




Key conservation actions for European steppes in the context of the Post-2020 Global Biodiversity Framework

Cristian Pérez-Granados^{1,2}  · Ana Benítez-López³ · Mario Díaz³ · João Gameiro^{4,5,6} · Bernd Lenzner⁷ · Núria Roura-Pascual⁸ · Julia Gómez-Catasús^{9,10} · Rocío Tarjuelo¹¹ · Adrián Barrero^{9,10} · Luis Bolonio¹² · Gerard Bota² · Mattia Brambilla¹³ · Carolina Bravo¹⁴ · Lluís Brotons^{2,15,16} · Daniel Bustillo-de la Rosa^{9,10} · Xabier Cabodevilla² · Antonio Calvo Búrdalo¹⁷ · Ana Carricondo¹⁸ · Fabián Casas¹⁹ · Elena D. Concepción³ · Soraya Constán-Nava^{1,20} · Tiago Crispim-Mendes²¹ · David Giralt² · Marina Golivets²² · Guillaume Latombe²³ · Antonio Leiva²⁴ · Germán M. López-Iborra¹ · Gabriel López-Poveda¹ · Santi Mañosa^{25,26} · Carlos A. Martín²⁷ · Manuel B. Morales^{9,10} · Francisco Moreira^{4,5,6} · Francois Mougeot¹⁴ · Boris Nikolov²⁸ · Pedro P. Olea^{9,10} · Alejandro Onrubia²⁹ · Margarita Reverter^{9,10} · Natalia Revilla-Martín² · Stanislas Rigal³⁰ · Gema Ruiz Jiménez²⁴ · Pedro Sáez-Gómez^{9,10} · Martin Šálek^{31,32,33} · Iván Salgado³⁴ · Andrea Santangeli³⁵ · Carlos Santos³⁶ · Ana Sanz-Pérez^{2,25} · David Serrano³⁷ · João Paulo Silva^{4,6} · Antonio Torrijo²⁴ · Juan Traba^{9,10} · Piotr Tryjanowski³⁸ · Radovan Václav³⁹ · Francisco Valera¹² · Matthias Vögeli⁴⁰ · Julia Zurdo^{9,10} · Ana T. Marques^{4,5,6}

Received: 16 January 2024 / Accepted: 14 November 2024 / Published online: 24 January 2025
© The Author(s) 2025, corrected publication 2025

Abstract

The Kunming–Montreal Global Biodiversity Framework (KM–GBF) envisions a world living in harmony with nature by 2050, with 23 intermediate targets to be achieved by 2030. However, aligning international policy and national and local implementation of effective actions can be challenging. Using steppe birds, one of the most threatened vertebrate groups in Europe, as a model system, we identified 36 conservation actions for the achievement of the KM–GBF targets and we singled out—through an expert-based consensus approach—ten priority actions for immediate implementation. Three of these priority actions address at least five of the first eight KM–GBF targets, those related to the direct causes of biodiversity loss, and collectively cover all the targets when implemented concurrently. These actions include (i) effectively protecting priority areas, (ii) implementing on-the-ground habitat management actions, and (iii) improving the quality and integration of monitoring programmes. Our findings provide a blueprint for implementing effective strategies to halt biodiversity loss in steppe-like ecosystems. Our approach can be adapted to other taxonomic groups and ecosystems and has the potential to serve as a catalyst for policy-makers, prompting a transition from political commitment to tangible actions, thereby facilitating the attainment of the KM–GBF targets by 2030.

Keywords Biodiversity targets · Conservation policy · Kunming–Montreal · Steppe birds · Consensus participatory approach

Introduction

Biodiversity is essential for sustaining life, ecosystem functioning, and human well-being (Díaz and Malhi 2022). However, global biodiversity is declining rapidly, with an

average reduction of 69% in species populations since 1970 (WWF 2022), and up to one million species are currently at risk of extinction due to anthropogenic activities (IPBES 2019). The reasons are manifold, but are dominated by direct exploitation, land and sea use change, invasive alien species, climate change, and pollution (Díaz et al. 2019; IPBES 2019; Díaz 2023). International policy frameworks, such as the Aichi Targets of the Strategic Plan for Biodiversity 2011–2020 (CBD 2011) and the United Nations Sustainable Development Goals (SDGs, UN 2015), have been designed to address and mitigate biodiversity loss and to foster peace

Handled by Garry Peterson, Stockholm Resilience Centre, Sweden.

Ana Benítez-López, Mario Díaz, João Gameiro and Ana T. Marques have equally contributed.

Extended author information available on the last page of the article

and prosperity for people and the planet. Despite concerted international conservation efforts, humanity has largely failed to meet these targets, and the loss of biodiversity continues unabated (IPBES 2019).

In December 2022, the UN Biodiversity Conference (CBD COP 15) adopted the Kunming–Montreal Global Biodiversity Framework (KM–GBF) to guide future biodiversity conservation policy. The KM–GBF comprises 23 action-oriented targets that should be accomplished by 2030 to address the biodiversity crisis and achieve a global vision of “living in harmony with nature by 2050” (CBD 2022). The first eight targets of the KM–GBF directly address the biodiversity crisis through (i) effectively protecting, managing, restoring, and connecting at least 30% of important areas (Targets 1, 2, and 3), (ii) ensuring management actions to reduce extinction risk of threatened species and promoting the sustainable use of species and ecosystems (Targets 4 and 5), (iii) preventing or reducing the introduction and establishment of invasive alien species (Target 6), (iv) reducing nutrient loss to the environment and the use of pesticides (Target 7), and v) contributing to climate change mitigation and adaptation (Target 8) (CBD 2022).

The KM–GBF builds upon the achievements, shortcomings, and lessons learned from the Strategic Plan for Biodiversity 2011–2020. It also partially aligns with the goals of other international policy frameworks and action programmes, such as the UN Agenda for Sustainable Development 2030, the UN Decade on Ecosystem Restoration 2020–2030, and the EU General Union Environment action programme to 2030. Therefore, the current decade is critical to bending the curve of biodiversity loss and providing a standard of living in closer harmony with nature (Leclère et al. 2020). A key factor limiting the success of prior global conservation initiatives was the difficult translation of global targets into effective, evidence-based national- or local-level actions (Sutherland et al. 2004; Svancara et al. 2005; Green et al. 2019; Perino et al. 2022), an issue shared across various global policy goals, including public health, sustainable development, and education, among others (e.g. Moyer and Hedden 2020; Greer et al. 2022). Here, we aim to identify concrete conservation actions that will contribute to the effective translation of the first eight KM–GBF targets for European steppic habitats (steppes hereafter, Traba et al. 2013). To do so, we use a design protocol that could provide valuable insights for addressing similar issues for other ecosystems as well as in other policy domains. European steppes encompass natural and seminatural open habitats, such as natural steppes, dry cereal farmlands and grasslands, and scrublands. We focused the exercise to steppes, because the European steppe biome plays a major ecological role (e.g. acting as a global carbon sink, improving nutrient circulation, and maintaining wild ungulates, reviewed by Wesche et al. 2016) and has great relevance for European

