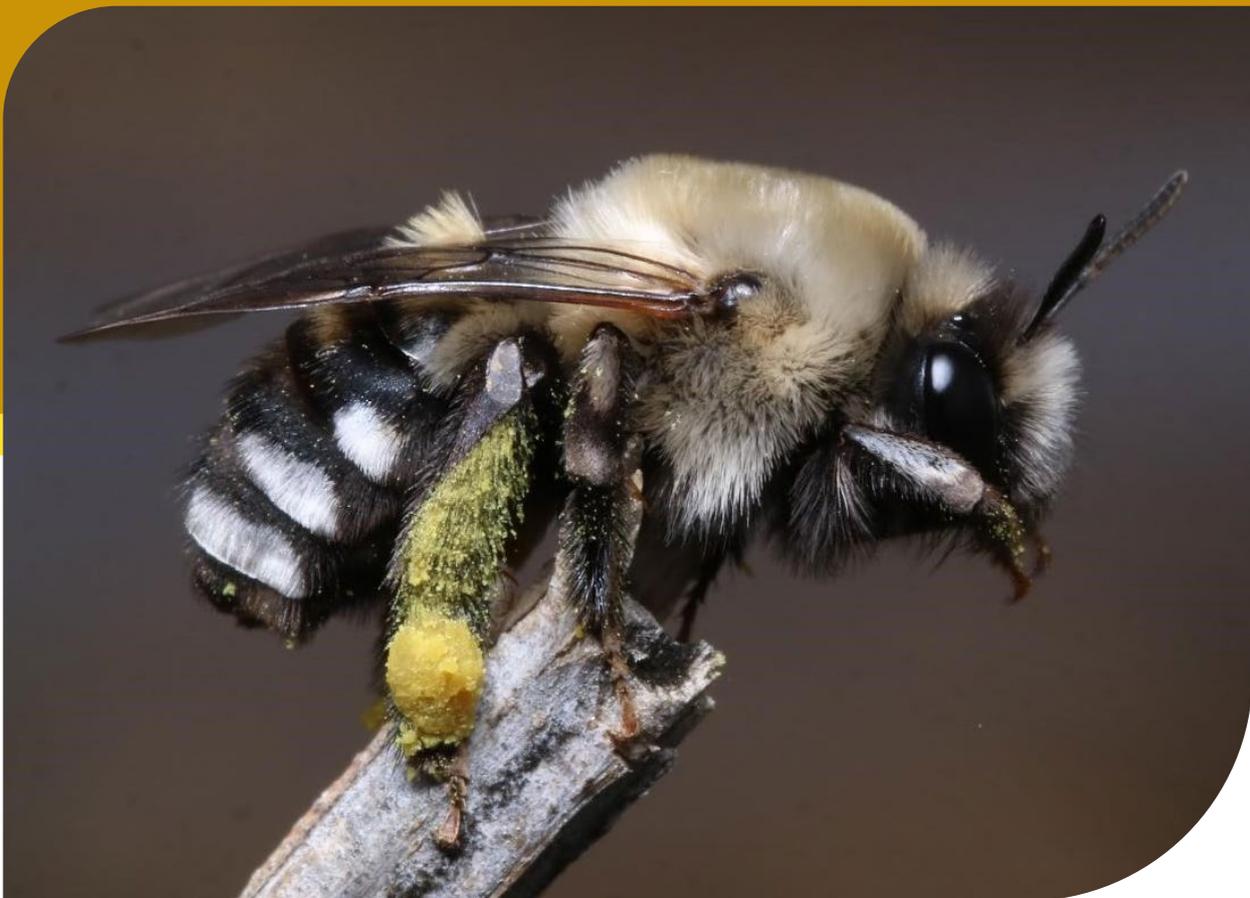# European Wild Bees:
moving from assessment to conservation planning

Reverté, S., Ghisbain, G., Albrecht, M., Bartomeus, I., Bellotto, V., Bogusch, P., Boustani, M., Fiordaliso, W., Flaminio, S., Fornoff, F., Gaspar, H., Gekière, A., Geslin, B., Ješovnik, A., Ortiz-Sánchez, F.J., Petanidou, T., Potts, S.G., Radchenko, V., Ruiz, C., Soares, A., Soon, V., Stavrinides, M., Straka, J., Tourbez, C., Trottet, A., Underwood, E., Wood, T.J., Zimmerman, D., Lees, C., Garn, A.-K. and Michez, D.

European Commission

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SSC Species Survival Commission

CONSERVATION PLANNING SPECIALIST GROUP

IUCN SSC WILD BEE SPECIALIST GROUP

European Wild Bees:
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IUCN SSC Wild Bee Specialist Group (WBSG): was established in 2021 following the expansion of the existing IUCN SSC Bumblebee Specialist Group to cover all species of bees. It brings together experts around the world dealing with wild bees, which will through their work strive to assess the threat of extinction for these species through Red Listing, generate and disseminate scientific knowledge, engage in conservation actions for these species and build public awareness about wild bee significance.

Contents

Acronyms & Abbreviations

A2P	Assess-to-Plan, a conservation planning process developed by the CPSG that integrates Red List assessment with action planning
Buzzing Schools	A project funded by the European Commission's Youth for Pollinators Pilot Project under the EU Pollinators Initiative with the goal of engaging youth on pollinator conservation through learning ecosystems.
CAP	EU Common Agricultural Policy
CPSG	IUCN SSC Conservation Planning Specialist Group
DiSSCo	The Distributed System of Scientific Collections is a Research Infrastructure funded by the programme Horizon of the European Commission which aims to create a new business model for one European collection that digitally unifies all European Natural Science assets.
EPIC-Bee	A two-year project (2025-2026) funded by the Directorate General for Environment of the European Commission to build capacity in pollinator taxonomy at the European scale.
ERL Pulse	A three-year project (2022-2024) funded by the Directorate General for Environment of the European Commission to reassess the status and trends of 11 groups of organisms, among which bees, to update the existing Red Lists.
EU-PoMS	EU Pollinator Monitoring Scheme
FAIR	Findable, Accessible, Interoperable and Reproducible
KPA	Key Pollinator Area, a spatial area where a remarkable diversity of wild bees is recorded.
IBA	Important Bird Area
IPA	Important Plant Area
IPM	Integrated Pest Management
LIFE 4 Pollinators	A four-year project (2019-2024) co-funded by the LIFE European Fund with the goal of involving people to protect wild bees and other pollinators in the Mediterranean.
NGO	Non-Governmental Organisation
NRR	Nature Restoration Regulation
ORBIT	A three-year project (2021-2024) funded by the Directorate General for Environment of the European Commission to develop resources for European bee inventory and taxonomy at the European scale.

PBA	Prime Biodiversity Areas
PollHab	A two-year project (2025-2026) funded by the Directorate General for Environment of the European Commission to support the Member States in including pollinator species as typical species for the habitats protected under the Habitats Directive.
SAFEGUARD	A four-year project (2021-2025) funded by the programme Horizon of the European Commission to make a step change in the protection and restoration of European pollinators, their essential services and the wider co-benefits they provide, thereby making a significant contribution to the ambitious EU Green Deal and the EU Biodiversity Strategy for 2030.
SPRING	A three-year project (2021-2024) funded by the Directorate General for Environment of the European Commission to test the protocols for the EU-PoMS and to build capacity in pollinator identification.
TETTRIs	A four-year project (2023-2026) funded by the programme Horizon Innovation Action of the European Commission aiming to produce a transformative change in the role played by taxonomy in tackling biodiversity challenges by boosting taxonomic capacity and transferring critical scientific knowledge to societal actors.
WBSG	IUCN SSC Wild Bee Specialist Group
WildPosh	A four-year project (2024-2027) funded by the programme Horizon Europe of the European Commission aiming to improve the evaluation of the risk to wild pollinators of pesticide exposure, and to enhance the sustainable health of wild pollinators and pollinator services in Europe.

Executive summary

Introduction

Bees are part of the insect order Hymenoptera, which also includes wasps and ants. In Europe, there are representatives of six families of bees: Andrenidae, Apidae, Colletidae, Halictidae, Megachilidae, and Melittidae. The best-known bee in Europe is the Western Honey Bee (*Apis mellifera*), and the bumblebees (species in the genus *Bombus*). Few people know that in total 2,138 species of bees are currently recorded in Europe (Ghisbain et al., 2023), from which 172 are threatened with extinction. Bees are amongst the most efficient insect pollinators, both of wild plants and crops, because to provision resources for their offspring, they need to visit many flowers. In contrast with many other insect groups, most bees construct cells where females store pollen and nectar before laying their eggs, providing the food necessary for the larvae during their development. Most bee species are solitary, meaning that each female builds a nest by herself. Only a few species are social, like some bumblebees and the Western Honey Bee, characterised by a clear social hierarchy where a queen lays eggs and a caste of sterile workers exists. This report focuses on populations of wild bees in the European region. Managed populations are excluded from the analysis and the report.

The planning approach

Between July and December 2024 and following the assessment of European bees for the IUCN Red List, 24 bee experts from 16 European countries participated in two online conservation action planning workshops. The workshops focused on 172 species categorised as threatened (the IUCN Red List Categories of Vulnerable, Endangered, and Critically Endangered) in Europe. The project followed the IUCN SSC CPSG "Assess-to-Plan" (A2P) methodology which is designed to build consensus among assessors and other experts on the 5-10 years priority actions needed for threatened species and to identify organisations who could take this action.

Challenges and opportunities for bee conservation in Europe

Bee conservation faces multiple challenges that are common to the conservation of other insect groups. Bees are very diverse in terms of species, ecology, morphology, behaviour, and habitat utilisation. The determination of these factors at the species level requires an expertise that takes a long time to acquire, and tools (i.e. keys, reference collection) that can be difficult to access or do not exist for many parts of Europe and for some species. Moreover, wild bees are exposed to many threats such as the decrease of habitat extent and quality, pesticide and other agrochemical use, and climate change. They are also facing specific threats like parasite and disease spill-over from managed pollinators, and the spread of invasive exotic plant and insect species. Overall, the monitoring of most bee species populations and distributions is still insufficient to characterise population and distribution trends and the impact of threats. Consequently, we have limited information to develop species-specific or group-specific plans

to mitigate declines. However, wild bees benefit from greater public and political awareness than most insects, thanks to the key role they have in the pollination of both domesticated and wild plants. They also partly benefit from the good reputation of Honey Bees that provide honey, wax and other products. The action plan we propose here and its implementation at different spatial levels has therefore a greater potential to be effective than plans for other insect groups. In addition, bees can act as a flagship group for which implemented action will benefit to a wider group of other insects, invertebrates, and habitats.

This document

This document begins with an introduction describing the species within the scope of this project, their geographic distribution, major habitat types, and other specific needs. It also includes further details of the planning workshops that generated the actions described in the rest of the document. Recommended conservation actions are organised under five goals: 1) sufficient tools, databases, and experts; 2) adequate protection, management, and restoration of priority habitats; 3) priority areas free of chemical pollutants, with stricter rules for their application outside; 4) policy support, and 5) a cultural shift towards appropriate behaviours regarding biodiversity conservation. Each goal includes a set of associated sub-goals and is prefaced by explanatory text. Each of these goals is directed towards a different group of conservation actors. All five goals and sub-goals are summarised in Table 1. This should be considered a working document, to be used and re-shaped for other purposes, and updated as required.

Audience

The target audience is the diverse array of decision-makers, managers, practitioners, and scientists required to implement recommended actions. Key audiences include: European and national government agencies and local management authorities, NGOs, policy makers (local, national, and regional), the scientific community and places of learning (universities, institutes, schools), the main land-user groups (agriculture, grasslands, forestry), Natura 2000 site managers, municipal managers of public territory and parks, nature conservation area management bodies, groups with similar conservation interests (primarily groups aiming to conserve habitats for wild entomophilous plants or, for instance, other invertebrate species), and local communities in areas where action is most needed. Relevant business sectors are also included, such as the beekeeping industry, the agrochemical industry, and the constuction industry, among others.

Implementation

This plan is European in scope. Though much can be done at the European and at the European Union levels to direct, support, and incentivise useful action, work on the ground will need to be implemented, supported, and enabled at national, sub-national and local levels and would benefit from dialogue and collaboration among the diverse stakeholder groups working there. National or sub-national planning workshops aimed at customising and operationalising this preliminary plan for the local context, could catalyse uptake and progress.

Table 1- *Summary of recommended goals and 5-10 year sub-goals*

Goals	Sub-goals
Goal 1. Sufficient tools, databases, and experts	1- Species-level identification keys at regional and European levels for all bee genera
	2- Training, certification and coordination of European and national experts
	3- Targeted and coordinated monitoring for threatened and overlooked species
	4- Increased development and use of standardised national and European IUCN Red Lists
	5- Dynamic, accessible and centralised repository for wild bee data
Goal 2. Adequate protection, management, and restoration of priority habitats	1- General recommendations for all or multiple systems
	2- Specific recommendations for micro-habitats of specialist bees
	3- Specific recommendations for mountain and island bees
Goal 3. Priority areas free of chemical pollutants, with stricter rules for their control	1- Chemical pollutants are banned inside and around priority areas
	2- Pesticide use is rare and carefully targeted; it is not applied as a precaution; and nitrogen deposition from all sources everywhere, is significantly reduced
	3- Research development
Goal 4. Policy support	1- General policy-related recommendations and synergies with instruments and measures
	2- Habitats Directive and species lists as a tool for bee conservation
	3- The Nature Restoration Regulation and EU Pollinator Monitoring Scheme
	4- Well-targeted policies, subsidies and incentives support conservation of priority bee micro-habitats
	5- Refined methods for testing toxicity of new chemicals on non-model species
	6- Stricter rules on the management of domesticated bee species
	7- Improve the biosecurity policies on exotic species
Goal 5. Cultural shift towards appropriate behaviours regarding biodiversity conservation	1- Materials and initiatives to improve public perception of wild bee diversity
	2- Develop new teaching methods
	3- Raise awareness of practices that support wild bees
	4- Guidance on wild bee conservation measures for all relevant sectors

Megachile cypricola Mavromoustakis, 1938, female, Cyprus © Jordan Benrezkallah

Introduction

Biology and ecology

One of the main characteristics of bees is that their larvae are not free-living like in many other insect groups (Michez et al., 2019). Bees construct nests with cells in which they accumulate a provision of pollen and nectar, after which they lay eggs. Thus, when the larvae hatch from the eggs, they have all the required food to develop into adults without leaving the nest. They remain inside the protected cells as they develop, significantly increasing their survival, but at a cost of laying clutch sizes that are in general much smaller than for other insect groups. Only a few species, those with a developed social structure (such as some bumblebees and the Western Honey Bee) do not store food in the cells with eggs but directly feed the larvae as they develop.

The most favourable conditions for developing wild bee offspring are usually associated with relatively warm and low humidity places since most bee species build nests in soil (except for most members of the family Megachilidae, part of Apidae and some Colletidae). This is probably one of the reasons why the highest species diversity is found in the Mediterranean region, the most species-rich area of the continent (as is the case in all regions of the world with a comparable climate).

Bees rely on two main floral resources: pollen and nectar. Pollen is collected primarily to feed their offspring, whereas nectar provides energy for adults. Species differ in their degree of dietary specialisation. Some are generalists, collecting pollen and nectar from a wide range of plants, while others are specialists which depend on a restricted set of plant species.

The complete range of social behaviours can be found in bees: completely social and solitary species, and a range of different sociality levels in between. Solitary species make their own nest, every female providing for her own offspring. They can build more than one nest, containing from one to 20 or more cells, in each of which the female usually lays only one egg. About 77% of the wild bees lead a solitary life, not forming true hierarchies involving a queen and workers. Some solitary species can form aggregations with a high density of nests located close to each other. Sometimes, such aggregations can number hundreds of thousands or even several million nests.

Bumblebees and the Western Honey Bee show the most complex social behaviour. Other species lead a primitive social way of life, where in one nest with one queen, live from just one worker up to several dozens of workers raising the offspring of the queen. Of the European species, only 4% are highly social.

Finally, around 20% of the wild bee species are brood parasites (also called cuckoo bees). In those species, females do not make their own nest but lay eggs inside the nest of other bee species. A brood parasitic bee larva usually kills an egg or a young larva of the host, then eats the provision that the host female collected for her own offspring. As a result, only the larvae of the brood parasites survive in such nests. There are also social parasites, in which the parasitic female kills and takes the place of the queen in the social nest. As a result, the workers raise the parasite's offspring (Michener, 2007).

One important factor used to assess bee diversity in Europe is the variety of nesting strategies and resources they employ. These strategies can be categorised as follows: 1) ground-nesting species, on areas where bare ground is available or, conversely, among thickets of plants close to their roots, with different species being selective regarding the texture and type of soil, its density,

humidity, exposition, openness or shading, the angle of inclination and exposure of the ground surface, the presence or absence of other bee nests, etc.; 2) species that use preexisting cavities, like holes in wood, walls, especially drystone walls, or reed and wood sticks, passages of xylophagous insects in wood, old passages of nests of other bee species, cracks or depressions in stones and other similar cavities in various materials. The presence of suitable building materials of plant or mineral origin from which to construct the cells is also of great importance; 3) some species chew their way through mud walls, inside plant stems, and some make holes on pieces of wood to make galleries inside to place the brood cells; 4) some species build their nests on the ground, ceilings, rocks and other open surfaces above ground or in large cavities such as tree hollows, small animal caves, etc. Among the unusual nesting sites, it is worth noting the use of empty snail shells, keyholes, and folds of hanging clothes (Radchenko & Pesenko, 1994).

