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NINA Report

Establishing a national pollinator action plan for Romania

Justifications and suggestions for establishing measures to support pollinator conservation

Erik Stange, Graciela M. Rusch, Markus A. K. Sydenham

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Abstract

Stange, E., Rusch, G.M. & Sydenham, M. 2023. Establishing a national pollinator action plan for Romania: Justifications and suggestions for establishing measures to support pollinator conservation. 2022. NINA Report 2163. Norwegian Institute for Nature Research.

Pollinators are an economically, ecologically, and socially important species group that has experienced conspicuous and often drastic declines in both their abundance and diversity over recent decades. The loss of wild pollinators is a serious cause for concern because animal pollination plays an important role in the structure and function of many of the world's ecosystems. This role includes the enhanced agricultural production of a substantial portion of the crops used in global food production. International Union for Conservation of Nature (IUCN) Red Lists for European pollinating insects estimate that 37% of all bee species and 31% of all butterfly species are presently experiencing declining populations, and 27% of hoverfly species have an elevated risk of extinction in the near future. We have little data on the abundance or trends for these species' groups in Romania, but the situation there is likely similar to that of its neighbouring countries and/or Europe as a whole. Pollinating insect declines are the result of several interacting factors. These includer habitat loss from intensification of agriculture and development; pollution (including pesticide and herbicide use); climate change; pests, parasites, and pathogens; and even competition between species of pollinating insects.

As a result of the concern generated by global and regional assessment of pollinator declines, governments, experts and concerned parties have drafted several strategic responses involving agri-environment schemes and pesticide restrictions, urban and commercial initiatives, and rewilding at a range of spatial scales. We present an overview of pollinator strategies and action plans from both the EU and 11 of its nation states (plus Norway), exploring both their commonalities and the difference between them. These EU and EU-member state pollinator strategies provide some guidelines for establishing and implementing a Romanian national pollinator strategy. Based on the content of these strategy documents, we provide suggestions for the focal areas and specific measures. These include measures for promoting systematic monitoring of pollinating insect species, promoting research addressing pollinating insects, addressing the causes of pollinator declines and fostering public engagement in the effort to ensure continued existence of Romania's pollinators. We recommend that a national pollinator strategy specify concrete goals associates with the measures it proposes to enact, and that the strategy includes a plan for how to evaluate progress towards these goals.

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Sammendrag

Stange, E., Rusch, G.M. & Sydenham, M. 2023. Etablering en nasjonal handlingsplan for pollinerende insekter for Romania: Begrunnelse og forslag for tiltak for å sikre bevaring av pollinator mangfold. 2022. NINA Rapport 2163. Norsk institutt for naturforskning.

Pollinatorer er en økonomisk, økologisk og sosialt viktig artsgruppe som har opplevd en tydelig og ofte drastisk nedgang i både antall og mangfold de siste tiårene. Det pågående tapet av ville pollinatorer er en alvorlig grunn til bekymring da deres pollineringsbidrag spiller en viktig rolle i strukturen og funksjonen til mange av verdens økosystemer. Denne rollen inkluderer økt produksjon av avlingene som brukes i global matproduksjon. International Union for Conservation of Nature (IUCN) anslår at 37 % av alle biearter og 31 % av alle sommerfuglarter for tiden opplever minkende bestander, samt at 27 % av svevefluearten har en økt risiko for utryddelse i nær fremtid. Det foreligger lite data om populasjonsstørrelser eller trender for disse artsgruppene i Romania, men forholdene er sannsynligvis sammenlignbare til situasjonen i nabolandene og/eller Europa som helhet. Nedgang av pollinerende insekter er et resultat av flere samvirkende faktorer. Disse inkluderer tap av habitat fra intensivering av jordbruk og utvikling; forurensning (inkludert bruk av plantevernmidler og ugressmidler); klimaendringer; parasitter og patogener; og til og med konkurranse mellom arter av pollinerende insekter.

Som følge av bekymringen de globale og regionale nedgangene av pollinatorer har skapt, har regjeringer, eksperter og engasjerte interessenter utarbeidet flere strategiske potensielle løsninger som involverer landbruksordninger og plantevernmiddelrestriksjoner, urbane og kommersielle initiativer, og naturrestaurering på en rekke romlige skalaer. Denne rapporten oppsummerer en oversikt over pollinatorstrategier og handlingsplaner fra EU og 11 av dets nasjonalstater, samt Norge, der vi sammenfatter både fellestrekk og forskjeller mellom dem. Basert på innholdet i disse strategidokumentene gir vi forslag til satsingsområder og konkrete tiltak for etablering og implementering av en rumensk nasjonal pollinatorstrategi. Disse inkluderer tiltak for å fremme systematisk overvåking av pollinerende insektarter, fremme forskning om pollinerende insekter, adressering av årsakene til pollinatornedgang og fremme offentlig engasjement i arbeidet med å sikre fortsatt eksistens av Romanias pollinatorer. Vi anbefaler videre at en nasjonal pollinatorstrategi spesifiserer konkrete mål knyttet til tiltakene den foreslår iverksatt, og at strategien inkluderer en plan for hvordan man skal evaluere fremdriften mot disse målene.

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Contents

Abstract **3**

Sammendrag **4**

Contents **5**

Foreword **7**

1 Introduction **8**

2 Status and trends of pollinating insects **11**
2.1 Status and trends for pollinating insects in Europe 12
2.1.1 Bees 12
2.1.2 Butterflies and moths 12
2.1.3 Other pollinating insects 13
2.2 Status and trends for pollinating insects in Romania 14
2.2.1 Bees 14
2.2.2 Butterflies and moths 18
2.2.3 Other pollinating insects 19

3 Major threats to bees and other pollinator species **21**
3.1 Habitat loss 23
3.2 Pollution, pesticides and herbicides 25
3.3 Residential and commercial development 27
3.4 Climate change 28
3.5 Pests, parasites and pathogens 28
3.6 Competition between pollinator species 28

4 Measures for mitigating pollinator loss **30**
4.1 Pollinator monitoring 30
4.2 Agri-environmental measures 30
4.3 Measures for facilitating climate change adaptation 31
4.4 Measures for green spaces and private property 32

5 European and national pollinator strategies **34**
5.1 The EU Pollination Initiative and the New Deal for Pollinators 34
5.2 National Pollinator Strategies and Action Plans 38
5.2.1 Belgium 38
5.2.2 England 39
5.2.3 France 41
5.2.4 Germany 42
5.2.5 Ireland 43
5.2.6 Luxembourg 45
5.2.7 The Netherlands 48
5.2.8 Norway 49
5.2.9 Poland 50
5.2.10 Scotland 51
5.2.11 Spain 52
5.2.12 Wales 53
5.3 Common elements in national pollinator strategies 55
5.3.1 Introduction 55
5.3.1.1 Historical background and process of developing a national strategy 55
5.3.1.2 Importance of Pollination 55

5.3.1.3 Status and trends for pollinators 55
5.3.1.4 Causes of decline 56
5.3.1.5 Pollinator related research and initiatives 56
5.3.1.6 Governance and infrastructure 56
5.3.2 Actions for addressing pollinator declines 56
5.3.3 Reports on progress 60

6 Recommendations for establishing a Romanian pollinator strategy 61
6.1 Promoting pollinator monitoring 62
6.2 Promoting pollinator research 63
6.3 Measures for addressing the causes of pollinator decline 63
6.4 Measures for public engagement 65
6.5 Evaluating progress 66

7 Conclusions 68

8 References 69

Foreword

This report was produced as a deliverable for the the BeeActive! Project, “Mobilizing Citizens for the Conservation of Bees and Other Pollinating Insects in Romania” led by WWF Romania, and funded by Iceland, Lichtenstein and Norway’s Active Citizens Fund Romania, Call #3 – Civic activism and advocacy, Medium, Large and Strategic Grants.

The primary goal of the project is to support work towards developing an integrated action plan for pollinator conservation in Romania. BeeActive! aims to build a critical mass of Romanian citizens, especially young people, mobilized to actively support measures to improve public policies and decisions for the conservation of pollinators, in the context of their decline. BeeActive! has three strategic objectives: i) involve stakeholders and establish partnerships, ii) inform and influence decision and policymakers on pollinator conservation and related funding, and iii) raise awareness of the importance of pollinator conservation and the role of public policies through education and public engagement.

This report contributes to the second strategic objective and falls under Activity 6: Scientific substantiation of the requirements for the conservation of pollinators (i.e., a review on the status of pollinators and the main sources of impact on them). This report presents the most important official statistics and existing research, as well as a review of the strategic plans for conservation of pollinators that have been adopted in other countries in Europe—including Norway. We provide a summary and a set of recommendations and proposals of measures that will be presented to and discussed with other key stakeholders in Romania, negotiated with the decision makers, and promoted through the communication activities.

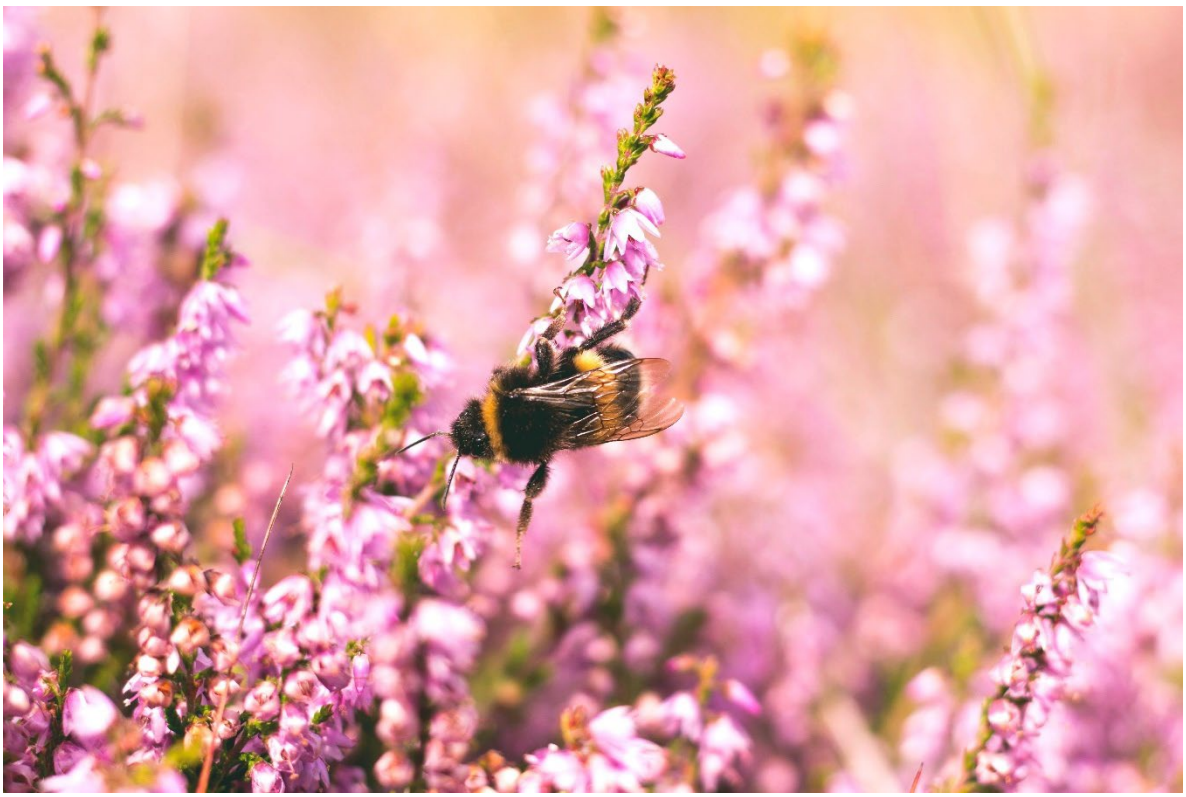
We begin with a brief overview of the knowledge pertaining to the status and trends of European insect pollinators, including a regional perspective of Romania and its neighbours. We then provide an overview of our current understanding of the drivers that impact pollinator species, both on the European continent and within Romania. We present general descriptions of some of the measures being used for pollinator conservation, together with an overview of some of the evidence available for assessing these measures’ effectiveness. We then provide summaries of several of the national pollinator strategies and action plans developed by other European nations, which may provide inspiration for a similar action plan for Romania. Finally, we present suggestions for how Romania could establish its own national action plan for pollinator conservation.