biodiversity conservation (Kirschner et al. 2020). These unique habitats harbour distinctive communities of flora and fauna (Morales and Traba 2016, see Kirschner et al. 2020); therefore, safeguarding steppes is key to preserving a remarkable and species-rich ecosystem in Europe (Burfield et al. 2023; Morales et al. 2023). Over the past 300 years, vast portions of European steppes have undergone significant anthropogenic transformations, including their conversion into intensive agricultural land and settlements (Ellis et al. 2010). Hence, most European steppes are currently facing global threats owing to land-use intensification and climate change (Morales and Traba 2016). Because many European steppes are of anthropogenic origin and are managed for food production, they cannot be fully set aside for protection, and any conservation and management decisions need to be concerted across disparate stakeholders (Velado-Alonso et al. 2024), being thus an adequate case that could potentially translate to other ecosystems. We focused our study on Europe, where there is extensive research on biodiversity conservation and a strong commitment to environmental protection through regulations and agreements (e.g. the EU General Union Environment action programme to 2030, the EU IAS Regulation 1143/2014, Nature Restoration Law). Developing actions for Europe will help to identify conservation priorities regarding this endangered system (Wesche et al. 2016). Besides, the lessons and recommendations derived from this study may be applicable to other steppe areas and inform future similar exercises beyond Europe.

Steppe birds are of particular concern because they are one of the most threatened bird groups in Europe (Burfield et al. 2023) due to significant population decline since the 1970s, largely attributed to land-use changes resulting from anthropogenic activities (e.g. agricultural intensification and infrastructure development; Serrano et al. 2020; Šálek et al. 2021; Douglas et al. 2023; Rigal et al. 2023). Steppe birds can be considered study models and umbrella species for steppe conservation (Morales et al. 2023). Our final goal integrates a vision of “Steppes in harmony” by 2050, showcasing an effective, timely approach to identify actions based on internationally agreed-upon policies directly taking into account the opinions of experts and the needs of the specific context (Perino et al. 2022). The developed set of priority conservation actions provides guidelines to policy-makers and environmental administrations at the European, national, and regional levels for the implementation of the KM–GBF across Europe. These conservation actions might be tailored by the different stakeholders according to their commitments to the targets and their unique circumstances (Xu et al. 2021). Examples of potential stakeholders include nature NGO’s, such as BirdLife International partners, Ministries of Agriculture and/or Environment and the respective Nature Conservation Authorities, main public and private

farming associations, and infrastructures companies or lobbies at the regional and local levels.

We conducted a participatory Delphi-type study (Vernon 2009) with a multidisciplinary expert group (Supplementary Material S1). The method comprised the following steps: (i) selection of a facilitator team and recruitment of an expert panel, (ii) identification of the current situation of steppe birds (see Supplementary Material S2), (iii) online participatory discussions to collaboratively develop a comprehensive set of conservation actions to achieve the first eight targets of the KM–GBF, (iv) anonymous questionnaire survey to prioritise the most important actions to achieve the KM–GBF targets through consensus (66% agreement used as consensus threshold), and (v) identification of the links between prioritised actions and the KM–GBF targets (Fig. 1). The approach employed is generalisable beyond our specific regional and ecosystem focus and provides a roadmap that can be transferred to other contexts.

Materials and methods

Design

We employed the Delphi method, a structured, iterative, anonymous, and multi-round technique frequently used to facilitate consensus among groups of experts (Vernon 2009). The Delphi method is often reported as being too time-consuming and potentially having high attrition rates (Benitez-Capistros et al. 2014). To address these concerns,

we conducted the entire process online and minimised the interval between rounds (e.g. two days between the first and second rounds), ensuring sustained participant engagement (Mukherjee et al. 2015). This modified Delphi approach involved two successive online questionnaires distributed to the expert panel; only the second questionnaire was anonymous.

Recruitment of the expert panel

Participants were assembled to represent active experts in different aspects of steppe bird and ecosystem conservation across Europe, including academic researchers, conservation managers, and policy-makers from local and national environmental administrations, and NGO representatives. A total of 57 experts participated, forming a group from 11 European countries: 49 scientists, six conservation managers and policy-makers, and two NGO representatives (Supplementary Material S1). Academic researchers mostly belong to the *Research Group on Steppe Birds*, with ample expertise in steppe conservation and including several active members of different global and European conservation initiatives, such as IUCN and IPBES. Two European countries, Spain and Portugal, accounted for 44 out of the 57 (77.2%) participants.

Round 1: proposal of conservation actions

Participants received a link to a Google Docs document and were explicitly asked to i) summarise the current situation of

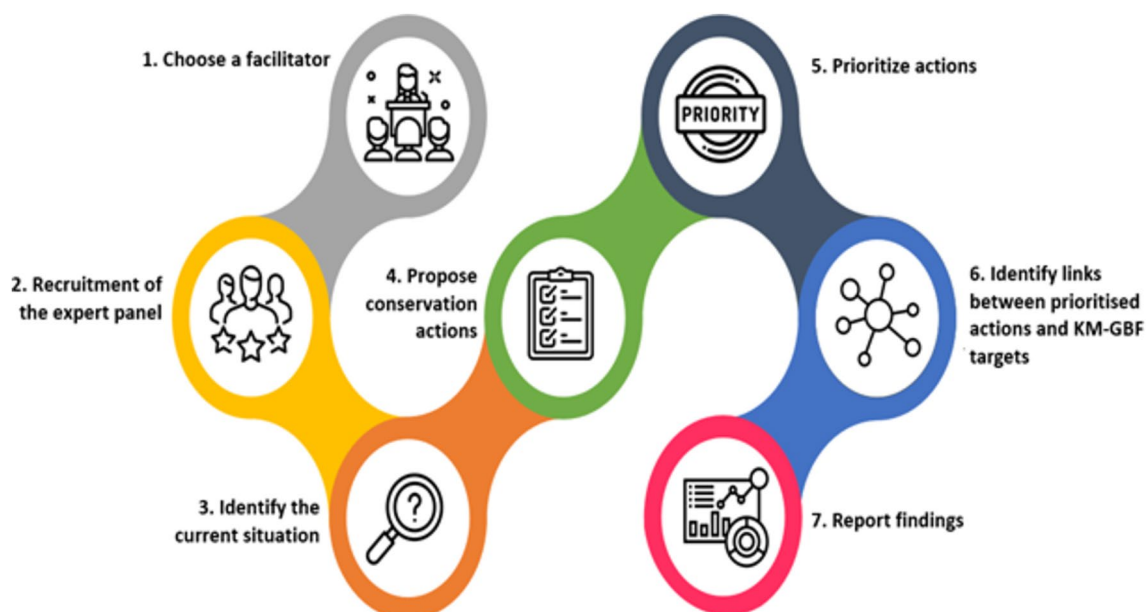


Fig. 1 Flowchart of the Delphi method employed to identify and prioritise conservation actions to achieve the first eight global targets of the Kunming–Montreal Global Biodiversity Framework. Steppe ecosystems and steppe bird species were used as a case study

steppe birds concerning each of the eight KM–GBF targets and ii) propose conservation actions specifically tailored to achieve each target. Targets were addressed independently, and thus, the same or similar conservation actions could be included in more than one target. We held an online participatory discussion between 2 and 19 June 2023 during which each participant proposed conservation actions aimed at the conservation of steppe birds, and using the current scientific literature and researcher’s experience to guide this process. During this period, experts iteratively shared their input, proposing new conservation actions or editing the existing ones based on direct and ongoing feedback from fellow participants and from the team who facilitated the process (facilitation team hereafter, see Supplementary Material S1). Through this iterative process, personal opinions gave rise to group consensus. At the end of the first round, the participants drafted and agreed on a final set of 49 conservation actions (Supplementary Material S1).