Bees are usually active from spring to autumn, but this is dependent on the climate of the region. Most species have one generation per year, but some, especially in the southern regions, can have multiple generations per year (or even overlapping generations in the case of social species). For some species, parsivoltinism has been noted when part of the generation is emerging not the following year but one year later (two years after the nest was built), which ensures additional preservation of the population in the event of passing through an unfavourable year.

Why wild bees need their own plan

Wild bees, both as adults and larvae, rely entirely on floral resources for survival. Because of their nesting biology, adults must collect pollen and nectar for their developing larvae and seal it inside closed nests. Over a lifetime, this requires visiting tens of thousands of flowers. This intense foraging activity makes wild bees exceptionally effective pollinators of both wild and cultivated plants in Europe. As a result, they are among the most critical components of terrestrial ecosystems.

Bees simultaneously play a crucial role in human economic activity, not only by ensuring high yields and quality in entomophilous crops, but also as a potential source of substances for pharmaceuticals. In addition, due to the specific structure of some flowers and the pollination behaviour of bees, some plants, including economically important ones, such as alfalfa, tomatoes, and berries can be pollinated only by a small number of wild bee species and not by the Western Honey Bee. As a result, the seed productivity of such plants directly depends on the presence of specific wild bees (Garibaldi et al., 2013; Pritchard & Vallejo-Marín, 2020; Reilly et al., 2024). These bees differ from other groups in that they lay relatively few eggs and carefully provision their offspring with pollen and nectar.

Their nesting behaviour requires them to return repeatedly to deposit these resources, which makes them 'central place foragers'. Wild bees fly on average often only around 100 m to 500 m radius from their nest to forage and to obtain the materials they need to build their nest, meaning that they are extremely sensitive to the local conditions. If they are not able to find resources in the vicinity of their nest, they will not be able to secure the next generation. Moreover, exposure to toxic substances threatens them more compared to other insects which are able to disperse to other sites and select a different area where to lay their eggs.

Another feature of wild bees that distinguishes them from the vast majority of other insects is diversity and species-specificity of nest location (Michez et al., 2019). Therefore, not only the availability of a wide diversity of flowering plants, but also the presence of suitable nesting sites and, in some cases, specific building materials, are among the main limiting factors for maintaining wild bee diversity (Müller et al., 2024). It is also worth noting that many threatened bee species pollinate plants that are themselves threatened. This provides an additional reason to develop conservation plans that address both bees and the plant species they depend on.

Scope and characteristics of the A2P species subset

For the scope of this report, only the threatened European species were selected. In total 172 species were included, of which 51 are endemic to Europe (Figure 1, Appendix 1). However, the conservation actions proposed in this report will also benefit non-threatened species that overlap in habitat or biological traits.
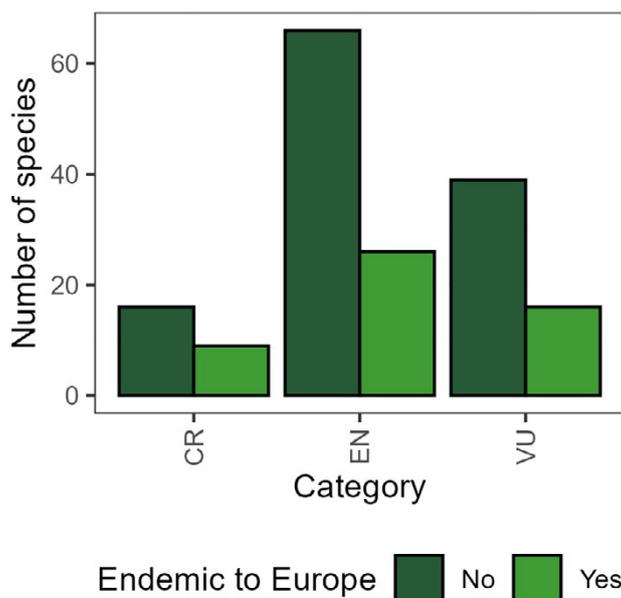
Figure 1. *Number of threatened bee species per per IUCN Red List threatened Category (CR = Critically Endangered, EN = Endangered, VU = Vulnerable), separating species endemic to Europe and species that are not endemic to Europe*

Concerning the traits of the different species, not all bee species have the same behaviour or ecological requirements. Most threatened bees nest underground, in soil cavities that are either self-made or naturally occurring, while only a minority build their nests above ground (Figures 2 and 3). That means that most bee species are sensitive to soil management, including ploughing, compaction, pollution or erosion. Moreover, most of the species are actively building their nests (excavators), digging galleries in the ground. A non-negligible proportion are renters, which means that they use cavities that already exist to make their nests (either above or underground). A few species use mud to build the interior of their nests, and are called mason bees. Regarding the micro-habitat where the species make their nests, the majority of species use mineral micro-habitats (soil, rocks, walls, etc., Figure 4). A small minority of species use plant tissue, such as wood, stems, roots, or even animal materials, such as empty snail shells.
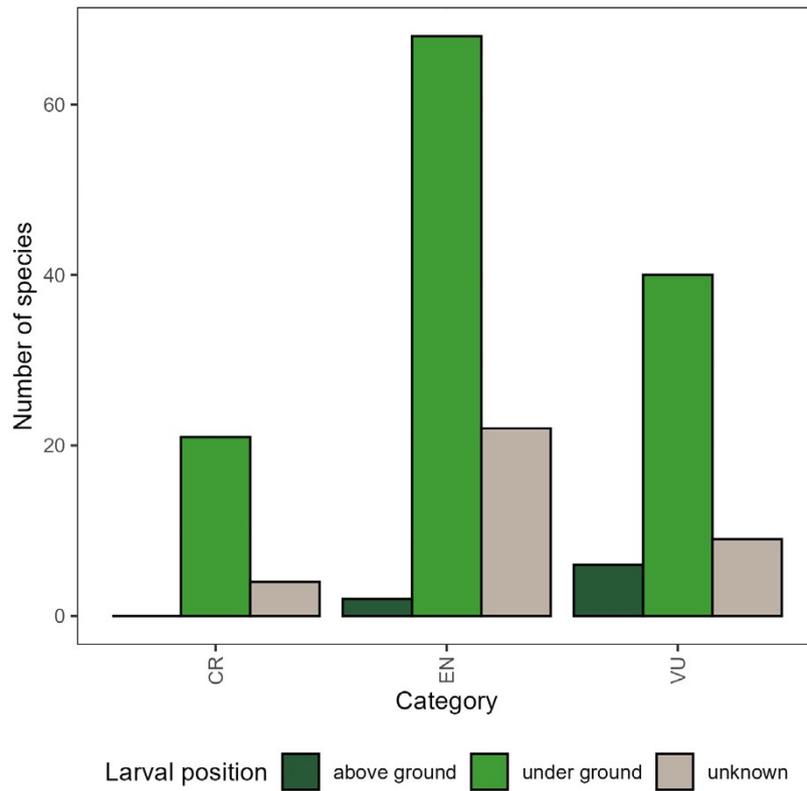
Figure 2. *Position of the larvae (and thus the nest), per IUCN Red List threatened Category.*
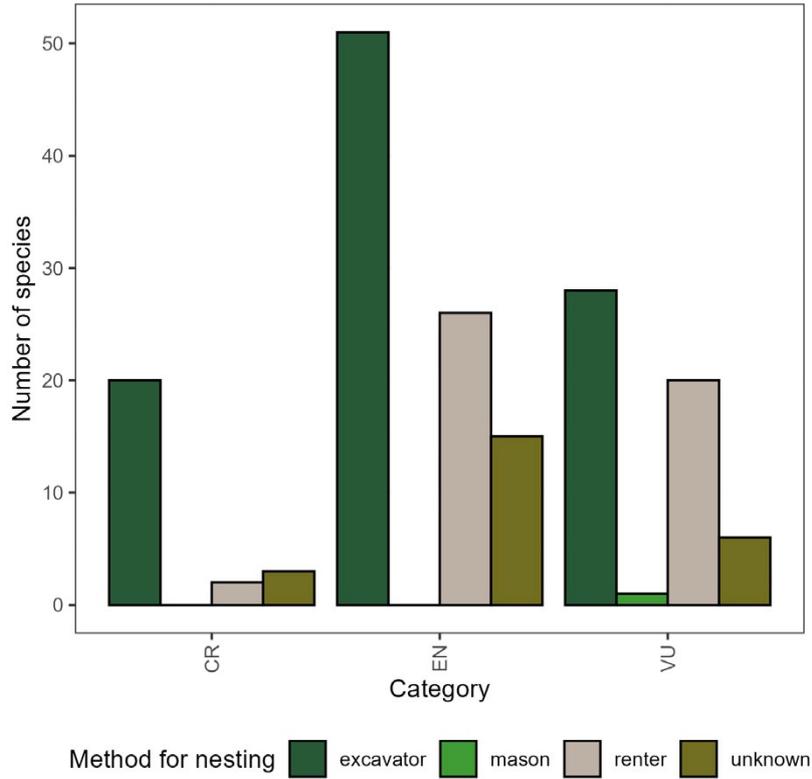
Figure 3. *Method used for creating the nests of the different species, per IUCN Red List threatened Category.*
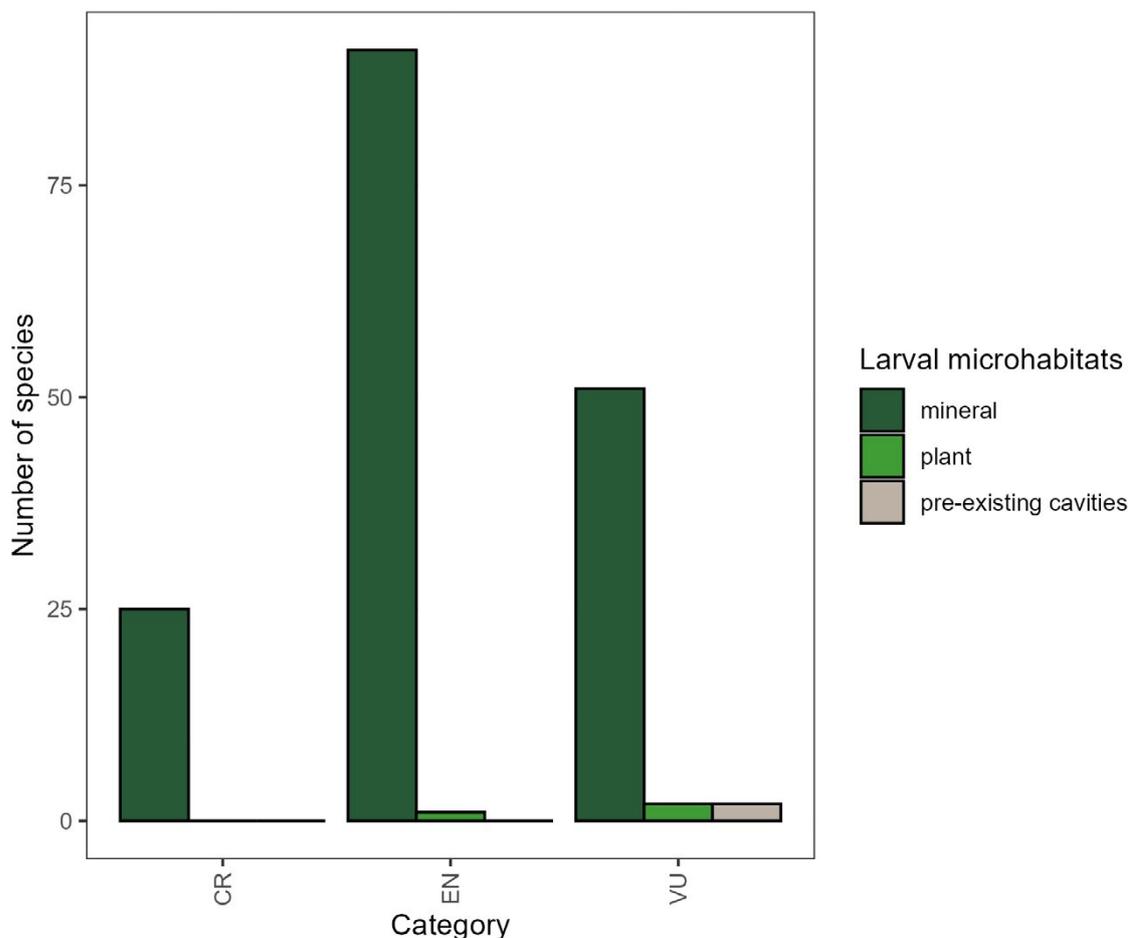
Figure 4. *Micro-habitats of the larvae of the different species, per IUCN Red List threatened Category.*

In terms of social behaviour, the most threatened species are solitary, accounting for about three quarters of the total (Figure 5). Solitary behaviour means there is no cooperation between different females. It also means they lack certain advantages of social species, such as collective detoxification of toxins and pollutants, or the presence of workers dedicated exclusively to foraging for the colony, even at distances beyond the feasible range for solitary females, who must also build nests and carry out other tasks in addition to foraging. A proportion of species are brood parasites, relying entirely on the nests of other bees for reproduction. As they occupy a higher level in the trophic network, they are particularly sensitive to environmental constraints, especially the presence or absence of suitable host species. Consequently, their populations are limited by the availability of both host bees and the plants these hosts depend on.

Colletes nasutus Smith, 1853, female, Hungary.
© Henrik Gyurkovics
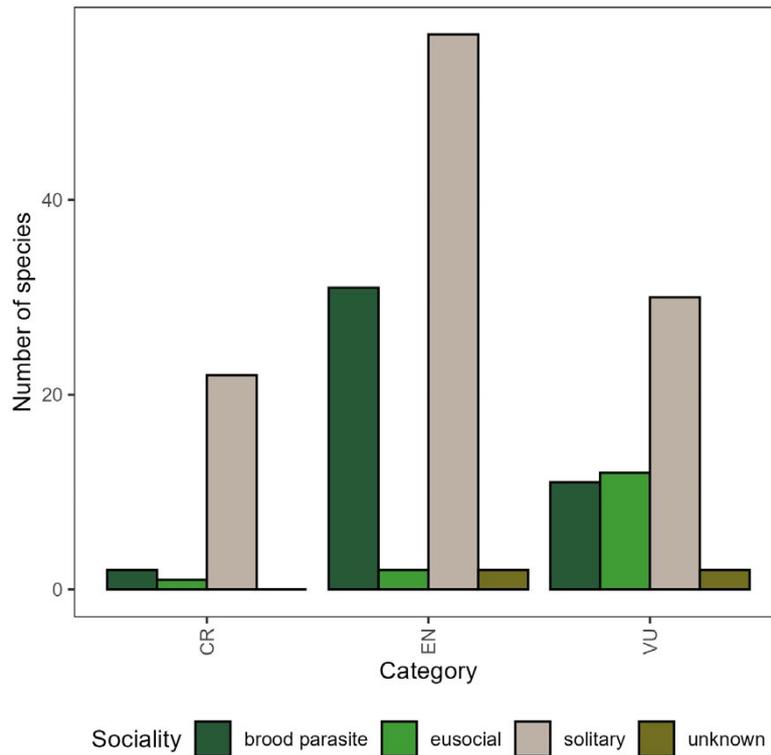
Figure 5. *Sociality of the different species, per IUCN Red List threatened Category.*

The seasonality of threatened bee species strongly influences the conditions they face during their active periods. Seasonality is relatively evenly distributed across the three threatened categories (Figure 6). In all three, most species are active in spring and summer, with a slightly higher number flying in summer, particularly in the Vulnerable category. A small number of the species is active throughout the year, many of them being bumblebees. Seasonality also shapes exposure to major threats. For example, pesticide applications peak in spring and summer, and climate change impacts such as heatwaves are most frequent in summer, when most of the threatened species are active.
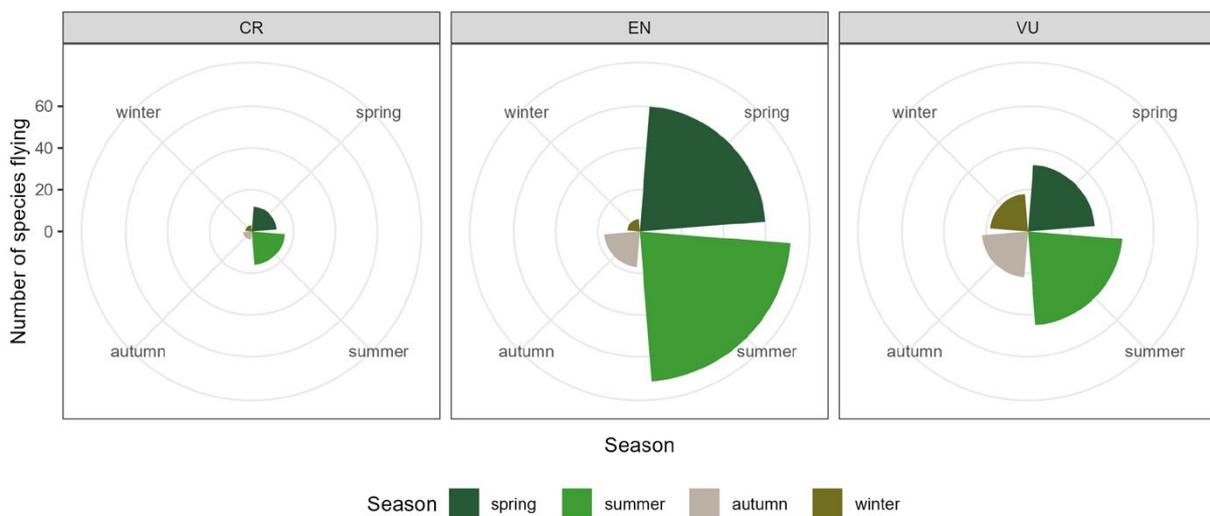
Figure 6. *Season in which the different species are active, per IUCN Red List threatened Category. Note that most species are active in more than one season.*

An important factor in determining conservation priorities is the diet breadth of the different species (Figure 7). Specialist bees can collect pollen for their larvae only from a restricted subset of plant species. Specialist species are generally more limited in their distribution, and their success depends on the presence of the plants on which they are specialised. This means that specialist bees are more sensitive to changes in the environment, including changes in the composition of plant communities. These species cannot occur at a certain locality if the plant species are absent, and thus management practices (e.g. nitrogen deposition) or habitat destruction can potentially threaten them more than generalist species.