August 4, 2023
Erik Stange

1 Introduction

Pollinators are an economically, ecologically, and socially important species group that has experienced conspicuous and often drastic declines in both their abundance and diversity over recent decades. The 2016 “Thematic Assessment of Pollinators, Pollination and Food Production,” by the International Panel on Biodiversity and Ecosystem Services (IPBES), provides the most complete picture of the status and trends of pollinators to date (IPBES 2016e). Pollinator diversity loss is documented both in terms of the number of species and extinction risk for the species included in national Red Lists (e.g., The Norwegian Biodiversity Information Centre 2021) and through changes in species assemblages’ composition and increased dominance of species with broader ranges and more general resource requirements (Bommarco et al. 2012). The conclusion is that human activities—including climate change and habitat loss—are among the primary threats to pollinator species. The 2016 IPBES assessment also draws attention to the many studies that document how diversity of wild pollinators (i.e., wild bees, wasps, beetles, hoverflies and other flies, butterflies and moths, birds, bats and other animal species groups) often make important contributions to pollination of plants humans rely on for food even when managed bees are present in high numbers (IPBES 2016d).

This documented loss of wild pollinators is a serious cause for concern. Animal pollination plays an important role in the structure and function of many of the world’s ecosystems. Around 80% of all angiosperms (flowering plant species) in Europe depend on animal pollination (Ollerton et al. 2011). This percentage is even higher in the tropics, where nearly 90% of all known wild flowering plant species (approximately 308 000 species) depend—at least in part—on the transfer of pollen by animals (Ollerton et al. 2011). Pollinator decline can therefore result in dramatic effects on plant communities (Lever et al. 2014). In some cases, the loss of even a single species can disrupt the plant-pollinator networks of the remaining species, and thereby reduce plant reproduction even if other effective pollinators remained in the system (Brosi & Briggs 2013).



Bombus soroeensis forages on *Calluna vulgaris (common heather).* ***Photo by*** *Josephine Amalie Paysen* ***on*** *Unsplash*

Insect pollination contributes to the production of food in both quantity and quality, thereby constituting an important part of global food security. This service provided by insects has been estimated at around €150 billion globally and €14.2 billion in the European Union (Breeze et al. 2016, Gallai et al. 2009). Pollinated crops include those that provide fruit, vegetables, seeds, nuts and oils. Many of these crops are important dietary sources of vitamins and minerals (i.e., vitamin A, iron, and folate), without which malnutrition can be expected to increase (Chaplin-Kramer et al. 2014). Pollinator-dependent crops *contribute* to 35% of the global food production volume, and insect pollinators are *directly responsible* for between 5 and 8% of the global agricultural production volume (Lautenbach et al. 2012). Of the 107 world's leading crop types (crops that produce fruits or seeds for direct human use as food), 91 either completely depend on pollination or show increased yield in connection with animal pollination (Klein et al. 2007). There are several crop types that do not depend directly on pollinators for the plant parts humans consume (i.e., potatoes, carrots, parsnips, alliums and other vegetables), but animal pollination is still important for their propagation. Many forage species (e.g., legumes) also benefit from animal pollination (Klein et al. 2007).

Solitary bee *Chelostoma rapunculi. Photo by Markus Sydenham, NINA*

In addition to food crops, pollinators contribute to crops that provide biofuels (e.g. canola and palm oils), fibres (e.g. cotton and flax), medicines, forage for livestock, and construction materials. Some species also provide materials such as beeswax for candles and musical instruments, and arts and crafts (IPBES 2016b).

The international community has responded to the publicity surrounding pollinator declines by enacting several initiatives to stop and reverse the loss of pollinators. One of the earliest initiatives was in May 2000, when the Conference of Parties (COP) to the Convention on Biological Diversity established an International Initiative for the Conservation and Sustainable Use of Pollinators (also known as the International Pollinators Initiative) as a cross-cutting initiative within the programme of work on agricultural biodiversity (CBD 2000). FAO was invited to facilitate and

coordinate the initiative in cooperation with other relevant organizations. This led to establishment of the International Pollinators Initiative and its Plan of Action 2000-2015, which has since been replaced by the Plan of Action 2018-2030.

At the COP13 on Biological Diversity in December 2016, Decision XIII/15 (CBD 2016) was passed, encouraging Parties, other organizations and stakeholders to use the recommendations from the IPBES thematic assessment mentioned above to help guide their efforts towards improving conservation and management of pollinators, address drivers of pollinator declines, and work towards sustainable food production systems and agriculture (Underwood et al. 2017).

Within the past decade, the EU has enacted a range of measures with benefits to pollinators. These are integrated into health and environmental policy (e.g., the Birds and Habitats Directives, the EU legislation on pesticides, and invasive alien species), the Common Agricultural Policy, Cohesion Policy and Research and Innovation policy (Potts et al. 2021b). However, it became increasingly clear that a more integrated approach directed specifically at pollinators and their habitat was needed to put an end to their decline, and in June 2018, the European Commission adopted the EU Pollinators Initiative (or EPI; European Commission 2018). A growing number of European countries also have introduced their own national strategies for addressing pollinator declines, some of which predate the EPI.

Bombus pascorum. Photo by Arnstein Staverløkk, NINA

2 Status and trends of pollinating insects

Several recent reviews highlight an alarming global trend in declining insect abundance and diversity (Sánchez-Bayo & Wyckhuys 2019, van Klink et al. 2020, Wagner 2020). Studies focusing on insect status within individual European countries underscore this overall pattern of insect declines. For example, a meta-analysis across 63 protected sites in Germany found a 77% decline in flying insect biomass from 1987 to 2016, likely due to agricultural intensification in the surrounding fields, with protected sites potentially acting as ecological traps (Hallmann et al., 2017). One third of insect species from Germany's forest and grassland environments have disappeared over a period of just 10 years (Seibold et al., 2019). Switzerland's Red List of threatened insect species indicates that approximately 60% of the county's insect species are endangered or potentially endangered, and the situation in particularly serious for insects whose habitat can be found near agricultural areas and aquatic environments *(*Altermatt et al., 2019*).* While many of the insects included in these studies are not pollinators, the overriding message from these studies suggest that the extent of insect decline in Europe may have been underestimated.

The IPBES thematic assessment concluded that there were substantial declines among several important insect pollinator taxa, and particularly in north-west Europe and North America (IPBES 2016e). Zattara and Aizen (2021) used publicly available data on specimen collections and observations gathered at the Global Biodiversity Information Facility (GBIF), mostly coming from museum and academic collections and complemented by citizen science efforts. They found that the number of bee species being collected or observed over time has been steadily declining since the 1990s, potentially reflect a worldwide decline in bee diversity given that many species are becoming rarer and less likely to be found. This unfortunate trend is particularly worrisome for insect pollinators because of their important role in ecosystem function and the ecosystem services they provide.

Europe supports a rich diversity of wild pollinators, comprising 2051 species of bees, 482 species of butterflies, and almost 1000 species of hoverflies plus thousands of species of moths, flies, wasps, beetles, and other insects (Potts et al. 2021b). The available data that describe the abundance, diversity and distribution of Europe's pollinating insects is recognized as some of the highest quality and longest-term available, which means that the understanding of the extent and severity of insect pollinator declines on the European continent is probably the strongest of any region in the globe (Potts et al. 2021b). In this chapter, we present examples from the current evidence describing the status and trends of taxonomic groups of insect pollinators, with a section addressing the available information and important knowledge gaps regarding the status and trends of these taxonomic groups in Romania.

Examples of evidence documenting pollinating insect declines:

- Global decrease in the number of bee species collected since 1990s (Zattara & Aizen 2021)
- 37% of European bee species have declining populations (Nieto et al. 2014)
- Twenty bee and wasp species have gone extinct in the UK since 1909 (Ollerton et al. 2014)
- One third of western European butterfly species are declining (van Strien et al. 2019, van Swaay et al. 2006)
- 39% decline of grassland butterflies since 1990 (van Swaay et al. 2019)
- 37% of European hoverfly specie are threatened (Vujić et al. 2022)

2.1 Status and trends for pollinating insects in Europe

2.1.1 Bees

The 2014 European Red List of Bees gathered evidence on 1,965 bee species and concluded that 37% of bee species have declining populations (Nieto et al. 2014). Specifically, 9.1% of all European bee species are threatened with extinction and a further 5.4% of bees are considered *Near Threatened* (Nieto et al. 2014). However, the absence of a standardized monitoring program for bees means that there are substantial knowledge gaps in the actual status for much of the community of European bee species. The data presently available are not sufficient to assess the extinction risk of over half (57%) of all European bee species (Nieto et al. 2014), implying that the actual proportion of bee species that are in decline or facing extinction could be even higher.

In their proposal for an EU Pollinator Monitoring Scheme, Potts et al. (2021b) provide several examples where data from long-term insect monitoring provides insights into the status and trends of insect pollinators. Since the 1950s, wild bees in the Netherlands, Belgium and Great Britain have generally declined in diversity and occurrence (Biesmeijer et al. 2006, Carvalheiro et al. 2013). While bees experienced dramatic losses between the 1950s and 1980s, declines may have slowed since the 1990s (Carvalheiro et al. 2013). Twenty bee and wasp species have become extinct in Britain since 1909 (Ollerton et al. 2014).

The data available from long-term observations also indicate that insect pollinator distribution is constricting as a response to changes in Europe's climate. In a meta-analyses of data spanning over 110 years, Kerr et al. (2015) found several consistent trends of how climate change has altered bumble bee species distributions. Several species experienced losses from southern range limits while simultaneously failing to expand their northern range limits. Several species living in southern Europe also demonstrated shifts to higher. In a separate analyses, Soroye et al. (2020) found that overall extinction rates of bumble bees, driven by climate change, greatly exceed rates of colonization, thereby contributing to severe species declines across Europe. By comparing current data on species habitat preferences with projected climate changes, analytical models describing bumble bees species distribution suggest that up to 36% of species are projected to be at high risk from climate change by 2100 (i.e., losing >80% of their current range), with 41% at risk of losing 50 - 80% of their current range (Rasmont et al. 2015). Data from the UK already document an overall trend in species decreasing range size: an analyses of 137 UK wild bee species between 1980 and 2016, the average trend across all species was a 25% decline in site occupancy, with 37% of species declined and 20% increased (Powney et al. 2019). These declines were greatest between 2006 and 2013, and the average trend across species has since stabilized (Powney et al. 2019).

2.1.2 Butterflies and moths

Western European butterfly populations have seen major declines between the 1950s and 1970s, and one third of the species are still declining (van Strien et al. 2019, van Swaay et al. 2006). The EU Grassland Butterfly Indicator identified two periods with substantial declines in 37% of species between 1990 – 1998 and between 2002 – 2012 (van Swaay et al. 2019). Modelling shifts in butterfly distributions showed that, by 2080, 70% of species are projected to lose >80% of their current range and are therefore considered to be at high risk from climate change (Settele et al. 2008).

The IUCN Red List for butterflies of continental Europe states that 31% of butterfly species have declining populations and 9% are classified as threatened (van Swaay et al. 2010). On average, 27% of butterfly species are considered threatened within the 24 EU countries that have national Red Lists (Maes et al. 2019). A European Grassland Butterfly indicator from 16 countries

(including Romania) shows a 39% decline of grassland butterflies since 1990 (van Swaay et al. 2019). The data used by the IUCN to evaluate species' status show considerable variation in butterflies' extinction risk between countries. Butterfly declines are highest in northwest Europe (e.g., 55% in the Netherlands and 49% in Belgium), and lower in the Mediterranean (e.g., 3% in Spain and 6% in Italy). More than a century of data has revealed a decline of more than 80% of butterflies in the Netherlands between 1890 and 2017 (van Strien et al. 2019).