Round 2: questionnaire to prioritise actions

Aiming to guide the decision-making process, and ensure efficient fund allocation, we sought to identify a reduced set of prioritised, consensus-based, conservation actions to maximise the success of the eight global targets of the KM–GBF in steppe ecosystems. To do this, the facilitation team synthesised the conservation actions proposed during the first round by removing or merging redundant actions, resulting in a final list with 36 conservation actions (Supplementary Material S3). Participants received an electronic questionnaire containing these 36 actions and were asked to choose, according to their expert opinion, the 15 most important actions to achieve the first eight global targets of the KM–GBF in steppe ecosystems. Forty-five out of the 57 members of the first panel (78.9%) completed the anonymous questionnaire (the identities of the participants were known by the facilitation team to flag double voting). The order of proposed actions was randomised each time a participant opened the questionnaire to avoid voting bias.

We used percentage agreement as a measure of consensus (Diamond et al. 2014). Actions that received agreement from at least 66% of the participants were considered priorities for achieving the vision of steppes in harmony. At the end of the questionnaire, the results, including the identified consensual conservation actions, were shared with all participants.

Round 3: identifying links between prioritised actions and GBF targets

We examined the relationships between the prioritised actions and the eight KM–GBF targets by carefully evaluating whether the implementation of each prioritised action could contribute to the achievement of each of the eight

global targets (Fig. 2). Initially, researchers from the facilitation team conducted the assessment and agreed on the preliminary links between the prioritised actions and targets. Subsequently, these links were shared with all participants, inviting their input and feedback to reach a final assessment.

Results

Identification and prioritisation of conservation actions

A panel of 57 experts identified 49 conservation actions to achieve the first eight KM–GBF targets in the steppe ecosystems. The number of actions proposed per target ranged from four (targets 6, 7, and 8) to 11 (target 4). A detailed list of the conservation actions proposed per target can be found in Supplementary Material S2.

In the following step, the participants were asked to prioritise the most important actions among the 36 distinct conservation actions (after removing or merging redundant ones, Fig. 1). Ten of these actions (28%) reached the consensus threshold of 66% of votes to be considered most relevant for steppe bird conservation (Box 1). These actions included (i) four management actions to enhance habitat structure and food availability (Actions 3, 4, 9, and 10); (ii) three regulatory interventions to minimise infrastructure impacts, protect priority areas, and reduce agrochemical use (Actions 1, 2, and 7); (iii) two societal interventions aiming to engage local communities and promote land stewardship (Actions 5 and 6); and (iv) one research intervention to improve monitoring systems (Action 8). The three conservation actions with the highest consensus (i.e. number of participant votes) were Action 1 (minimise infrastructure impacts within areas of highest importance; 89% consensus), Action 2 (protect priority areas; 82% consensus), and Action 3 (fund environmentally friendly management actions, e.g. through the Common Agricultural Policy or similar instruments; 80% consensus) (Box 1).

Box 1: Description of the consensus-driven conservation actions aimed at achieving the first eight targets of the Kunming–Montreal Global Biodiversity Framework. Steppe birds and steppe ecosystems were used as a case study. Actions are ordered by consensus agreement (i.e. number of participant votes).

Action 1: minimise infrastructure impacts (89% consensus)

Avoid the development of human infrastructures (e.g. highways, urban developments, mines, power lines, wind and solar farms, and infrastructures for irrigation) in the areas of highest importance for steppe birds (see Action 2). Environmental impact assessments for new infrastructures should be

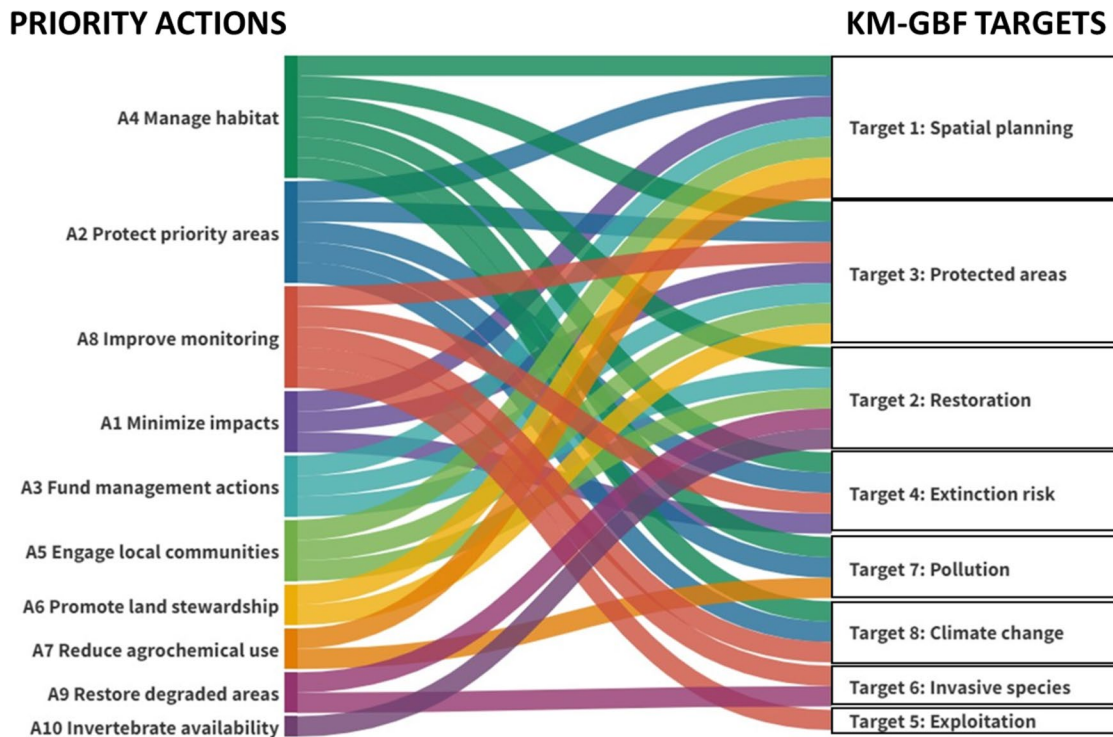


Fig. 2 Sankey diagram showing the links between the prioritised conservation actions and the first eight Kunming–Montreal Global Biodiversity Framework targets. The size of the boxes is proportional to the number of targets to which a particular conservation action can contribute (action column, left side) and the number of actions covering each target (target column, right side). Actions and targets are ordered by the number of links

tribute (action column, left side) and the number of actions covering each target (target column, right side). Actions and targets are ordered by the number of links

particularly comprehensive and technically sound in buffer zones surrounding protected areas. In areas with high levels of bird mortality due to human activities, it is crucial to implement effective mitigation strategies and compensatory actions.