Generalist bees, by contrast, can collect pollen from a variety of flower species. They can feed on a diversity of flowering species, can potentially thrive in a wider set of floral environments, and can be less sensitive to changes in the plant community around their nest.

Importantly, the proportion of species for which we lack information on diet breadth is larger in the Critically Endangered Category. This has important implications for conservation, because if we do not understand their floral requirements, there will be more difficulties in delivering conservation actions for those species. This highlights the importance of generating basic knowledge—in this case on diet breadth—to develop dedicated management practices to support threatened bee species at the local scale (Wood et al., 2019, 2021).
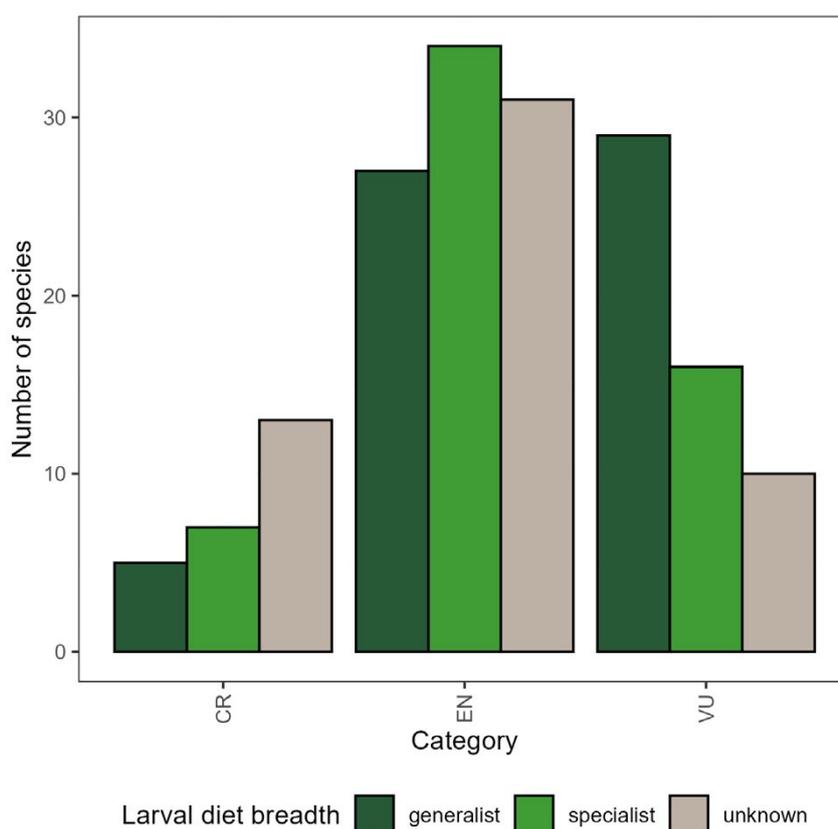
Figure 7. *Larval diet breadth of the different species, per IUCN Red List threatened Category.*

The A2P workshop

The A2P project was a partnership between the IUCN SSC Conservation Planning and Wild Bee Specialist Groups, the IUCN European regional office in Brussels and the IUCN Red List Unit in Cambridge.

To increase the efficiency of discussions, the A2P process began by grouping species that are expected to benefit from the same kinds of conservation actions, taken either in the same areas or by the same groups of people. Based on the advice of experts, the following two working groups were formed, each focusing on the threatened species of a different habitat type and on the main risks to wild bees there.

GROUP 1. Specialist and parasitic species

Focus species: *See Appendix 1*

Working group members: Denis Michez, Ignasi Bartomeus, Hugo Gaspar, Vladimir Radchenko, Simone Flaminio, Petr Bogusch, Jakub Straka, Villu Soon, Matthias Albrecht, Felix Fornoff, Thomas Wood, Benoît Geslin, Albano Soares.

Specialist bee species rely exclusively, or almost exclusively, on certain plant species or families for the collection of pollen for their larvae. These species occur across the European territory, but certain habitats (e.g. grasslands, steppe, wetlands, dry ecosystems, dune and back dune, shrublands) host a higher proportion of specialist bees due to the diversity or rarity of the plant species present. These habitats are often receding, and so are the food sources for those species, threatening their survival. Some of those species can also be island endemics or mountain species.

Brood parasitic bees do not make their own nest but lay their eggs inside nests made by other bee species. As many brood parasitic species are largely specialists of their host bee species, their larvae are also indirectly specialised in the same food sources as the hosts. Thus, their presence is determined not only by the presence of the host bee species but also by the presence of the food source. Since brood parasites are highly dependent the populations of specific host bee species, they are more sensitive to changes in host populations and community compositions, increasing their risk of extinction.

Colletes collaris Dours, 1872, male and female, Spain. © José Luis Romero

GROUP 2. Island and mountain species

Focus species: *See Appendix 1*

Working group members: Guillaume Ghisbain, Sara Reverté, Carlos Ruiz, Theodora Petanidou, Simon G. Potts, Dominique Zimmerman, Javier Ortiz-Sánchez, Menelaos Stavrinides, Evelyn Underwood.

Islands harbour a high proportion of both endemic and threatened species. Island species are particularly vulnerable to anthropogenic disturbances due to their small population sizes and restricted and naturally fragmented distribution ranges (although this may not represent 'severe fragmentation' in Red List terms). In particular, island species are especially sensitive to invasive species, habitat loss and climate change. In Europe, the islands with the highest pressures are in the Mediterranean and in the Macaronesian archipelagos, due to tourism related development projects and uses and climate change.

Being confined within particular climatic zones, mountain species suffer similar threats as island species. This is especially true in alpine habitats functioning like ecological islands, being isolated by a matrix of non-suitable habitats (lowlands and forests). Mountain habitats are among the most affected by climate change, making the species living there especially sensitive to climate change threats.

Island and mountain species might also be specialist on certain pollen sources or brood parasites of other bee species.

Over the two sessions, the working groups described the main threats causing declines or preventing recovery of threatened species in these areas, the obstacles to taking effective conservation actions, and discussed actions that must be taken over the next 5-10 years, focusing on what might be most achievable. The results of these discussions are further described in the following pages.

Lasioglossum chalcodes (Brullé, 1839), female, Spain © Thomas Wood

Goal 1. Sufficient tools, databases & experts

1.1 Summary

The conservation of wild bees is currently hindered by incomplete knowledge of their diversity and distribution, insufficient identification tools and expertise at the European level (taxonomic impediment), limited monitoring schemes, and the lack of a centralised repository. Building capacity through reference collections, citizen science, grants, and training programmes is crucial for developing expertise and strengthening conservation networks. In addition, more information is needed on population trends of bee communities and on populations in less-surveyed areas, underlining the importance of targeted monitoring at both national and European levels. Finally, the use of IUCN Red List frameworks and the development of centralised, accessible data repositories, supported by standardised protocols for surveying species and habitats, are essential to foster collaboration between local partners (Michez, Boustani et al., 2026; Nieto et al., 2014).

1.2 Challenges and opportunities

The lack of comprehensive, up-to-date information on the distribution and status of wild bee species in Europe significantly hampers conservation planning and action. For many threatened species, knowledge is incomplete given their rarity. Some efforts are underway to address this issue via the centralisation of existing information from public and private repositories on the distribution and traits of European wild bees, mostly through the European Union projects such as ORBIT, ERL Pulse, DiSSCo, TETTRIs, WildPosh and SAFEGUARD. All available information will be aggregated into a database accessible to practitioners, conservationists, policymakers, and the public. However, even if this centralised database is the product of years of work, it is still a work in progress. Many existing databases still need to be carefully checked and validated before integration; a lot of important records remain in museums and private collections awaiting digitisation; and much research and monitoring data is not yet openly available.

To ensure the long-term sustainability of conservation efforts, capacity building in wild bee identification is essential. A fundamental requirement for assessing the status of threatened populations is the ability to identify species. Currently, there is a risk that valuable knowledge held by experienced amateurs will be lost, as many experts are reaching retirement age, while at the same time few positions in taxonomy are available for younger specialists. Creating dedicated academic degrees, training citizen scientists, incentivising young taxonomists, and supporting a new generation of researchers through grants and certifications are key to building expertise and strengthening conservation networks across Europe. However, all these actions are only effective if we ensure a stable job market for taxonomists and recognise its unique contribution to society by eliminating job insecurity and the current precarious job conditions.

One important task that must accompany capacity building is the creation of identification tools to help both amateur and professional entomologists perform their work effectively. Currently, such tools are available only for a subset of species and/or for a subset of countries (mostly in central, western, and northern

Europe, although the Mediterranean region holds most of the continent's diversity). Species-level identification keys for all bee genera and all European countries are vital for training citizen scientists and young taxonomists, particularly keys that enable the unambiguous identification of threatened species.

Part of this task started within the EU project SPRING (2021-2024), which developed a trial for creating a Europe-wide network of taxonomic training. This was only a test phase, including courses in multiple European countries and at multiple expertise levels. The continuation of the effort is taking place under the EU project EPIC-Bee (December 2024-December 2026), in which training at species level for species-rich groups will be performed and European-wide keys on species level are planned to be developed for certain species-rich genera. These projects alone cannot fully resolve the lack of expertise in bee identification at the continental level, but they will contribute to a blueprint for future initiatives to build new expertise across countries.

The next step in the conservation of threatened bee species is to use the network of newly trained experts to expand existing knowledge. There is a pressing need to survey unexplored areas of conservation interest (e.g. mountains, islands—especially in the bee-rich Mediterranean region—as well as steppes) and to conduct targeted monitoring of overlooked or understudied species, since current knowledge of their status and distribution is still insufficient to support effective conservation actions. Enhanced coordination and integration of spatial, temporal, and phenological data on threatened species is necessary to allow conservationists to address gaps in knowledge and respond effectively to further emerging threats. A targeted monitoring for threatened species can complement existing EU-wide monitoring initiatives like EU-PoMS,

provided these efforts are aligned with species-specific requirements. In this context, the updated Red List assessments summarised in Michez, Boustani et al. (2026), offer a standardised framework to assess the conservation status of species, prioritise efforts, and monitor progress. Yet, a significant percentage of species are Data Deficient, and national Red Lists for wild bees remain incomplete or outdated in many regions, especially in southern and eastern Europe. Regularly updated assessments of all bee species both at the continental level and at the national level are needed to ensure timely interventions.

Finally, developing an online, open-access repository centralising all available information on wild bees in Europe is critical for efficient monitoring, fostering collaboration, and supporting evidence-based conservation strategies by researchers, policymakers, and practitioners. Despite the recommendations of making data FAIR (Findable, Accessible, Interoperable and Reproducible), bee data are extremely hard to collate mainly due to lack of accessibility (e.g. not digitised) and interoperability (e.g. closed access databases, with no standard metadata) (Marshall et al., 2024). So far, the information available on the distribution, ecology, and conservation of bees has been fragmented and difficult to access. The development of a centralised repository that collates all available information in one place is therefore of utmost importance for supporting conservation actions. This repository should be easy to use, open to the wider community, and maintained as a live database with personnel dedicated to its management, operation, and curation. A dedicated budget is needed to support the operation of the platform and the personnel responsible for continuously expanding it with new data, while also ensuring that all data are clear, validated, standardised, and as complete as possible.

1.3 Recommendations

Table 3. *Sub-goals and recommended priority actions for filling the gaps in information, tools and expertise related to wild bees, over the next 5-10 years.*

1.3.1 Species-level identification keys at regional and European levels for all bee genera	
Recommended actions	
1.3.1.1	Synthesise and update available taxonomic information and construct regional and European-level identification keys for the >2,100 bee species of Europe. This action has started with the projects ORBIT and EPIC-Bee, but keys are still required for many parasitic groups (e.g. *Melecta, Sphecodes*) and large genera (e.g. *Andrena, Anthophora, Lasioglossum*). Construct simplified keys with pictures to be used by amateurs in citizen science initiatives.
1.3.1.2	Assemble high quality pictures of uncommon species and their environments and add them to the centralised database (1.3.5).
1.3.1.3	Translate and adapt European keys into regional keys in local languages.
1.3.2 Training, certification and coordination of European and national experts	
Recommended actions	
1.3.2.1	Follow the recommendations presented in the *European Red List of Insect Taxonomists* by Hochkirch et al. (2022) to address the significant deficit in bee taxonomic expertise within Europe.
1.3.2.2	Train citizen scientists to identify and sort the common bee species of their region, so experts are only needed for more challenging cases. Develop a level certification scheme (this is partially done under the EPIC-Bee framework).
1.3.2.3	Develop and fund grant schemes for young researchers and practitioners and establish a stable job market for professional taxonomists.
1.3.2.4	Secure permanent positions for high-profile taxonomists in universities and academic institutions that can be fully dedicated to work on the digitisation of museum data, creation of new collections (including reference collection), molecular analyses, databasing of new spatial records and creation of updated (regional) tools for bee identification. A new generation of taxonomists is also urgently needed in the context of the forthcoming EU-PoMS protocol.
1.3.3 Targeted and coordinated monitoring for threatened and overlooked species	
Recommended actions	
1.3.3.1	Survey bee species-rich areas that have not been previously explored, in particular mountains and islands in the Mediterranean areas, habitats and plants in which threatened bee species can be found. Use the results to identify areas with the highest concentrations of threatened wild bee species for priority monitoring and conservation research.
1.3.3.2	Coordinate national and European monitoring to ensure spatial and temporal distribution data on each species, incorporating phenological data to capture seasonal variations in their life cycles and ecological interactions.

1.3.3.3	Implement in the EU-PoMS monitoring the "rare and threatened species module" in all countries.
1.3.3.4	Increase the spatial coverage of data by gathering opportunistically collected, validated spatial records from non-academic entomologists, and digitise existing insect collections (see point 1.3.2.4).

1.3.4 Increased development and use of standardised national and European IUCN Red List

Recommended actions

1.3.4.1	Use the updated *European Red List of Bees* assessments in the IUCN Red List of Threatened Species to inform conservation priorities, planning and action for threatened wild bees.
1.3.4.2	Promote regularly updated national and regional Red List assessments for wild bees across European countries, at least every 10 years.
1.3.4.3	Follow the recommendations from the present report for taxa undergoing similar threats but currently classified in non-threatened categories.

1.3.5 Dynamic, accessible and centralised repository for wild bee data

Recommended actions

1.3.5.1	Assess the efficiency of the existing platforms dedicated to collect insect species data (GBIF, iNaturalist, ObsIdentify, etc) and distribution and use this information to design an optimised new European repository for wild bee data. The repository should include distribution, phenology, morphological and ecological traits, species-specific resource requirements, bee–plant interaction networks, pictures of specimens in the field for all wild bee species (with special emphasis on threatened species), and molecular (DNA) data.
1.3.5.2	Secure funding for development and staffing of the European repository for wild bee data and for ensuring its long-term functioning and updating.
1.3.5.3	Create a standardised data form for collecting information from non-academic entomologists and citizen scientists.

Goal 2. Adequate protection, management and restoration of priority habitats

2.1 Summary

Effective conservation strategies for pollinators, particularly wild bees, must account for the multifaceted threats they face as well as the environmental, ecological, and management-related factors involved. However, their relatively small foraging areas make the use of a network of easy established micro-reserves a cost-effective option to protect small habitats hosting threatened species. By identifying priority areas, addressing habitat loss and connectivity, and promoting coordinated management actions, we can help ensure that wild bees continue to thrive in a rapidly changing world.

2.2 Challenges and opportunities

2.2.1 All systems or multiple systems

Identification of current priority areas and future refugia

Systematic inventories and monitoring of wild bee populations are lacking in many regions, hindering efforts to understand and mitigate their decline. Without robust data, conservation initiatives may fail to identify priority areas and species. Priority areas are locations with a high concentration of wild bee species, particularly threatened ones, regardless of their formal protection status. These areas are also characterised by a diversity of floral and nesting resources. Their distribution will not necessarily align with existing protected areas, since the designation of most protected sites, including Natura 2000, has largely followed the needs of vertebrates.