Less information is generally available on the trends of moths, although one national study found that total British moth abundance had decreased by 31% between 1969 and 2006 (Conrad et al. 2006). However, recent evidence suggests that moth biomass may be increasing, implying that a few species are doing well (Macgregor et al. 2019). There is currently no European Red List for moths.

2.1.3 Other pollinating insects

Fewer studies are available on population sizes and trends for hoverflies, compared to bees and butterflies. The first IUCN European Red List for hoverflies was released in June 2022, and assesses the conservation status of 890 species considered native or naturalised in Europe (Vujić et al. 2022). Of these, 314 species were found to be threatened or having an elevated risk of extinction in the near future. Additionally, 45 species were classified as data deficient (DD) because there was insufficient data to assign a conservation status. Vujić et al. (2022) estimate that roughly 37% of European hoverfly species are likely threatened—using the presumption that at least some, but not all, of the DD species are found to be threatened.

Vujić et al. (2022) also report that a staggering 62.4% of European hoverfly species have an unknown population trend (555 species), of which 45.6% (253 species) are considered threatened. This means that we do not know whether these species populations are increasing, decreasing or stable, because we do not have data from systematic monitoring schemes of hoverflies.

Keil et al. (2011) assessed temporal changes in species richness of hoverflies from the UK and the Netherlands, comparing museum specimen data prior to and post 1980. Their findings were mixed. When species richness was assessed at a fine scale (10 x 10km), it was increasing in the Netherlands and decreasing in the UK. When assessed at a national scale, however, species richness was increasing in the UK and showed no change in the Netherlands. Powney et al. (2019) also investigated UK hoverfly distributions by analysing occupancy of 1 km^2 squares of 214 hoverfly species between 1980 and 2013. They found that 33% of species declined and 10% increased, with an average trend across species being a 24% decline. This average trend gradually declined between 1987 and 2001, but has since stabilised (Powney et al. 2019).

Species distribution modelling for three genera of hoverflies (*Cheilosia*, *Merodon*, and *Pipiza*) indicates that climate change is likely to have variable impacts on species—with a mix of range contractions, expansions and shifts (Kaloveloni et al. 2015, Radenković et al. 2017). Range expansions and shifts resulting from climate change could make Northern Europe the area of the continent with the highest species diversity, replacing the current hotspot in central Europe (Miličić et al. 2018).

Pollinating insects also include other insect taxa—such as beetles, wasps, and thrips—although these taxa usually constitute a rather small proportion of the entire group. with the exception of dipterans (Diptera: Syrphidae). Some studies have examined changes in entire insect communities, although it is difficult to establish what proportion of these insects are actual pollinators without sorting and identifying the insect samples.

2.2 Status and trends for pollinating insects in Romania

Romania's geographic location gives the country potential for considerable species diversity. It lies in a biogeographic zone of five overlapping ecoregions: alpine, continental Pannonic, Pontic, Balkan, and steppic. The predominantly temperate-continental climate features considerable variation in dominant vegetation types—including steppe, silvosteppe, oak forests, meadow vegetation and many more. Romania is also rich in traditional cultural landscapes that harbour unique farmland biodiversity (Cremene et al. 2005, Palang et al. 2006). Romanian borders include a major part of the Carpathian mountains: Europe's largest continuous temperate forest ecosystem and mountain range (Ioras 2003, Oszlányi et al. 2004). Carpathian ecosystems are known to harbour exceptionally high biodiversity, with large numbers of endemic species (Ioras 2003).The combination of bioclimate and cultural factors correspond with a high rate of endemic and sub-endemic species. For example, Ioras (2003) reports that Romania is home to 228 endemic and sub-endemic plant species, which is higher than in Bulgaria (170 species) or Hungary (11 species) (Ioras 2003). Romania is also home to a considerable number of endemic species of Lepidoptera—with more than 80 endemic species and subspecies, including 28 butterflies (Rákosy 1998).

Romania's considerable variety of flowering plant species, flower sizes, the long duration of its blooming periods, and the relatively uniform distribution and high proportion of *melliferous flora* (plants whose flowers produce substances that can be converted into honey) provide extremely favourable conditions for beekeeping (Ion et al. 2018). Beekeeping activity occurs in all of Romania's 41 counties (Iuliana 2014), and the country ranks among the top honey producing nations within the EU. In 2018, it produced more honey than any other EU country (30 900 tons), despite not being the country with the most beehives (European Commission 2020). Such honey production levels suggest foraging conditions that also would be favourable for wild pollinating insects. However, the European Commission beekeeping statistics report considerable volatility in the number of beehives in Romania over recent years, with total beehives varying from 1550 in 2014 to 2472 in 2016.

2.2.1 Bees

There is presently little available information that might provide insight into the status and trends of Romanian bee species. Bees of Romania[1] is an online resource originally published in 2010 by Bogdan Tomozii, of the Natural Science Museum complex in Bacau (Tomozii 2017). Dr. Tomozii contributed to the 2017 European Red List of Bees (Nieto et al. 2014) as an assessor of *Andrena* species (solitary bees). The website provided a checklist of nearly 750 bee species recorded on the territory of Romania (beginning from the mid-19th century), as well as species that potentially live in Romania, based on records from nearby countries. The site also provides a list containing relevant references for the listed species and photos of some species. However, it is unable to provide data on species' abundance or distribution since these data do not exist.

Atlas Hymenoptera[2] is another website containing information on the occurrence of bee species in Romania. This site benefitted from contributions of work done within the STACCATO project (Sustaining Agricultural Change Through Ecological Engineering and Optimal Use of Natural Resources 2015-2018), a BiodivERsA funded EU project including Romanian researchers. Atlas Hymenoptera was originally a joint initiative intended to maintain a biogeographic database of Hymenoptera in Western Europe. It now contains information about Hymenoptera systematics (phylogeny), ecology, and biogeography—including species distribution maps and illustrations of many species from all over Europe.

[1] http://www.beesofromania.ro/
[2] http://www.atlashymenoptera.net/

The current European Red List of Bees (Nieto et al. 2014) reports a moderately high number of threatened species in central and western Romania (Figure 1). It also shows a moderately high density of species regarded as data deficient throughout a large portion of the country (Figure 2).

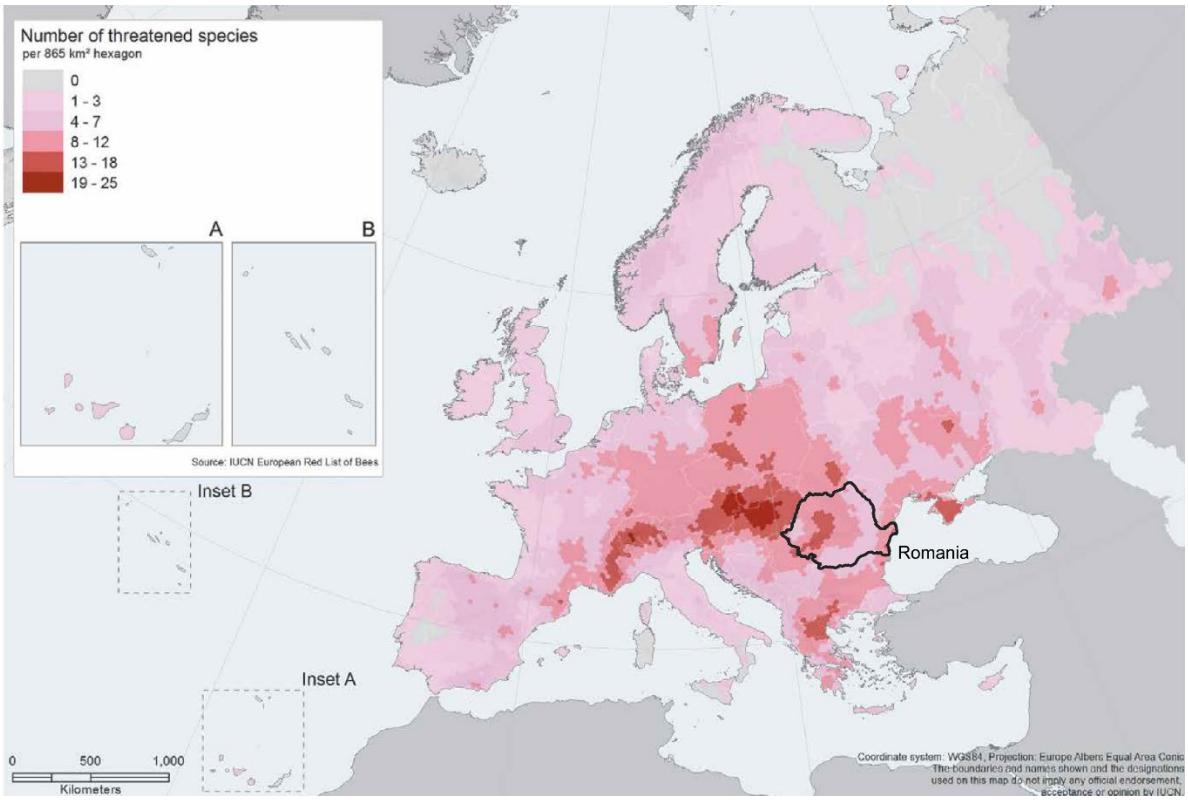


Figure 1. The distribution of threatened bee species as assessed by the IUCN European Red List for Bees (redrawn from Figure 9 in Nieto et al. 2014).

Romania does not have its own Red List for bees. The online searchable IUCN Red List[3] provides information on the status and trends for bee species evaluated at a global scale, including 630 species of bees whose distributions are known to include Romania. Of these 630 species, one species is listed as critically endangered (CR), 18 species are endangered (EN), 12 species are vulnerable (VU), 20 species are near threatened (NT), 326 species are least concern (LC) and 231 species lack sufficient data to assess extinction risk or population trends (Table 1). In virtually all cases, the data used to describe species' population trends was collected outside of Romania. Accordingly, we cannot know specifically whether the information is representative of species' status and population trends within Romania. The Red List also lists a single species that is endemic to Romania (i.e., it is presently found in no other country in the world). *Stelis scutellaris* is belongs to the family Megachilidae (leaf cutter bees) and lives in forests, shrubland, grassland, rocky areas (e.g. inland cliffs, mountain peaks), and artificial (developed) habitats. The data on *S. scutellaris* is insufficient to determine either its extinction risk or trends in its abundance.