Action 2: protect priority areas (82% consensus)

Identify and prioritise the areas of highest importance for steppe birds, such as areas with high breeding output and/or large population sizes during breeding, winter, or migratory stop-over periods, and promote their effective protection under appropriate legal designations. The network of protected areas should encompass at least 30% of the identified areas. The selection of these areas should be carried out in collaboration with national, regional, and local stakeholders, taking into account the connectivity of the network.

Action 3: fund management actions (80% consensus)

Implement environmentally friendly actions that are subsidised to improve the conservation of steppe birds and their habitats. Evaluate their cost-effectiveness to ensure a positive impact. These actions can be subsidised by mechanisms such as the Common Agricultural Policy (CAP) for EU member

states or equivalent mechanisms for nonmembers (e.g. the Swiss agri-environmental scheme, which includes the programme of Proof of Ecological Performance and ecological direct payments to promote biodiversity). Management practices that negatively affect steppe birds should not be eligible, especially in key areas for steppe bird conservation.

Action 4: manage habitat (71% consensus)

Carry out in situ management actions that benefit the whole community of steppe birds and ensure the specific needs of the most threatened species. These actions may include restoring degraded steppe ecosystems and implementing species-specific actions such as habitat management or predator control programmes.

Action 5: engage local communities (69% consensus)

Incorporate all available knowledge for spatial planning of areas to restore and protect, increasing the participation of various stakeholders (farmers' unions, hunters, herders, scientists, managers, conservation-focused NGOs, renewable energy developers, local citizens) for consensual socioecological management of steppes. Management will include local knowledge of traditional sustainable land uses.

Action 6: promotion of land stewardship (69% consensus)

Promote long-term land stewardship programmes and land purchases through adequate subsidies and economic incentives to enforce land-use limitations. These programmes and purchases should be designed based on economic studies and agreements among landowners, administrations, and other stakeholders. The overarching goal is to harmonise, at a regional scale, areas of land-sharing with agricultural practices that are compatible with the requirements of steppe birds and areas of land-sparing where plots of land are set aside for the restoration of suitable habitats. This approach will benefit steppe birds, particularly those associated with shrub–steppe habitats.

Action 7: reduce agrochemical use (67% consensus)

Reduce the use of pesticides and fertilisers in steppe ecosystems by at least 50% and 20%, respectively. This action aligns with the environmental objectives for 2030 of the European Green Deal and Farm-to-Fork Strategy. Reduction strategies should include a significant decrease in the use of coated seeds and impose stricter restrictions on agrochemical use in and around areas of highest importance for steppe birds.

Action 8: improve monitoring (67% consensus)

Improve the quality, duration, and implementation of monitoring programmes, including demographic (e.g. population trends, age structure, and sex ratios) and genetic parameters, to keep conservation status updated and identify key factors driving population dynamics. Monitoring programmes should include standardised surveys (e.g. BACI design) and robust statistical analyses to obtain reliable, up-to-date data on the distribution, size, and structure of steppe bird populations. These surveys should also focus on anthropogenic threats, including habitat loss and degradation, climate change, pollution, and biological invasions.

Action 9: restore degraded areas (67% consensus)

Identify degraded steppe ecosystems in Europe and implement restoration measures in at least 30% of these areas by 2030. Restoration efforts should be carried out using environmentally friendly measures such as promoting extensive grazing and fallow management, taking into account the socioecological context. These measures should aim to benefit a wide range of steppe birds and incorporate participatory and inclusive planning that involves local communities. Restoration of steppes should be prioritised after the cessation of anthropogenic disturbances in steppe ecosystems. This includes initiatives such as the restoration of abandoned

mines or gravel pits, as well as ecosystem restoration following the eradication of invasive species.

Action 10: improve invertebrate availability (67% consensus)

Implement specific actions to boost the diversity and abundance of invertebrates, a key resource for most steppe bird species, especially during the breeding period. These measures require a reduction in the use of biocides (Action 7) and could include the creation of beetle banks, ponds, and other small water bodies, promotion of crop rotations, and the implementation of other environmentally friendly measures, such as the effective management of weeds.

Identifying links between prioritised actions and GBF targets

The prioritised conservation actions potentially contribute to multiple KM–GBF targets. Nine of the top ten priority conservation actions contributed to more than one target, with an average of three targets per action (range: 1–6; Fig. 2). There was no significant association between the number of votes and the number of targets each action could contribute to (Spearman's rank correlation = 0.519, $p = 0.124$). The conservation action contributing to the most targets was the implementation of habitat management (Action 4, linked to six targets; Fig. 2). Two actions also had the potential to contribute to five targets each: (i) the effective protection of priority areas under appropriate legal designations (Action 2, Fig. 2) and (ii) the improvement of monitoring programmes (Action 8, Fig. 2). Interestingly, there was a high complementarity among these three actions, which collectively contributed to partly achieving all eight KM–GBF targets. This is particularly true for targets 3, 4, and 8, with each of them covered by these three actions (Fig. 2). In contrast, four actions aligned with only one (Action 10) or two (Actions 6, 7, and 9) KM–GBF targets (Fig. 2).

Discussion

Bridging the gap between the international biodiversity framework and national and local implementation of effective actions can be challenging, potentially hindering the effectiveness of international initiatives aimed at halting biodiversity loss (Perino et al. 2022). Using the conservation of steppe birds under the KM–GBF in Europe as a case study, we showed how structured participatory processes can effectively help bridge this gap. To this end, we designed expert- and consensus-based conservation actions that stem from on-the-ground experience and scientific evidence. This approach allows for the swift formulation of targeted actions

for implementation at national and regional scales that will contribute to achieving international policy goals. Although our conservation actions were identified focusing on European steppes, we expect that our findings might be transferable to halt steppes' biodiversity decline outside Europe, since steppes' main threats are shared among regions (Wesche et al. 2016). Nonetheless, the proposed actions will not be fully applicable to other ecosystems (i.e. old-growth forests or wetlands), which would require developing specific conservation actions according to their characteristics and specific threats. In that case, the participatory process we developed and applied here will be useful to develop such context-specific conservation actions.