Standardised monitoring programmes are necessary to ensure that data can be compared over time and across regions. This knowledge is crucial for identifying threatened species, areas of high biodiversity, and emerging threats, enabling evidence-based conservation planning. Using newly-updated IUCN Red List data for threatened wild bees is an essential starting point for recognising priority areas that need urgent attention. Moreover, modelling tools should be developed to predict which regions will act as refugia for threatened species under different future scenarios, including dark diversity analysis tools. This proactive approach can help prioritise areas that are likely to remain vital for pollinators under the stress of climate change and other human-induced pressures (Ghisbain et al., 2024).

The identification of Key Pollinator Areas is one of the proposed actions of the Revised EU Pollinators Initiative, to be led by European Commission in collaboration with Member States and European Environmental Agency. This action should be implemented as planned, following recommendation developed in GOAL 1 for the data, and the results widely communicated as an important tool for targeted conservation

and restoration activities. SAFEGUARD and the European bees Red List projects are opportunities to identify gaps of knowledge, and to have access to standardised and validated data.

Identification of threats and priority species

Land managers are not necessarily aware of the different threats acting in the areas they are responsible of. As the threats are most often multiple, it is also important to quantify each of the threats to prioritise actions. Each identified biodiversity area should have specific management actions targeting the key threats to wild bees, such as habitat loss and homogenisation, pesticide use, or overgrazing. Conservation efforts should focus on species that are considered high priority based on their Red List status and the national responsibility to protect them. Prioritising actions for these species ensures that limited resources are allocated efficiently to maximise impact.

Seek synergies with other species groups and initiatives

Protected areas offer a unique opportunity to safeguard pollinators, but the integration of wild bee conservation objectives within and around these areas is often neglected. The identification and the level of protection of areas do consider mainly vertebrates, and very few invertebrates. Coordinated conservation efforts across species groups and existing initiatives should be essential for improving the management of pollinator habitats as the largest network of protected sites in the EU Natura 2000, based on sites of the EU Habitats Directive (HD) and the EU Birds Directive (BD) is designed to be a "coherent" ecological network of protected sites. Currently the EU is launching a "Pledges" process to reach the 2030 EU biodiversity targets. The protected areas target for 2030 is to designate 30% of the terrestrial area as protected (and managed) sites, and 10% as "strictly" protected. Within this process there are opportunities to review existing national protected areas systematically, and threatened species should be considered within this. Red-listed bees (nationally and EU Red Listed) as well as bee KPA (Key Protected Areas), could be important inputs into this process, to support supplementation of existing protected

areas measures or to enhance their status to strict protection regimes.

Moreover, active communication to and between conservation stakeholders, streamlined processes for obtaining work permits, effective control, and reduced administrative burdens for conservation actions can facilitate the integration of bee-friendly practices into these protected landscapes. Such actions will increase the effectiveness of protected areas in providing suitable habitats for wild bees and other pollinators.

Favour Connected micro-habitats

Many wild bees need complex network of connected micro-habitats in their foraging range (from 50m to 1 km) around their nest. These micro-habitats can be different for the requirement in nesting resources, host-plant resources, or host resources (if parasitic) (Danforth et al., 2019). Sustaining bee species diversity in a landscape requires the spatial and temporal continuity of diverse micro-habitats. Due to a range of natural resource management decisions and practices, these micro-habitats continue to be lost even where macrohabitat is still present. One of the most effective ways to enhance wild bee conservation is by promoting connected micro-habitats within the landscape. This includes ensuring a balance of land-use types to support diverse habitats, such as native flower-rich meadows, bare ground patches (e.g. unpaved roadsides or lightly vegetated areas with vegetation gaps), stone walls with soil crevices, hedgerows of indigenous plant species separating agricultural fields and forest edges. The creation and maintenance of these habitats should focus on temporal, vertical and horizontal diversity, making it easier for bees to find food, nesting sites, and shelter. Within a landscape-scale approach, narrow strips of land such as hedgerows, and the areas under power lines or alongside canals and railway lines, can provide habitat refugia and corridors for invertebrates. For example, if land under power lines is left for several years without cutting, it results in an area less ecologically valuable, potentially leaving only brambles and dead small wood sticks instead of open areas with wild flowers.

Intensification and mechanisation of agriculture, mechanised management in natural areas, and mowing of roadside verges are some of the important processes that lead to larger open areas with sharper borders. Loss of more gradual ecotones (transition zones), including hedgerows, results in less diversity of the plant species and nesting resources important to wild bees. For example, it provides fewer microhabitats for species nesting in deadwood. Special attention should be paid to restoring ecotones between different habitat types, particularly in areas with intensive land-use.

Reduce or remove nitrogen deposition and pesticides

Many bee habitats, especially for rare or threatened species, are dependent on low to medium nutrient levels. This is especially true for most open species-rich grassland, for all scrubland and heathland habitats and for oligo- to mesotrophic waterbodies and bog systems. The deposition of nitrogen from agricultural activities and the widespread use of pesticides are two of the most pressing threats to wild bee populations. Excessive fertiliser use significantly reduces the plant diversity and consequently the diversity of bee species (Rasmont et al., 2021). Unfertilised, extensively managed agricultural land is substantially better nesting habitats for ground-nesting bees than intensively managed and fertilised agricultural land regularly receiving high nitrogen inputs, most likely a consequence of the relatively dense vegetation cover of the latter (Albrecht et al., 2023). Sublethal and cumulative effects of pesticides on pollinators can impair crucial behaviours such as foraging, navigation, and reproduction, reducing their overall fitness and survival and thus lead to long-term declines (see Goal 3) (Raine & Rundlöf, 2024). Herbicides are also over-used to control potential unwanted plants, but these plants are an important food resource for bees in agricultural areas. Strategies should aim to reduce nitrogen inputs through better agricultural practices and enforce regulations that limit pesticide use. These actions are essential for maintaining habitat quality that support wild bee populations and ensuring they have access to safe foraging areas.

Create buffer zones

Unlike most insects, wild bees build nests and forage in the surrounding landscape. This means that even if they nest within a protected area, they may depend on resources outside its borders. Buffer zones around protected habitats can act as a barrier, reducing the negative impacts of pollutants such as nitrogen and pesticides. Buffer zones need to be sufficiently large to effectively protect priority areas and maintain safe conditions for wild bee populations. In addition, buffer zones can mitigate habitat fragmentation by offering corridors that allow bees to move between habitat patches. The EU Biodiversity Strategy includes information about buffer zones around Protected Areas and encourages margins for pollinators around agricultural areas.

Good practices in beekeeping

Beekeeping can pose a threat to wild bees if not carefully managed (Lázaro et al., 2021; Ropars et al., 2022). One key concern is competition between wild bees and managed Honey Bees for floral resources, as well as the potential spread of parasites and diseases from managed colonies to wild populations (Geslin et al., 2023). Competition is predicted to be more significant in the future because nectar availability is foreseen to be less abundant and available due to the effect of climate change. Beekeepers should be educated about the risks associated with hive density, placement, and the movement of bees, especially in areas that are critical for wild pollinators (e.g. protected areas or areas in which threatened species occur). Ensuring that beekeeping practices does not negatively impact wild bee populations is essential for maintaining biodiversity and ecosystem health (Mallinger et al., 2017).

Management of invasive plants and insects

The spread of invasive species is a growing concern for wild bee conservation (Stout & Morales, 2009). Invasive plants can outcompete native flora, reducing the availability of food sources for native bees, especially for foraging specialists. Invasive insects can prey on or outcompete native pollinators, spread diseases or alter

plant-pollinator network structures (Zakardjan et al., 2022). Habitat restoration efforts should prioritise the removal of invasive species and focus on replanting with a diversity of native vegetation that supports local pollinators. Additionally, early detection and swift removal of new invasive species will help prevent their spread and the disruption of native ecosystems.

Limit soil erosion

Soil erosion negatively impacts wild bee habitats, especially those used by ground-nesting species. Changes in water management, such as the paving of drainage systems or the loss of riparian zones, disrupt natural sandy banks or loose soils that many species rely on for nesting. Erosion can destroy nesting sites and reduce the availability of floral resources. Effective land management practices that limit soil disturbance (e.g. no- or low-till farming) and soil erosion, such native hedgerows, cover crops, contour farming, and grazing management, will help protect these vital habitats for wild bees. Traditional terraces for agriculture, especially the ones still cultivated, support wild

bee diversity, because they constitute enduring systems that are supportive to bee nesting (diverse micro-habitats) and rich on floral resources (many annuals). Orchard management, particularly in Mediterranean areas, are also important for bees, since their large extent and relatively stable conditions across years make them potentially valuable habitats. In this context, natural ground covers protect soil erosion and provide bees with flower resources. Eroded areas (if limited) make open soil with perfect opportunities for ground nesting bees.

Optimal fire management

Fires can lead to direct loss of habitat and to overall degradation, with gradual loss of plant diversity and abundance. Fire impacts may differ among plant species. While sensitive and susceptible species may not survive burning, more resilient plant species may survive and become dominant, changing species composition, and reducing overall diversity at fire-affected sites. Fires can also create favourable conditions for the establishment of invasive plants, reducing the diversity of native plant species.

Dasypoda argentata Panzer, 1809, male, Spain. © José Luis Romero

Additionally, fire can affect the long-term quality of soil because rains wash away organic matter more easily after fires. This impacts plant diversity by creating conditions suitable only for plants that can grow in poor-quality soils, reducing the quality of the subsequent herb-layer micro-habitat.

In fire-prone areas, appropriate fire management strategies are crucial for protecting wild bee habitats (moderate fires can even be favourable; Lazarina et al., 2019). Particular attention should be given to forest management, ensuring that the accumulation of dry litter does not reach levels where fire intensity becomes catastrophic. This can be achieved through prescribed burning, a practice currently applied in only a few countries. Creating fire breaks is another effective measure, especially when these zones are planted with fire resistant native species (e.g. caper) and maintained sustainably through methods such as controlled grazing.

Post-fire management is equally important. Grazing should be avoided to allow natural regeneration, and beekeeping should be carefully controlled. Only at later stages should restoration with native flowering species be undertaken. Such practices not only protect bee populations from fire damage but also ensure they have access to vital resources during the recovery phase.

2.2.2 Recommendations for micro-habitats of specialist bees

Specialist bees often rely on very specific micro-habitat conditions such as the abundance of particular host plants (e.g. Campanulaceae, Caprifoliaceae, Lythraceae or Orobanchaceae) or presence of bare soil and nesting material / nesting site (e.g. dry stems of particular Apiaceae/Rosaceae, mud or resin). Many specialist bees use rare or declining habitats such as sand dunes, bogs or cliffs, which may be under-represented in terms of conservation status. The loss or degradation of these habitats can have severe consequences for their populations. Conservation efforts need to address the unique needs of these species by focusing on habitat protection, restoration, and avoidance of practices that degrade the environment.

Protected areas

Protected areas hosting specialist bees share similar challenges than exposed in the previous chapter. The recommendation and opportunities described earlier apply here too. However, specific management measures should be developed / prioritised for habitats within protected areas to maintain the conservation status of micro-habitats crucial for specialist wild bees. This includes creating pesticide-free zones and restricting access to priority areas, especially in regions where wild bees are at risk. In some cases, moderate management measures (e.g. light and controlled disturbances) applied in small parts of the protected area (if the protected area is large) can be enough to keep the system interesting for wild bee nesting and foraging; such measures can be ploughing and grazing. Management practices in protected areas are essential to counteract natural succession, which is accelerated by excessive nutrient input (e.g., from atmospheric deposition and surrounding agricultural activities) and compounded by the absence of nutrient reduction through grazing by wild grass-feeding animals. In addition, managers should ensure a proper protection of unique habitats like sand dunes, bogs or cliffs which are key to protect the associated wild bee fauna. Protected areas should be continuously monitored (i.e. with standardised protocols and estimations of population sizes) and optimised to ensure they meet the conservation needs of wild bees.

Urban areas

Urban ecosystems impose different environmental constraints on plant and animal communities than natural ecosystems, which in turn affects pollinators and their ecological interactions. Anthropogenic land-use change is one of the main drivers of terrestrial biodiversity loss, including that of insects. Among these changes, urbanisation has been identified as a significant threat to global biodiversity, including pollinators (Tsang et al., 2025). However, appropriately managed cities can contribute to the conservation of pollinators by providing them with

habitats and benefit from the many services that pollinators deliver. Green spaces in (peri-) urban areas can provide pollinators with food, foraging opportunities, and sites for reproduction, shelter, and nesting that may be absent in surrounding agricultural landscapes. A city can be species rich in pollinators. For example, Fortel et al. (2014) found 31% of France's bee fauna in a survey of Lyon. However, creating and maintaining habitats for wild bees presents unique challenges. This includes integrating pollinator-friendly practices into urban planning, such as creating flower-rich corridors, planting native vegetation, and reducing the use of pesticides. A particular challenge is the selection of plants in urban gardens, where ornamental species with large, showy flowers often provide little or no nectar and pollen for bees.

Evidence shows that the most effective approach is a diverse mix of native plants, providing pollen- and nectar-rich flowers that attract both generalist and specialist pollinators throughout their entire activity season. The selection of non-native ornamental plants is a major problem, requiring persistent communication with city staff, especially gardeners, as well as with citizens who may lack awareness of pollinator needs. Finally, as in protected areas, measuring and monitoring pollinator populations is a key step for informing evidence-based policy and effective conservation actions. It enables urban planners to make informed decisions on where interventions can be most effective. In cities, there are additional opportunities to develop citizen science programmes, which have the added benefit of raising awareness about pollinator conservation.

Agricultural areas

Wild bees can be threatened by many factors in agricultural areas like exposure to pesticides and habitat degradation through (over)fertilisation, limited floral resources in quantity, diversity and time, homogeneity of landscape structure or competition with managed species. However wild bees can also benefit from disturbances occurring in agricultural areas, among them keeping the vegetation open (e.g. permanent flower-rich grasslands in previously forested areas), or traditional (light) ploughing that allows

Andrena monilia Warncke, 1967, female, Spain © Thomas Wood

higher plant diversity (supporting annuals vs. perennials). Agricultural areas are critical for bee conservation in proving open, potentially flower-rich landscape, but intensive farming practices often degrade habitats and reduce biodiversity. Implementing biodiversity-friendly farming practices, such as reducing pesticide use, planting hedgerows with indigenous and melliferous plant species, maintaining green infrastructure within or around crops, encouraging crop diversity, and maintaining buffer zones around protected areas, will create habitats that support wild bee populations. Additionally, adopting integrated farming systems that priortise ecological health can improve the resilience of agricultural landscapes to climate change and other stresses. Simple measures such as reducing field sizes and increasing the local diversity of crops used can have profound effects on bee populations.

The abandonment of traditional, extensive agricultural practices and subsequent succession and reforestation can significantly alter ecosystems, often leading to the loss of vital micro-habitats for bees. Fallow lands are therefore important, especially when managed in a traditional manner, i.e. allowing controlled grazing, so to diminish the overdevelopment of grasses. Crop rotation systems, often coupled with fallow lands, are beneficial for wild bees, especially if the intermediate crop bears entomophilous flowers (Rasmont et al., 2021).

2.2.3 Mountain and island bees

Mountain and island ecosystems are crucial refugia for many endemic and specialised species in Europe. However, these areas face increasing pressure from infrastructure development, especially tourism and related urbanisation, climate change, and land-use changes (especially overgrazing), intensive and poorly regulated beekeeping activities, requiring targeted conservation actions to protect the unique biodiversity they harbour (Kougioumoutzis et al., 2022; Minachilis et al., 2021). The following recommendations outline key strategies for conserving mountain and island bees and can be added to the general recommendation developed in the first chapter. For example, from these general

recommendations, priority should be given to the identification and the management of KPAs and potential refugia in mountain and island areas, ensuring that their biodiversity value is maintained. Additionally, exposure to pesticides should be limited as much as possible.

Limit the impact of climate change

Mountain and island areas can be relatively small and isolated. They are, by definition, limited in a spatial point of view by areas showing different climate and environmental characteristics from the surroundings. Climate change is a major threat to mountain and island bees (Ghisbain et al., 2024; Rasmont et al., 2015). Rising temperatures can shift flowering times, creating spatial and temporal mismatches between bees and their food sources (Gérard et al. 2020). However, the main problem with mountains and islands is that these species are often adapted to spatially narrow ecological niches, and they have limited opportunities of movement / migration. They are overall less likely to be able to migrate to areas with better conditions, because of the lack of usable corridors between them. For example, alpine species will move higher in elevation with rising temperatures, until no habitat is available for them. They cannot use the lowlands to move to another mountain, the same way than island species cannot use the sea to migrate to other islands. However, structural diversity of habitats affects the availability of different local microclimates and thus gives individuals the possibility to mitigate extreme conditions.

On mountains, reduced snow cover depth and duration, and changing precipitation patterns, may further disrupt the availability of floral resources. On islands, climate change exacerbates the challenges posed by habitat loss, with rising sea levels threatening coastal habitats crucial for bee survival. By managing and creating high-quality habitats with an abundance of flowering plants and creating corridors between these habitats, we can help mitigate some of these impacts and maintain the connectivity needed for bee populations to adapt. The effects of climate change are felt less intensely in areas where high-quality habitats are available (see below), in contrast with areas already suffering from other environmental pressures.