[3] www.iucnredlist.org/species

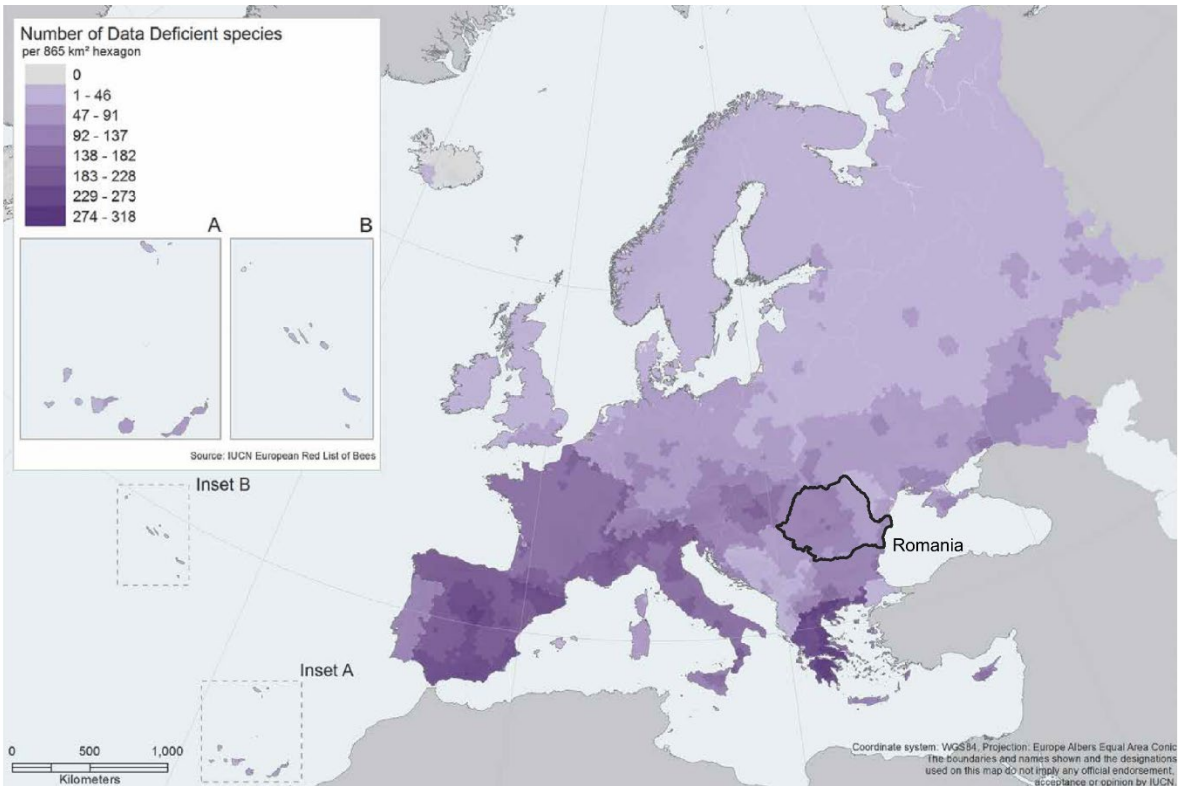


Figure 2. The number of species assessed by the IUCN Red List for Bees (redrawn from figure 10 in Nieto et al. 2014) whose data is insufficient to determine either their extinction risk or population trends.

Table 1. Bee species with geographic distributions including Romania and listed as either critically endangered (CR) endangered (EN) or vulnerable (VU) on the IUCN Red List.

Species name	**Family**	**Habitat type**	**IUCN status**	**Population trend**
Bombus cullumanus	Apidae	Grassland	CR	↓
Halictus carinthiacus	Halictidae	Grassland	EN	↓
Bombus zonatus	Apidae	Grassland	EN	↓
Melitta melanura	Melittidae	Grassland	EN	↓
Trachusa interrupta	Megachilidae	Shrubland, Grassland	EN	↓
Bombus mocsaryi	Apidae	Grassland	EN	↓
Bombus fragrans	Apidae	Grassland	EN	↓
Dasypoda suripes	Melittidae	Shrubland, Grassland	EN	↓
Colletes anchusae	Colletidae	Grassland	EN	↓
Colletes nastus	Colletidae	Grassland	EN	↓
Colletes punctatus	Colletidae	Shrubland, Grassland	EN	↓
Ammobatoides abdonimalis	Apidae	Grassland	EN	↓
Parammobatodes minutus	Apidae	Grassland	EN	↔
Andrena comta	Andrenidae	Grassland	EN	↓
Halictus carinthiacus	Halictidae	Forest, Shrubland, Grassland	EN	↓
Dasypoda spinigera	Melittidae	Shrubland	EN	↓
Nomada pulchra	Apidae	Unknown	EN	unknown
Andrena magna	Andrenidae	Grassland	EN	unknown
Ammobates melectoides	Apidae	Shrubland, Grassland, Artificial	EN	↓
Halictus semitectus	Halictidae	Forest, Grassland	EN	↓
Biastes truncates	Apidae	Forest, Shrubland, Rocky areas	VU	↓
Bombus pomorum	Apidae	Shrubland, Grassland	VU	↓
Colletes fodiens	Colletidae	Shrubland, Grassland	VU	↓
Bombus confuses	Apidae	Grassland, Artificial	VU	↓
Bombus alpinus	Apidae	Grassland	VU	↓
Bombus muscorum	Apidae	Forest, Shrubland, Grassland, Wetlands	VU	↓
Bombus distinguendus	Apidae	Grassland	VU	↓
Systropha planidens	Halictidae	Shrubland, Grassland	VU	↓
Bombus gerstaeckeri	Apidae	Forest, Grassland	VU	↔
Colletes chengtehensis	Colletidae	Grassland	VU	↓
Andrena transitoria	Andrenidae	Shrubland, Grassland	VU	↓
Halictus leucaheneus	Halictidae	Shrubland, Grassland	VU	↓

Research on bumble bees in Hungary can also provide insight into bees' extinction risk within Romania. While only one of the 25 bumble bee species (*Bombus Latr.*) found in Hungary is included in the Hungarian national Red List, evidence from Sárospataki et al. (2005) suggests that a greater proportion of should be included. Sárospataki et al. (2005) used 50 years of species occurrence records (4000 total) and found that four species were data deficient or nationally extinct, and about 60% of species were considered either rare or moderately rare. Changes in distribution and occurrence frequency indicated that 10 of the 21 native species showed a declining trend, while only three species increased in frequency of occurrence. These data indicate that seven species (33% of the native fauna) should be labelled as critically endangered (CR) and three (14%) as endangered (EN) according to the criteria for IUCN Red List categories. The authors conclude that their results demonstrate the urgent need for developing protection plans for bumble bees in Hungary, and further underline the causes of concern over bumble bees all over Europe.

2.2.2 Butterflies and moths

Information on Romanian Lepidoptera fauna is far more developed than what is presently known about its bees. An updated distributional checklist of the Lepidoptera of Romania was published in 2021 (Rákosy & Goia 2021). There are further one publication covering species portraits of Romanian Noctuid moths, which also include information on species distribution (Rákosy 1996) and one publication on butterflies (Rákosy 2013). The website of the Lepidopterological Society Romania[4] provides updates on various related publications and projects, and links to freely available studies published in the Entomological Information Bulletin and Entomologica Romanica.

According to the European Red List of Butterflies, Romania is home to 41% of all butterfly species in Europe (van Swaay et al. 2010). Only six countries (Italy, France, Spain, Greece, Bulgaria and Austria) have greater butterfly species richness than Romania. Six per cent of the butterfly species with distributions that include Romania are considered threatened at the European level (IUCN 2013, van Swaay et al. 2010).

The first Romanian Red List of Lepidoptera (specifically butterflies and macro-moths) was published in 2003 (Rákosy et al. 2003), with an update published in 2021 (Rákosy et al. 2021). The updated Red List reports the conservation status for 1567 species and subspecies of Lepidoptera, both with reference to Romania's eight historical provinces and for the country as a whole. At the national scale, the red list reports that 15 species are extinct, 9 are critically endangered (CR), 29 are endangered (EN), 66 are vulnerable (VU) and 270 are near threatened (NT). The report cites Dobrogea as the region with the highest number of regionally extinct and critically endangered species (19 and 7, respectively), and notes that Transylvania has the most endangered (22) and vulnerable (41) species. The red list further identifies mountain peat bogs as the most negatively impacted Lepidoptera habitat type in Romania, as evidenced by the four species associated with this habitat that are now nationally extinct. The red list further provides detailed information and illustrations for 101 charismatic species, with data presented in tables and pie charts facilitating a reasonably accurate insight into the situation of butterflies and moths in the country.

Systematic butterfly monitoring in Romania began in 2012 (IEEP 2019). Butterfly occurrence and abundance are monitored by volunteers on fixed transects using the same method as is already used in other European countries. The Lepidopterological Society Romania (LSR) coordinates the scheme with the support of Butterfly Conservation Europe. The Butterfly Conservation Europe manual on butterfly monitoring has been translated into Romanian. The scheme grew to include 17 transects used for monitoring in 2015. However, the lack of enough volunteers is currently a huge impediment in the success of this initiative (IEEP 2019).

[4] www.lepidoptera.ro

We found no mention of comparable monitoring initiatives for other groups of wild pollinators. In general, citizen science is still somewhat new in Romania. For example, there is little data generated by Romanian citizens on the Global Biodiversity Information Facility and iNaturalist platforms (IEEP 2019).

2.2.3 Other pollinating insects

An online checklist for the Syrphidae of Romania[5] lists 486 species, based on Stanescu and Parvu (2005).

The online searchable IUCN Red List provides information on the status and trends for Syriphidae (hoverfly) species whose distributions are known to include Romania. Reports for the species included on the list provide the assessed extinction risk and indications on the species' population trends. The Red List includes assessment for 420 species of hoverflies whose distributions include Romania. Of these, three species are listed as critically endangered (CR), 43 species are endangered (EN), 18 species are vulnerable (VU), 21 species are near threatened (NT), 327 species are least concern (LC) and 8 species lack sufficient data to assess extinction risk or population trends (Table 2). In virtually all cases, the data used to describe species' population trends was collected outside of Romania. Accordingly, it is impossible to determine whether the information is representative of species' status and population trends within Romania.

Table 2. Hoverfly species with geographic distributions including Romania and listed as critically endangered (CR) on the IUCN Red List.

Species name	Habitat type	IUCN status	Population trend
Sericomyia bequarti	Forest, Shrubland	CR	↓
Eumerus banaticus	Grassland	CR	unknown
Orthonevra gemmula	Grassland, Wetlands	CR	unknown

[5] https://www.syrphidae.com/checklist.php?country=RO

Hoverfly *Volucella inanis,* native to Romania but is not considered threatened. *Photo by Martin Sepion on Unsplash*

3 Major threats to bees and other pollinator species

Research investigating declines in the abundance of pollinating insects indicates that these negative trends generally arise from a complex interplay of several stressors (e.g., lack of food sources due to habitat loss, diseases, and pesticides) and biological processes (e.g., species dispersal and species interactions) at a range of scale from genes to ecosystems. Most of the stressors stem from human activity. Sánchez-Bayo and Wyckhuys (2019) reviewed 73 historical reports of insect declines across the globe—the vast majority from Europe. They found that habitat loss/change, pollution (including both pesticides and other air/water/soil-contaminants), biological traits (e.g., predation, competition, dispersal) and climate change were the most frequently listed factors in losses for insect groups, including pollinators (Figure 3). Authors are now calling for interdisciplinary research on the nature and impacts of these interactions as an important step in finding the most effective measures to tackle pressures (Vanbergen & the Insect Pollinators Initiative 2013).

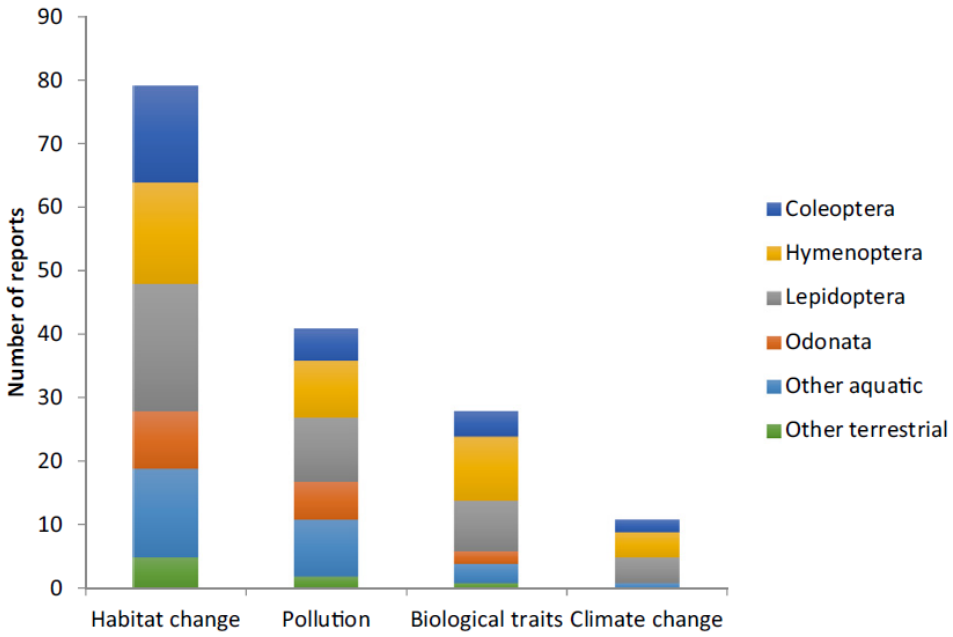


Figure 3. The four major drivers of decline for each of the studied taxa according to reports in the literature. Bees belong to Hymenoptera. Pollinating species can also be found among the orders of Coleoptera and Lepidoptera (Sánchez-Bayo & Wyckhuys 2019).

