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Research article

Comparative stakeholder perceptions of wildlife management in five European multi-use landscapes

Christian Kiffner [a,b,c,*], John D.C. Linnell [d,e], Simona Capelli [f], Marco Ciolli [f,g], Ana Iglesias [h], Kyle Jewell [e,f], Bjørn Kaltenborn [d], Hannes J. König [a], Daniel Martin-Collado [i,j], Hristina Prodanova [k], Barbara Soriano [h], Vanya Stoycheva [k], Clara Tattoni [l], Sandra Uthes [b], Stefania Volani [f], Moya Zöller [m], Emu-Felicitas Ostermann-Miyashita [a,b,n]

[a] Faculty of Life Sciences, Thaer-Institute of Agricultural and Horticultural Sciences, Humboldt-Universität zu Berlin, Albrecht-Thaer-Weg 5, 10099, Berlin, Germany
[b] Leibniz Centre for Agricultural Landscape Research (ZALF), Eberswalder Str. 84, Müncheberg, 15374, Germany
[c] Max Planck Institute for Evolutionary Anthropology, Department of Human Behavior, Ecology and Culture, Deutscher Platz 6, 04103 Leipzig, Germany
[d] Norwegian Institute for Nature Research, Vormstuguveien 40, 2624, Lillehammer, Norway
[e] University of Inland Norway, Department of Forestry and Wildlife Management, Anne Evenstads Vei 80, NO-2480, Koppang, Norway
[f] Department of Civil, Environmental and Mechanical Engineering, University of Trento, Via Mesiano 77, 38123, Trento, Italy
[g] C3A – Center Agriculture Food Environment, University of Trento, Via Edmund Mach 1, 38098, San Michele all'Adige, Italy
[h] Universidad Politecnica de Madrid, UPM-CEIGRAM, Spain
[i] Departamento de Ciencia Animal, Centro de Investigacion y Tecnología Agroalimentaria de Aragon (CITA), Avda. Montañana 930, 50059, Zaragoza, Spain
[j] Instituto Agroalimentario de Aragon-IA2 (CITA-Universidad de Zaragoza), Zaragoza, Spain
[k] National Institute of Geophysics, Geodesy and Geography—Bulgarian Academy of Sciences, Department of Geography, Acad. G. Bonchev str., bl. 3, 1113, Sofia, Bulgaria
[l] Department of Theoretical and Applied Sciences, Environment Analysis and Management Unit (UAGRA), University of Insubria, Via Jean Henry Dunant 3, 21100, Varese, Italy
[m] Institute of Geography and Geology, Department of Sustainability Science and Applied Geography, University of Greifswald, 17489, Greifswald, Germany
[n] Wildlife Conservation Research Unit, Department of Biology, University of Oxford, Abingdon Road, Tubney, Oxfordshire, UK

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ABSTRACT

Human-wildlife coexistence in shared landscapes requires effectively navigating different stakeholder interests. Despite progress in this field, most studies focus on a limited number of "problematic" wildlife species. This narrow scope overlooks the species-specific nature of human-wildlife interactions. To identify general patterns in stakeholder perceptions of diverse wildlife species, we implemented a modified *3i* (interest, influence, impact) method to assess how individuals within seven stakeholder groups (crop farmers, livestock farmers, foresters, hunters, tourism operators, protected area managers, and staff of environmental non-governmental organizations) rated their interest in, their influence on, and how they are impacted by twelve wildlife species categories: moose, red deer, wild reindeer, chamois, roe deer, brown bear, wild boar, grey wolf, European ground squirrel, cormorant, eagles, and vultures (some of them were site-specific).

The study design consisted of two steps: 1) assessing expert perceptions of the *3i* for each stakeholder-species combination in each of the five study areas in Bulgaria, Germany, Italy, Norway, and Spain, and 2) assessing stakeholder (251 individuals) perceptions of the *3i*. We found substantial variation in stakeholder perceptions across groups, sites, and species categories. Within-group heterogeneity and individual respondents belonging to multiple stakeholder categories further challenged simplistic assumptions of distinct and well-defined stakeholder perspectives. Expert perceptions often underestimated stakeholder interest in wildlife species categories and occasionally diverged from stakeholder-perceptions of influence and impact. Notably, perceived impacts of brown bears, wolves, and eagles often exceeded the perceived influence on these species categories, underscoring a sense of powerlessness in managing interactions in some sites.

* Corresponding author. Faculty of Life Sciences, Thaer-Institute of Agricultural and Horticultural Sciences, Humboldt-Universität zu Berlin, Albrecht-Thaer-Weg 5, 10099, Berlin, Germany.
E-mail addresses: christian.kiffner@hu-berlin.de, christian.kiffner@zalf.de (C. Kiffner).

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Our study provides a comparative framework for understanding major patterns in key conservation conflicts in Europe, and emphasizes the importance of addressing contextualized stakeholder diversity and heterogeneity for more effective co-management of human-wildlife coexistence. These findings offer actionable pathways for improving conservation outcomes and participatory wildlife management across Europe.

1. Introduction

Currently, more than a third of the global terrestrial surface area is characterized by substantial overlap between human and wildlife (here, narrowly defined as mammal and bird species) populations (Zhang et al., 2024). This overlap is expected to further increase across most terrestrial regions as humans expand into remaining natural habitats and as concurrent wildlife recovery returns many species to human-modified landscapes (Ma et al., 2024). The co-occurrence of different land uses and a diversity of wildlife species creates the potential for human-wildlife interactions, including those that are often termed human-wildlife conflicts (IUCN, 2023; Nyhus, 2016). While negative outcomes of human-wildlife interactions, such as livestock or crop loss, are often the focus of disputes, actual 'conflicts' emerge from disagreements among people over how wildlife populations should be managed. Such conservation conflicts usually stem from differences in interests, values, and worldviews regarding wildlife (Redpath et al., 2013).

Effectively navigating divergent interests and trade-offs associated with wildlife management is a global challenge (Ceauşu et al., 2019; König et al., 2020) including in Europe's rural landscapes (König et al., 2021a). Over recent decades, changes in wildlife management, climate, rural human population size and structure, and agricultural practices, have contributed to population size increases in ungulate species such as roe deer (*Capreolus capreolus*), red deer (*Cervus elaphus*) and wild boar (*Sus scrofa*) (Burbaite and Csányi, 2009; Carpio et al., 2021; Massei et al., 2015). Concurrently, changes in species protection, law enforcement, land cover, and prey densities, have facilitated the recovery and range expansion of large carnivore species such as grey wolves (*Canis lupus*), European lynx (*Lynx lynx*) and Eurasian brown bear (*Ursus arctos arctos*) (Chapron et al., 2014; Cimatti et al., 2021). Similarly, changes in conservation efforts, such as reintroduction and supplementary feeding programs, have facilitated the stabilization and partial recovery of eagle (Fernández-Gil et al., 2023), and vulture species (Badia-Boher et al., 2019; Safford et al., 2019). As a result of these developments, residents of rural landscapes now face higher wildlife abundances and are confronted with species that had been absent from many areas.

An evolving body of literature suggests that management in multifunctional landscapes ideally aims for human-wildlife coexistence (Frank et al., 2019; König et al., 2020; Madden, 2004; Nyhus, 2016; Salvatori et al., 2021; Woodroffe et al., 2005). Following Carter and Linnell (2016), we define human-wildlife coexistence as a dynamic but sustainable state in which humans and wildlife co-adapt to living in shared landscapes. Human-wildlife interactions and competing interests are managed by institutions that ensure the long-term persistence of wildlife populations, social legitimacy, and tolerable levels of risk.

While many extant European wildlife species adapt seemingly well to patchworks of cropland, pastures, forest plantations, settlements and protected areas, navigating competing and complementary human interests remains a major challenge (Grossmann et al., 2020; Peterson et al., 2005; Redpath et al., 2013). Stakeholders, defined as individuals, groups, or organizations who are impacted by wildlife, have influence on wildlife populations, or have an interest in wildlife (Linnell, 2013), sometimes hold divergent interests, values, and worldviews regarding how wildlife species should be managed (Redpath et al., 2013). For instance, one might naively assume that directly impacted land users, such as farmers or foresters, primarily see wildlife as a threat to their livelihood. In contrast, conservation-oriented individuals typically prioritize the persistence and conservation of wildlife populations over human interests (König et al., 2021b). In practice, however, such distinctions across stakeholders are rarely as clear-cut as they may appear and these nuances warrant greater attention (Grossmann et al., 2020).

To navigate diverse interests, human-wildlife coexistence management either aims to identify co-designed solutions or decide on compromises across stakeholder groups (Carter and Linnell, 2016; Kaltenborn and Linnell, 2022). However, since wildlife species often simultaneously provide both services and disservices to different stakeholders (Ceauşu et al., 2019), it is important to acknowledge that trade-offs and imperfect solutions are inevitable (Carter and Linnell, 2023; Redpath et al., 2013). Moreover, if conflicting interests among stakeholders are poorly addressed, human-human conflicts over the management approaches may escalate quickly and become entrenched. To effectively manage these complex situations, diagnosing underlying issues and matters of contention is a crucial first step (Zimmermann et al., 2020).

To this end, frameworks from different academic paradigms, such as the social-ecological framework of ecosystem services and disservices (SEEDS; Ceauşu et al., 2019) and the framework for participatory impact assessment (FoPIA; König et al., 2021b; Paas et al., 2021), have been developed. While these approaches have effectively explored select perspectives on human-wildlife coexistence, particularly in localized contexts or for specific species (König et al., 2021b) such as large carnivore assemblages in single (van Heel et al., 2017) or multiple European regions (Grossmann et al., 2020), they remain limited in scope. The lack of multi-taxa, transnational comparative studies limits our ability to identify general patterns in how stakeholders perceive their interactions with a diverse suite of wildlife species. While conservation conflicts are often highly case-specific (Zimmermann et al., 2021), identifying common patterns across sites is an essential step toward understanding the broader dynamics (Alba-Patiño et al., 2024; Marino et al., 2021).

To capture the social dimension of human-wildlife coexistence, König et al. (2021b) proposed adopting the *3i* method, an approach initially developed to assess stakeholder involvement in environmental research (Reed, 2008). Applied to the human-wildlife coexistence context, this stakeholder-centered method begins by identifying key stakeholder groups using expert knowledge of the system. Individual stakeholders are then asked to rate the three "*i*"s: their *interest* in, *influence* on, and *impact* by wildlife species. Since this method produces quantitative, species-specific data, it allows for a nuanced assessment of stakeholder perceptions across these three dimensions (Reed, 2008). Furthermore, by quantifying contrasts across dimensions, the *3i* method can be extended to identify mismatches between the perceived impact of and the ability to influence the outcomes of human-wildlife interactions. Such contrasts can indicate perceptions of powerlessness or frustration, which are core ingredients for the escalation of conflicts (Dickman, 2010; Ogra, 2008; Zimmermann et al., 2020).