Optimise habitat management

Maintaining habitat heterogeneity is essential for supporting wild bee populations, especially in mountain grasslands and coastal areas. Even small fragments of undisturbed habitats, such as woodland patches or isolated meadows, can support large populations of wild bees.

In mountain areas, land-use changes present a dual challenge. Overgrazing by livestock in high altitude meadows exerts a detrimental impact on wild bee habitats by degrading plant diversity and soil structure. Intensive grazing reduces floral abundance and diversity, limiting essential foraging resources for wild bees. Additionally, the compaction and erosion of soil caused by overgrazing can destroy nesting sites, particularly for ground-nesting species. This leads to habitat homogenisation, reducing the overall availability of suitable micro-habitats and negatively affecting bee populations. On the other hand, stopping grazing in areas that traditionally were grazed under controlled regime, also leads to decreased wild bee diversity, due to overwhelming presence of competitive non-bee friendly vegetation, mostly grasses. Abandonment of areas that are difficult to access (e.g. steep slopes) can also lead to habitat degradation. As an epitome, the best management is moderate grazing, which is habitat type specific. Establishing optimal numbers of grazing animals ensures that floral resources are not overexploited, while delaying the first grazing or mowing date in grasslands allows bees to forage during peak bloom. When properly managed, abandoned areas can regenerate into diverse habitats that support wild bee populations. Grazing systems, when thoughtfully planned, can enhance biodiversity by creating and maintaining habitat heterogeneity. Furthermore, traditional techniques such as mowing can enhance pollinator populations because they maintain floral diversity and staggered blooming periods, which provide consistent foraging resources for pollinators throughout the growing season. It minimises habitat disturbance compared to mechanised mowing, allowing a greater variety of plants to support diverse pollinator species. In overgrazed or intensively used areas, it is vital to preserve high quality habitat fragments to maintain local biodiversity and provide essential resources for pollinators. Montane farmers should be provided with guidance on how to enhance biodiversity through sustainable grazing practices, such as supporting grazing by sheep, which help disperse seeds and increase plant diversity. Additionally, incentivising the recultivating of abandoned areas like old terraces for agriculture or difficult-to-access areas can help restore vital habitats. Proper management of grazing pressure by establishing optimal animal numbers and delaying grazing or mowing until after the peak bloom will ensure that floral resources remain available for pollinators.

A frequent measure to prevent fires, applied especially in the Mediterranean area, is general mowing before the beginning of the fire season, which can be as early as in late April, which constitutes a catastrophic action for both plants (which are not allowed to complete their cycle, thus not seed-setting, and fewer plants grow in the following years) and for bees (no forage is left for them). A counteractive measurement to protect both plants and insects would apply a mowing that is selective (select particular species with high coverage to mow) or to rotate mowing, i.e. mow the area in parts alternating with years.

Regarding coastal ecosystems, sandy areas, salt marshes, and back-dune habitats, are vital for many species of wild bees. To protect these environments, effective management strategies to control invasive species are needed, as island ecosystems are particularly vulnerable to ecological disruptions. In the same way, remnant habitats, crucial for the maintenance of threatened species at the regional or national scale (permanent grasslands, shrublands, etc.), should be prioritised for rapid protection measures in cases where immediate threats to their persistence are identified. This is even more critical for oceanic islands, where small populations of wild bees persist most of the time in small habitat patches. In particular, the dune structures should be protected by establishing designated no-access zones to minimise tourist and recreational impact on fragile dune systems. Moreover, erosion should be mitigated by implementing natural erosion control measures, such as planting deep-rooted native vegetation, to stabilise dunes and maintain micro-habitats.

Regulate tourism development

The construction of tourist infrastructure, such as ski resorts in mountainous areas and beach resorts on islands, can have devastating effects on local ecosystems, including wild bee populations. Ski resorts can destroy flower-rich meadows, compact soil, and remove topsoil, reducing the availability of nesting sites and floral resources. On islands and coastal areas of mainland, urbanisation and the expansion of tourism infrastructure significantly threaten wild bee populations through the destruction of coastal sandy areas, salt marshes, and back-dune habitats, which are critical for many bee species. These habitats are irreplaceable for specialist bees which depend on specific environmental conditions to survive. Moreover, tourist infrastructures are related to high water consumption and depletion of the island water resources, as well as insect control, both affecting wild bees for different reasons. Regulating new construction of touristic infrastructures and providing guidance for sustainable tourism practices can help mitigate these impacts.

2.3 Recommendations

Table 4. *Sub-goals and recommended priority actions for filling the gaps in information, tools and expertise related to wild bees, over the next 5-10 years.*

2.3.1 General recommendations for all or multiple systems	
Recommended actions	
2.3.1.1	Implement action 2.3 of revised pollinator initiative which calls for identification of priority areas ensuring also identification of future climate refugia.
2.3.1.2	Identify and quantify threats and priority species for each area based upon the Red List status (European as well as national or regional) and national responsibilities for protecting these species.
2.3.1.3	Seek synergies with other species groups and with other initiatives (e.g. Natura 2000, IBA, IPA, PBA) to increase chances of successful management and protection of KPAs.
2.3.1.4	Favour connected micro-habitats through vertical, horizontal and temporally diverse landscape structures: • Pursue optimal proportions of different land-use types to encourage abundant, suitable micro-habitats that will support multiple bee species requirements. • Avoid planning of infrastructure such as high-speed roads, paths, etc., along forest borders, which will destroy ecotones. • Apply landscape rather than single system management. • Restore semi-natural ecotones (transition zones), especially in intensively used and heavily modified landscapes ((e.g. SPACE hedgerows, mown strips under powerlines, canal, railway and roadside planted strips etc).
2.3.1.5	Substantially reduce or remove excess nitrogen deposition, pesticides and seed coatings (see also Goal 3).
2.3.1.6	Create buffer zones of sufficient size to protect priority areas from excess nitrogen deposition, pesticides and seed coatings (see also Goal 3).

2.3.1.7	Good practices in beekeeping: • Assess the total number of hives to be installed in a beekeeping area, by considering (measuring) nectar and pollen capacity of the area (i.e. to avoid resource competition with wild bees). • Offer guidance for practitioners in beekeeping to alert about potential risk of competition and parasite spillover. • Carefully consider the number and distance between beehives, and in border zones around them (noting the > 3km foraging range of the Western Honey Bee).
2.3.1.8	Management of invasive plants and insects: • Habitat restoration to control/eradicate invasive plant species and restore with native plants. • Prioritise species list of which to focus on- add to invasive species action plans, or which areas to focus on. • Support policy to quickly detect and eliminate new potential invaders (See Goal 4).
2.3.1.9	Limit soil erosion through: • Establishment of vegetative buffers: Planting native melliferous flowering plants along field margins and slopes. • Application of a dehesa-type of agroforestry, a system that has been traditionally used throughout the Mediterranean region. • Create perennial cover (but allow also areas with annual plants): Maintaining perennial plant cover in vulnerable areas. • Install erosion control structures: Use of techniques such as terracing (supported by natural vegetation or, better, by drystone walling) or silt fences in agricultural and degraded lands. • Reduce tillage: Implementing low-till or no-till farming practices.
2.3.1.10	Optimal fire management: • Fire breaks to be managed sustainably for biodiversity (e.g. by using grazing or/and adapting timing of mowing). • Manage by planting fire-resistant plants. Prioritise unmanaged areas where fire is more prevalent (e.g. management of abandoned areas to avoid out of control *Eucalyptus* in Portugal). • Intermediate disturbance rule applies: Manage forests to keep flammable matter controlled and apply prescribed fire to achieve the highest post-fire bee diversity. • After fire, clean out fast-growing plants that only take space and do not produce floral resources as well as exotic invasive plants. • Avoid repeated fires in short time periods.

2.3.2 Specific recommendations for micro-habitats of specialist bees

Recommended actions

2.3.2.1	For protected areas, develop planning management measures to enhance or maintain the conservation status of any habitats (including micro-habitats) or vegetation types; systematically screen, optimise and review for pollinator conservation, including bees: • pesticide free area (See Goal 3). • restrict access of vehicles. • develop inventories of wild bees as a standard procedure, including population monitoring.
2.3.2.2	For urban areas, develop the following measures: • enhance green spaces: develop and maintain parks, rooftop gardens, and flower-rich public areas with native plants. • create corridors: establish green corridors that connect isolated habitats. • preserve undisturbed patches: leave areas of bare soil, dead wood, and unmanaged vegetation to provide nesting sites for different wild bee species. • avoid installing managed Western Honey Bee colonies: introducing colonies in urban areas can increase competition for resources, potentially displacing native wild bees and spreading diseases. • change consumers (citizen's) and civil gardener's behaviour: sow and support native plants that produce nectar and pollen for pollinators and drop ornamental plants with showy flowers. • allow continuous flowering in urban areas with native plants having successive flowering period. • incentivise the use of native entomophilous plants in private gardens vs. dropping the use of lawn. • develop inventories of wild bees as a standard procedure, including population monitoring. • raising awareness on pollinators: development of citizen science in link with monitoring programme.

Bombus distinguendus Morawitz, 1868, female, Poland © Justyna Kierat

Goal 3. Priority areas free of chemical pollutants, with stricter rules for their control

3.1 Summary

Bees are vital pollinators, and their decline is an alarming ecological issue. They face threats from various chemical pollutants, including pesticides (active ingredients and co-formulants), fertilisers, plastics, phthalates, antibiotics, fine particulate matters and heavy metals. Addressing these threats requires a multifaceted approach that combines policy changes, agricultural practices, and scientific research to reduce the harmful impact on these essential species. This section explores the key challenges posed by chemical pollution and presents opportunities for addressing them, particularly in relation to pesticides and their impacts on wild bee populations. Through comprehensive policy changes, the promotion of sustainable agricultural practices, the establishment of buffer zones, and increased research into the long-term effects of pollutants, it is possible to reduce the harmful impacts on these crucial pollinators.

3.2 Challenges and opportunities

Chemical pollution in the environment can come from multiple sources. Those that affect bees, can be divided mostly in the following groups: (i) pesticides (primarily herbicides, fungicides, and insecticides); (ii) fertilisers; (iii) plastics (micro- and nanoplastics); (iv) phthalates; (v) antibiotics; (vi) fine particulate matters; and (vii) heavy metals (Arena & Sgolastra, 2014; Carvalheiro et al., 2019; Gekière et al., 2023; Raine & Rundlöf, 2024).

3.2.1 Pesticides and their impact on bees

Pesticides, particularly insecticides, are among the most direct threats to bee populations. Designed to kill insect pests, primarily by interfering with neurotransmission or mitochondrial respiration, these chemicals often have unintended effects on non-target species, including bees (Desneux et al., 2007). While insecticides are the primary concern, fungicides, which are typically used to control fungal diseases, have also been found to harm bee reproduction (Rondeau & Raine, 2022). Though the exact mechanisms are not fully understood, researchers hypothesise that these chemicals disrupt the biology of bee life cycles through various molecular mechanisms. Bees collect pollen and nectar, which contain fungi and bacteria, to feed their larvae. Bee larvae, especially solitary bee larvae, acquire their gut microbiota from their food and nest environment. Fungicides could potentially interfere with the development of larvae by altering the microbial environment within the food and nest. Furthermore, specific combinations of insecticides and fungicides have been shown to have synergistic effects, since fungicides may impede the detoxification abilities of bees towards insecticides (Schuhmann et al., 2022). Pesticides are mostly found in formulations, namely active ingredients are mixed with a handful of co-formulants that facilitate the action of the active

ingredients (i.e. surfactants, emulsifiers and solvents). Such adjuvants have been shown to increase the toxicity of active ingredients in bees, and some adjuvants are even more toxic than the active ingredient itself. Yet, these chemicals are never mentioned in ecotoxicological risk assessments and are not necessarily listed on product labels (i.e. manufacturing secret) (Straw, 2024).

Pesticides are widely used in both agriculture and silviculture, as well as in the private sector, and they can spread into non-target habitats through water and soil. Pesticides reach floral rewards, such as pollen and nectar, that are ingested by bees as larvae and adults. Moreover, runoff can create toxic environments for ground-nesting bees that encounter such chemicals in their nest (Sgolastra et al., 2019). Pesticide use is particularly problematic in regions where invasive insects require increased insecticide use, such as the citrus industry, where pest management depends on large-scale chemical treatments.

Pesticides, including biopesticides, are particularly worrying because they also display non-lethal effects in bees, which are often overlooked in ecotoxicological risk assessments. Pesticides approved on the market have been shown to have negative non-lethal consequences for bees, such as reduction of cognitive abilities (e.g. reduced foraging efficacy), impaired egg laying (e.g. fewer offspring), impaired immunity (e.g. poor resistance towards pathogens), impaired larval development, or impaired reproductive capacities (e.g. damaged sperm), among others (Siviter et al., 2021). Although these effects are not lethal, they significantly hinder the reproductive abilities of the bees and therefore the welfare of their populations. Pesticides are also known to alter the gut microbial communities of bees. Although our knowledge on this topic remains limited, the disturbance of the gut microbiota induced by pesticides (typically fungicides which impact yeasts) may hinder the digestion mechanisms.

3.2.2 Other chemical pollutants

There has been a historical focus on the effects of pesticides on bees, mostly because pesticides are applied in insect-pollinated crops and other flower-rich habitats, thereby directly impacting bees and their food resources. However, other chemical threats have been highlighted in the last decade. For instance, large plastics as well as micro- and nano-plastics are increasingly used in our societies and are now found ubiquitously in soils and water. Bees are exposed to these microscopic pollutants that readily pass through their gut or trachea to reach their haemolymph, brain and other organs, causing substantial damage. Despite the evidence, plastics are not yet regulated by environmental laws (Sheng et al., 2024). Combustion and mechanical processes in industries and in thermic vehicles generate microscopic pollutants, known as fine particulate matters, made of various chemicals (e.g., metals and reactive gases) that been detected in different organs of bees. Beyond their presence in fine particulate matters, metals are in their ionic form in water and soils where they are particularly abundant in sewage sludge and industrial effluents. These metals accumulate in pollen and nectar, are ingested by bees, readily penetrate their organs, and cause severe oxidative damage. Consequently, metals have been shown to induce physiological, histological, cytological and microbial damage in bees. Despite this evidence, bees are not protected from these pollutants by any environmental law. Even more worrying is that such pollutants have mostly been studied in isolation, while their potentially synergistic effects remain largely overlooked (Gekière et al., 2023, Gekière, 2025).

3.2.3 Reducing pesticide use

To mitigate the harmful effects of pesticides on wild bees, lessons should be learnt from previous experience to adapt EU regulations (Sgolastra et al., 2020; Siviter et al., 2023). A series of actions must be taken to phase out chemical pollutants from priority areas. These include banning the use of pesticides in priority areas and ensuring that buffer zones are established around priority areas where pesticides are prohibited, whether in the form of sprays, seed coatings, or genetically modified organisms (GMOs) that produce toxins. The European Commission's Sustainable Use of Pesticides (SUD) Proposal and the Pollinator Action Plan offer a framework for achieving these goals.

It is also essential to advocate for stronger provisions within EU law to restrict pesticide use in ecologically priority areas. Expanding existing pesticide bans, eliminating subsidies for harmful chemicals, and promoting alternative, sustainable agricultural practices are crucial steps. Economic incentives must be adjusted to encourage the use of pest-resistant (tested for toxin production in case they are genetically modified) crop varieties, reduce pesticide applications to less than 50% of crop fields annually, and prioritise biodegradable pesticides that leave no long-lasting residues. Additionally, establishing buffer zones of adequate size (ranging from 100 meters to 1 kilometre) around priority areas can help protect them from excess nitrogen, pesticide contamination, and other pollutants.

The promotion of integrated pest management (IPM) is another key strategy (Pecenka et al., 2021). IPM combines multiple pest control methods, including biological control, habitat manipulation, and cultural practices combined with continuous pest monitoring. Pesticides should be used only when strictly necessary, based on monitoring data that confirms pest thresholds have been reached. By adopting IPM, farmers can reduce their reliance on harmful chemicals while maintaining agricultural productivity.

3.2.4 Reducing nitrogen pollution

Another significant challenge to wild bees is nitrogen pollution, which can come from fertilisers, livestock farming, and industrial activities (e.g. acid rain). Nitrogen deposition can alter the composition of plant species in the environment, creating conditions that are unfavourable for entomophilous plants, bees and other pollinators (Carvalheiro et al., 2019; Rasmont et al., 2021). Excess nitrogen can lead to changes in soil composition and nutrient levels, disrupting the growth of plants that are essential food sources for wild bees. Furthermore, nitrogen pollution may alter the nutritional profiles of nectar and pollen in some plants, with consequences for bees relying on these resources.

To combat this issue, policies should aim to reduce nitrogen emissions from all sources, including agriculture, transportation, and industry. For sensitive habitats, such as bogs, heathlands, and species-rich grasslands, nitrogen inputs should be kept well below critical levels to prevent ecological damage. Strategies to limit nitrogen runoff, such as protecting semi-natural structures like hedgerows, can help filter out nitrogen and reduce its impact on surrounding ecosystems.