The European Red List for Bees acknowledges the considerable information gaps concerning how various forces might have negative impacts on European bee populations. The majority of European bee species (56.7%, or 1067 species) are listed in the most recent Red List as Data Deficient, which means it is not possible to either identify what threats they may be subject to or what effects those threats might have. This means that "any overview of the threats to continental bee *apifauna*[6] will necessarily be incomplete" (Nieto et al. 2014). However, the European Red List for Bees provides an overview (Figure 4) of the frequency to which individual factors are regarded as threats to the 663 bee species that were able to be assessed. No threats could be identified for 212 bee species (Nieto et al. 2014).

[6] Bee species

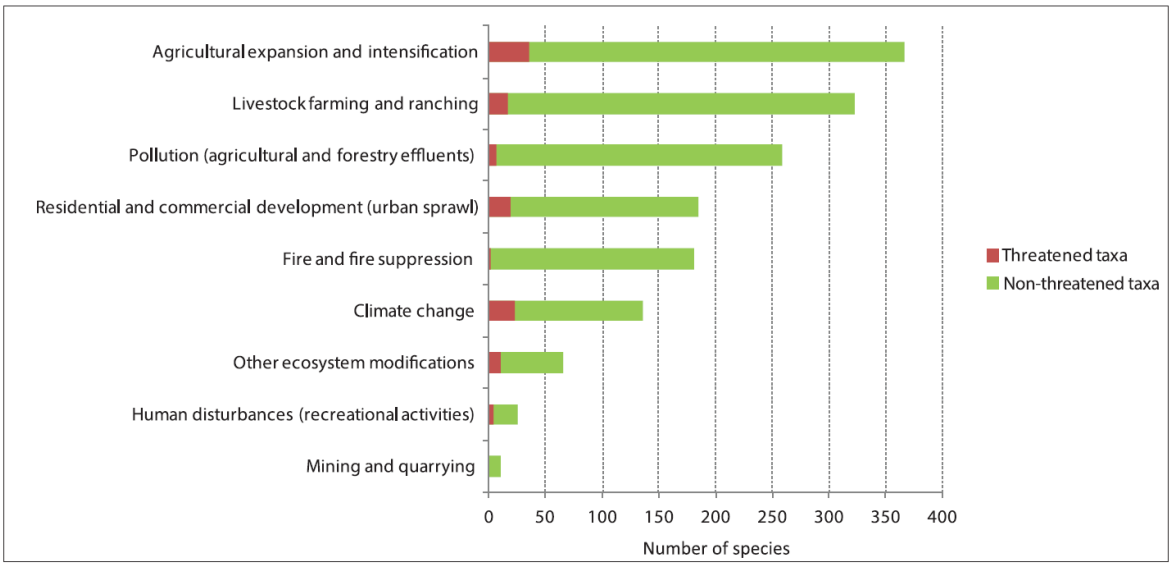


Figure 4. Major threats to bees in Europe, according to the European Red List for Bees (Nieto et al. 2014)

There is somewhat less uncertainty surrounding the factors that threaten European butterflies, however the situation as presented in the European Red List for Butterflies largely mirrors that of European bees. Again, habitat loss through agricultural intensification, agricultural abandonment, and changes for both of woodlands and non-agricultural area management are regarded as the primary drivers impacting butterflies' extinction risk (Figure 5; van Swaay et al. 2010).

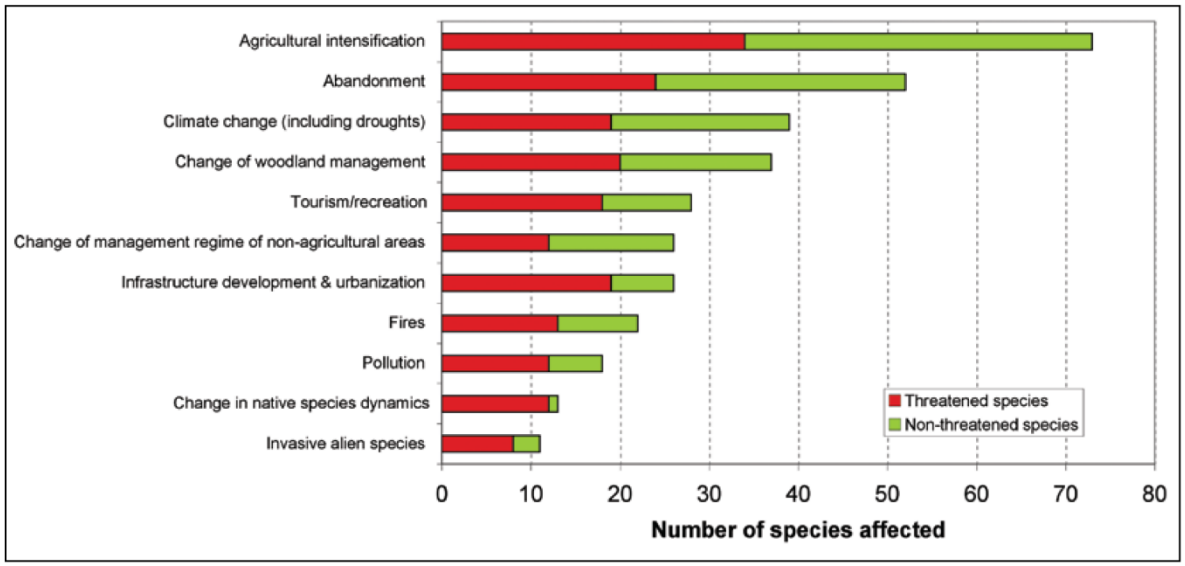


Figure 5. Major threats to butterflies in Europe, according to the European Red List for Butterflies (van Swaay et al. 2010).

In this chapter, we present a brief discussion of the dominant factors that constitute threats to bee species. Bees are generally regarded as the species group that contributes the most to animal-mediated plant pollination because they are far more effective at pollination than non-bee insect pollinators (Rader et al. 2016). Consequently, most of the published literature on threats pollinating species primarily addresses bees; although there is ample reason to expect the

stressors that impact bee species also affect other groups of pollinators in similar ways (IPBES 2016f). Where possible, we provide examples of research activities that has enhanced our understanding of the nature and severity of threat factors—either alone or in combination with other factors. Most of this insight comes from work outside of Romania. Wherever possible, however, we link the discussion of the factor to Romanian conditions.

3.1 Habitat loss

Farmland covers nearly half (40%) of the EU-27 area (EEA 2010). Agricultural landscapes have traditionally supported high levels of biodiversity in Europe (Bignal & McCracken 1996). However, the expansion and intensification of European agriculture over the second half of the 20th century have led to dramatic landscape changes, with severe declines in farmland biodiversity (Benton et al. 2003). Many remnants of semi-natural habitats that are principal hotspots for pollinating bees have been converted into high intensity areas for agricultural production (i.e., arable land; Henle et al. 2008).

Intensive arable farming (i.e., cultivating crops through ploughing the soil, often involving crop monocultures with little to no crop rotation across years) leads to both a loss of uncultivated habitats (Sydenham et al. 2014) and an increased use of insecticides and herbicides (Gill & Raine 2014). Greater densities of grazing livestock decrease flower resource availability for bees and damage the soil in fragile ecosystems (Vulliamy et al. 2006). Conversion of areas with semi-natural vegetation to commercial timber plantations also leads to land cover that has little to offer for foraging bees (Navarro-Cerrillo et al. 2013).

The European Red List includes 366 species affected by changes in agricultural practices that cause large scale habitat loss and degradation. In particular, a transition from grassland hay crop practices to more intensive silage production (more frequent harvesting), combined with more intense grazing, has led to anything from large to complete losses of herb-rich grasslands. In England and Wales, 97% of all semi-natural grasslands have been converted into agricultural-improved grassland[7] or arable lands (Hooftman & Bullock 2012). Between 97 and 99% of historically managed grasslands in Sweden are now gone (Dahlström et al. 2008). Both the intensity of the agricultural practices and the spatial distribution of what little natural or semi-natural habitat remains often combine to determine species richness and diversity of the pollinating insect community (Hendrickx et al. 2007).

[7] Commonly defined as either land used for grazing (but not arable land), or land that has been improved by management practices such as liming and top dressing. Agriculturally improved grasslands do not contain a significant presence of sensitive plant species indicative of native unimproved grassland. See https://www.lawinsider.com/dictionary/improved-grassland

Ciurila, Romania. Photo by Marko Michelovski on Unsplash

Traditional land use and agricultural practices have created landscapes with hay meadows and pasture habitats with high species diversity (Schmitt & Rákosy 2007, Varga 2003). These habitats are now considered among Europe's most important elements of natural heritage and thus of major conservation priority (Dover et al. 2000, van Swaay et al. 2006, WallisDeVries et al. 2002). Most areas that still have larger quantities of these important habitats, including Romania, are located in south-eastern Europe, and whose economies largely forced a maintained traditional land-use systems and agricultural practices (Konvicka et al. 2006). The high biodiversity associated with agricultural landscapes in Central and Eastern European countries has been attributed to the existence of extensively managed systems—such as low-intensity systems for livestock, arable and permanent crops, as well as mixed systems—which have remained mainly in upland and remote areas (Kovács-Hostyánszki et al. 2016). In these systems, both arable fields and grasslands hold abundant flower resources, which are important for pollinator communities, indicating that pollinator conservation can rely even on arable fields under traditional management regime (Kovács-Hostyánszki et al. 2016). After Romania's accession to the European Union, a significant intensification of agricultural production has taken place, including greater use of pesticides, herbicides and fertilizers.

Agricultural abandonment is another growing concern of land use change that can generate negative effects on bees. Abandonment of cultivated or grazed fields leads to the conversion of herb-rich grasslands to first shrublands, and ultimately to forested woodland. In several Eastern European countries, abandonment is the key driver of changes in species composition in semi-natural grasslands, not habitat fragmentation from land use intensification (Dauber et al. 2006). The decreasing profitability of farming, together with the restructuring of the agricultural sector following the breakup of the Soviet Union, have resulted in the abandonment of grasslands formerly used for grazing livestock and a subsequent reforestation that threaten the persistence of extensively managed landscapes and may result in biodiversity loss for this region (Cremene et al. 2005).

Studies investigating land cover changes in Romania provide an indication of the extent of both agricultural intensification and abandonment. Kuemmerle et al. (2009) used Landsat TM/ ETM+ satellite images to classify land cover maps and assess landscape pattern changes of Arges County in southern Romania from 1990 to 2005. They found that cropland abandonment was the most widespread change (a decrease of 512 km^2, or 7.5% of the study area, corresponding

to a 21.1% abandonment rate). They concluded that likely due to declining returns from farming, tenure insecurity, and demographic developments during transition, since >80% of the abandonment occurred between 1990 and 1995. Forest cover and forest fragmentation remained remarkably stable over this same period.

Meanwhile, subsidies for agricultural development became widely available in Romania after the country joined the EU in 2007. These incentives have led to a high degree of land consolidation and intensification in the southern part of the country and in other areas containing plains. Incentives have also led to the substantial loss of forests and green protection belts, making southern Romania among the regions in Europe with the highest desertification risk (Prigent et al. 2018). Land and farm abandonment have continued in the mountain areas, where targeted incentives from the Common Agricultural Policy (CAP) National Strategic Plan for 2023-2027 aim to slow or even reverse this trend.