In this study, we apply the *3i* method to analyze perceptions of stakeholder groups at the interface of natural resource utilization and conservation towards a wide range of wildlife species in five European case study sites. In a first step, we focus on the stakeholder groups and investigate overlap between them. In addition, we analyzed the pluriactivity of stakeholders, i.e. the engagement in multiple activities that are associated with wildlife interactions. In a second step, we compare perceived three "*i*" scores (interest in, influence on, and impact by wildlife species categories) across stakeholder groups, species, and case studies. By including an independent expert perception of the three "*i*"s, we provide a system-wide perspective to contextualize stakeholder-perceptions. Finally, by examining contrasts between the three "*i*" dimensions, we identify perceived power imbalances. As achieving human-wildlife coexistence is increasingly recognized as a pressing societal challenge (Carter and Linnell, 2023; Gross et al., 2021), we discuss our findings in the context of developing more inclusive and just wildlife management strategies across Europe (Harris et al., 2023).

2. Material and methods

2.1. Study sites

We selected five multi-use landscapes across five European countries (Bulgaria, Germany, Italy, Norway, and Spain), covering an East-West and North-South gradient (Fig. 1). We intentionally chose landscapes that contain both protected and diverse human land uses, with most (4/5) of these areas designated as UNESCO Biosphere Reserves. These reserves are designed to balance food production with biodiversity protection, making them ideal arenas for studying human-wildlife coexistence (König et al., 2020, 2022). At the onset of the study, we defined the extent of each study area and only considered stakeholders who were residing or working in the landscape. Therefore, our study is place-based, and insights are not representative of entire countries.

The Bulgarian case study area is located in the central part of the country (districts "Lovech", "Gabrovo", "Stara Zagora", "Plovdiv", and "Sofia"), covering the Central Balkan Biosphere Reserve with its core, buffer, and transition zones. The Biosphere reserve covers 369 km^2 and 112,357 humans reside in the adjacent municipalities (National Statistical Institute, 2024). The Central Balkan National Park constitutes the core and buffer zones of the Biosphere Reserve (Ministry of Environment and Water, 2016). The landscapes are predominantly mountainous with an average altitude above 1000 masl, and the climate is characterized by temperate to cold temperate conditions (Prodanova et al., 2024a). Several rivers – Vit, Osam, Yantra, Maritza, and Tundzha – flow through the area and form its watersheds. About 60 % of the territory is covered by broadleaved forests, dominated by beech (*Fagus sylvatica*); UNESCO considers these forests of "Outstanding Universal Value" (UNESCO, 2025). Other vegetation forms include meadows, shrubs, and coniferous forests [including spruce (*Picea abies*), European silver fir (*Abies alba*), and the endemic Balkan pine (*Pinus peuce*)]. The Central Balkan National Park provides multiple ecosystem services including nature-based tourism (Bancheva-Preslavska, 2025; Prodanova et al., 2024b) and has supported extensive livestock grazing for more than eight centuries.

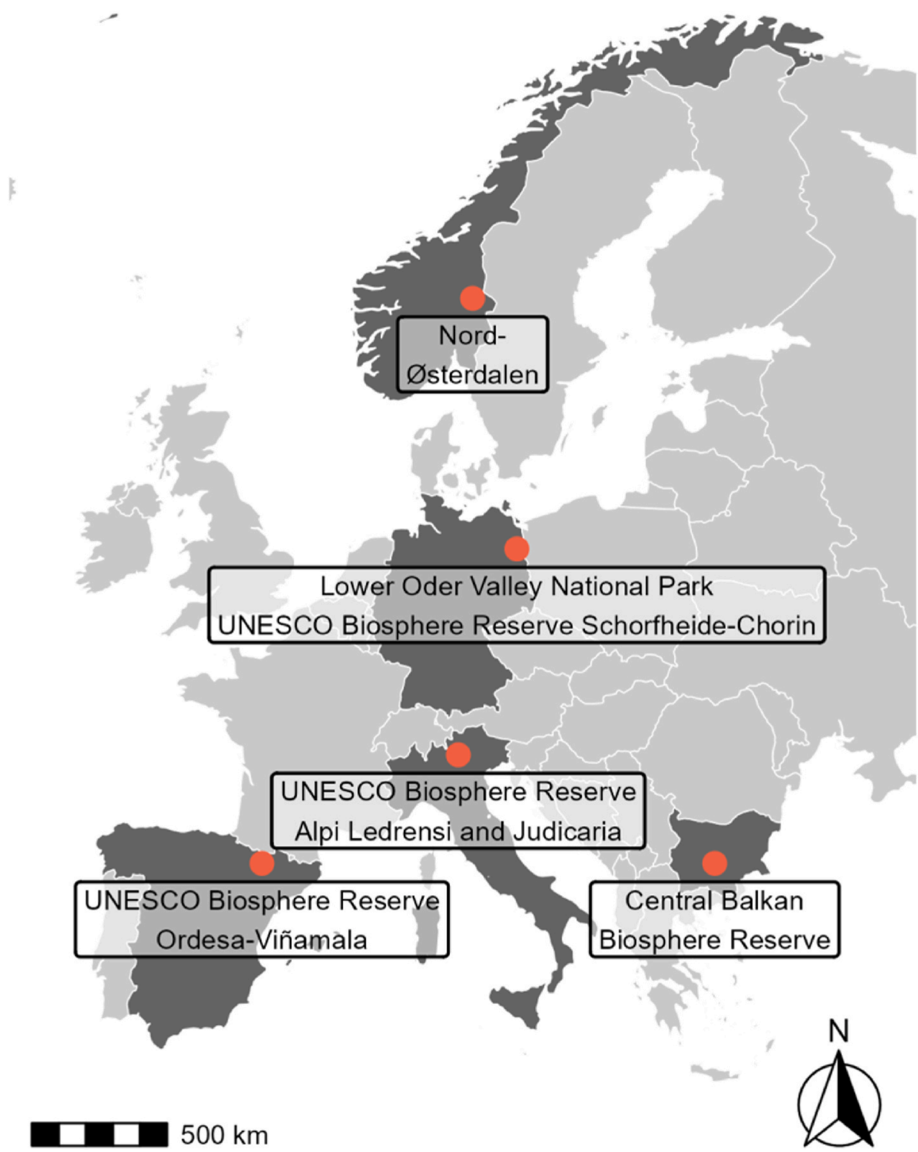

Fig. 1. Map of Europe showing the approximate locations of the five case study sites where we implemented the 3i method to assess stakeholder interest in, influence on and impact by wildlife species categories.

Livestock predation by wolves and bears is common and grazing in high mountain pastures often conflicts with the conservation of European ground squirrels (*Spermophilus citellus*) (Koshev et al., 2019).

The German study area is located in the northeast of the country and borders Poland to the East. It includes the counties “Barnim”, “Märkisch-Oderland”, “Oberhavel”, and “Uckermark”. The study area covers 8476 km^2 and is home to 682,543 people (Zensus Datenbank, 2022). The study area contains a mix of diverse land-uses and two protected areas. The Lower Oder Valley National Park protects a stretch of riverine habitat along the Oder River and constitutes one of Germany’s most intact “Polder” landscapes, i.e. a low lying tract of land enclosed by dikes that is periodically flooded. The UNESCO Biosphere Reserve Schorfheide-Chorin (1292 km^2), located to the west of the Lower Oder Valley National Park (105 km^2), is characterized by gently undulating terrain and a mosaic of pine (*Pinus sylvestris*), oak (*Quercus* spp.) and lowland beech (*Fagus sylvatica*) forests, heathlands, meadows, cropland, and settlements (Schubert, 2022). Human-wildlife interactions are common in the predominantly rural study area. Hunting of ungulates is a common practice, and wolves have naturally recolonized the region over the past two decades, leading to relatively frequent incidences of livestock predation (Kiffner et al., 2022). In 2021, a fence was built along the eastern border of the study area to prevent the immigration of wild boars from neighboring Poland, aiming to reduce the risk of African Swine Fever virus spreading into Germany (Sauter-Louis et al., 2022).

The Italian study area, Alpi Ledrensi and judicaria Biosphere Reserve, is located in the northeastern alpine region of the Autonomous province of Trento. The total area of the reserve is c. 474 km^2 and the study area includes a 40 km buffer around the reserve. As of 2025, the human population of the municipalities in the case study area is 38,804 (ISTAT, 2025). The area hosts a broad variety of environments stretching from the low elevation Mediterranean assemblages and terraced olive groves (*Olea europea*) of Lake Garda to the high-altitude pastures and mountain peaks (<3000 masl) of the Brenta Dolomites. Vegetation is highly diverse, featuring riverine formations along the banks of Sarca and Chiese rivers, and beech (*Fagus sylvatica*), spruce (*Picea abies*), larch (*Larix decidua*), and dwarf mountain pine (*Pinus mugo*) forests distributed throughout the lower and upper slopes. On the valley floors and lower slopes, the area includes several villages of significant cultural, historical, and architectural value. The biosphere reserve is one of the most visited protected areas in Trentino. Common human-wildlife interactions include wildlife watching, sport fishing, and hunting. Brown bears occasionally damage beehives; bears, and occasionally wolves, prey on livestock (Tattoni et al., 2025); multiple ungulate species damage crops (Tattoni et al., 2017), and collisions with vehicles are common (Menapace et al., 2023).

“Nord-Østerdalen” is located in the southeastern part of Norway and is roughly equivalent to the Innland county. It covers approximately 52,000 km^2 with a human population of 376,304 (Statistics Norway, 2024). While not designated as a UNESCO Biosphere Reserve, it features similar characteristics, with a diverse mix of land uses and conservation areas. The area includes parts of five national parks (Dovre, Rondane, Forolhogna, Femundsmarka, Fulufjellet), multiple landscape protection areas and nature reserves, large tracts of privately owned land and some commonage areas. The environment ranges from low lying forest lands, river valleys, lake systems, and agricultural lands to high mountain regions. A large portion is used for various types of pastoralism. Encounters between people and red deer or moose are quite common through the forested and low-lying parts of the area, and hunting of ungulates, small game and carnivores is common. In alpine areas, people frequently encounter wild reindeer. Encounters between people and large carnivores, including livestock predation, are less common but do occur (Kaltenborn et al., 2013).