Bombus confusus Schenck, 1861, male, Ukraine © Eugene Karolinskiy

3.2.5 Research development for the testing of pesticide and other pollutants

To fully understand and mitigate the impacts of chemical pollution on wild bees, there is a pressing need for further research on pesticide toxicity and the effects of lesser-explored pollutants such as heavy metals, phthalates, and plastics (e.g., by developing databases; Gekière et al., 2024). Currently, pesticide testing primarily focuses on short-term and lethal effects in specific model bee species, such the Western Honey Bee, Buff-tailed Bumblebee (*Bombus terrestris*) and Red Mason Bee (*Osmia bicornis*). However, these tests do not account for long-term ecological impacts or the effects on bee populations in natural and seminatural ecosystems, especially the ones with a limited flight distance (Sgolastra et al., 2020; Siviter et al., 2023).

It is critical to expand testing protocols to assess the broader, cumulative effects of chemical exposure over time, particularly in relation to sub-lethal doses and indirect ecological consequences, such as disorientation or disrupted foraging behaviour in pollinators. Research into the effects of emerging pollutants like plastics, heavy metals and phthalates is essential for developing comprehensive strategies to provide protection from all forms of chemical contamination. Developing reliable methods to test the long-term effects of these pollutants on new bee models is equally important, since current models may not fully represent the entire bee community (Jütte et al., 2023).

It is also crucial for policies to request full transparency from manufacturers when sharing pesticide labels. Today, farmers, consumers or scientists are not allowed to know exactly the full composition of pesticide products, due to manufacturing secrecy. Revealing the exact formulation through laboratory techniques is also illegal. This policy prevents scientists from properly assessing and understanding the effects of pesticide formulation on bees. It has been argued that for biological conservation purposes, the right to know what is in the products outweighs the companies right to secrecy. However, the situation is unresolved (Straw, 2024).

3.3 Recommendations

Table 5. *Sub-goals and recommended priority actions for filling the gaps in information, tools and expertise related to wild bees, over the next 5-10 years.*

3.3.1 Chemical pollutants are banned inside and around priority areas	
Recommended actions	
3.3.1.1	Ban chemical pollutants in priority areas.
3.3.1.2	Create buffer zones of sufficient size (100m - 1km) to protect priority areas from excess nitrogen deposition, pesticides and seed coatings, or via genetically modified organisms (GMO) producing toxins themselves (see EU Biodiversity Strategy and Pollinator Action Plan for information).
3.3.1.3	Ensure strong provisions for prohibiting the use of pesticides in ecologically priority areas in the EU law, building on the Commission's proposal for a Regulation on the sustainable use of plant protection products.
3.3.1.4.	Prohibit the development of industries releasing massive amounts of chemical pollutants (e.g., heavy metals and fine particulate matters) in their smokestacks and wastewater near priority areas.

3.3.2 Pesticide use is rare and carefully targeted; it is not applied as a precaution; and nitrogen deposition from all sources, everywhere, is significantly reduced

Recommended actions

3.3.2.1	Reduce significantly the use of pesticides and fertilisers.
3.3.2.2	Reconsider EU subsidies for pesticides and fertilisers.
3.3.2.3	Advocate for changes in economic incentives to: • encourage use of crop varieties (non-toxin producing in case of GMOs) bred for resilience to certain pests to reduce reliance on pesticides. • prevent application of pesticides or seed-coatings on more than 50% of the production surface per year without exceptions, to allow for insect population recovery, and only if no toxic residues from previous years remain in the fields. • only allow pesticides and seed-coatings which are fully biodegradable and will leave no residues after one year. • transition to agricultural systems that use fewer pesticides or harmful fertilisers while maintaining productivity, for example, organic farming and Farming with Alternative Pollinators (FAP). • protect and encourage semi-natural structures such as native hedgerows to help filter out nitrogen influences, and other strategies to limit run-off and aerial dispersal.
3.3.2.4	Avoid watering insect-pollinated crops with water massively contaminated with heavy metals from sewage sludge.
3.3.2.5	Reduce atmospheric nitric oxide (NOx) originating from combustion (heating, cars, etc.), and atmospheric ammonium originating mainly from fertilisers and livestock breeding.
3.3.2.6	For oligotrophic habitats (bogs, heathland, many types of species-rich grasslands etc.), ensure that total nitrogen input is well below their specific critical loads for nitrogen and below critical levels for ammonium.
3.3.2.7	Promote Integrated Pest Management (IPM) as the default method for managing pests outside priority areas.

3.3.3 Research development

Recommended actions

3.3.3.1	Ensure that the test for admission of pesticides and seed coatings to the market considers long-term effects within semi-natural ecosystems and is based on the most sensitive organism groups.
3.3.3.2	Assess the field-realistic exposure of bees to less explored pollutants such as heavy metals and plastics. Typically, quantify these chemical pollutants in pollen and nectar resources as well as soils with ground-nesting bees.
3.3.3.3	Develop standardised protocol to assess the sensitivity of bees to less explored pollutants such as heavy metals and plastics, considering not only the lethal effects of these molecules but also a set of major sublethal impacts (e.g. fertility, cognition).
3.3.3.4.	Develop protocols to sequester heavy metals from sewage sludge in water treatment plants.
3.3.3.5.	Develop "crop cycles" including metal-chelating abiotically pollinated plants (i.e., phytoremediation) to extract metals from soils before planting insect-pollinated crops. Also favour metal-excluding entomophilous plants in metal-polluted areas.

Goal 4 Policy support

4.1 Summary

There has been a notable rise in EU policies supporting wild pollinators since the last published Red List of European Bees (Nieto et al., 2014, see Box 1). To effectively support wild bee populations, these policies must be fully implemented, by securing the resources for actions on the ground and increasing coordination at all levels. To support the threatened wild bees, the Rare and Threatened Species module must be a part of the obligate methodology in the upcoming delegated act that will define the EU Pollinator Monitoring Scheme. The Habitat Directive could better support wild bees through the identification of typical species of protected habitat types. Threatened wild bee species should be added to international and national legislations, such as national lists of protected species. Most importantly, wild bee protection should be mainstreamed into other policies, especially pesticide regulation and the risk assessment process, but also agriculture, the energy sector, spatial planning, and business. To ensure the protection of wild bees and support beekeepers, targeted changes to the regulation of managed pollinators are needed.

4.2 Challenges and opportunities

4.2.1 General recommendations

With wild pollinators supported by EU's youngest environmental regulation (the Nature Restoration Regulation), the first point is adequate implementation and enforcement of existing legislation at the national and local levels. Effort should be dedicated to influence politicians' commitment to environmental policies, to ensure resources for actions on the ground and coordination on all levels.

Whether driven through EU, or through national or local policy measures, what happens for wild bees will depend heavily on-site management and practices. Currently, the area covered by wilderness or protected area is insufficient to meet the needs of the different wild bee species, especially the threatened ones. Most European habitats, including habitats important for pollinators in protected areas (EEA report, 2020), are not in a good conservation status and will require active restoration measures. A fundamental change is that restoration and conservation efforts should not be done in the different members states separately, but in coordination. If habitats are to be restored across borders, restoration efforts need to be performed in synchrony and in coordination by all the Member States involved.

EU Habitat conservation management and restoration efforts should be linked to the requirements of bee species, for example by attention to habitat-typical species. There is often insufficient knowledge of the needs of individual species to do this (Michez, Boustani et al., 2026, Nieto et al., 2014). This knowledge must be expanded, through provision of information materials to site managers. This is currently missing from most EU Member States and other European nations.

In addition, there is a big trend towards rewilding areas of land, including many former farms, and this can be very helpful for bee conservation by kick-starting the process of creating more space for nature and more connections between natural areas across the landscape. The rewilding process implies reducing human

intervention respecting the natural dynamics of ecosystems. This could apply to agricultural areas but also in cities where wastelands are crucial habitat for the maintenance of diverse wild bee assemblages.

In policy terms, habitats important for threatened bee species must be considered in the process of defining EU-Pledges, under the EU Biodiversity Strategy. These pledges require Member States to designate additional areas for protection, aiming for 30% of protected area of land, out of which one third, or 10% of the total, is strictly protected. Member states should include habitats important for threatened wild bee species in those 10 and 30%.

Box 1. Policies for pollinators

- Starting with EU Pollinator Initiative (COM (2018) 395), published by Commission in 2018, wild pollinators entered EU environmental policies. Although not legally binding, the EU Pollinator Initiative provided a list of actions aiming to increase knowledge, address pressures, and raise awareness about wild pollinators. Most importantly, it established wild pollinators as key new taxa in the EU policy landscape and secured increased funding for research and conservation projects, including first expert proposals for EU Pollinator Monitoring (Potts et al., 2021).

- The EU Biodiversity Strategy for 2030 (COM (2020) 380) included reversing pollinator decline as one of its key commitments. It also established the framework to set up a Working Group for Pollinators, an expert group where European Commission, Member States' representatives, and various stakeholders discuss pollinator policy preparation and implementation.

- In early 2023, the Commission launched Revision of EU Pollinator Initiative: A New Deal for Pollinators, with more actions addressing drivers of decline, including climate change, and more actions for Member States.

- In the summer of 2024, Nature Restoration Regulation (NRR) was adopted, after two year-long negotiations. NRR provides the first legally binding targets for reversal of pollinator decline and establishment of wild pollinator monitoring, as well as for habitat restoration, diversifying agroecosystems, and greening of urban areas, all of which can benefit pollinators.

- The monitoring methodology has been defined in a follow-up legislation to NRR, a delegated act in November 2025, based on options from the refined Proposal for the EU pollinator monitoring scheme (Potts et al., 2024).If implemented fully, the existing pollinator policy and the upcoming delegated act will significantly contribute to the conservation of wild bees and other pollinating taxa across the EU.

4.2.2 Habitats Directive and species lists as a tool for bee conservation

A revision of the Habitats Directive (for EU countries) and the Bern Convention (for countries within and outside the EU) should include wild bee species. Under the Revised EU Pollinator Initiative, the Commission will identify pollinators species, including wild bees, typical of habitat types protected under the Habitats Directive, many of which are important for pollinators. Including wild bees as typical species will mean that the Member States will need to consider their status when assessing the conservation status of habitat type protected under the Directive. Including wild bee species in the monitoring and assessment of these habitats will streamline pollinator conservation through on-the-ground action in Natura 2000 protected areas. Member states should ensure that the conservation measures planned and implemented for these habitat types, under the Natura 2000 management plans, take wild bee conservation into account, through raising awareness, capacity building, and developing management advice based on bee biology.

Wild bees should also be considered for inclusion in the national legislations of different European countries, especially protected species list and species in priority areas. Strictly protected species are important conservation tool, and the national focus can provide a great diversity of species and habitats covered.

Red listing continues to be an important tool for understanding the status of bees and, potentially, for increasing their protection and conservation, both at regional and national levels. Currently, there is a large discrepancy between European countries with regards to Red Lists for bees. Some countries have updated Red Lists, while others have outdated lists, or no list at all. There are also large national differences in how the lists are drawn up and how the analyses and assessments are performed. A standardisation of the criteria is vital to the comparison of results across countries, and thus the use of IUCN criteria is encouraged for all the new lists prepared. Exchanging expertise, advice, and information on developing national Red Lists using the knowledge and experience of wild bee experts would help increase the value and use of this tool.

IUCN Red List categories have been recently updated for all wild bees at the European and EU scales (Michez, Boustani et al., 2026). It is important that these new designations are recognised in national protection and management plans. Currently, the Red Lists are implemented in various ways or not at all in the day-to-day conservation work. The EU LIFE programme funds conservation projects which target European threatened species, but this should be broadened to other funding programmes and to species threatened at the national level. The available EU funding for threatened species must be expanded, stimulated, and be made more publicly known. Additionally, countries/regions need to focus on their threatened species even if they are not threatened at the European level.

4.2.3 The Nature Restoration Regulation and EU Pollinator Monitoring Scheme

The EU Nature Restoration Regulation (NRR) sets legally binding targets for wild pollinator populations. Under Article 10 of the Regulation, Member States must improve diversity and reverse decline of wild pollinator populations and achieve an increasing trend. To demonstrate successful implementation, annual data about wild pollinator populations need to be collected through standardised monitoring, with the trend assessed in 2030 and every six years thereafter. Taxa that are planned to be included in this monitoring include wild bee species, as well as hoverflies, butterflies, and moths. The monitoring methodology will be based on options from the latest expert proposal (Potts et al., 2024). On 19 September 2025, the European Commission adopted a Delegated Regulation setting out the standardised method to be followed by all Member States for the pollinator monitoring under Article 10 of the NRR. This Delegated Regulation provides the much-needed standardisation of data collection and a legal basis for its coordinated implementation in each Member State.

To support wild bee conservation under NRR, it is critical that the Rare and Threatened Species module (RaTS) is an obligatory part of the EU Pollinator monitoring scheme (EU-PoMS), under the delegated act following NRR. Other proposed monitoring methods (Potts et al., 2024) will be designed to provide sufficient data to assess the trend of common and widespread species, but targeted methods are critical to address threatened species. Member States should ensure the implementation of this module and use the collected data for immediate and targeted conservation actions.

In addition to targets for pollinators, the NRR regulation opens many opportunities for restoring habitats for bees, including grasslands, forests, wet habitats, and urban and agricultural ecosystems. For agroecosystems, Member States need to improve on 2 out of 3 provided biodiversity indicators for agriculture, including high-diversity landscape features such as buffer strips, fallow land, hedgerows, field margins, and stonewalls which would benefit the conservation of bee species and their habitats. Unfortunately, the level of detail and ambition for decreasing the pressures within the agroecosystems is too low to ensure full pollinator protection. The increasing need to boost the production of pollinator-dependent crops is incompatible with maintaining an agriculture heavily reliant on chemical inputs.

If robustly implemented, the NRR will provide the incentives for decreasing the pressures, in order to meet the legal targets for increasing

pollinator population trends. However, this depends on many factors and might take longer time than there is left for successful wild bee conservation. It is therefore essential to address the pesticide regulation as a key measure for European biodiversity conservation and food safety, through ambitious policy at all levels.

4.2.4 Policies, incentives and support

The EU Common Agricultural Policy (CAP) has the potential to provide a mechanism and incentives for agriculture to be a biodiversity supporter. However, in some cases, the subsidies provided by the CAP are not sufficiently informed by species' biology and as a result can have the opposite effect than intended. The current implementation of agri-environmental measures under the CAP needs to be critically evaluated and changes useful for bees need to be recommended and incorporated. For example, farmers can currently receive money from the EU for setting aside flower strips which are potentially beneficial to wild bees. Unfortunately,

the CAP currently promotes measures at annual basis, and so these strips may be removed or ploughed over in the subsequent year, with destructive effects in their long-term value, potentially disturbing the ground nesting bee species and helping the populations of common species vs. those of the rarer ones. If funding were contingent on a more permanent period for these strips (at least 2-3 years), their value for wild bees could be significantly increased.

Other policies like the European Climate Law shows also potential of convergence of actions. For example, nature-based solution related to attenuation of the impact of climate change (e.g. heat waves in urban areas) should consider the possibility to use native entomophilous plants.

Further, in some countries, subsidies are paid to beekeepers to place their colonies in "areas of interest for biodiversity." By funding beekeepers to intensify their practices in biodiversity hot-spots, countries paradoxically increase the risk of competition for floral resources, disease
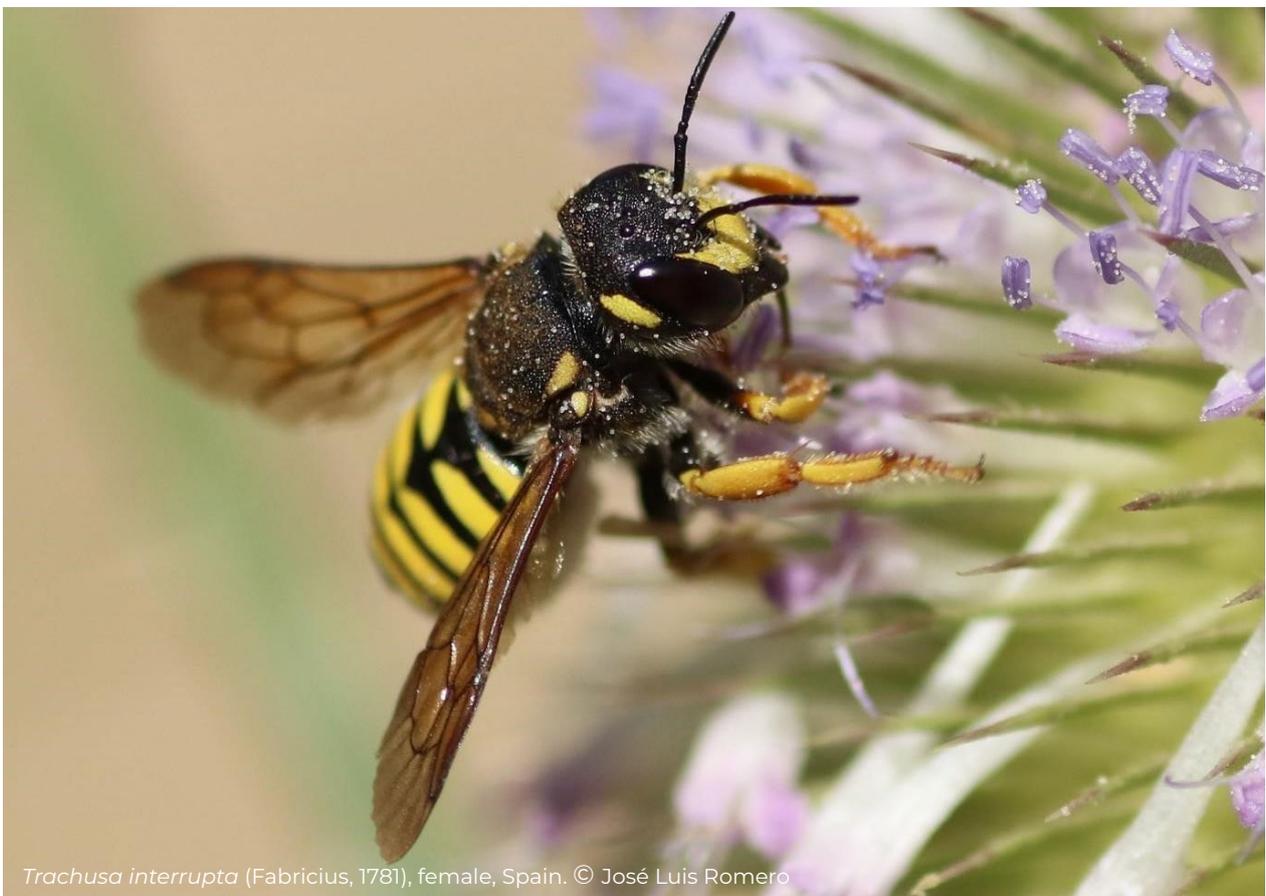
Trachusa interrupta (Fabricius, 1781), female, Spain. © José Luis Romero

Lasioglossum virens (Erichson, 1835), female, Portugal © Thomas Wood

transmission between species, and ultimately threaten these ecologically important areas.