We identified ten actions based on expert opinion and consensus agreement that, if implemented promptly, will significantly contribute to achieving the KM–GBF targets and improve the conservation of steppe birds and associated habitats in Europe. It is worth highlighting that although conservation efforts in steppes are low and usually made at local scale, most of the derived actions have been already implemented and their effectiveness for steppes' bird conservation proved (See Sutherland et al. 2020). These actions ranged from purely legislative measures, such as protecting priority areas for European steppe birds, to on-the-ground actions related to habitat management, improving food availability, and restoring degraded steppes. According to our findings, and in alignment with the KM–GBF, these actions should be implemented in collaboration with a wide array of stakeholder groups, including local communities, public and private sectors (e.g. farmers), nongovernmental actors, managers, and scientists. Empowering local communities and relevant stakeholders to actively maintain and restore biodiversity is critical (Bouamrane et al. 2016; FPP 2020, see Velado-Alonso et al. 2024 for effective communication in farmland biodiversity conservation). Importantly, local communities often find themselves lacking the needed authority or legal tools to prevent external interventions that lead to significant land transformations for economically profitable ventures or to participate actively in the implementation of biodiversity policies (FPP 2020; Reyes-García et al. 2022). The problem of engaging local communities in biodiversity conservation is also potentially hindered by the existence of conflicting views within the community (e.g. Cusack et al. 2021). Contrasting perspectives are commonplace regarding steppe ecosystems, which are often deemed unproductive and unattractive (Laiolo and Tella 2006). The species associated with these ecosystems, despite being under threat, are seldom recognised as emblematic due to a lack of public awareness (Cortés-Avizanda et al. 2022). Moreover, the lack of public understanding of the importance of steppe ecosystems and their associated species makes this habitat more vulnerable to habitat transformations (Serrano et al. 2020). This perception was common across our expert panel, which

identified minimising the future development of infrastructures in key steppe areas as a top priority action (Box 1).

Effectively addressing the global biodiversity crisis and successfully achieving the KM–GBF targets requires implementing multiple, coordinated, and context-dependent conservation actions that address a wide range of direct and indirect drivers (Bolam et al. 2021; Leadley et al. 2022). Three consensus-based actions have the potential to contribute each, at least partially, to the achievement of five of the eight KM–GBF targets: implementing on-the-ground habitat management actions, effectively protecting priority areas under appropriate legal designations, and improving the quality and integration of monitoring programmes. These actions should be considered key elements for successfully applying the KM–GBF approach within steppe ecosystems. Indeed, the implementation of these three actions will contribute to partly achieving all eight targets and be crucial in facilitating the implementation of other prioritised actions, including the effective limitation of human infrastructure development within areas of highest importance for steppe birds or the enhancement of invertebrate availability through habitat management.

Although we invited a wide range of stakeholders (e.g. managers, NGO representatives, private sector, local communities), most participants of our process were academic researchers. While this resulted in a robust set of priority actions, future initiatives would benefit from a broader expertise. The expert panel was also skewed toward the Iberian Peninsula, likely reflecting the region's prominence in conservation efforts and scientific research towards steppe ecosystems, as well as its significant importance for steppe biodiversity conservation in the European context. Likewise, further research could replicate our participatory process targeting local, regional, and national managers and relevant stakeholders to discuss how to implement the derived actions. The implementation of some actions (e.g. legal protection of priority areas or avoidance of infrastructure impacts) may conflict with other factors, such as social acceptability, or regional and national plans, such as national strategies for economic growth or the EU's transition towards renewable energies (Nijse et al. 2023). Thus, there is a need for sustainable development and increased efforts to mitigate climate change while contributing to biodiversity conservation (see, e.g. Santangeli et al. 2016). Likewise, funding limitations may also curb the implementation of certain proposed actions. This deficit in funding is, in part, responsible for the lack of success of past initiatives (CBD 2014). Although there have been improvements in securing funding within KM–GBF, it will likely fall short of achieving most of the targets (e.g. Deutz et al. 2020). This significant funding deficit for biodiversity stresses the need to prioritise actions through consensus, as we did in our participatory process (Mispiratceguay et al. 2021). Other factors

that may limit the implementation of conservation actions are their associated costs and their delayed responses (time lags), which may impact the number of actions implemented (cost) and whether the KM–GBF targets can be achieved by 2030 (owing to delayed responses). For example, implementing some of the proposed actions, such as managing habitat, reducing agrochemical use, or improving invertebrate availability, is expected to benefit steppe birds in the short term. However, the positive impact of implementing actions such as integrating and improving the quality of monitoring programmes or engaging local communities may be delayed and measurable only in the middle and long term. The development of conservation actions aiming to achieve the KM–GBF targets would benefit from considering other factors that can influence their effectiveness, such as the costs of their implementation, their social acceptability, or conflicts with other regional or national plans. Likewise, further research should aim to apply scenario analyses to assess how the socio-economic context may influence the feasibility of implementing one or other conservation actions (e.g. Pérez-Granados et al. 2024; Roura-Pascual et al. 2024).

The prioritised actions could also contribute to the achievement of several other international targets, such as the targets of the Paris Climate Agreements (three actions linked to climate change mitigation and adaptation, Target 8 of the KM–GBF) and targets included in the UN Decade on Ecosystem Restoration 2020–2030 (five actions linked to steppes' restoration, Target 2 of the KM–GBF). Additionally, most of the prioritised actions could contribute to the success of the UN 2030 Agenda for Sustainable Development. For example, Goal 15 “Life on Land” aims to protect and restore terrestrial ecosystems, combat climate change, halt and reverse land degradation, and stop biodiversity loss, which is strongly related to the first eight KM–GBF targets. Actively promoting collaborations with these concurrent global initiatives could foster synergies, such as facilitating legislative measures or increasing funding resources (Chan et al. 2023). Collaboration among international bodies can improve monitoring efforts to assess the effectiveness of implemented actions (Díaz et al. 2021). The data gathered would improve synthesis made by expert panels on biodiversity, such as the Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services (Nicholson et al. 2021; Chan et al. 2023). Ultimately, collaborative efforts between different initiatives and countries could also facilitate the implementation of actions at a national or local scale (Rogalla von Bieberstein et al. 2019) while ensuring fund allocation and improving public awareness and societal perception and valuation of biodiversity (Martínez-Jauregui et al. 2021; Nicholson et al. 2021). This is crucial to achieving the main vision of the CBD—living in a world in harmony with nature (CBD 2022).

Conclusions

The current decade is critical for international policy to bend the curve of biodiversity loss and provide a standard of living in closer harmony with nature. A limiting factor for the implementation of biodiversity conservation actions is the difficulty of translating international policy goals into national- or local-level conservation interventions. The success of global commitments, such as the Kunming–Montreal Global Biodiversity Framework (KM–GBF), is contingent upon the identification and implementation of concrete actions by relevant authorities and stakeholders (Chan et al. 2023). Here, we propose a list of expert consensus-driven conservation interventions that, if implemented, promise significant progress towards achieving the first eight targets of the KM–GBF in European steppes, thereby mitigating biodiversity loss in such ecosystems. Given the delayed ecological responses following action implementation, immediate action is crucial to realise the KM–GBF's vision by 2030. We hope our study serves as a catalyst, inspiring and encouraging all relevant stakeholders to implement the identified high-priority actions. The Delphi approach employed here can be applied to other ecosystems, taxonomic groups, and sociopolitical contexts, promoting a fast and effective formulation of conservation actions to achieve international policy goals.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s11625-024-01602-6>.