Investigations that focus on specific smaller areas within Romania offer a nuanced description of land use change trends both before and after Romania's entrance into the EU. For example, Cheţan et al. (2018) used imagery from Sentinel 2 satellite to estimate the extent of habitat change at three study sites in the Apuseni Mountains between 1986 and 2015. These sites included the Apuseni-Vlădeasa Mountains (93 000 ha and 1154 m average elevation), Defileul Mureşului Inferior – Dealurile Lipovei (56 000 ha and 229 m average elevation) and the Drocea-Zarand (41 000 ha and 391 m average elevation). They found that pastures and meadow habitat types at all three sites deteriorated until 2000 due to expansion of agricultural activity that occurred primarily before 1993. Natural regrowth of vegetation in the Apuseni-Vlădeasa Mountains site containing mixed forests improved considerably after 2000, but with an this improvement slowed following 2007 after the site was designated as Special Protected Area (SPA). The other two sites containing both meadows and deciduous forests experienced a constant overall deterioration during the past three decades, mainly due to land abandonment.

Land use trends in the Apuseni Mountain region do not, however, necessarily reflect trends occurring at a national scale. The most recent investigations of land cover change in Romania using CORINE (Coordination of Information on the Environment) data describe general patterns of continued deforestation and urbanisation, with slowing rates of agricultural development (Petrişor et al. 2020).

3.2 Pollution, pesticides and herbicides

Among the many negative aspects of modern agricultural practices is the widespread use of chemicals: pesticides, herbicides and fertilizers. Herbicides and pesticides are collectively referred to as plant protection products, or PPP. The European Red List concluded that 259 species of bees are threatened either directly or indirectly by agrochemcial use (Nieto et al. 2014). A growing body of research documents how wild bees are negatively affected through persistent sublethal effects of certain insecticides and fungicides that include effects on learning performance, behaviour and neurophysiology (Rundlöf et al. 2015, Sgolastra et al. 2017, Stanley & Raine 2016, Woodcock et al. 2017). Further, wild bees are often exposed to mixtures of pesticides that can have more pronounced effects in combinations ("the so-called "cocktail effect") than individually (Botías et al. 2017, Sgolastra et al. 2017), and approaches to risk assessment in bees typcallydo not consider co-exposures from multiple stressors.

Herbicides can both damage and reduce the availability of the floral resources on which bees depend. Herbicides can also disrupt or delay the flowering, so that the timing does not coincide with the period when bees most need food for breeding and rearing their young (Boutin et al. 2014). Herbicides can also have considerable local effects on bees, with the most pronounced effects on pollen foragers (Nabhan & Buchmann 1995). While herbicides generally have indirect effects on bees, herbicides can also be more directly toxic. Glyphosate, a commonly used chemical for control of broadleaf plants, was originally believed to be non-harmful to animals (including

bees) because it targets an enzyme only found in plants and microorganisms. However, more recent work has demonstrated how glyphosate kills the specialized gut microbiota in bees and increases their susceptibility to infection (Motta et al. 2018).

Nitrogen-rich fertilizers are a common component within agricultural intensification on much of the European continent. Their use promotes growth of the crops they target, but fertilizer run-off also provides a competitive advantage in the surrounding vegetation to graminoid (grass-like) plants over species of broad leaf plants whose flowers pollinators visit. Fertilizer run-off can then lead to vegetation in non-crop areas that is low in flowering plants (especially *Fabaceae*) that are important resources for bees like Bombus spp. and other pollinator species that specialize on Fabaceae (Wilson et al. 1999).

Romania's accession to the EU initially resulted in dramatic increases in agrochemical use and agricultural intensification due to greater access to low-cost artificial fertilisers and pesticides (Kovács-Hostyánszki et al. 2016). Use of agrochemicals has since stabilized, particularly within the past decade. Eurostat[8] reports that pesticide sales in the EU have remained largely stable between 2011 and 2020, with insecticides constituting 14% of the 350 000 tonnes of pesticides sold in the EU in 2020. Romania was one of 11 of the 16 Member States whose consumption of pesticides decreased between 2011 and 2020. The sharpest decline was recorded in Czechia (-38%). Portugal, Denmark, Romania, Belgium and Ireland all reported sales that were at least 20% lower in 2020 than in 2011.

Romania passed a law (63/2013) in 2013 to introduce a National Action Plan for the sustainable use of pesticides, as required by the European Directive on the Sustainable Use of Pesticides (European Commission 2009). The Romanian legislation included a special work stream for reducing the impact of plant protection products on pollinating insects. These measures appear to recognize the potential danger PPP pose to honeybees. The text of the 2013 National Action Plan for mitigating the risks related to the use of plant protection products[9] reads as follows:

The pollinating insects, in particular the bees, are subject to special measures in the National Action Plan concerning their protection when applying plant protection products. In this context, the leaf application of insecticide products dangerous for pollinating insects shall comply with the following risk reduction measures:

a) do not apply on crops during blooming;
b) do not apply during the active season of the bees;
c) avoid applying during the blooming period of the weeds: remove weeds before blooming;
d) remove or cover the hives during application and after the treatment;
e) before proceeding to leaf treatment on the crops, it is mandatory to advise the beekeepers in the area.

On the basis of a notification from the professional users, the local authorities, namely the county and Bucharest plant health units, shall inform, in writing, the beekeepers of the plant protection product application operations by aerial spraying, at least seven days before the application of these treatments.

Unfortunately, there has never been any publicly available evidence of rigorous efforts to follow-through or enforce the policies as presented in the 2013 plan. A revised National Action Plan was passed in 2019, which lead to the subsequent repealing of the 2013 legislation[10]. The newer plan reiterated that it is illegal to apply PPP to multifunctional protection zones adjacent to surface waters, as required by several pieces of complementary legislation. The 2019 plan also identifies several benefits of establishing protection zones between agricultural parcels, or as a buffer between agricultural areas and other land cover types. There is, however, no mention of

[8] 346 000 tonnes of pesticides sold in 2020 in the EU - Products Eurostat News - Eurostat (europa.eu)
[9] National Action Plan for mitigating the risks related to the use of plant protection products 2013
[10] Decision No 135 of 12 March 2019 approving the National Action Plan on reducing risks associated with the use of plant protection products.

legal requirements connected to protection zones that are not adjacent to water. The newer plan also makes no mention of limiting the timing of PPP application as to not interfere with pollinating insects' foraging. It appears that only one of the measures specified in the 2013 plan remained in the 2019 plan: the National Phytosanitary Authority is required to notify area beekeepers at least 7 days in advance of any planned PPP use.

Not all agricultural areas in Romania are characterized by agricultural intensification. Many of the traditional agricultural landscapes in Romania are still present, featuring a comparatively high proportion of semi-natural vegetation and biodiversity, including pollinators, despite the political and economic changes during the 20th century (Kovács-Hostyánszki et al. 2016). Agricultural intensification has not progressed in areas like the Transylvanian Basin to the same degree that it has elsewhere, and mechanization and application of artificial fertilisers and pesticides are still at low levels compared with areas on the plains that are characterized by intensive agricultural activity. Use of mineral fertiliser in Southern Transylvania has even declined considerably in the period immediately following the breakup of the Soviet Union (Figure 6).

Figure 6. Nutrient amount of inorganic fertilizers (kg/ha) used in four counties in extensively managed agricultural systems in Southern Transylvania after the collapse of the socialist system in 1990. From (Kovács-Hostyánszki et al. 2016).

3.3 Residential and commercial development

Both the European Red List for Bees and the European Red List for Butterflies define urban sprawl and infrastructure development as an important contributor to the overall loss of pollinating insects' habitat extent and quality (Nieto et al. 2014, van Swaay et al. 2010). The report for bees describes how tourism in coastal and mountain areas has led to dramatic increases in the infrastructure for both visitors and residents in areas of Spain and the Mediterranean. Urban expansion is also occurring in areas with sandy soils that would otherwise provide important nesting habitat for many ground-nesting bee species. However urban and peri-urban green infrastructure including public green spaces, allotment and private gardens can provide important resources for pollinators and harbour high diversity of pollinator species with important conservation and cultural values attached (Ahrné et al. 2009, Stange et al. 2018). Unfortunately, we were unable to find any information that describes the rate or scale of residential and commercial development in Romania, or how development may have impacted pollinators.

3.4 Climate change

Climate is a major factor determining the species distribution (biogeography) of both pollinating insects and the flowering vegetation that is their resource base. Changes in climate can lead to shifts in distribution that move species towards the poles or to higher elevations (Parmesan et al. 1999). However, not all species have the capacity to track climatic changes the same way. Some species may be limited by developmental timing or lack of mobility, and the pace of climate change will almost certainly be greater than plants species' ability to migrate. We can expect a serious mismatch between the climatic zones that are suitable for pollinating insects and the distribution of their main food plants (Schweiger et al. 2008). Climate change is considered to be an important driver of increased extinction risk and 136 (113 non-threatened and 23 threatened) bee species appear to be threatened by ongoing temperature changes (Nieto et al. 2014). More widespread and prolonged heat waves and summer droughts, and an increase in temperature across the Boreal, Arctic and Alpine regions are already having an effect on the species associated with these habitats, as the bumble bee species of these biomes come under increased threat of extinction (Callaghan et al. 2004, Rasmont et al. 2015, Ødegaard et al. 2009).

European bumble bees are one species group that can be particularly susceptible to climate warming. Rasmont et al. (2015) modelled the current climatic niche for almost all European species (56 out of 69) and projected future climatically suitable conditions based on three climate change scenarios. They found that the majority of species will experience moderate to strong decreases in the size of their climatically suitable areas by 2050. Only a few species (between 4 and 6) will experience an expansion of suitable areas. The 13 species they did not include in their models are extremely rare with very localized distributions. Two of these species presently have distributions that include areas within Romania: *Bombus deuteronymus* and *Bombus laesus*. If climate changes decrease the suitability of their current ranges, there is a high possibility that these species will face either local or global extinction within the next century.

3.5 Pests, parasites and pathogens

Parasites and pathogens can be widespread in nature but may only become problematic when bees are domesticated and crowded (Morse & Nowogrodzki 2000). Other stressors, like pesticides or lack of adequate food sources, can interact with parasites and pathogens and cause disease levels in individuals and colonies to increase, thereby contributing to pollinator declines (Vanbergen & the Insect Pollinators Initiative 2013). Pests and pathogens are primarily a concern for the management of domestic bee species (i.e., honeybees and some species of bumble bees). Neither the European Red List for Bees nor the European Red List for Butterflies include pests, parasites and pathogens as major threats to bees or butterflies. However, bee diseases are known to move between bee species and can spill over from managed to wild bee species (Morse & Nowogrodzki 2000).

3.6 Competition between pollinator species

One of the more contentious issues within pollinator conservation is the debate concerning the existence and severity of competition between domesticated honeybees and wild pollinators for limited nectar and pollen resources. As mentioned earlier, managed bees can be a source of disease spillover that would negatively affect wild bee populations. But it is considerably more likely that managed bees compete with wild bees over the nectar and pollen from available floral resources. If floral resources are limited, locally high density of honeybees could result in wild bees needing to forage on less nutritious plants, spend more time searching for flowers that are unoccupied, or travel longer distances from their nests to find food (Mallinger et al. 2017). A

steadily growing body of research on this topic has demonstrated that competition between honeybees and wild bees does occur (Balfour et al. 2015, Ropars et al. 2019, Walther-Hellwig et al. 2006), and the effects can be especially strong in highly modified agricultural landscapes (e.g., oilseed rape fields) with almost no natural flowering vegetation (Lindström et al. 2016).

The extent of competitive effects often depends on many factors, including overall resource availability, the degree of niche overlap between managed and wild bee species, and densities of both managed and wild bees (Herbertsson et al. 2016). An additional challenge for researchers moving forward is determining whether negative effects from competition are strong enough to affect reproductive success and ultimately have population-level impacts on wild bee species (Thomson & Page 2020). High densities of honeybees can also generate indirect effects on wild pollinators if honeybees increase their reproductive success of the plants they prefer enough to alter the composition of the flowering vegetation, thereby decreasing availability of the plants wild pollinator species either prefer or depend on (Mathiasson & Rehan 2020).