The EU could take note of the example of the UK 25-year environment plan and associated legislation which includes payments to farmers for taking action that benefits the environment. This works through the adoption of a principle called "no net loss of natural capital", that is incorporated into planning processes for land management. There are subsidies for the adoption of this natural capital principle.

4.2.5 Refined methods for testing pesticides

The EU pesticide risk assessment has been shown to be insufficient to protect pollinators (see Goal 3 for further details about impact of chemical pollution, including pesticides). In Europe, pesticide approval processes have traditionally focused on assessing risks to Western Honey Bee, often neglecting the diverse and unique vulnerabilities of wild bee species that are usually more sensitive to pesticides, due to their vastly different biology, including solitary life style, ground nesting, and smaller body size of many wild bees (Arena & Sgloastra, 2014; Raine & Rundlöf, 2024). Recognising this gap, the European Food Safety Authority (EFSA), published in 2023 its revised guidance on the risk assessment of plant protection products on bees (*Apis mellifera*, *Bombus* spp. and

solitary bees) (EFSA, 2023). This aims to incorporate the latest scientific knowledge and address the specific needs of wild bees, including bumblebees and solitary bees. However, like the last Guidance, this document needs to be approved by Member States, at the Standing Committee for Plants, Animals, Food and Feed (PAFF Standing Committee). To ensure comprehensive protection of all pollinators, it is imperative that Member States adopt and implement these updated guidelines, mandating pesticide risk assessments that encompass the full spectrum of bee species.

4.2.6 Stricter rules on the management and trade of domesticated and managed species

Managed pollinators are important for agriculture and economy but can also pose risks to wild populations (Geslin et al., 2017; Aizen et al., 2019). In Europe, the dominant managed pollinators include the Western Honey Bee, Buff-tailed Bumblebee, and a few solitary species that are managed for crop pollination (e.g. *Osmia cornuta, Megachile rotundata*). Managed species can be subject to international trade, and thus moved to different countries or continents, carrying with them pathogens such as viruses, bacteria, and parasites. When those specimens are moved to their new location (Europe or elsewhere), they can potentially carry those pathogens with them which could rapidly spill over

into the local wild bee fauna. In addition, the movement of subspecies across the continent (e.g. *Bombus terrestris terrestris* is commercialised in southern Spain, where only *Bombus terrestris lusitanicus* is present) is mixing the genetic material of local subspecies, with unknown consequences for the persistence of local adaptations (Bartomeus et al., 2020).

To avoid this major conservation issue, intercontinental trade of managed bees (including Honey Bees, bumblebees, and other solitary managed species) should be forbidden. The risk of import of managed bees into Europe from other continents poses a great risk for wild bee health.

Moreover, for the managed bees that are already in Europe, stronger veterinary and health checks should be performed to limit the impact of pathogens that are already present in Europe and limit their expansion on the wild bee communities.

4.2.7 Improve the biosecurity policies on exotic species

The European biosecurity policy to prevent introduction of new exotic species should be rapidly improved. In the past couple of years, new non-native species of both social and solitary bees have entered the European continent with potential negative impacts on native wild bee communities and for beekeepers (Bortolotti et al., 2018; Ghisbain et al., 2021; Uzunov et al., 2024). The actions to improve European biosecurity policy for bees can be adapted from the recommended actions for ants (Blight & Rabitsch, 2024). In particular, the alien species of insects or plants that could pose a risk for native pollinators could be proposed for List of Invasive Alien Species of Union Concern (the "Union List"). This list is at the core of The Invasive Alien Species Regulation (Regulation (EU) 1143/2014), with its last update published in 2022 (Commission Implementing Regulation (EU) 2022/1203).

Dasypoda braccata Eversmann, 1852, female, Hungary. © Henrik Gyurkovics

4.3 Recommendations

Table 6. *Sub-goals and recommended priority actions for filling the gaps in information, tools and expertise related to wild bees, over the next 5-10 years.*

4.3.1 General policy-related recommendations and synergies with instruments and measures	
Recommended actions	
4.3.1.1.	Ensure full implementation of existing pollinator policies, by securing the resources for actions on the ground and increasing coordination at all levels.
4.3.1.2.	Link EU habitat restoration efforts and management with the requirements for the main pollinators such as bees.
4.3.1.2	Address the habitats importance for threatened wild bee species in the EU Pledges process for the EU protected area and conservation status targets under the EU-Biodiversity Strategy 2030.
4.3.1.3	Promote more wild areas without any interventions across all different types of European habitats throughout their whole range and include these in the 10% target on strictly protected areas for 2030.
4.3.1.4	Coordinate policy across national borders and between regions inside countries to create effective corridors and enhance overall landscape connectivity.
4.3.1.5	Link Nature-based solutions to pollinator conservation by using native entomophilous plants.
4.3.2 Habitats Directive and species lists as a tool for bee conservation	
Recommended actions	
4.3.2.1.	Create a list of bee taxa as typical for Habitat types protected under the EU Habitats Directive (this is partially done under the PollHab framework).
4.3.2.2	Redefine priority habitats of Annex I of the Habitats Directive based on their importance for threatened wild bees.
4.3.2.3	Raise awareness about bee species typical of Annex I habitats protected under The EU Habitats Directive, and build capacity for their monitoring, assessment, and management.
4.3.2.4	Develop management advice and tools based on typical bee species biology, to inform actions aiming to improve their conservation status.
4.3.2.5	Prepare a national Red List of bees for every European country following IUCN criteria, and make periodic updates (every 5 years), and use them as a tool for prioritising national conservation actions and monitoring progress.
4.3.2.6	Add threatened bee species to national protected species lists to provide a legal mandate to protect them at the national level. Islands should be rapidly targeted with conservation and protection measures as populations of wild bees are smaller and more fragile.
4.3.3 The Nature Restoration Regulation and EU Pollinator Monitoring Scheme	
Recommended actions	
4.3.3.1	Ensure that Rare and Threatened species module is part of obligate monitoring under the EU-PoMS defined by upcoming delegated act under the NRR. Support implementation of Rare and Threatened species module at national level and use the collected data for immediate and targeted conservation actions.

4.3.3.2	Land in early state of ecological succession (e.g. abandoned agricultural land, burnt areas during the first post-fire years) should be prioritised and assessed through continuous monitoring until achieving the expected bee diversity.
4.3.3.3	Allow natural vegetation to recover, avoiding reforestation, especially with conifers; if necessary, reforestation should allow the existence of forest openings for wild plants and pollinators.
4.3.3.4	Create indicators of the health of bee communities, easily usable by stakeholders and managers.

4.3.4 Well-targeted policies, subsidies and incentives support conservation of priority bee micro-habitats

Recommended actions

4.3.4.1	Promote subsidies in Europe for farmers adopting the "no net loss of natural capital" principle.
4.3.4.2	Extend nature-supporting provisions for graziers and farmers in priority areas to support bee conservation.
4.3.4.3	Critically review the current implementation of agri-environmental measures under the CAP and recommend changes useful for bees (e.g., ensure that incentives to create field margins for pollinators require them to be in place for more than the current 1 year, remove subsidies for beekeeping in biodiversity rich areas and in areas under ecological succession).

4.3.5 Refined methods for testing toxicity of new chemicals on non-model species

Recommended actions

4.3.5.1	Request all Member States to approve the revised guidance on the risk assessment of plant protection products on bees from EFSA in front of the PAFF Standing Committee.

4.3.6 Stricter rules on the management of domesticated bee species

Recommended actions

4.3.7.1	Ban the import of Western Honey Bee colonies and queens and any other bee species individuals into European territory from other continents. In agriculture and industry, limit the use of managed pollinators exclusively to species that are already present in the European territory.
4.3.7.2	Develop strict rules on the management of the health of domesticated species already present on European territory thorough periodic veterinary assessments including comprehensive pathogen screening.

4.3.7 Improve the biosecurity policies on exotic species

Recommended actions

4.3.7.1	Update the European invasive alien species policy to prevent introduction of new non-native species in European territory, including plants and bees. Create an alert list of non-native invasive bee species for the public to report them.

Goal 5. Cultural shift towards appropriate behaviours regarding biodiversity conservation

5.1 Summary

Wild bees, and most importantly, species beyond the well-known Western Honey Bee, play a crucial role in pollination, ecosystem health, and agriculture. However, their significance remains largely overlooked by the public, practitioners and policymakers. An important impediment for conservation is the poor public awareness, often the wrong messages associated to green washing and knowledge passed over to citizens. In light of their declining populations due to habitat loss, pesticide use, and climate change, it is vital to enhance awareness and promote education about wild bees, their diversity, and their ecological role. This section outlines key initiatives to improve the public perception and knowledge of wild bee diversity, engaging with the education system, raising awareness of practices that support wild bees, and guiding relevant sectors in conservation measures. By raising public awareness, we will not only improve the public's perception of wild bees but also ensure that future generations value and protect these vital species.

5.2 Challenges and opportunities

5.2.1 Materials and initiatives to improve public perception of wild bee diversity

There is a general lack of knowledge and awareness of wild bees in the public. Most people are aware of the Western Honey Bee, but not of the more than 2,100 other bee species in Europe (Ghisbain et al., 2023). To foster a greater understanding and appreciation of wild bees, national-level awareness campaigns must be launched in the national language, targeting diverse sectors such as agriculture, forestry, beekeeping, education, land/garden management, journalism, and policy-making. These campaigns must emphasise the diversity of bee species, their ecological role, and their importance for biodiversity and as ecosystem service providers.

Politicians can play an influential role by sponsoring a wild bee species as a flagship for these efforts. This initiative would not only raise curiosity about wild bees but also provide an easily recognisable symbol for the campaign. Public engagement should also focus on emotional and aesthetic connections. Producing high-quality images of wild bees in their natural habitats and organising guided walks where people can observe and learn about them can spark interest and foster deeper appreciation.

Accessibility of this content is fundamental: it should be readily available, easy to find, extensively illustrated and devoid of unnecessary technical terms. Most importantly, it should be concise, interesting, and engaging. Digital tools can also raise awareness and engage the public. Additionally, promoting citizen science

activities, where individuals contribute to bee monitoring and data collection will empower the public and increase their involvement conservation efforts.

5.2.2 Developing new teaching methods

The change in mentality at the society level starts by raising awareness to the younger generations. Educational initiatives are key to ensuring long-term changes in public understanding and behaviour regarding wild bees. School and adult learning curricula should be developed to cover the ecological importance of bees, including their diversity, roles in pollination, and the threats they face. These curricula should aim to spark curiosity in students, encouraging them to pursue further self-directed learning about bees and their role in nature. The European project "Buzzing schools: engaging youth on pollinator conservation through learning ecosystems" is a preliminary example of an opportunity to work on this aspect. This also applies to the EU project "LIFE 4 Pollinators - Involving people to protect wild bees and other pollinators in the Mediterranean" that developed series of educational actions and materials (www.life-4pollinators.eu). Most importantly, school curricula must teach children and teenagers how their daily consumer choices, such as buying local pesticide-free rather than imported food produced with synthetic pesticides, or choosing certain clothes and technologies, affect the climate, landscape change, and ultimately bee populations. In this way, education can foster an environmentally responsible attitude.

Additionally, the Pollinator Academy (Box 2, https://pollinatoracademy.eu/) a European knowledge hub on wild pollinators, should be promoted as a valuable resource in the education system across Europe. By translating its content into all European languages and stimulating the creation of new educational materials, the website can provide teachers and students with access to up-to-date information on pollinator conservation.

In agricultural schools, it is essential to integrate state-of-the-art content regarding the significant impact of agricultural practices on wild bee populations. By providing students with knowledge about sustainable farming practices that support bee health, we can encourage future generations of farmers to adopt productive and pollinator friendly strategies.

Finally, it is also important that polytechnical schools, especially city-planners are to be also aware of the knowledge regarding the presence of bee-friendly areas within the urban environment.

Megachile cypricola Mavromoustakis, 1938, female, Cyprus © Jordan Benrezkallah

5.2.3 Raising awareness of practices that support wild bees

Raising public awareness of everyday practices that positively and negatively affect wild bees is essential for fostering a culture of conservation. One practical approach is to create brochures and informational materials, produced using natural materials and eco-friendly processes to minimise environmental impact, that outline simple actions individuals can take to support bee conservation, such as reducing pesticide use, creating bee-friendly gardens, and promoting native plants that provide food for bees. These materials should also highlight the major threats faced by wild bees and communicate the often-overlooked impacts of consumer choices, particularly those related to food purchases. Educating the public about how purchasing decisions, for example buying pesticide-treated produce or non-sustainable goods, can harm wild bees will encourage more environmentally responsible behaviour.

Another important element of conservation is understanding what we aim to protect. Learning to identify wild bees and recognise them in the field through their foraging or flying behaviour is an important step towards becoming an enthusiastic protector. To support this, simple guiding tools with bee pictures are necessary. Such tools can be used during bioblitzes not only to facilitate learning but also to make involvement more enjoyable.

5.2.4 Guidance on wild bee conservation measures for relevant sectors

Effective conservation of wild bees requires the active involvement of multiple sectors, particularly agriculture, beekeeping, forestry, and land management. The European Union's Pollinator and Biodiversity Guidance documents provide a framework for national governments, local authorities, and industry professionals to adopt policies and practices. These documents should include dedicated sections on identifying, protecting, and managing threatened bee species, as well as creating and restoring habitats for threatened bees.

Special attention must be given to micro-habitats, which are crucial for wild bee survival. The EU guidance should emphasise the preservation and restoration of these micro-habitats and their importance for the most threatened bee species. For farmers and land managers, the guidance should provide detailed recommendations on sustainable grazing regimes and the creation of suitable areas for wild bee communities, with particular focus on species that are most at risk.

A cautionary note should be made about good-intentioned conservation measures not based on scientific evidence, as those can have counter-productive consequences. While many restoration measures aim at flashing actions involving a visible and tangible outcome such as seeding plants or increasing managed species, those are often not the most effective actions in the long term and for the most threatened species. In general, a protocol that aims to understand the current situation and which species are present in each site, and which threats are present and how to remove them, is more efficient. Hence, educating the society will also ensure the conservation actions promoted are based on solid scientific grounds.

By ensuring that all relevant sectors—from agriculture to urban development—are equipped with the knowledge and resources to protect wild bees, we can create a holistic, integrated approach to bee conservation that addresses the many challenges these important pollinators face.

> ## Box 2. Welcome to the Pollinator Academy (pollinatoracademy.eu)
>
> The Pollinator Academy is a learning platform with integrated taxonomic tools and information on European pollinators. Its goal is to strengthen taxonomic capacity in Europe by providing access to resources and training materials that make taxonomic knowledge more accessible. The platform is divided into six main sections:
>
> 1. **Pollinator taxonomy**. Discover more about the identification of bees, hoverflies, and butterflies.
> 2. **Factsheets**. Explore factsheets of bee and hoverfly genera in Europe, including detailed images.
> 3. **Resources**. Use our search engine to find taxonomic tools and resources.
> 4. **Training**. Explore our microlearnings, enrol in a taxonomic course, or find useful training materials.
> 5. **Get involved**. Find out more about the EU monitoring scheme and other pollinator initiatives.
> 6. **About us**. Find out more about our mission and who is behind this learning platform.