Acknowledgements This study was carried out with no public or private funding as part of the commitment of the recently created “Grupo de Investigación en Aves Esteparias—Grupo de Investigação em Aves Estepárias (GIAE)” to improve the current status of steppe birds and ecosystems in Europe. We are grateful to Beatriz Arroyo, who participated in the Delphi process and contributed to the design of the conservation actions, and to two anonymous reviewers that contributed to improve the manuscript. CPG acknowledges the support from Ministerio de Educación y Formación Profesional through the Beatriz Galindo Fellowship (Beatriz Galindo—2020 call). ATM was funded by the project NORTE-01-0246-FEDER-000063, supported by Norte Portugal Regional Operational Program (NORTE2020), under the PORTUGAL 2020 Partnership Agreement, through the European Regional Development Fund (ERDF). JG was supported by a postdoc scholarship (BIOPOLIS 2022–13). ABL was supported by a Ramón y Cajal grant (RYC2021-031737-I) funded by MCIN/AEI/<https://doi.org/10.13039/501100011033> and the EU (“NextGenerationEU”/PRTR). RT was funded by the project ‘CLU-2019-01—iuFOR Institute Unit of Excellence’ of the University of Valladolid, funded by the Junta de Castilla and co-financed by the European Union (ERDF ‘Europe drives our growth’). This paper is a contribution by MD and EDC to the PTI AGRIAMBIÓ, partially financed by the Spanish Ministry of Agriculture. The paper contributes to the ELECTROSTEPPE Project (TED2021-130352B-I00), funded by MCIN/AEI/<https://doi.org/10.13039/501100011033> and the European Union (“NextGenerationEU”/PRTR).

Author contribution Cristian Pérez-Granados, Ana Benítez-López, Mario Díaz, João Gameiro, Bernd Lenzner, Ana Teresa Marques:

conceptualisation, methodology, formal analysis; investigation, writing—original draft, writing—review and editing, visualization, Núria Roura-Pascual: conceptualisation, methodology, investigation, writing—review and editing. All participants: investigation—online contribution, writing—review and editing.

Funding Open Access funding provided thanks to the CRUE-CSIC agreement with Springer Nature.

Data availability All data generated during the study are included in the Supplementary Information.

Declarations

Conflict of interest The authors declare no conflict of interest.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Benitez-Capistrós F, Hugé J, Koedam N (2014) Environmental impacts on the Galapagos Islands: identification of interactions, perceptions and steps ahead. *Ecol Ind* 38:113–123
- Bolam FC, Mair L, Angelico M, Brooks TM, Burgman M, Hermes C, Butchart SH (2021) How many bird and mammal extinctions has recent conservation action prevented? *Conserv Lett* 14(1):e12762
- Bouamrane M, Spierenburg M, Agrawal A, Boureima A, Cormier-Salem M-C, Etienne M, Le Page C, Levrel H, Mathevet R (2016) Stakeholder engagement and biodiversity conservation challenges in social-ecological systems: some insights from biosphere reserves in western Africa and France. *Ecol Soc* 21(4):25
- Burfield I, Rutherford C, Fernando E, Grice H, Piggott A, Martin R, Staneva A (2023) Birds in Europe 4: the fourth assessment of species of European Conservation Concern. *Bird Conserv Int* 33:E66
- CBD (2011) Strategic plan for biodiversity 2011–2020, including Aichi biodiversity targets. <http://www.cbd.int/sp/>
- CBD (2014) High-level panel. Resourcing the Aichi biodiversity targets: an assessment of benefits, investments and resource needs for implementing the strategic plan for biodiversity 2011–2020. Second Report. <https://www.cbd.int/financiam/hlp/doc/hlp-02-report-en.pdf>
- CBD (2022) Convention on biological diversity. Kunming–Montreal Global Biodiversity Framework. <https://www.cbd.int/doc/c/e6d3/cd1d/daf663719a03902a9b116c34/cop-15-l-25-en.pdf>. Accessed 09 Aug 2023
- Chan S, Bauer S, Betsill MM, Biermann F, Boran I, Bridgewater P et al (2023) The global biodiversity framework needs a robust action agenda. *Nat Ecol Evol* 7:172–173
- Cortés-Avizanda A, Pereira HM, McKee E, Ceballos O, Martín-López B (2022) Social actors' perceptions of wildlife: insights for the conservation of species in Mediterranean protected areas. *Ambio* 51:990–1000
- Cusack JJ, Bradfer-Lawrence T, Baynham-Herd Z, Castelló y Tickell S, Duporge I, Hegre H, Bunnefeld N (2021) Measuring the intensity of conflicts in conservation. *Conserv Lett* 14(3):e12783
- Deutz A, Heal GM, Niu R, Swanson E, Townshend T, Zhu L, Delmar A, Meghji A, Sethi SA, Tobinde la Puente J (2020) Financing nature: closing the global biodiversity financing gap. The Paulson Institute, The Nature Conservancy, and the Cornell Atkinson Center for Sustainability
- Diamond IR, Grant RC, Feldman BM, Pencharz PB, Ling SC, Moore AM, Wales PW (2014) Defining consensus: a systematic review recommends methodologic criteria for reporting of Delphi studies. *J Clin Epidemiol* 67:401–409
- Díaz M (2023) Dealing with global threats to biodiversity: a pressing but realistic challenge. *Front Conserv Sci* 4:1147470
- Díaz S, Malhi Y (2022) Biodiversity: concepts, patterns, trends, and perspectives. *Annu Rev Environ Resour* 47:31–63
- Díaz S, Settele J, Brondízio ES, Ngo HT, Agard J, Arneth A, Zayas CN (2019) Pervasive human-driven decline of life on Earth points to the need for transformative change. *Science* 366(6471):eaax3100
- Díaz M, Concepción ED, Morales MB, Alonso JC, Azcárate FM, Bartomeus I, Velado-Alonso E (2021) Environmental objectives of Spanish agriculture: scientific guidelines for their effective implementation under the Common Agricultural Policy 2023–2030. *Ardeola* 68:445–460
- Douglas DJ, Waldinger J, Buckmire Z, Gibb K, Medina JP, Sutcliffe L, Koper N (2023) A global review identifies agriculture as the main threat to declining grassland birds. *Ibis* 165(4):1107–1128
- Ellis EC, Klein Goldewijk K, Siebert S, Lightman D, Ramankutty N (2010) Anthropogenic transformation of the biomes, 1700 to 2000. *Glob Ecol Biogeogr* 19(5):589–606
- FPP (2020) Forest Peoples Programme, International Indigenous Forum on Biodiversity, Indigenous Women's Biodiversity Network Centres of Distinction on Indigenous and Local Knowledge, and Secretariat of the Convention on Biological Diversity. Local Biodiversity Outlooks 2: Moreton-in-Marsh: Forest Peoples Programme
- Green EJ, Buchanan GM, Butchart SHM, Chandler GM, Burgess ND, Hill SLL, Gregory RD (2019) Relating characteristics of global biodiversity targets to reported progress. *Conserv Biol* 33:1360–1369
- Greer SL, Falkenbach M, Siciliani L, McKee M, Wismar M, Figueras J (2022) From health in all policies to health for all policies. *Lancet Public Health* 7(8):e718–e720
- IPBES (2019) Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (Eds Brondízio, E. S. et al.)
- Kirschner P, Závieská E, Gamisch A, Hilpold A, Trucchi E, Paun O, Sanmartín I et al (2020) Long-term isolation of European steppe outposts boosts the biome's conservation value. *Nat Commun* 11:1968
- Laiolo P, Tella JL (2006) Fate of unproductive and unattractive habitats: recent changes in Iberian steppes and their effects on endangered avifauna. *Environ Conserv* 33(3):223–232
- Leadley P, Gonzalez A, Obura D, Krug CB, Londoño-Murcia MC, Millette KL, Xu J (2022) Achieving global biodiversity goals by 2050 requires urgent and integrated actions. *One Earth* 5(6):597–603
- Leclère D, Obersteiner M, Barrett M, Butchart SH, Chaudhary A, De Palma A, Young L (2020) Bending the curve of terrestrial biodiversity needs an integrated strategy. *Nature* 585(7826):551–556
- Martínez-Jauregui M, Touza J, White PCL, Soliño M (2021) Choice of biodiversity indicators may affect societal support for conservation programs. *Ecol Indic* 121:107203
- Mispiratceguy M, Ganisheva K, Ostermann OP, Neuville A, Battistella L, Mandrici A, Bertzy B, Garcia Bendito E, Dubois G (2021) Monitoring and mapping biodiversity conservation funding with