Bombus distinguendus foraging on lupine *(Lupinus spp).* Photo by Arnstein Staverløkk, NINA

4 Measures for mitigating pollinator loss

4.1 Pollinator monitoring

An essential condition for assessing the effectiveness of any action or measure intended to mitigate pollinator loss is a sufficient understanding of the status and trends of the species in question (see Chapter 2 of this report). Monitoring is central to the study of the environment and resource management. Monitoring provides the primary means to gauge the state of natural resources, understand the causes of change, and make predictions based on scenarios of intervention options. Establishing an effective strategy for monitoring pollinating species' populations and their associated habitats and land-uses can be viewed as the primary measure necessary to understand changes that may be occurring in pollinator communities. In the "Proposal for an EU Pollinator Monitoring Scheme," Potts et al. (2021a) identify a number of the major knowledge gaps that can only be addressed through standardized monitoring. These knowledge gaps are equally relevant for Romania and include the following:

- Most information on the status and trends of European pollinators focuses on diversity and occupancy. However, there is an urgent need to understand how pollinator abundance and biomass are changing, because this is virtually unknown except for some butterfly species.
- While there are good data to estimate changes in population sizes of butterflies, this is almost entirely lacking for wild bees, moths, and hoverflies at European and national levels.
- IUCN Red Lists cover European butterflies, bees, and hoverflies; however, not all Member States have Red Lists for these groups. Furthermore, the European wild bee list has 57% data deficient species, indicating the general lack of knowledge of a majority of European bee species.
- Trends in the provision of pollination services, and the abundances of key wild insect crop pollinators, are largely lacking beyond studies done at local scales.
- The geographic extent and temporal changes of pollination deficits in most crops and wild flowering plants is missing.
- Finally, data, studies and taxonomic capacity are much richer in the north and west of Europe, with Mediterranean and eastern European areas much less well studied.

4.2 Agri-environmental measures

The primary goal of any suite of agri-environmental measures should be to slow or reverse the conversion of land areas (e.g., natural and semi-natural permanent grasslands) that are important habitats to pollinators. Once natural and semi-natural grasslands are converted to arable land, it is extremely difficult to restore these areas to their original ecological state. It may be impossible to reestablish their flowering plant communities with the local genetic diversity, and the loss of plant diversity can naturally be expected to translate into lower diversity in the pollinator community. Given the large proportion of area in the EU that is used for agriculture, as either permanent grassland or arable land (ca. 40% of the terrestrial area in the EU[11]), agri-environmental pollinator mitigation measures can potentially have a larger impact on improving current conditions for wild pollinator species than measures that are directed towards areas that are already under protection.

There is growing evidence that the quality, magnitude, and resilience of crop pollination—and the resulting crop production—is determined more by pollinator diversity than by pollinator abundance (Vasiliev & Greenwood 2020). Ensuring food security remains one of the more common

[11] Farms and farmland in the European Union - statistics - Statistics Explained (europa.eu)

and pragmatic motivations for adopting national strategies to promote pollinator conservation, and there are important policy implications stemming from pollinator diversity's greater relative importance. It is not enough to employ measures that solely address improving habitat quality, especially if they only provide benefits for one or a small number of common pollinator species. Pollinator strategies also need to adopt a landscape approach to provide habitat complementarity and connectivity (Senapathi et al. 2015). Habitat complementarity refers to the importance of maintaining resources usually found in large areas of natural and semi-natural habitats—including overwintering sites, refuges pollinators use during bad weather, and permanent foraging resources for when crops are not in bloom. Habitat connectivity refers to maintaining cohesive networks of pollinator friendly habitat within the broader mosaic of human dominated land uses.

Scheper et al. (2013) conducted a meta-analysis to investigate effectiveness of several agri-environmental measures for enhancing species richness and abundance of the studied pollinator taxa. While all agri-environmental measures included in the analyses had positive effects on the pollinator community, enhancing pollinator food resources directly through the sowing of flower seed mixtures had the most pronounced impact[12]. Simply expanding the area of extensive grasslands without consideration of the proportion of flowering plants had the least pronounced effect. The effect of the measure also depends on the landscape context, and the pre-existing conditions. Both the results from Scheper et al. (2013) and similar meta-analyses from Batáry et al. (2010) demonstrate that measures for promoting pollinators appear to have the greatest impact when implemented in cropland habitats situated in simple landscapes. Even in such intensively farmed landscapes with decimated floral resource availability, plants can respond to reduced management intensity. Such results are encouraging, because they demonstrate how even simple measures can substantially enhance flower resource availability to pollinators (Pywell et al. 2005).

Cole et al. (2020) consulted experts from 18 European countries for their opinions on the measures in the EU's Common Agricultural Policy (CAP) directed at pollinators, and their potential to support wild pollinators on farmland. The CAP defines a set of landscape and habitat features (Ecological Focus Areas, or EFAs) that farmers could select from to be eligible for basic area-based payments. Experts' assessments of EFA options varied substantially regarding the resources they were perceived to provide. Expectations of measures' effectiveness also varied geographically and temporally (with respect to a growing season). For example, field margins can provide relatively good pollinator forage throughout the season in Southern and Eastern Europe but lacked early-season forage in Northern and Western Europe. Under standard management, no single EFA option achieved high scores across resource categories and no CAP measure adequately addressed a scarcity of late season forage.

The experts consulted by Cole et al. (2020) highlighted the need to create a variety of interconnected, well-managed habitats that complement each other with respect to how areas provide resources that pollinators need. These authors propose that future agricultural policy integrates the different delivery "vehicles" aimed at protecting biodiversity (e.g., enhanced conditionality, eco-schemes and agri-environment and climate measures). The authors also stress the importance of an effective monitoring framework for evaluating which measurements are most effective under local conditions.

4.3 Measures for facilitating climate change adaptation

Given the wide variety of ways that climate change may affect pollinators, and how climate change interacts with other factors affecting pollinator communities, strategies for mitigating climate change's impacts cannot seek to address the effects of climate change alone. Rasmont et al. (2015) propose three strategies to ensure that measures designed to assist pollinator species'

[12] The authors did not specify to what degree sown seed mixtures consisted of native plant species.

populations will also help them respond to the effects of a changing climate. In principle, conservation measures should aim at (i) guaranteeing unrestricted movement of the species through the landscape to new areas and even aiding movement where possible, (ii) facilitate the colonisation success in the new areas, and (iii) improve habitat conditions and microclimatic protection in the areas indicated to become unsuitable at average. Such measures will include enhancing and restoring connected habitats, such that landscapes also provide a diversity of floral resources which can provide flowers blooming throughout the period of the year when pollinating insects are actively foraging.

4.4 Measures for green spaces and private property

Stabilising and ultimately reversing the declines of pollinating insects will require the large, landscape-scale measures described above—enacted by authorities from continental (i.e., the EU) to national and municipal administrative levels. However, there are also several things private citizens can do to help reduce negative impacts on insect pollinators. Insect pollinators are incredibly adept at finding even the smallest patches of flowering vegetation, even in urban environments (Stange et al. 2017). Residents can enhance pollinator habitats' suitability by encouraging growth of flowering plants that are native to the area they live in—whether these plants grow in window boxes, private and allotment gardens, in public parks and city landscaping or along road verges and the borders of cultivated land. Seed mixes of native flowering plants are generally hard to find, but harvesting seeds from desirable wild plants along road verges and flowering meadow remnants is one way that private individuals can acquire seeds for sowing.

Municipalities and private individuals can also increase the availability of nesting sites for bee species in urban and peri-urban environments and other private lands. The majority (>80%) of solitary bees and bumble bee species make their nests in the ground and prefer areas with loose soil with a high sand content. Species that make their nests in trees, rushes and other tube-shaped substrates can utilize bee hotels that individuals can either purchase or easily put together themselves. To be most effective, however, it is important that the nesting elements in such hotels are appropriate for the local bee fauna, with a variety of hole dimensions that will replicate the materials bee species would utilise in the wild. What is even more important is to ensure that naturally occurring nesting substrates are readily available, and landowners can make sure that they are present on their property. Finally, private citizens can avoid using harmful pesticides and herbicides in their gardening and landscaping activities.

One response to the growing awareness of widespread pollinator declines has been campaigns that promote small scale beekeeping in private gardens and within urban environments (Alton & Ratnieks 2013, Moore & Kosut 2013). While participation in beekeeping activities is a fantastic way to grow awareness of the important role pollinators play, managed domestic honeybees are not themselves a threatened species (Aizen & Harder 2009). In areas where floral resources are limited, such as heavily modified agricultural landscapes or urban areas with low levels of green spaces and porous surfaces, introducing honeybees can lead to increased competition with wild bee species and further exacerbate the negative pressures on wild bee species (Herbertsson et al. 2016, Lindström et al. 2016). Urban beekeeping activities should therefore be sensitive to the potential competition and take care not to reach high levels of beehive densitiy. There are no established guidelines for what a sustainable density of domestic honeybees might be for a given area (Stange 2020), and determining the intensity of competition between honeybees and wild bee species is a hotly contentious area of current research (see Chapter 3.6 in this report). However, in urban, peri-urban and all other types of modified landscapes, measures that increase the availability of flowering and nesting resources will have far greater positive effects on the pollinating insect community than introducing potential competitors.

Andrena hattorfiana. Photo by Arnstein Staverløkk, NINA

5 European and national pollinator strategies

As a result of the concern generated by global and regional assessment of pollinator declines, particularly those documented in the IPBES assessment (IPBES 2016e), governments, experts and concerned parties have drafted several strategic responses, involving agri-environment schemes and pesticide restrictions, urban and commercial initiatives, and rewilding at various scales (Stout & Dicks 2022). Initiatives range from global (e.g., the CBD's International Pollinator Initiative, and the Coalition of the Willing on Pollinators – Promote Pollinators), to continental (e.g., EU, North America, Africa, Oceania), to national and local scales. These strategies, initiatives, action plans and other associated documents can serve as inspiration for Romania's national pollinator strategy. We begin with a brief overview of the plan generated at the EU level. We then provide similar overviews of the initiatives from 12 European nations that currently have either plans or strategies in place.

5.1 The EU Pollination Initiative and the New Deal for Pollinators

The EU established its European Pollinator Initiative (EPI) in 2018 based on calls from the European Parliament and the European Commission for more decisive action to protect pollinators and their habitats, and to put an end to their decline. The initiative was developed through broad stakeholder consultations, and identified a set of 31 short-term measures to be taken by the EU by 2020 and other long-term objectives (towards 2030) under three priority areas:

1. Improving knowledge on pollinator decline, its causes, and consequences
2. Tackling the causes of pollinator decline
3. Raising awareness, engaging wider society, and promoting collaboration

The 31 individual measures are organized into 10 more broadly defined “actions”, which are presented together with their timeline in a table that was published as an “Annex to the Communication” (European Commission 2018). Each action consists of two to five more specific sub-actions. The document does not identify how progress will be measured. The ten actions are:

1. Support monitoring and assessment
2. Support research and innovation
3. Facilitate knowledge sharing and access to data
4. Conserve endangered pollinator species and habitats
5. Improve pollinator habitats on and around farmland
6. Improve pollinator habitats in urban areas and in the wider landscape
7. Reduce impacts of pesticide use on pollinators
8. Reduce impacts of invasive alien species on pollinators
9. Encourage the business sector and citizens to act
10. Promote pollinator strategies and collaboration at all levels

The initiative’s first priority (actions 1 – 3) acknowledges that the existing evidence clearly demonstrates an alarming decline of pollinators and warrants immediate actions. However, the plan also recognizes that the knowledge base demonstrating the declines still needs to be improved to better understand the nature of the declines: which species are impacted, where, and what the causes are.

In its second priority area (actions 4 – 8), the EPI identifies loss of habitats, pesticide use, invasive alien species and “other threats” (including climate change, environmental pollution, and diseases) as the causes of pollinator decline to be addressed. The plan cites the EU CAP and incentives for farmers to utilize sustainable farming practices within Natura 2000 as two policy areas that hold promise for maintenance and creation of pollinator habitats within agriculturally dominated landscapes. It also suggests measures to how utilization of nature-based solutions in urban and peri-urban areas can be improved, and encourages regional and local authorities to invest in such solutions.