5.3 Recommendations

Table 7. *Sub-goals and recommended priority actions for promoting a cultural shift towards biodiversity-friendly attitudes and behaviour over the next 5-10 years.*

5.3.1 Materials & initiatives to improve public perception of wild bee diversity	
Recommended actions	
5.3.1.1	Raise awareness campaigns, at the national levels and in national languages, about the diversity, ecology and importance of bees. Engage all relevant sectors: agriculture and forestry, education, land management, journalism, policy makers.
5.3.1.2	Get politicians to sponsor/adopt a wild bee species as flagship species which they can use as an example to raise public curiosity about wild bees (the Western Honey Bee is excluded).
5.3.1.3	Engage the public through their biological and aesthetic sensitivity: create dissemination materials including high-quality pictures of bees in the field, organise guided walks to engage with live bees, promote citizen science participation.
5.3.1.4	Use bioblitzes repeatedly as an effective tool to spark enthusiasm in children and adults and build a core group of enthusiasts to participate in larger conservation campaigns.
5.3.1.5	Create an atlas of wild bees including tourist-frequented areas, regional, national and transnational covering biology, ecology and other folklore material that may inform people.
5.3.2 Develop new teaching methods	
Recommended actions	
5.3.2.1	Develop and implement school and adult-learning curricula to raise awareness of the ecological importance of bees and their diversity and foster the curiosity of the students to encourage them in further self-learning.

5.3.2.2	Promote the Pollinator Academy (pollinatoracademy.eu), the European portal functioning as a knowledge hub about wild pollinators. Stimulate the creation of new content on the platform, including the translation of existing content in all European languages.
5.3.2.3	Integrate the most relevant state-of-the-art content and tools into agricultural school curricula. Educate students about the impact of the different management practices on wild bees and encourage the adoption of the most sustainable ones.
5.3.2.4	Promote an environmentally responsible attitude in children and teenagers by educating them on the impacts of their daily consumer choices on climate, landscape alteration, and ultimately bee populations.

5.3.3 Raise awareness of practices that support wild bees

Recommended actions

5.3.3.1	Create brochures (using natural materials and eco-friendly processes) that are easily available to the public and explain both the major threats faced by wild bees and the everyday behaviours that support or harm them.
5.3.3.2	Provide brochures to the public with information about threats to wild bees and pro-environmental behaviours, including the usually overlooked impact of purchases in the environment (particularly food purchases).
5.3.3.3	Engage schools, municipalities, farmers, beekeepers to apply particular management rules and codes of conduct, by providing targeted incentives (e.g. different types of certificates recognising their contribution to wild bee safeguard). Promote the obtention of the label "pollinator-friendly" by LIFE 4 Pollinators.

5.3.4 Guidance on wild bee conservation measures for all relevant sectors, especially agriculture, forestry, beekeeping & grasslands/grazing systems

Recommended actions

5.3.4.1	Centralise and promote the existing Pollinator guidelines (EU Pollinator and Biodiversity Guidance documents, project-developed guides) across the different sectors and develop the guidelines that are missing. Ensure they include a dedicated section on identifying, protecting, and managing threatened bee species.
5.3.4.2	Create EU Pollinator Guidance documents for national governments, local authorities, forestry, agriculture, nature protection, and urban & rural development sectors, include sections on protecting, restoring, and establishing habitats for bees, emphasising those of most importance to threatened species.
5.3.4.3	Create EU Pollinator Guidance documents for farmers about ideal grazing regimes for bee-relevant areas and habitats, emphasising those of most importance to threatened species.

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Appendix 1. Threatened wild bee species at the European level

Family	Species	RL Category	Group
Andrenidae	*Andrena boyerella*	CR	Specialist
Andrenidae	*Andrena chaetogastra*	CR	Islands/mountain
Andrenidae	*Andrena chelma*	CR	Mountain
Andrenidae	*Andrena clusia*	CR	Specialist/mountain
Andrenidae	*Andrena heinrichi*	CR	Islands
Andrenidae	*Andrena heterodoxa*	CR	Islands
Andrenidae	*Andrena hungarica*	CR	Specialist
Andrenidae	*Andrena incisa*	CR	Specialist
Andrenidae	*Andrena labiatula*	CR	Specialist
Andrenidae	*Andrena lonicera*	CR	Mountain
Andrenidae	*Andrena metallescens*	CR	Specialist/mountain
Andrenidae	*Andrena ornata*	CR	Specialist
Andrenidae	*Andrena passerina*	CR	Islands
Andrenidae	*Andrena stoeckhertella*	CR	Specialist
Andrenidae	*Andrena tridentata*	CR	Specialist
Andrenidae	*Andrena troodica*	CR	Islands
Andrenidae	*Flavipanurgus merceti*	CR	Specialist
Andrenidae	*Simpanurgus phyllopodus*	CR	Specialist
Apidae	*Ammobates dusmeti*	CR	Brood parasite
Apidae	*Anthophora borealis*	CR	Specialist
Apidae	*Anthophora senilis*	CR	Specialist
Apidae	*Bombus cullumanus*	CR	Specialist
Apidae	*Epeolus fasciatus*	CR	Brood parasite
Colletidae	*Colletes merceti*	CR	Specialist
Megachilidae	*Icteranthidium cimbiciforme*	CR	Islands/specialist
Andrenidae	*Andrena chersona*	EN	Specialist
Andrenidae	*Andrena comta*	EN	Specialist
Andrenidae	*Andrena flavobila*	EN	Specialist
Andrenidae	*Andrena lindbergella*	EN	Islands/mountain

Family	Species	RL Category	Group
Andrenidae	*Andrena magna*	EN	Specialist
Andrenidae	*Andrena monilia*	EN	Specialist
Andrenidae	*Andrena ranunculorum*	EN	Mountain
Andrenidae	*Andrena roseipes*	EN	Specialist
Andrenidae	*Andrena saettana*	EN	Islands
Andrenidae	*Andrena soror*	EN	Specialist
Andrenidae	*Andrena stepposa*	EN	Specialist
Andrenidae	*Andrena taxana*	EN	Specialist
Andrenidae	*Andrena urdula*	EN	Specialist
Apidae	*Ammobates melectoides*	EN	Brood parasite
Apidae	*Ammobates vinctus*	EN	Brood parasite
Apidae	*Bombus armeniacus*	EN	Specialist
Apidae	*Bombus konradini*	EN	Mountain
Apidae	*Eucera brachycera*	EN	Specialist
Apidae	*Eucera excisa*	EN	Mountain
Apidae	*Eucera morio*	EN	Specialist
Apidae	*Nomada alpigena*	EN	Brood parasite
Apidae	*Nomada arrogans*	EN	Brood parasite
Apidae	*Nomada blepharipes*	EN	Brood parasite
Apidae	*Nomada bouceki*	EN	Brood parasite
Apidae	*Nomada calimorpha*	EN	Brood parasite
Apidae	*Nomada collarae*	EN	Brood parasite
Apidae	*Nomada confinis*	EN	Brood parasite
Apidae	*Nomada elsei*	EN	Brood parasite
Apidae	*Nomada emarginata*	EN	Brood parasite
Apidae	*Nomada errans*	EN	Brood parasite
Apidae	*Nomada fenestrata*	EN	Brood parasite
Apidae	*Nomada flavilabris*	EN	Brood parasite
Apidae	*Nomada incisa*	EN	Brood parasite
Apidae	*Nomada italica*	EN	Brood parasite
Apidae	*Nomada kornosica*	EN	Brood parasite
Apidae	*Nomada laticrus*	EN	Brood parasite
Apidae	*Nomada melanopyga*	EN	Brood parasite
Apidae	*Nomada noskiewiczi*	EN	Brood parasite
Apidae	*Nomada pulchra*	EN	Brood parasite
Apidae	*Nomada sicula*	EN	Brood parasite
Apidae	*Nomada sybarita*	EN	Brood parasite
Apidae	*Nomada tenella*	EN	Brood parasite

Family	Species	RL Category	Group
Apidae	*Nomada thersites*	EN	Brood parasite
Apidae	*Nomada trapeziformis*	EN	Brood parasite
Apidae	*Parammobatodes minutus*	EN	Brood parasite
Colletidae	*Colletes anchusae*	EN	Specialist
Colletidae	*Colletes caspicus*	EN	Specialist
Colletidae	*Colletes collaris*	EN	Specialist
Colletidae	*Colletes graeffei*	EN	Specialist
Colletidae	*Colletes meyeri*	EN	Specialist/mountain
Colletidae	*Colletes nasutus*	EN	Specialist
Colletidae	*Colletes punctatus*	EN	Specialist
Colletidae	*Colletes sierrensis*	EN	Specialist
Colletidae	*Colletes wolfi*	EN	Specialist
Colletidae	*Hylaeus glacialis*	EN	Mountain
Colletidae	*Hylaeus hellenicus*	EN	Mountain
Colletidae	*Hylaeus ibericus*	EN	Mountain
Colletidae	*Hylaeus koenigsmanni*	EN	Islands/mountain
Colletidae	*Hylaeus mariannae*	EN	Islands/mountain
Halictidae	*Dufourea inermis*	EN	Specialist
Halictidae	*Halictus adjikenticus*	EN	Mountain
Halictidae	*Halictus candiae*	EN	Islands
Halictidae	*Halictus carinthiacus*	EN	Mountain
Halictidae	*Halictus pyrenaeus*	EN	Mountain
Halictidae	*Lasioglossum algirum*	EN	Mountain
Halictidae	*Lasioglossum breviventre*	EN	Mountain
Halictidae	*Lasioglossum leucomontanum*	EN	Islands/mountain
Halictidae	*Lasioglossum quadrisignatum*	EN	Specialist
Halictidae	*Lasioglossum setulellum*	EN	Specialist
Halictidae	*Lasioglossum setulosum*	EN	Specialist
Halictidae	*Lasioglossum sexnotatulum*	EN	Specialist
Halictidae	*Nomiapis femoralis*	EN	Specialist
Halictidae	*Nomiapis valga*	EN	Specialist
Halictidae	*Seladonia microcardia*	EN	Islands
Halictidae	*Seladonia semitecta*	EN	Specialist
Halictidae	*Sphecodes pinguiculus*	EN	Brood parasite
Megachilidae	*Coelioxys emarginatus*	EN	Brood parasite
Megachilidae	*Coelioxys polycentris*	EN	Brood parasite
Megachilidae	*Hoplitis bicallosa*	EN	Specialist
Megachilidae	*Hoplitis cypriaca*	EN	Islands

Family	Species	RL Category	Group
Megachilidae	*Megachile diabolica*	EN	Specialist
Megachilidae	*Megachile hohmanni*	EN	Specialist
Megachilidae	*Osmia maritima*	EN	Specialist
Megachilidae	*Stelis hispanica*	EN	Brood parasite
Megachilidae	*Trachusa integra*	EN	Specialist
Melittidae	*Dasypoda braccata*	EN	Specialist
Melittidae	*Dasypoda frieseana*	EN	Specialist
Melittidae	*Dasypoda spinigera*	EN	Specialist
Melittidae	*Dasypoda suripes*	EN	Specialist
Melittidae	*Melitta kastiliensis*	EN	Specialist
Melittidae	*Melitta melanura*	EN	Specialist
Andrenidae	*Andrena aberrans*	VU	Specialist
Andrenidae	*Andrena gelriae*	VU	Specialist
Andrenidae	*Andrena isolata*	VU	Mountain
Andrenidae	*Andrena pallitarsis*	VU	Specialist
Andrenidae	*Andrena simillima*	VU	Specialist
Andrenidae	*Andrena transitoria*	VU	Specialist
Andrenidae	*Halopanurgus baldocki*	VU	Specialist
Apidae	*Ammobatoides abdominalis*	VU	Brood parasite
Apidae	*Anthophora porphyrea*	VU	Islands
Apidae	*Anthophora purpuraria*	VU	Islands
Apidae	*Biastes truncatus*	VU	Brood parasite
Apidae	*Bombus alpinus*	VU	Specialist/mountain
Apidae	*Bombus confusus*	VU	Specialist
Apidae	*Bombus distinguendus*	VU	Specialist
Apidae	*Bombus fragrans*	VU	Specialist
Apidae	*Bombus glacialis*	VU	Specialist
Apidae	*Bombus hyperboreus*	VU	Brood parasite
Apidae	*Bombus laesus*	VU	Specialist
Apidae	*Bombus modestus*	VU	Specialist
Apidae	*Bombus muscorum*	VU	Specialist
Apidae	*Bombus pomorum*	VU	Specialist
Apidae	*Bombus pyrrhopygus*	VU	Specialist
Apidae	*Bombus zonatus*	VU	Specialist
Apidae	*Epeolus sigillatus*	VU	Brood parasite
Apidae	*Eucera quilisi*	VU	Specialist
Apidae	*Nomada argentata*	VU	Brood parasite
Apidae	*Nomada baccata*	VU	Brood parasite

Family	Species	RL Category	Group
Apidae	*Nomada erythrocephala*	VU	Brood parasite
Apidae	*Nomada halophila*	VU	Brood parasite
Apidae	*Nomada rhenana*	VU	Brood parasite
Colletidae	*Colletes chengtehensis*	VU	Specialist
Colletidae	*Colletes moricei*	VU	Islands
Colletidae	*Colletes pulchellus*	VU	Specialist
Halictidae	*Dufourea balearica*	VU	Islands
Halictidae	*Dufourea halictula*	VU	Specialist
Halictidae	*Dufourea minuta*	VU	Specialist
Halictidae	*Lasioglossum ariadne*	VU	Islands/mountain
Halictidae	*Lasioglossum chalcodes*	VU	Islands
Halictidae	*Lasioglossum euboeense*	VU	Specialist
Halictidae	*Lasioglossum laeve*	VU	Specialist/mountain
Halictidae	*Lasioglossum peregrinum*	VU	Specialist
Halictidae	*Lasioglossum subfasciatum*	VU	Mountain
Halictidae	*Lasioglossum virens*	VU	Specialist
Halictidae	*Rophites quinquespinosus*	VU	Specialist
Halictidae	*Sphecodes atlanticus*	VU	Brood parasite
Megachilidae	*Anthidium montanum*	VU	Specialist/mountain
Megachilidae	*Hoplitis fulva*	VU	Specialist
Megachilidae	*Hoplitis holmboei*	VU	Specialist
Megachilidae	*Hoplitis saxialis*	VU	Mountain
Megachilidae	*Megachile cypricola*	VU	Islands
Megachilidae	*Megachile leucomalla*	VU	Specialist
Megachilidae	*Paradioxys pannonicus*	VU	Brood parasite
Megachilidae	*Stelis annulata*	VU	Brood parasite
Megachilidae	*Trachusa interrupta*	VU	Specialist
Melittidae	*Dasypoda argentata*	VU	Specialist
Melittidae	*Melitta iberica*	VU	Mountain

Appendix 2. Details of participants

Name	Surname	Relevant affiliation or role	Country
DOMINIQUE	ZIMMERMAN	Montane	Austria
VITTORIO	BELLOTTO	IUCN Brussels - Biodiversity	Belgium
MIRA	BOUSTANI	Specialist bees	Belgium
WILLIAM	FIORDALISO	Specialist bees	Belgium
SIMONE	FLAMINIO	Specialist bees and Island bees (Italian islands)	Belgium
ANTOINE	GEKIERE	Chemical pollution	Belgium
GUILLAUME	GHISBAIN	Montane; boreal bees; specialist bees	Belgium
KONSTANTINE	GOSPODINOV	IUCN Brussels - European Biodiversity	Belgium
KRISTIN	LEUS	IUCN CPSG Europe	Belgium
DENIS	MICHEZ	Specialist bees; bee conservation; policy	Belgium
NIAMH	PHELAN	IUCN Brussels - Biodiversity	Belgium
SARA	REVERTÉ	Support in the coordination	Belgium
MAHBOOBEH	SHIRKHORSHIDI	IUCN Brussels - Biodiversity	Belgium
CLÉMENT	TOURBEZ	Specialist bees, invasive / managed species	Belgium
AURORE	TROTTET	IUCN Brussels - European Biodiversity	Belgium
EVELYN	UNDERWOOD	Policy	Belgium
CARLOS	RUIZ	Island bees	Canary Islands
ANA	JESOVNIK	Policy	Croatia
MENELAOS	STAVRINIDES	Island bees	Cyprus
PETR	BOGUSCH	Cuckoo bee; Pannonian bees	Czechia
JAKUB	STRAKA	Cuckoo bee; Pannonian bees	Czechia
ANN-KATRINE	GARN	IUCN CPSG Europe	Denmark
CHRISTINA	RITZL VEJLGAARD	IUCN CPSG Europe	Denmark
VILLU	SOON	Boreal species	Estonia
BENOIT	GESLIN	Specialist bees	France
FELIX	FORNOFF	Specialist bees	Germany

THEODORA	PETANIDOU	Island bees (Greek Islands); montane bees (Mediterranean)	Greece
THOMAS J.	WOOD	Specialist and montane bees	Netherlands
HUGO	GASPAR	Specialist bees (Portugal)	Portugal
ALBANO	SOARES	Specialist bees	Portugal
IGNASI	BARTOMEUS	Specialist bees (Spain)	Spain
F. JAVIER	ORTIZ-SANCHEZ	Montane / Spain	Spain
MATTHIAS	ALBRECHT	Specialist bees (threat in agroecosystem)	Switzerland
VLADIMIR	RADCHENKO	Specialist bees, Pannonian species	Ukraine
DAVID	ALLEN	IUCN Cambridge - Regional Biodiversity	United Kingdom
CAROLINE	LEES	IUCN CPSG	United Kingdom
NATASHA	PETERS	IUCN CPSG	United Kingdom
SIMON G.	POTTS	Global European pollinator initiative	United Kingdom

European Wild Bees:
Moving from assessment to conservation planning