- eConservation 1.0, EUR 30858 EN, Publications Office of the European Union, Luxembourg
- Morales MB, Traba J (2016) Prioritising research in steppe bird conservation: a literature survey. *Ardeola* 63(1):137–150
- Morales MB, Merencio Á, de la Morena ELG (2023) Evaluation of a potential umbrella species using favourability models: the case of the endangered little bustard (*Tetrax tetrax*) and steppe birds. *Biodivers Conserv* 32(10):3307–3327
- Moyer JD, Hedden S (2020) Are we on the right path to achieve the sustainable development goals? *World Dev* 127:104749
- Mukherjee N, Hüge J, Sutherland WJ, McNeill J, Van Opstal M, Dahdouh-Guebas F, Koedam N (2015) The Delphi technique in ecology and biological conservation: applications and guidelines. *Methods Ecol Evol* 6(9):1097–1109
- Nicholson E, Watermeyer KE, Rowland JA, Sato CF, Stevenson SL, Andrade A, Watson JE (2021) Scientific foundations for an ecosystem goal, milestones and indicators for the post-2020 global biodiversity framework. *Nat Ecol Evol* 5(10):1338–1349
- Nijssse FJ, Mercure JF, Ameli N, Larosa F, Kothari S, Rickman J, Politt H (2023) The momentum of the solar energy transition. *Nat Commun* 14(1):6542
- Pérez-Granados C, Lenzner B, Golivets M, Saul WC, Jeschke JM, Essl F, Roura-Pascual N (2024) European scenarios for future biological invasions. *People Nat* 6(1):245–259
- Perino A, Pereira HM, Felipe-Lucia M, Kim H, Kühl HS, Marselle MR, Bonn A (2022) Biodiversity post-2020: closing the gap between global targets and national-level implementation. *Conserv Lett* 15(2):e12848
- Reyes-García V, Fernández-Llamazares Á, Aumeeruddy-Thomas Y, Benyei P, Bussmann RW, Diamond SK, Brondizio ES (2022) Recognizing Indigenous peoples' and local communities' rights and agency in the post-2020 Biodiversity Agenda. *Ambio* 51(1):84–92
- Rigal S, Dakos V, Alonso H, Auniš A, Benkő Z, Brotons L, Devictor V (2023) Farmland practices are driving bird population decline across Europe. *Proc Natl Acad Sci* 120(21):e2216573120
- Rogalla von Bieberstein K, Sattout E, Christensen M, Pisupati B, Burgess ND, Harrison J, Geldmann J (2019) Improving collaboration in the implementation of global biodiversity conventions. *Conserv Biol* 33(4):821–831
- Roura-Pascual N, Saul WC, Pérez-Granados C, Rutting L, Peterson GD, Latombe G, Jeschke JM (2024) A scenario-guided strategy for the future management of biological invasions. *Front Ecol Environ* 22(4):e2725
- Šálek M, Kalinová K, Daňková R, Grill S, Žmihorski M (2021) Reduced diversity of farmland birds in homogenized agricultural landscape: a cross-border comparison over the former Iron Curtain. *Agric Ecosyst Environ* 321:107628
- Santangeli A, Toivonen T, Pouzols FM, Pogson M, Hastings A, Smith P, Moilanen A (2016) Global change synergies and trade-offs between renewable energy and biodiversity. *Gcb Bioenergy* 8(5):941–951
- Serrano D, Margalida A, Pérez-García JM, Juste J, Traba J, Valera F, Donazar JA (2020) Renewables in Spain threaten biodiversity. *Science* 370(6522):1282–1283
- Sutherland WJ, Pullin AS, Dolman PM, Knight TM (2004) The need for evidence-based conservation. *Trends Ecol Evol* 19(6):305–308
- Sutherland WJ, Dicks LV, Petrovan SO, Smith RK (2020) What works in conservation 2020. Open Book Publishers, p 794
- Svancara LK, Brannon JR, Scott M, Groves CR, Noss RF, Pressey RL (2005) Policy-driven versus evidence-based conservation: a review of political targets and biological needs. *Bioscience* 55(11):989–995
- Traba J, Sastre P, Morales MB (2013) Factors determining species richness and community composition in steppe birds of peninsular Spain. In: Morales MB, Traba J (eds) *Steppe ecosystems: biological diversity, management and restoration*. NOVA Science Publishers, New York, pp 29–46
- UN (2015) *Transforming Our World: the 2030 Agenda for Sustainable Development A/RES/70/1*
- Velado-Alonso E, Kleijn D, Bartomeus I (2024) Reassessing science communication for effective farmland biodiversity conservation. *Trends Ecol Evol* 39(6):537–547
- Vernon W (2009) The Delphi technique: a review. *Int J Ther Rehabil* 16(2):69–76
- Wesche K, Ambarlı D, Kamp J, Török P, Treiber J, Dengler J (2016) The Palaearctic steppe biome: a new synthesis. *Biodivers Conserv* 25(12):2197–2231
- WWF (2022) *Living Planet Report 2022—building a nature positive society*. In: Almond REA, Grooten M, Juffe Bignoli D, Petersen T (eds) WWF, Gland, Switzerland
- Xu H, Cao Y, Yu D, Cao M, He Y, Gill M, Pereira HM (2021) Ensuring effective implementation of the post-2020 global biodiversity targets. *Nat Ecol Evol* 5(4):411–418