In Spain, the study area is the UNESCO Biosphere Reserve Ordesa-Viñamala, located in the north east of Spain, bordering France. Since many stakeholders reside outside of the reserve, we extended the geographic range of our study area to adjacent municipalities and the provincial capital: “Bielsa”, “El Puyeo de Araguás”, “Huesca”, “Jaca”, “La Fueva”, “Labuerda”, “Torla-Ordesa”, and “Zaragoza”. The entire area covers approximately 2228 km^2 and is home to 757,332 people (National Statistics Institute of Spain, 2024a, 2024b). The reserve, with an extent of c. 1173 km^2 and a human population of 6162 people, is home to unique species of flora and fauna and is characterized by forests, deep valleys, mountains, and steep cliffs at high altitudes (Alonso, 2012). It represents the mountain ecosystem of the Pyrenees. Hunting of ungulates is permitted within the biosphere reserve and is regulated through game management plans. While multiple ungulate species cause damage to crops and valley pastures, the most obvious impact is from wild boar populations, which are increasing (Bueno et al., 2011). Ecotourism is well-developed in the area; vulture species are supported by feeding stations, many of which also serve as tourist attractions (García-Jiménez et al., 2022).

2.2. Selected wildlife species categories

We chose twelve wildlife species categories that we considered as either significant for wildlife conservation, human-wildlife interactions, or both. To allow for comparisons across sites, we combined closely related and ecologically similar species into broader categories. While not all species are present in each site, this selection reflects a balance between local relevance and cross-site comparability.

First, we included widely distributed and abundant mammal species, including roe deer, red deer, wild boar, and grey wolf. These species play crucial roles as herbivores, omnivores, and carnivores, and are of economic and cultural importance to local communities. Second, we included locally relevant mammal species such as wild reindeer (*Rangifer tarandus*; Norwegian site), moose (*Alces alces*; German and Norwegian sites), chamois (*Rupicapra rupicapra/Rupicapra pyrenaica*; Bulgarian, Italian, and Spanish sites), brown bear (Bulgarian, Italian, and Norwegian sites), and the European ground squirrel (*Spermophillus citellus*; Bulgarian site). Third, we included three bird species categories. As conflict-prone species, we included cormorants (*Phalacrocorax carbo*; German and Italian sites), eagles (golden eagle *Aquila chrysaetos* and white-tailed eagle *Haliaeetus albicilla*; all sites, with species composition differing across sites), and vultures (bearded vulture *Gypaetus barbatus,* griffon vulture *Gyps fulvus*, Egyptian vulture *Neophron percnopterus*, and cinereous vulture *Aegypius monachus*; Bulgarian and Spanish sites, with species composition differing across sites).

2.3. Initial stakeholder group selection and expert perceptions

Before this study, the research protocol and questionnaire instruments were reviewed and approved by the ethics committee of the Humboldt-Universität zu Berlin (Application 2024-04-Ostermann).

Based on previous projects in some of our study areas (Jacobsen and Linnell, 2016; König et al., 2021b; Soriano et al., 2024) we initially identified ten key stakeholder groups: crop farmers, livestock farmers, private forest owners, forestry professionals, hunters, tourism operators, protected area managers, environmental non-government organizations (NGOs), road authorities, and municipal land use authorities. During a subsequent discussion among the authors, we decided to remove the road and municipal land use authority groups and to combine the private forest owners and forestry professionals into a single group, resulting in seven key stakeholder groups: crop farmers, livestock farmers, foresters, hunters, tourism operators, protected area managers, and staff of environmental NGOs.

In each case study we first assessed expert perceptions of stakeholder interest in, influence on, and impact by wildlife, using a scale from 0 to 10, where 0 means no interest/influence/impact and 10 means full interest/influence/impact. These assessments were completed by co-authors with long-term experience in each area. When needed, co-authors consulted local stakeholder boards (i.e. representatives of the hunting, forestry, agriculture, and conservation sectors in each site) and additional local experts (e.g. other researchers). Per site, one (Germany, Bulgaria with consultation of the stakeholder board and a representative of the Executive Environment Agency), two (Norway with consultation of colleagues, Italy with input from the stakeholder board), or three (Spain) authors provided their scores; when multiple assessors were involved, a consensus was reached through discussion. The most challenging questions varied by site but commonly included “interest in” (due to its subjective nature) and “impact by” (due to spatial variation in species distributions and differing local experiences among stakeholders).

2.4. Stakeholder perception of the three “i”s

We administered the *3i* survey to stakeholders in each of the study sites. Using existing contacts with known stakeholders, we reached out to stakeholders via phone or email, explained the purpose of the survey and invited them to participate in the survey. We then either sent them a word document of the survey, or a link to an online version of the survey. In the process, we also asked potential respondents to forward the survey to other stakeholders. In some cases, we directly recruited respondents during specific events and asked them to fill out a hardcopy version of the survey.

The survey was initially developed in English and later translated into the language of each study area to ensure accessibility for respondents (Table S 1). The translated text was also further reviewed and discussed by each national research group to ensure that the intended meaning of the statements and questions was maintained. The survey contained three parts: The first part provided a brief overview of the study and included a request for consent to participate, emphasizing anonymity in filling out the survey. In the second part, respondents provided data about their demographic background, openness to having discussions with people who hold opposing views on wildlife management, and stakeholder group membership. In addition, we asked respondents to indicate their involvement in activities such as farming, livestock keeping, forestry, beekeeping, and wildlife-watching, either as a hobby or as part of their professional work. In the third part, respondents were asked to rate their interest in, influence on, and impact by the species category, using a scale from 0 to 10, where 0 means no interest/influence/impact and 10 means full interest/influence/impact. Only the species categories present in a given site were included in the survey of that site (see 2.2). Each of the three “i”s was briefly explained in this section to ensure consistent understanding. Additionally, respondents had the opportunity to provide comments for each of the listed wildlife category (S 1).

2.5. Analysis

We conducted all analyses in R 4.2.2 (R Core Team, 2021).

To characterize the respondents, we described the sample in terms of age, gender, educational background, and openness to discussion. As many respondents in Bulgaria, Italy and Germany opted to indicate membership in multiple stakeholder groups, we analyzed the overlap between each of the seven stakeholder groups by calculating the Jaccard index:

$$J_{ab} = \frac{|A \cap B|}{|A \cup B|}$$

Where J_{ab} is the Jaccard index for stakeholder groups *A* and *B*. $|A \cap B|$ represents the number of respondents who are members of both groups and $|A \cup B|$ is the number of respondents who are members of group *A*, group *B,* or both groups. The index ranges from 0 (no overlap) to 1 (complete overlap). In simpler terms, the Jaccard index measures how much two groups share in terms of their members, with higher values indicating greater overlap between the groups. Using the *igraph* (Csárdi et al., 2024) and *ggraph* (Pedersen, 2024) packages, we visualized the overlaps. In these networks, stakeholder groups are represented as nodes, and the edges between them indicate the degree of overlap.

Since respondents in the Norwegian and Spanish sites were not asked to indicate membership in multiple stakeholder groups, we instead analyzed pluriactivity, defined as the extent of engagement in multiple wildlife-related activities. For each site, we calculated the Jaccard index to quantify the degree of shared engagement across activities such as farming, livestock keeping, forestry, beekeeping, and wildlife watching, considering both hobby and professional contexts. We also visualized these patterns of pluriactivity using network graphs.

To explore and compare stakeholder perspectives regarding the three “i”s for the selected wildlife categories in the five sites, we used descriptive and visual analyses. To address cases where respondents indicated membership in multiple stakeholder groups, we created duplicate entries for those respondents.

To compare expert and stakeholder perceptions, we visually contrasted the two metrics and calculated the root mean square error (RMSE). The RMSE quantifies differences between predicted values (expert perceptions) and the observed values (individual stakeholder responses) using the formula:

$$RMSE_{ijk} = \sqrt{\frac{1}{n_{ijk}} \sum_{l=1}^{n_{ijk}} \left(S_{ijk} - E_{ijk}\right)^2}$$

Where $RMSE_{ijk}$ represents the root mean square error for type *i* (interest, influence, impact), species category *j* and site *k*; n_{ijk} is the number of stakeholder responses for type *i*, species category *j* and site *k*; S_{ijk} is the *l*-th stakeholder response for type *i*, species category *j* and site *k*, and E_{ijk} is the expert perception for type *i*, species category *j* and site *k*. This metric normalizes discrepancies by the number of responses, ensuring that it is not overly sensitive to variations in sample sizes. In simpler terms, the RMSE provides a single value that summarizes how much stakeholder responses differ from expert perceptions, with smaller RMSE values indicating closer alignment between the two. We visualized the RMSE scores using heat maps to illustrate differences between expert and stakeholder perceptions.

To analyze differences among the three “i”s (interest, influence, impact), we calculated the pairwise differences between these metrics for each species category across different sites. Specifically, we calculated pairwise differences (Interest-Influence, Interest-Impact, and Influence-Impact) for each individual response within each stakeholder group-species-site combination. These differences were averaged to represent the group's perspective using the following generalized formula:

$$Diff_{ijk} = \frac{1}{n_{ijk}} \sum_{l=1}^{n_{ijk}} \left(X_{ijk} - Y_{ijk}\right)$$

Where $Diff_{ijk}$ is the mean difference between metrics *X* and *Y* for species category *j* and site *k*, n_{ijk} is the number of stakeholder responses for species category *j* and site *k*, X_{ijk} and Y_{ijk} are the *l*-th stakeholder's responses for the two different metrics (i.e. interest-influence, interest-impact, influence-impact) for species category *j* and site *k*.

We visualized these differences using heat maps, which indicated the direction and strength of the deviations. Negative values represent a lower level of the first-mentioned metric compared to the second, while positive values indicate a higher level.

3. Results

3.1. Stakeholder groups

In total, we recorded responses from 251 individuals across the five sites (Bulgarian site: 33, German site: 58, Italian site: 75, Norwegian site: 27; Spanish site: 58; Table S2). The majority of respondents were middle-aged (35–49) to older middle-aged (50–64) males. In the

Bulgarian site, respondents were slightly younger, with an approximately even gender ratio (Fig. S1). Most of the respondents had at least secondary school education or professional training, with a substantial percentage (Bulgarian site: 69.7 %, German site: 79.3 %, Italian site: 41.3 %, Norwegian site: 74.1 %, Spanish site: 46.6 %) holding university degrees. The majority were open to engaging in discussions with individuals holding opposing views on wildlife management (Fig. S1).

