading to numerous management interventions.

These efforts have included both private initiatives and structured eradication programs led by local authorities, with intensified actions following the inclusion of giant hogweed in the European Union's list of invasive alien species of concern in 2017, which requires compulsory management across all EU Member States (European Commission 2025).

Since environmental management in Italy falls largely under the responsibility of regional authorities, most control measures, mainly based on mechanical techniques, were implemented regionally in accordance with local, national (MATTM 2022), and EU guidelines (Pergl et al. 2017). Early eradication programs were initiated in northern Italy, including, for example, actions in Valle d'Aosta (NAPEA project, Curtaz and Bassignana 2011), aimed at implementing good practices to contain the spread of *H. mantegazzianum* in Alpine meadows. Subsequent coordinated actions have been implemented across northern regions, involving regional authorities, parks, and forestry services, often in cooperation with local communities. These include long-term control in Lombardy since 2015 (Valle Camonica, MATTM 2022), programs that have limited the spread in Piedmont (Bonacito et al. 2024), and the regional strategy for invasive species in Friuli Venezia Giulia (2021–2026), which has brought giant hogweed close to eradication in this region (Carpanelli et al. 2024). Ongoing large-scale initiatives, within the European Union LIFE programme (LIFE NatConnect2030 2022) continue to prioritise this species as a target for coordinated management across northern Italy.

While these interventions have played a crucial role in limiting further spread, the persistence of the species highlights the need for continued and reinforced measures.

The occurrence of *H. mantegazzianum* recorded in our survey across the northern part of the country despite management actions also raises major ecological issues. As noted above, our results (Figure 1) show that the species is especially common in the Alpine region, where it is mainly found in mountain areas. Given that giant hogweed is widely recognized for its potential to rapidly dominate invaded ecosystems through competitive displacement of other species (Pyšek et al. 2007; Thiele et al. 2010), its persistence is a serious cause for concern, as these areas have exceptionally high conservation value. Indeed, the Alps represent one of the most important hotspots of endemic vascular plant diversity in Europe (Essl et al. 2009). Due to their unique floristic composition and richness in rare and endemic species (Peruzzi et al. 2015; Brundu et al. 2017), which have narrow ecological niches and limited distributions (Essl et al. 2011), the plant communities of this region are highly vulnerable to the spread of invasive species.

Climate change, which is already posing a threat to Alpine endemic species by reducing their habitat and altering current distribution patterns (Dirnböck et al. 2011; Dullinger et al. 2012), could further exacerbate this issue. A growing body of research has highlighted recent trends in plant invasions at high elevations, pointing to a possible upward range expansion in response to climate warming (Pauchard et al. 2009; Petitpierre et al. 2016) and soil disturbance (Geppert at al. 2021). In the European Alps in particular, non-native plant species have been reported to shift their ranges upward at a faster pace than native species in response to warming and increased habitat disturbance (Dainese et al. 2017; Geppert et al. 2023). In this context, the spread of *H. mantegazzianum* could intensify pressures on high-altitude species, representing an example of the synergy between biological invasions and climate change (Sage 2020; Ricciardi et al. 2021). In fact, given that colder temperatures have been identified as the main factor explaining the distribution of giant hogweed in Europe (Anibaba et al. 2022; Müllerová 2024), as temperatures continue to rise, this species could expand its range to higher altitudes, adding to the threat faced by already vulnerable mountain ecosystems (Shackleton et al. 2020) and negatively impacting the ecosystem services they support (Engler et al. 2011).

Regarding habitats, most populations were recorded in open and typically disturbed environments, either natural or human-induced, such as riparian zones (riverbanks and riparian woodlands) and ruderal sites along roadsides. Based on the information collected during this survey, it appears that in many cases populations have expanded from ruderal habitats into adjacent natural or semi-natural areas. Moreover, many of the recorded populations seem to have originally derived from domestic gardens in mountain regions, where the species was cultivated as an ornamental, thus reflecting the general pattern that identifies escape for ornamental purposes as a

major pathway of introduction and spread of alien plant species in Europe and worldwide (Pergl et al. 2020; IPBES 2023). Dedicated studies could further investigate these dynamics and help reconstruct the species' invasion history.

Another pattern emerging from our results is that *H. mantegazzianum* occurs in the wild only in northern Italy, despite the presence of high mountains throughout the country. The only recorded population outside the Alpine region is restricted to a single site in the northern Apennine Mountain chain (yellow dot in Figure 1). This is somewhat remarkable, considering that the Temperate region and the Apennine mountains—with many peaks exceeding 2,000 meters—extend across the entire peninsula and that, according to early botanical records, *H. mantegazzianum* was introduced in multiple sites across the country, including central and southern regions.

Enhanced monitoring of giant hogweed and further research on its introduction and invasion history will be crucial for identifying the factors that have limited its establishment in these regions, preventing its further spread and predicting potential future range shifts under changing climatic conditions.

Conclusions

Although significant control measures have been implemented, especially after *H. mantegazzianum* was included in the European Union's list of invasive alien species of concern, which made its control mandatory, the results of this study show that in Italy giant hogweed remains widespread and occurs in the wild throughout the entire Alpine Mountain range.

This is highly relevant given the conservation importance of both currently and potentially invaded Alpine ecosystems, which are recognized as biodiversity hotspots. Moreover, given the transboundary nature of biological invasions, neglecting the potential spread of *H. mantegazzianum* in this region may hinder control efforts in neighboring countries.

Overall, our results further reinforce the status of *H. mantegazzianum* as a serious environmental threat, with major implications for the conservation of high-altitude biodiversity, making it a high-priority target for monitoring and management actions beyond the local scale.

Authors' contribution

LC-G research conceptualization, manuscript writing; CM, GB: research conceptualization, sample design; CM: map design. All authors contributed by providing data and insights, discussing the results, revising and commenting on the manuscript.

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Data availability

Species georeferenced records are available at the European Alien Species Information Network: https://easin.jrc.ec.europa.eu/easin/RJD/Download/be7fb807-1da7-471e-bce0-881277b48945.

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Supplementary material

The following supplementary material is available for this article:

Table S1 Distribution of *Heracleum mantegazzianum* in Italy.

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2026/Supplements/BIR_2026_Celesti-Grapow_etal_SupplementaryMaterial.xlsx