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

Authors and Affiliations

Cristian Pérez-Granados^{1,2}  · Ana Benítez-López³ · Mario Díaz³ · João Gameiro^{4,5,6} · Bernd Lenzner⁷ · Núria Roura-Pascual⁸ · Julia Gómez-Catasús^{9,10} · Rocío Tarjuelo¹¹ · Adrián Barrero^{9,10} · Luis Bolonio¹² · Gerard Bota² · Mattia Brambilla¹³ · Carolina Bravo¹⁴ · Lluís Brotons^{2,15,16} · Daniel Bustillo-de la Rosa^{9,10} · Xabier Cabodevilla² · Antonio Calvo Búrdalo¹⁷ · Ana Carricondo¹⁸ · Fabián Casas¹⁹ · Elena D. Concepción³ · Soraya Constán-Nava^{1,20} · Tiago Crispim-Mendes²¹ · David Giralt² · Marina Golivets²² · Guillaume Latombe²³ · Antonio Leiva²⁴ · Germán M. López-Iborra¹ · Gabriel López-Poveda¹ · Santi Mañosa^{25,26} · Carlos A. Martín²⁷ · Manuel B. Morales^{9,10} · Francisco Moreira^{4,5,6} · Francois Mougeot¹⁴ · Boris Nikolov²⁸ · Pedro P. Olea^{9,10} · Alejandro Onrubia²⁹ · Margarita Reverter^{9,10} · Natalia Revilla-Martín² · Stanislas Rigal³⁰ · Gema Ruiz Jiménez²⁴ · Pedro Sáez-Gómez^{9,10} · Martín Šálek^{31,32,33} · Iván Salgado³⁴ · Andrea Santangeli³⁵ · Carlos Santos³⁶ · Ana Sanz-Pérez^{2,25} · David Serrano³⁷ · João Paulo Silva^{4,6} · Antonio Torrijo²⁴ · Juan Traba^{9,10} · Piotr Tryjanowski³⁸ · Radovan Václav³⁹ · Francisco Valera¹² · Matthias Vögeli⁴⁰ · Julia Zurdo^{9,10} · Ana T. Marques^{4,5,6}

- ✉ Cristian Pérez-Granados
cristian.perez@ua.es
- 1 Departamento de Ecología, Universidad de Alicante, 03080 Alicante, Spain
 - 2 Biodiversity Management and Conservation Program, Forest Science and Technology Centre of Catalonia (CTFC), Solsona, Spain
 - 3 Department of Biogeography and Global Change, Museo Nacional de Ciencias Naturales (BGC-MNCN-CSIC), 28006 Madrid, Spain
 - 4 Centro de Investigação Em Biodiversidade E Recursos Genéticos, CIBIOInBIO Laboratório Associado Universidade Do Porto, Campus de Vairão, 4485-661 Vairão, Portugal
 - 5 CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, InBIO Laboratório Associado, Instituto Superior de Agronomia, Universidade de Lisboa, 1349-017 Lisbon, Portugal
 - 6 BIOPOLIS Program in Genomics, Biodiversity and Land Planning, CIBIO, Campus de Vairão, 4485-661 Vairão, Portugal
 - 7 Division of BioInvasions, Global Change and Macroecology, Department of Botany and Biodiversity Research, University of Vienna, Vienna, Austria
 - 8 Departament de Ciències Ambientals, Facultat de Ciències, Universitat de Girona, 17003 Girona, Catalonia, Spain
 - 9 Departamento de Ecología, Universidad Autónoma de Madrid, 28049 Madrid, Spain
 - 10 Centro de Investigación en Biodiversidad y Cambio Global, CIBC-UAM, Universidad Autónoma de Madrid, 28049 Madrid, Spain
 - 11 Instituto Universitario de Investigación en Gestión Forestal Sostenible (iuFOR), Universidad de Valladolid, Valladolid, Spain
 - 12 Department Functional and Evolutionary Biology, Estación Experimental de Zonas Áridas (EEZA-CSIC), Ctra. Sacramento s/n, La Cañada de San Urbano, 04120 Almería, Spain
 - 13 Department of Environmental Science and Policy, Milan University, Via Celoria 26, 20133 Milan, Italy
 - 14 IREC (CSIC-UCLM-JCCM, Instituto de Investigación en Recursos Cinegéticos. Ronda de Toledo 12, 13005 Ciudad Real, Spain
 - 15 CSIC, Cerdanyola del Vallès, Spain
 - 16 CREA, Cerdanyola del Vallès, Spain
 - 17 Fundación Ecoánime, Extremadura, Spain
 - 18 SEO/BirdLife, Madrid, Spain
 - 19 Department of Zoology, Faculty of Sciences, University of Granada, Granada, Spain
 - 20 Gestión Ambiental de Castilla-La Mancha (GEACAM), C/ Jesús Nazareno, s/n, 02002 Albacete, Spain
 - 21 MED–Mediterranean Institute for Agriculture, Environment, and Development & CHANGE–Global Change and Sustainability Institute, Institute for Advanced Studies and Research, Universidade de Évora, Pólo da Mitra, Ap. 94, 7006-554 Évora, Portugal
 - 22 Department of Community Ecology, Helmholtz Centre for Environmental Research–UFZ, 06120 Halle, Germany
 - 23 Institute of Ecology and Evolution, The University of Edinburgh, King’s Buildings, Edinburgh EH9 3FL, UK
 - 24 Agencia de Medio Ambiente y Agua de Andalucía, Junta de Andalucía, C/ Johan G. Gutenberg, 1-Isla de La Cartuja, 41092 Seville, Spain
 - 25 Departament de Biologia Evolutiva, Ecologia i Ciències Ambientals, Facultat de Biologia, Universitat de Barcelona, Avinguda Diagonal, 643, 08028 Barcelona, Spain
 - 26 Facultat de Biologia, Institut de Recerca de la Biodiversitat (IRBio), Universitat de Barcelona, Avinguda Diagonal, 643, 08028 Barcelona, Spain
 - 27 Departamento de Biodiversidad, Ecología y Evolución, Facultad de Ciencias Biológicas, Universidad Complutense de Madrid, C/ José Antonio Novais, 12, 28040 Madrid, Spain
 - 28 Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd., 1000 Sofia, Bulgaria
 - 29 Fundación Migres, Apdo. 152, 11380 Tarifa, Spain
 - 30 INRAE, UMR TETIS, Montpellier, France
 - 31 Institute of Vertebrate Biology, Czech Academy of Sciences, Květná 8, 603 65 Brno, Czech Republic
 - 32 Faculty of Environmental Sciences, Czech University of Life Sciences Prague, Kamýcká 129, 165 00 Prague–Suchbát, Czech Republic
 - 33 Forestry and Game Management Research Institute, V.V.I, Strnady 136, 252 02 Jíloviště, Czech Republic
 - 34 Ideas Medioambientales Ltd. EIA Consulting, C/ San Sebastián 19, 02005 Albacete, Spain
 - 35 Animal Demography and Ecology Unit, Institute for Mediterranean Studies (IMEDEA), CSIC-UIB, 07190 Esporles, Spain
 - 36 Instituto da Conservação da Natureza e das Florestas, Rua Dr. Francisco António Vicente, nº 4, 5200-271 Mogadouro, Portugal
 - 37 Department of Conservation Biology, Estación Biológica de Doñana (EBD-CSIC), Avda. Américo Vespucio 26, 41092 Seville, Spain
 - 38 Department of Zoology, Poznan University of Life Sciences, Wojsk Polskiego 71C, 60-625 Poznan, Poland
 - 39 Institute of Zoology, Slovak Academy of Sciences, Dubravská Cesta 9, Bratislava, Slovakia
 - 40 Applied Ecology Research Group, Swiss Ornithological Institute, Seerose 1, 6204 Sempach, Switzerland