Particularly in the German and Italian sites, and to a lesser degree in the Bulgarian site, respondents often indicated membership in multiple stakeholder groups (in the Norwegian and Spanish sites, respondents did not have the option to indicate multiple memberships) (Fig. 2). In the Bulgarian site, small overlaps were evident between crop and livestock farmers, crop farmers and hunters, and hunters and the tourism sector. In the German site, we observed substantial overlap between hunters and foresters, hunters and livestock farmers, livestock and crop farmers, and foresters and livestock farmers. Each of the seven stakeholder groups had some overlap with at least three other groups. In the Italian site, a strong overlap was evident between crop and livestock farmers,

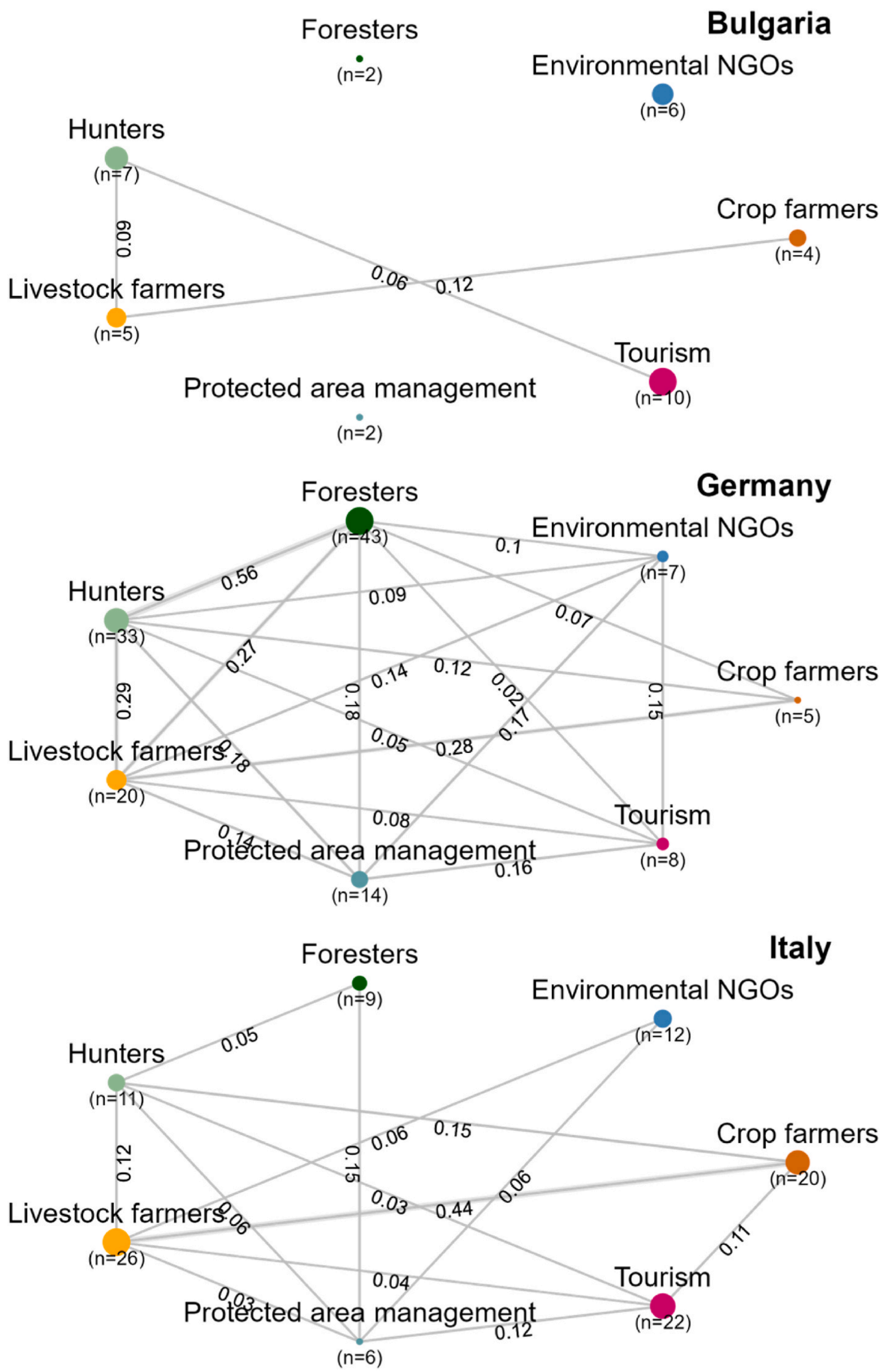

Fig. 2. Stakeholder networks of respondents from sites in Bulgaria, Germany, and Italy. Node sizes are proportional to the number of respondents in each stakeholder category (sample size indicated below each node). Edge widths represent the overlap between stakeholder dyads, calculated using the Jaccard index. Each edge is labelled with its corresponding Jaccard index score. For the Norwegian and the Spanish sites, respondents self-assigned to a single stakeholder group, therefore they are not shown.

while overlaps across other groups were less pronounced, though each stakeholder group had some overlap with at least two others (Fig. 2).

In all five sites, self-reported activities among stakeholders revealed notable pluriactivity, with many respondents engaging in multiple activities, such as forestry and hunting, as well as crop farming, wildlife watching, and livestock keeping. In contrast, respondents involved in beekeeping reported minimal involvement in other activities (Fig. 3).

3.2. Stakeholder perceptions toward wildlife species categories

Individuals from most stakeholder groups showed high interest in large herbivores (moose, red deer, wild reindeer, and chamois), omnivores (wild boar), and the carnivores grey wolf and brown bear (Fig. 4). However, most stakeholders in the Norwegian site showed less interest in wild boar compared to the other countries. Most stakeholders in the German and Italian sites expressed low to moderate interest in cormorants, with slightly higher interest among protected areas representatives. Interest in eagles was high among most stakeholder-site combinations. Interest in vultures differed distinctly across stakeholder groups in both the Bulgarian and Spanish sites.

The perceived influence on wildlife species categories varied considerably across species categories, sites, and stakeholder groups (Fig. 5). Most stakeholder groups reported high influence on red deer, roe deer, and wild boar. In contrast, respondents in the Norwegian site generally perceived themselves to have comparatively less influence on these ungulates. Across most sites, the perceived influence on chamois, brown bear, wolf, cormorant, and eagle was small to moderate. However, stakeholders in the Spanish site reported high influence on chamois. In addition, protected area managers in many sites reported high influence on chamois, brown bear, wolf, cormorant, and eagle. In the German and Norwegian sites, protected area managers reported low to moderate influence on several species categories, including large carnivores, cormorants and eagles. Perceived influence on the site-specific species categories such as wild reindeer, ground squirrel, and vulture varied across stakeholder groups (Fig. 5).

The majority of stakeholder groups reported being highly impacted by red deer, roe deer, wild boar, brown bear, and grey wolf (Fig. 6). However, stakeholders in the Norwegian site tended to report less impact from these species. Respondents in the German site perceived little impact by moose. In contrast, livestock farmers, foresters, hunters, and tourism operators in the Norwegian site perceived high moose impacts. While most stakeholder groups perceived chamois, cormorants, and eagles as having little to moderate impact, protected area managers reported high impacts from chamois (Bulgarian and Italian sites) and eagle (German site). With regard to chamois, stakeholders in the Spanish site reported greater impacts than their counterparts in the Bulgarian and Italian sites. The perceived impacts from site-specific species categories such as wild reindeer, ground squirrel, and vulture varied considerably across stakeholder groups (Fig. 6).

For all three “*i*” dimensions, the long boxplots indicate considerable variation within most site-stakeholder-species category combinations (Figs. 4–6).

3.3. Comparing stakeholder with expert perceptions

Contrasting stakeholder with expert perceptions suggests that most stakeholder groups had greater interest in wildlife species categories than expected by experts (Fig. 7). This trend was particularly evident for red deer (e.g. crop farmers, livestock farmers, and tourist operators in the Bulgarian and German sites), chamois (most stakeholder groups in the Bulgarian, Italian, and Spanish sites), roe deer (most stakeholder groups in all sites), wild boar (most stakeholder groups in all sites), cormorant (most stakeholder groups in the Italian and German sites), and eagle (most stakeholder groups in all sites). In contrast, expert and stakeholder perceptions aligned for some combinations (e.g. protected area managers with respect to brown bear [in the Norwegian, Italian, and Bulgarian sites], eagle and vulture [Bulgarian site]). Stakeholder perceptions were lower than those of experts in only a few cases (Figs. 4 and 7).

Differences between expert and stakeholder-perceived influence on wildlife species groups were less pronounced than those in “interest in” wildlife species categories (Fig. 6). However, several stakeholder-site-species category combinations deviated from this general pattern (Fig. 5; Fig. 7).

Similarly, expert and stakeholder perceptions aligned overall for impacts by wildlife (Fig. 7). Exceptions included mismatches for perceived impacts on hunters by wolves in the Norwegian site, impacts by ground squirrels and vultures on livestock farmers in the Bulgarian site, and impacts by chamois on hunters and tourism operators in the Spanish site (Figs. 6 and 7).

3.4. Comparing the three i dimensions

In most site-stakeholder-species combinations, perceived interest in a given wildlife category exceeded influence on that category (Fig. 8). This pattern was particularly pronounced for the moose in the German site (less so in the Norwegian site), brown bear in the Norwegian and Bulgarian sites (but not in the Italian site), the wolf in the Norwegian site (but not in the Italian site), and eagles across all sites. Overall, the wild boar was the only case where interest and influence aligned, or where influence frequently exceeded interest (Fig. 8).

Similarly, interest in a species category exceeded perceived impact by that category in many cases. While this was the case for brown bear and wolf in the Norwegian and Bulgarian sites, the opposite pattern was observed in the Italian site. Here, perceived impact often exceeded stated interest in brown bear. In the German site, crop and livestock farmers also perceived the impact from wolves to exceed their interest in this species (Fig. 8).

Perceived influence on and impact by wildlife broadly aligned for most of the species categories (Fig. 8). However, for brown bear and wolf, the perceived impact of the species exceeded the perceived influence on the species. This was particularly pronounced for livestock farmers (Bulgarian, German, Italian, and Norwegian sites), foresters (Bulgarian and Norwegian sites), hunters (German and Italian sites), and environmental NGOs (Bulgarian, German, Italian, and Norwegian sites). Similarly, hunters and tourism operators in the Spanish site, and livestock farmers in the Norwegian site, perceived the impact of eagles to outweigh their influence on this species category (Fig. 8).

4. Discussion

Based on a structured comparison of stakeholder perceptions in five European multiple-use landscapes, our results highlight the context-dependent nature of human-wildlife interactions, a pattern frequently observed in comparative studies on human-wildlife interactions (Zimmermann et al., 2021). Perceptions of interest in, influence on, and impact by wildlife species varied not only across sites and species but also between and within stakeholder groups. The observed heterogeneity, along with considerable pluriactivity of stakeholders, challenges simplified narratives of well-defined social conflicts associated with human-wildlife interactions. While experts often underestimated stakeholder interest in wildlife species, the most important general pattern to emerge was the mismatch between perceived impact and influence. This was particularly evident for certain stakeholders groups (especially, but not limited to, livestock keepers) in relation to large carnivores and birds of prey in some sites, underscoring a sense of powerlessness in managing interactions with these wildlife species.

4.1. Stakeholder perceptions across sites, stakeholder groups, and species

Using the *3i* method, we found substantial variation in stakeholder interest in wildlife species categories, though most wildlife received

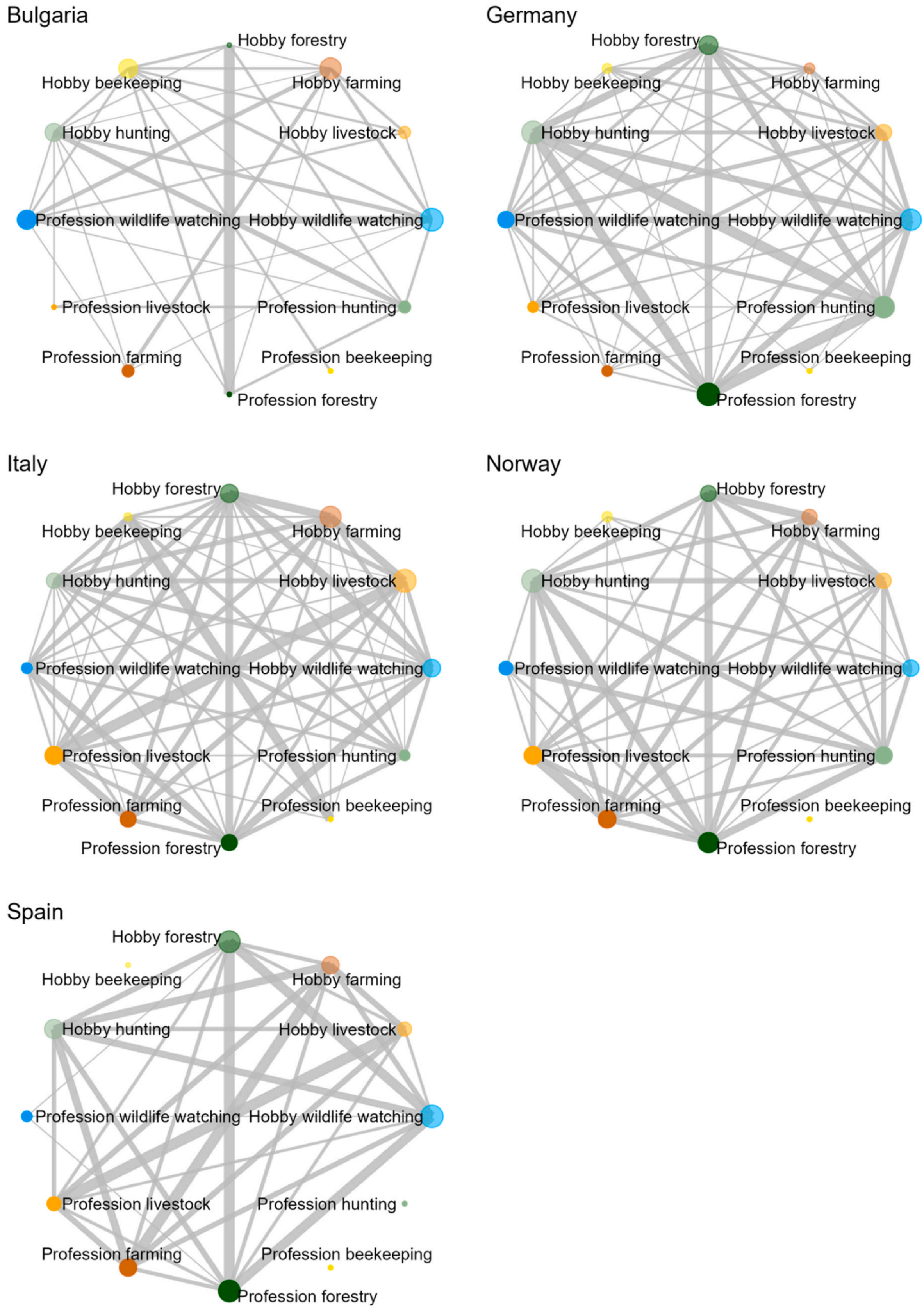

Fig. 3. Networks of activities (farming = crop farming; livestock = livestock keeping; forestry = forestry; hunting = hunting; beekeeping = beekeeping, wildlife watching = wildlife watching; either as hobbies or in professional capacities) reported by stakeholders in Bulgaria, Germany, Italy, Norway, and Spain. Node sizes are proportional to the number of respondents engaging in each activity, while edge widths represent the degree of shared engagement between activity dyads, calculated using the Jaccard index.

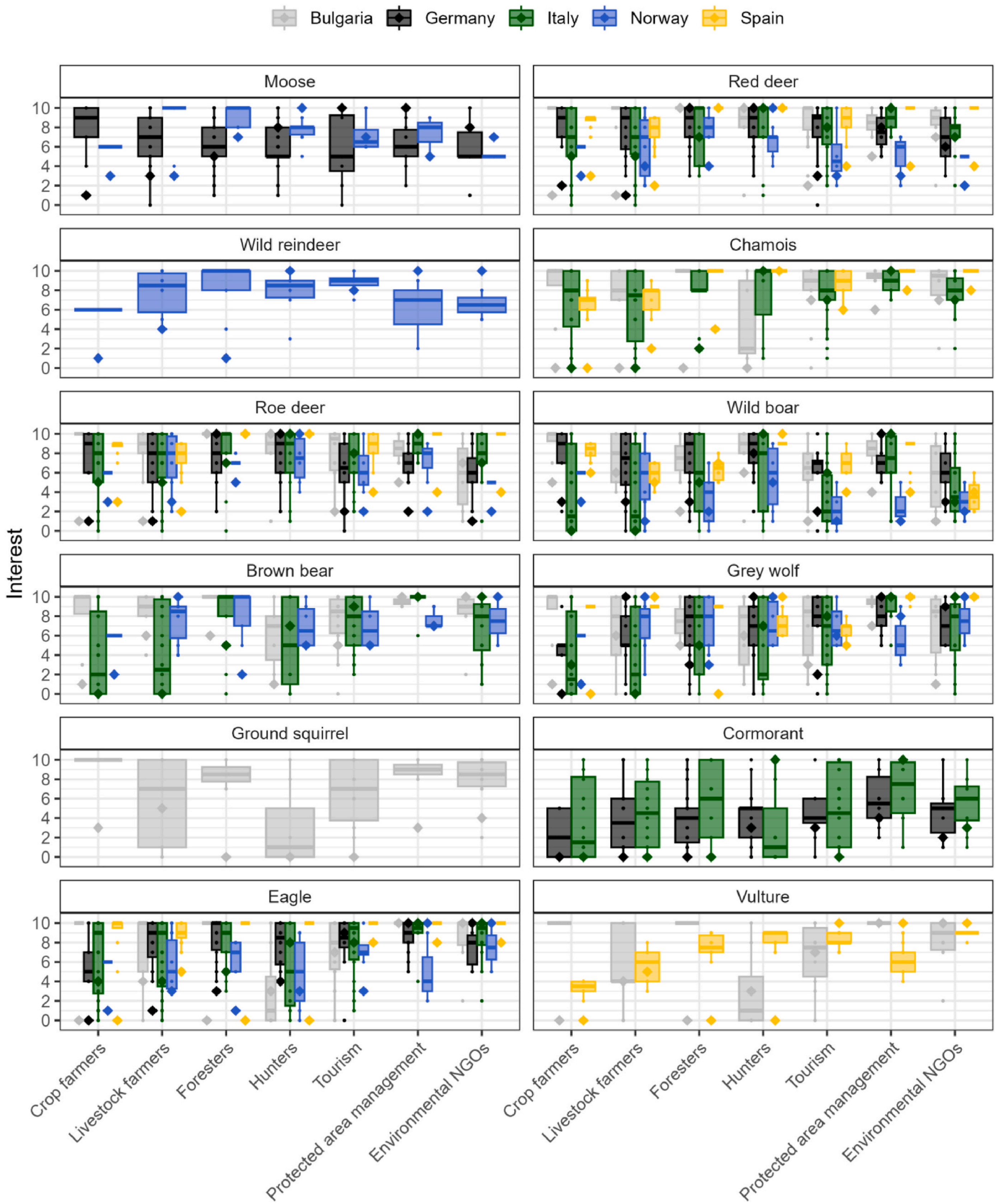

Fig. 4. Stakeholder interest in wildlife species categories in five European case study sites. Boxplots display the distribution of interest scores (on a scale of 0–10) for mammalian herbivores (moose *Alces alces*, red deer *Cervus elaphus*, wild reindeer *Rangifer rangifer*, chamois *Rupicapra rupicapra/Rupicapra pyrenaica*, and roe deer *Capreolus capreolus*), omnivores (wild boar *Sus scrofa*), two carnivores (grey wolf *Canis lupus* and brown bear *Ursus arctos arctos*), an endangered small herbivore (ground squirrel *Spermophilus citellus*), and three bird species or categories (cormorant *Phalacrocorax carbo*, eagles *Aquila chrysaetos* and *Haliaeetus albicilla*, and vultures *Gypaetus barbatus, Gyps fulvus*, *Neophron percnopterus,* and *Aegypius monachus*). Expert -provided scores are shown with diamond markers.

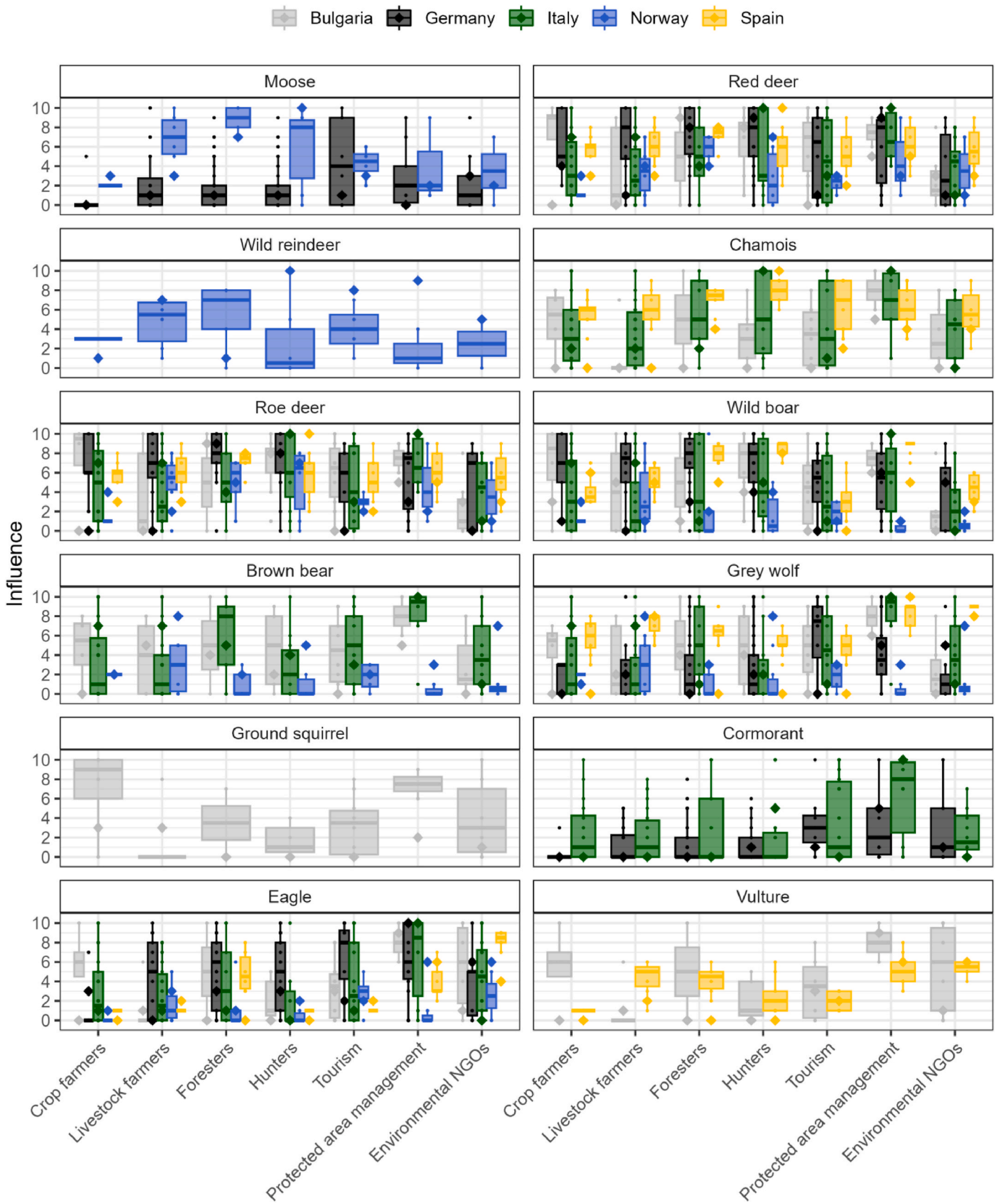

Fig. 5. Stakeholder influence on wildlife species categories in five European case study sites. Boxplots display the distribution of influence scores (on a scale of 0–10) for mammalian herbivores (moose *Alces alces*, red deer *Cervus elaphus*, wild reindeer *Rangifer rangifer*, chamois *Rupicrapra rupicapra/Rupicapra pyrenaica*, and roe deer *Capreolus capreolus*), an omnivore (wild boar *Sus scrofa*), two carnivores (grey wolf *Canis lupus* and brown bear *Ursus arctos arctos*), an endangered small herbivore (ground squirrel *Spermophilus citellus*), and three bird species or categories (cormorant *Phalacrocorax carbo*, eagles *Aquila chrysaetos* and *Haliaeetus albicilla*, and vultures *Gypaetus barbatus, Gyps fulvus*, *Neophron percnopterus,* and *Aegypius monachus*). Expert-provided scores are shown with diamond markers.

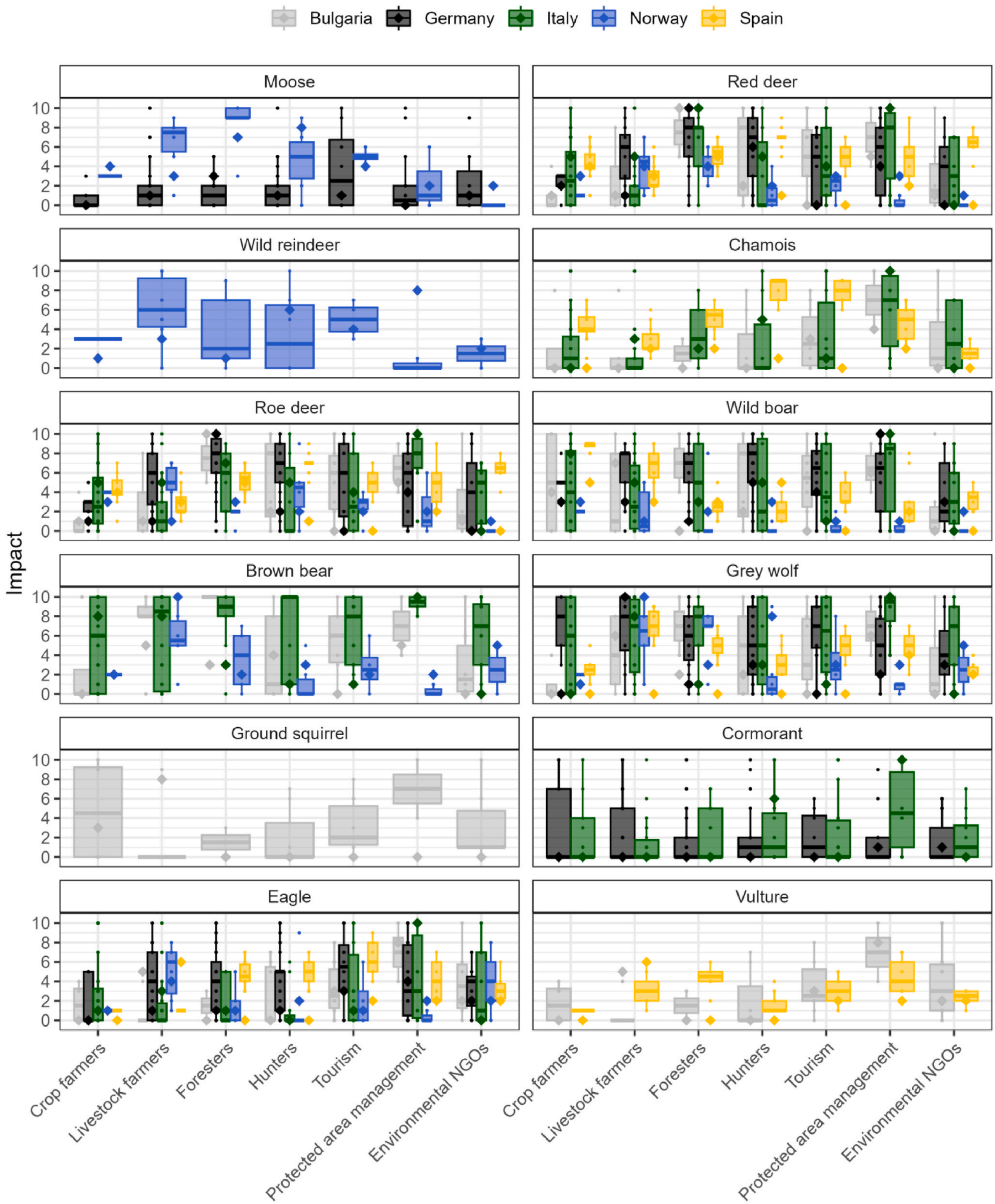

Fig. 6. Impact of wildlife species categories on stakeholder groups in five European case study sites. Boxplots display the distribution of impact scores (on a scale of 0–10) for mammalian herbivores (moose *Alces alces*, red deer *Cervus elaphus*, wild reindeer *Rangifer rangifer/Rupicapra pyrenaica*, chamois *Rupicrapra rupicapra/Rupicapra pyrenaica*, and roe deer *Capreolus capreolus*), an omnivores (wild boar *Sus scrofa*), two carnivores (grey wolf *Canis lupus* and brown bear *Ursus arctos*), an endangered small herbivore (ground squirrel *Spermophilus citellus*), and three bird species or categories (cormorant *Phalacrocorax carbo*, eagles *Aquila chrysaetos* and *Haliaeetus albicilla*, and vultures *Gypaetus barbatus, Gyps fulvus*, *Neophron percnopterus,* and *Aegypius monachus*). Expert-provided scores are shown with diamond markers.

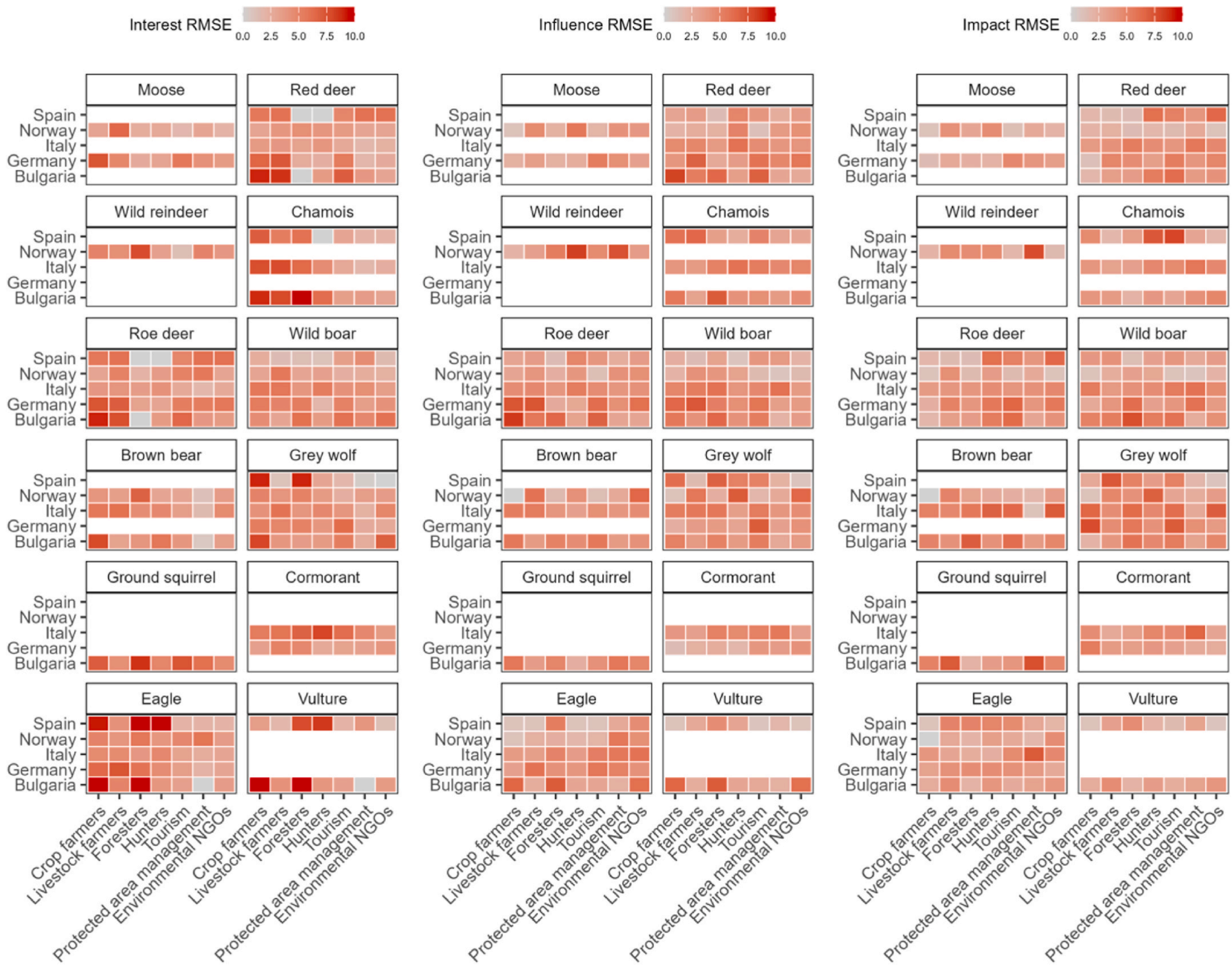

Fig. 7. Heatmap of stakeholder-expert agreement on the three "*i*"s: interest in, influence on, and impact by mammalian herbivores (moose *Alces alces*, red deer *Cervus elaphus*, wild reindeer *Rangifer rangifer*, chamois *Rupicapra rupicapra/Rupicapra pyrenaica*, and roe deer *Capreolus capreolus*), an omnivore (wild boar *Sus scrofa*), two carnivores (grey wolf *Canis lupus* and brown bear *Ursus arctos arctos*), an endangered small herbivore (ground squirrel *Spermophilus citellus*), and three bird species or categories (cormorant *Phalacrocorax carbo*, eagles *Aquila chrysaetos* and *Haliaeetus albicilla*, and vultures *Gypaetus barbatus, Gyps fulvus*, *Neophron percnopterus,* and *Aegypius monachus*). Each heatmap illustrates the level of agreement between stakeholder and expert perceptions of interest in each species category across stakeholder groups. Color intensity indicates the degree of agreement, providing insights into areas of consensus or divergence regarding the three "*i*"s.

high interest (Fig. 4). While we (indicated by the a priori expert scores) expected that stakeholders with clear connections to wildlife would have high interest in specific species (e.g. hunters interested in huntable species such as roe and red deer, tourism operators in charismatic species like eagles or bears, and conservation NGOs in species of conservation concern like vultures), we were surprised to observe relatively consistent high levels of interest across a broader range of species categories and stakeholder groups. These interest scores often exceeded expert expectations for stakeholder-species category combinations. This indicates that interest is not only shaped by direct management roles or tangible interactions but perhaps also by ecological, cultural, economic, or emotional significance that many wildlife species hold for people (Jacobs, 2012; Manfredo, 2008; Methorst et al., 2020).

We found that stakeholder perceptions of influence and impact varied considerably by species category and location (Figs. 5 and 6). While a range of cultural and regional differences may contribute to these patterns, it could be that species abundances also play a role in shaping these perceptions. For example, stakeholders in the Norwegian site perceived high influence on and impact by moose and reindeer, two species that are relatively abundant and hold substantial economic, cultural, and ecological significance in the region (Kaltenborn et al., 2014; Storaas et al., 2001; Timmermann and Rodgers, 2005). In contrast, roe deer and wild boar, while abundant in the German, Italian, Spanish and Bulgarian sites (Burbaite and Csányi, 2009; Carpio et al., 2021; Massei et al., 2015), were perceived as having little impact by stakeholders in the Norwegian site, likely due to their low densities in the Norwegian site (Markov et al., 2022; Melis et al., 2010). Similarly, stakeholders in the German site showed high interest in moose, despite its rarity in this area (Ostermann-Miyashita et al., 2023a), and reported little influence on or impact by moose. However, as we did not have access to comparable abundance estimates across sites and our sample includes only five sites, we could not formally test this hypothesis. We recommend that future research explicitly test the hypothesized positive association between species abundance and perceived impact, using a larger number of sites and standardized abundance estimates.

With regard to species categories, large carnivores, especially bears, wolves and eagles were often perceived as more problematic than other species, a pattern that is frequently observed in multi-species

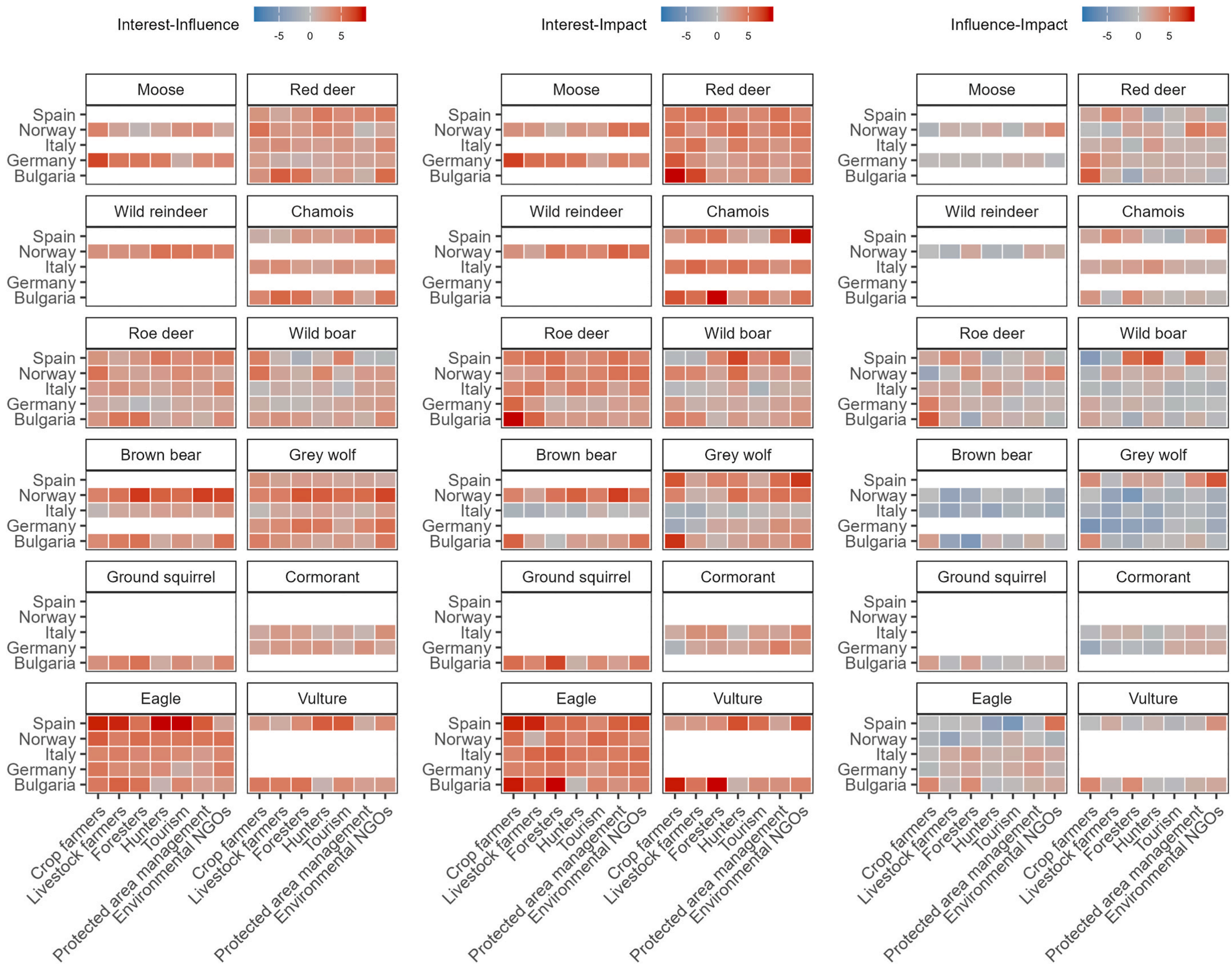

Fig. 8. Heatmap, illustrating differences between the three "*i*"s. interest in, influence on, and impact by mammalian herbivores (moose *Alces alces*, red deer *Cervus elaphus*, wild reindeer *Rangifer rangifer*, chamois *Rupicrapra rupicapra/Rupicapra pyrenaica*, and roe deer *Capreolus capreolus*), an omnivores (wild boar *Sus scrofa*), a carnivore (grey wolf *Canis lupus* and brown bear *Ursus arctos arctos*), an endangered small herbivore (ground squirrel *Spermophilus citellus*), and three bird species or categories (cormorant *Phalacrocorax carbo*, eagles *Aquila chrysaetos* and *Haliaeetus albicilla*, and vultures *Gypaetus barbatus, Gyps fulvus*, *Neophron percnopterus,* and *Aegypius monachus*). Each heatmap represents the difference between a dyad of interest, influence and impact. The color coding indicates the direction and magnitude of the differences.

assessments of attitudes towards wildlife (Basak et al., 2023; Ostermann-Miyashita et al., 2023b). However, such perceptions are not universal. For example, Lescureux and Linnell (2010) found that another large carnivore species, lynx (*Lynx lynx*), is typically perceived more neutrally, perhaps due to its more elusive behavior and lower perceived threat. More broadly, Cortés-Avizanda et al. (2022) demonstrated that local perceptions of species importance can diverge substantially from global conservation priorities, a pattern echoed in our findings of low interest in ground squirrels and vultures among some stakeholder groups (Fig. 4).

Patterns also emerged within stakeholder groups across sites. For example, livestock keepers generally perceived high impacts from large carnivores and low influence over these species, reflecting a shared sense of vulnerability. A notable exception included the wolf in the Spanish site, where livestock farmers did not perceive that wolf impacts exceeded their influence on this species. We hypothesize that this is due to the infrequent presence of wolves in this case study area. However, as wolves are more regularly present in areas adjacent to the Spanish site, this situation may change (Ballarín et al., 2023). On the other hand, hunters and foresters exhibited more site-specific variation, particularly regarding species like roe deer, red deer, and wild boar, likely reflecting differences in national hunting policies, laws and stakeholder roles (Putman, 2011).

4.2. Rethinking stakeholder roles

Media, politics, and public discourse often portray social conflicts around human-wildlife interactions as entrenched and polarized (Hansen et al., 2022; Marino et al., 2023; Mori et al., 2025) and contribute to exacerbate these conflicts by using sensational wording and images (Bombieri et al., 2018; Nanni et al., 2020). This polarized framing obscures the heterogeneity within stakeholder groups, reinforces stereotypes, and may eventually further entrench conservation conflicts (von Essen and Hansen, 2015). Across all three "*i*" dimensions, we observed substantial variation among and between stakeholder groups (Figs. 4–6). This challenges the often assumed notion that conflicts over human-wildlife interactions or wildlife management arise from well-defined, oppositional stakeholder interests for example between livestock farmers vs. conservationists (König et al., 2021b; Suryawanshi et al., 2013). Instead, our findings highlight the complexity of human societies, where diverse perspectives exist even within seemingly cohesive groups.

Although our sampling approach (based on direct contacts and snowball sampling) does not ensure representativeness, the observed diversity of perspectives echoes studies that found similarly diverse and value-based positions within stakeholder categories (Bredin et al., 2015; Jacobsen and Linnell, 2016). This social complexity was reflected in our sample, where people hold varied and sometimes conflicting views based on their roles and activities as exemplified by large variation in the three "*i*" scores (Figs. 4–6).

In this context, our results indicate a lack of clear distinctions between stakeholder groups, with individuals often identifying as being members of multiple stakeholder groups (Fig. 2). This result is consistent with the highly connected stakeholder networks described in similar research that focused on carnivore management across 14 European regions (Grossmann et al., 2020). In line with Grossmann et al. (2020), we assume that high levels of stakeholder overlap are prevalent among rural populations. For example, in many European regions, farmers have adopted diversification strategies such as mixed crop-livestock farms and agro-tourism to secure their income (Finger and El Benni, 2021). Similarly, engagement in multiple activities, such as forestry, hunting, crop and livestock farming, was relatively consistent across the five sites (Fig. 3) and largely resembled those identified by Grossmann et al. (2020).

While within group heterogeneity and overlap among stakeholder groups may challenge naïve perceptions of stakeholder roles, these aspects also present opportunities for preventing, resolving, or de-escalating conservation conflicts (Grossmann et al., 2020). For instance, individuals with multiple stakeholder roles – whether through their profession or leisure activities (Fig. 3) – may navigate internal trade-offs between competing interests and promote more balanced views that may diverge from the norms of one group. For example, farmers who identify as conservationists are less likely to support lethal control of wildlife compared to farmers who do not identify as conservationists (van Eeden et al., 2019). In addition, individuals wearing multiple stakeholder hats may be better positioned to understand and navigate diverse viewpoints. This capacity has been linked to greater empathy, a key skill for resolving social conflict (Kansky and Maassarani, 2022). Similarly, Eklund et al. (2023) highlight the importance of empathy and mutual understanding as prerequisites for coexistence. By integrating multiple perspectives, such individuals could act as mediators or connectors, and perhaps even facilitate dialogue between interest groups (Grossmann et al., 2020).

4.3. Methodological contributions and challenges

The *3i* method provides an efficient and structured framework for assessing stakeholder-wildlife relationships, offering nuanced insights into stakeholder perceptions of wildlife. While stakeholder perceptions do not directly translate into behavioral intentions, behaviors (Willcox et al., 2012), or lobbying for preferred wildlife management options (Eriksson et al., 2024; Kaltenborn et al., 2006), this method facilitates the identification of common ground among stakeholders, an essential starting point for establishing productive dialogue.

Unlike expert-driven approaches, such as the SEEDS framework (Ceaușu et al., 2019), the *3i* method engages stakeholders and the resulting scores for interest, influence, and impact reflect their lived experiences and priorities. Given the marked deviations between expert and stakeholder perceptions (Fig. 7), this participatory focus is crucial for capturing the complexity and diversity of stakeholder perceptions and avoiding the pitfalls of oversimplified, expert-driven approaches.

While the *3i* method is useful for quick and comparative assessments of stakeholder perspectives, it has limitations. By focusing on quantitative indicators of stakeholder-wildlife relationships, the methods does not explore the underlying drivers of these variations, which may be rooted in a suite of identity-based, psychological, cultural, or demographic factors (Clayton and Myers, 2015). In addition, we did not sample across all possible stakeholder groups (Linnell, 2013). While the demographic profile of our sample may be indicative of stakeholders involved in European wildlife management, and broadly reflects the demographic profile observed in a similar cross-European study (Grossmann et al., 2020), it is not a representative sample of the general rural public. More rigorous sampling frames across additional sites and stakeholder groups may provide more generalizable findings and could provide insights into additional dimensions such as gender roles and cultural identity. However, this would probably imply moving away from a stakeholder perspective as these wider demographics may not self-identify as stakeholders or engage in the potentially conflicting activities that our study focused on.

Furthermore, combining the *3i* method with qualitative interviews, perhaps with a subset of the sampled stakeholders, may provide a more comprehensive understanding of human-wildlife relationships and underlying causes of conflict (Zimmermann et al., 2020). Despite these concerns, extending the *3i* method to examine discrepancies between the three dimensions – particularly the contrast between influence on and impact by wildlife species – allows identifying challenges faced by stakeholders across sites.

4.4. Implications for the theory and practice of human-wildlife coexistence

The perception of powerlessness, especially in relation to large carnivores, is a recurring theme in the human-wildlife coexistence literature (Bredin et al., 2015; Frank et al., 2019; Jacobsen and Linnell, 2016; Treves and Karanth, 2003). High levels of perceived impact by wolves, bears, and in some sites also by eagles, coupled with a low sense of influence over these species categories, were particularly evident among livestock farmers, but also among foresters, hunters and even environmental NGOs or tourism operators (Fig. 8). For livestock farmers, this mismatch may result from several factors. These include ineffective prevention methods (Eklund et al., 2017; Kiffner et al., 2022), unpredictability of predation events (Tattoni et al., 2025), limited access to effective protection methods, lack of governmental funding, insufficient training, perceptions of excessive costs to implement prevention methods (van Eeden et al., 2018), delays in or absence of compensation payment schemes (Ravenelle and Nyhus, 2017), and the psychological toll of recurring livestock losses (Barua et al., 2013; Eklund et al., 2020). Together, these factors may contribute to increasing mistrust that some farmers have toward institutions and government agencies, as identified in several studies (Gronewold et al., 2012; Larsson et al., 2022). We recommend that future studies examine the relative importance of these factors to guide specific interventions that improve outcomes of human-wildlife interactions.

The perceived lack of agency in effectively preventing impacts by wolves and bears in multiple sites, provides context for understanding frequent calls for lethal control of bears and wolves (Fernández-Gil et al., 2016; Kiffner et al., 2019), and possibly also for widespread poaching of wolves in many European regions (Højberg et al., 2017; Liberg et al., 2012; Planillo et al., 2024; Sunde et al., 2021). Recent changes in EU law that ease restrictions on the use of lethal wolf control (Ostermann-Miyashita et al., 2025) present an opportunity to track whether such policy changes mediate stakeholder perceptions and increase their sense of agency. Repeated *3i* assessment could be used for this purpose, but, given the dynamic nature of attitudes towards wolves and bears (Dressel et al., 2015; Glikman et al., 2019; Tattoni et al., 2017, 2024), such assessments should ideally follow a robust before-after-control design.

Human-wildlife coexistence theory emphasizes that participatory models for engaging stakeholders yield better conservation outcomes than top-down approaches (Redpath et al., 2017; Treves et al., 2006).

When stakeholders perceive conservation conflicts as shared challenges, they are more likely to collaboratively work on solutions (Redpath et al., 2013). Evidence from conservation projects (Farwig et al., 2024) and measures, such as translocations of wildlife (Serota et al., 2023), demonstrates that applying these concepts in practice improve outcomes. Participation should not only be central to conflict mitigation but be integrated into adaptive wildlife management, ensuring that management remains responsive to evolving ecological and social dynamics. While exploratory in nature, our study provides insights relevant for both researchers and practitioners involved in designing stakeholder-engagement formats in wildlife management.

For authorities and conservation practitioners, the observed sense of powerlessness in preventing damage by wolves, bears, and eagles underscores the need for targeted efforts to address stakeholders' perceived lack of agency. Co-developing, co-testing, and scaling up accessible, context-specific, cost-effective, and culturally accepted damage prevention methods can empower stakeholders to better protect their assets such as livestock and beehives (Ostermann-Miyashita et al., 2025).

For both researchers and policymakers, the variation within and overlap among stakeholder groups highlights the importance of inclusive stakeholder engagement processes. Co-management initiatives should move beyond selecting a few representatives from stakeholder groups to instead involve a wider range of individuals, reflecting diverse interests, perspectives, and intra-group heterogeneity. As a possible starting point, establishing and sustaining forums for dialogue can create platforms for mutual understanding, allowing all interested parties to build trust, exchange information, establish a joint knowledge base, find common ground, and co-create place-based coexistence strategies (Hansen et al., 2022).

Finally, to achieve culturally sensitive and ecologically sustainable management practices, policymakers and conservation managers should embrace flexible, participatory frameworks that accommodate the full diversity of interests, needs, and values within and across stakeholder groups. Engaging a broad range of representatives, including underrepresented voices, can foster more equitable, just, and culturally sensitive co-management systems that balance the needs of both humans and wildlife (Harris et al., 2023).

CRediT authorship contribution statement

Christian Kiffner: Writing – original draft, Visualization, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **John D. C. Linnell:** Writing – review & editing, Project administration, Funding acquisition. **Simona Capelli:** Writing – review & editing, Software, Investigation, Data curation. **Marco Ciolli:** Writing – review & editing, Supervision, Software, Project administration, Investigation, Funding acquisition, Data curation. **Ana Iglesias:** Writing – review & editing, Resources, Project administration, Investigation, Funding acquisition, Data curation. **Kyle Jewell:** Writing – review & editing, Software, Investigation, Data curation. **Bjørn Kaltenborn:** Investigation, Data curation. **Hannes J. König:** Writing – review & editing, Resources, Project administration, Investigation, Funding acquisition. **Daniel Martin-Collado:** Writing – review & editing, Investigation. **Hristina Prodanova:** Writing – review & editing, Resources, Investigation. **Barbara Soriano:** Writing – review & editing, Investigation, Data curation. **Vanya Stoycheva:** Writing – review & editing, Resources, Investigation, Data curation. **Clara Tattoni:** Writing – review & editing, Investigation, Data curation. **Sandra Uthes:** Writing – review & editing, Funding acquisition. **Stefania Volani:** Writing – review & editing, Software, Investigation, Data curation. **Moya Zöller:** Investigation, Data curation. **Emu-Felicitas Ostermann-Miyashita:** Writing – review & editing, Project administration, Funding acquisition, Conceptualization.

Declaration of AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT 4o in order to improve readability and grammar. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvman.2025.126186.

Data availability

Data will be made available on request.

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