Under its third priority area (actions 9 – 10), the EPI seeks to mobilize and engage the public in pollinator conservation. Citizen science can provide decisive support to monitoring schemes that require collection of large amounts of data. The initiative encourages the European Commission and EU member states to raise awareness of and promote funding for strengthening the capacity for collaboration, both within research networks and across policy exchange platforms.

The European Court of Auditors (2020) issued a report that was highly critical of the progress made by the EPI, concluding that the approach has had little effect on halting the decline and that the initiative needed better management to achieve its objectives. The auditors further concluded that existing EU policies for biodiversity and agriculture, as well as pesticides legislation, did not offer adequate measures for the protection of wild pollinators.

In May, 2021, the European Commission issued its report assessing the progress in the plan’s implementation (European Commission 2021), presenting in far more positive terms which results generated with respect to new policies enacted and funding levels for new initiatives, and providing links to the relevant policy documents and reporting. Based on the feedback received on this report through stakeholder consultation through June 2022, the Commission expects to make revisions to the action framework of the EU Pollinators Initiative. Its potential follow-up will be devised in the context of the EU Biodiversity Strategy for 2030, which brings an increased ambition to address the decline of pollinating insects. The EPI materials argue that pollinating insects are generally considered good indicators of the health of terrestrial ecosystems, which makes them “an excellent candidate for tracking progress on broader sustainable development policy frameworks, the European Green Deal and UN Sustainable Development Goals (SDGs 2 and 15)” (European Commission 2018).

The European Commission released a revised action framework of the EPI January, 2023 under the title 'A New Deal for Pollinators' (European Commission 2023). This revision sets objectives and actions for 2030 under three priorities that differ slightly from the EPI (italicized text indicate changes from the EPI):

1. Improving knowledge of pollinator decline, its causes and consequences (unchanged)
2. *Improving pollinator conservation and* tackling the causes of their decline
3. *Mobilising society and promoting strategic planning and cooperation at all levels*

The list of specific measures was also revised and expanded and slightly restructured. The New Deal for Pollinators now includes 40 measures, with between two to six measures for each of 11 actions. These measures are presented in an annex to the communication announcing the New Deal for Pollinators (European Commission 2023). Each measure is described in the annex with a timeline for its completion and, in some cases, their descriptions identify what parties are responsible for measures' implementation. As with the priorities, the 11 actions in the New Deal closely resemble those in the previous version of the EPI.

1. Establish a comprehensive monitoring system
2. Support research and assessment
3. Promote capacity building and knowledge sharing
4. Improve conservation of pollinators species and habitats
5. Restore pollinator habitats in agricultural landscapes
6. Mitigate the impacts of pesticide use on pollinators
7. Enhance pollinator habitats in urban areas
8. Reduce the impacts of invasive alien species on pollinators
9. Tackle climate change and other causes of pollinator decline
10. Help citizens and businesses to act
11. Promote strategic planning and cooperation at all levels

Many of the changes in the presentation of priorities, actions, and specific measures might appear somewhat semantic in their nature. However, they also indicate a shift where various organizations, including the European Commission, assume more active roles in implementing the measures detailed in the framework. For example, the first action was changed from "*Support* monitoring and assessment" to "*Establish* a comprehensive monitoring system." Similarly, the third action was changed from "*Facilitate* knowledge sharing and access to data" to "*Promote* capacity building and knowledge sharing." And the action that had been "*Encourage* the business sector and citizens to act" became "Help citizens and businesses to act." Another change is explicit regarding the role of restoration activities for improving pollinator habitats: action #5: "Restore pollinator habitats in agricultural areas."

The additional action in the New Deal comes from explicitly treating climate change as a threat to pollinators: "Tackle climate change and other causes of pollinator decline." While the EPI listed climate change as a threat that can compound other threats to pollinator populations, the EPI did not include any measures specifically addressing climate change. The New Deal expansion of the original EPI's list of actions includes three measures for addressing threats not covered by the other actions that deal with threats to pollinators. These measures include identification of the most vulnerable zones for pollinators in the context of climate change, mitigating light pollution on nocturnal pollinators, and developing guidelines for assessing the risks of biocides on pollinators.

Upon its release, the New Deal for Pollinators effectively replaced the EPI as the relevant document describing EU actions towards protecting pollinators. Development of new national strategies, like Romania, and updates of existing strategies, will be linked to the structure and formulation of the priority areas and actions as they are presented in the New Deal. However, we have elected to include the brief description of the EPI structure and content in this report because it was the EPI that in place during the development of many EU member states' national pollinator

strategies. The descriptions of national pollinator strategies and action plans therefore include several mentions of how they might compare with the EPI that often served as their inspiration.

5.2 National Pollinator Strategies and Action Plans

(Presented in alphabetical order)

5.2.1 Belgium

Belgium's national strategy for promoting pollinators (*"Stratégie nationale Belge en faveur de pollinisateurs 2021-2030"*) is a 24-page document published in French and Dutch (Auwers 2021). Proposed actions to address pollinator declines in Belgium have focused on "bees" through two successive federal bee plans for 2012–2014 and 2017–2019. The 2017-2019 Belgian Federal Bee Plan (Auwers 2017) was aimed at halting the loss of both wild and domesticated pollinators, but its actions focused on honeybees. The plan that preceded it did not include any measures addressing wild pollinators (Coppée 2014). Policy competence on most areas of relevance to support wild pollinator conservation in Belgium sits with the regional governments, but there are currently no regional strategies focused on wild pollinators (Underwood et al. 2017), and no plan has replaced the Federal Bee Plan following its expiration in 2019.

Wild pollinator conservation actions in Belgium are mainly undertaken by NGOs (e.g., Natagora, Natuurpunt), based on their expertise and collaborations with other structures such as public administrations and universities. One example is the SAPOLL Interreg project (SAPOLL - Save our pollinators/ Samenwerken voor pollinators), which aims to improve the status of wild pollinators in the whole of Belgium and the north of France. The Royal institute of Natural Sciences coordinates a Belgian Pollinators Working Group (*Groupe de Travail Abeilles*), or PWG. This working group consists of scientific experts, civil society organizations, government administrations, universities, and associations. The PWG was established to provide the Belgian government with expertise on national, European or international research and policy on bees and ecosystem services provided by pollinators. The PWG developed a series of recommendations for a national pollinator strategy for Belgium, based on a cross-border (all of Belgium and northern France) action plan published by the SAPOLL project (SAPOLL 2019).

The SAPOLL cross-border pollinator action plan in June 2019, providing a comprehensive long-term strategy for through 2029. It includes 35 actions, divided into three main themes:

- to improve knowledge,
- to share knowledge and raise awareness,
- to help pollinators through concrete action.

Within the main theme of knowledge improvement, the plan lists 5 actions related to research and an additional 4 actions related to monitoring. Research actions address improving basic knowledge on the taxonomy, ecology and biogeography of wild pollinators; understanding the drivers affecting pollinators and the role agriculture has; and researching what effects domestic pollinators have on wild pollinator species.

The theme regarding sharing knowledge and raising awareness includes 10 actions including those intended to improve the public's general knowledge regarding pollinators, and motivating specific groups (private citizens, green space managers, farmers, beekeepers). Other actions target education and sharing information between groups.

The third theme addresses concrete management steps and is organized into three sub-themes: large-scale systemic changes in practice (e.g., encouraging alternatives to pesticide use and developing native seed and pollinator networks), management changes for specific areas (e.g., agricultural areas, forests, mining sites, hedgerows, natural areas, public and private green spaces), and using pilot projects to encourage best practices (both establishing pilot projects and monitoring their progress).

5.2.2 England

The National Pollinator Strategy for bees and other pollinators in England is a 36-page document published by the Department of Environment, Food and Rural Affairs (Defra 2014). It acknowledges contributions from a large number of NGOs (Bee Farmers' Association, British Beekeepers' Association, British Retail Consortium, Buglife, Bumblebee Conservation Trust, Campaign for the Protection of the Rural Environment (Kent), CLA, Friends of the Earth, Horticultural Trades Association, KPMG, National Farmers' Union, National Federation of Women's Institutes, National Trust, Pesticide Action Network UK, Royal Horticultural Society, Soil Association, Waitrose, The Wildlife Trusts) Academic partners (University of Cambridge and the Centre for Ecology & Hydrology). The authors also commend several of England's largest landowners (including, but not limited to, the National Trust, the Forestry Commission, and the Ministry of Defence) for committing to taking action to support pollinators on their land. They further acknowledge the organizations that have committed to assisting with the implementation of specific actions in a summary table at the end of the strategy document.

The strategy's goals identify five key priority areas, consisting of three thematic focal areas, and two broader categories of actions intended to support efforts within the focal areas. The three thematic focal areas are: 1) Supporting pollinators on farmland, 2) Supporting pollinators across towns, cities, and the countryside, and 3) Enhancing the response to pest and disease risks. The two categories of actions to support the aforementioned priority areas are 1) Raising awareness of what pollinators need to survive and thrive, and 2) Improving evidence on the status of pollinators and the services they provide.

The strategy expresses intent to achieve the following five outcomes:

- More, bigger, better, joined-up, diverse and high-quality flower-rich habitats (including nesting places and shelter) supporting our pollinators across the country.
- Healthy bees and other pollinators which are more resilient to climate change and severe weather events.
- No further extinctions of known threatened pollinator species.
- Enhanced awareness across a wide range of businesses, other organizations, and the public of the essential needs of pollinators.
- Evidence of actions taken to support pollinators

The strategy's chapters provide detail for each of the five key priority areas. Each chapter contains a bullet point list of actions, organized by the sector who is responsible for the actions. These lists begin with the actions that are priority for the government (in cooperation with others, where appropriate). They then continue by presenting contributions through actions that other sectors can make. Chapters also include lists of examples of actions already underway or completed, with a single case study that provides inspiration and insight with slightly greater detail (one to two paragraphs with pictures).

The strategy also includes a chapter on delivery and measuring success. It identifies Defra as responsible for overall delivery of the strategy, providing funding to address key evidence gaps. The plan also recognizes measuring success is initially difficult because England lacked a common understanding of the "baseline from which we are starting and an agreed set of measures against which to track our progress." In the interim, progress was proposed to be measured through existing or emerging indicators and monitoring plans.

The text of the strategy, as well as its brief length, suggest that it was written to appeal to English citizens and to encourage individuals to contribute to the strategy through 'simple actions'. The central message of the strategy is centred around the idea that actions are intended to expand availability of food, shelter, and nesting sites ('food and a home'), which is tied to the evidence that 'loss of good quality natural and semi-natural habitats that feed and shelter pollinators has been a key driver of change to their populations.' The strategy does address other environmental pressures (i.e., pests/ diseases, pesticides, and climate change).

A Implementation Plan for 2018-2021 is a 17-page document that provides more specific detail about which actions will be implemented to support the strategy (Defra 2018). It organizes actions into four themes:

- Strengthening the evidence base (16 actions)
- Managing our land (11 actions)
- Bee health (4 actions)
- Engaging people (9 actions)

For each theme, the implementation plan identifies how progress will be assessed ("what success will look like") and which steps the partners collaborating on the strategy will take. Each action is presented in table form, with largely qualitative descriptions of each action, which partners will lead the action, which partners will contribute and in what year the action will take place.

Bombus pascorum Photo by Arnstein Staverløkk, NINA

5.2.3 France

France's National Plan for Promoting Insect Pollinators and Pollination ('Plan national en faveur des insectes pollinisateurs et de la pollinisation'; Ministrère de la Transition Écologique & l'Alimentation 2021) replaces a national action (France Terre de pollinateurs) that was in place from 2016-2020. This plan targets both domestic and wild pollinating insects. The 96-page national plan document, published in French, is divided into two parts. The first part contains four chapters that provide the justification for the plan (the importance of insect pollination; the status and trends of both honeybees and wild pollinating insects; the purported drivers of this change), as well as an overview of its governance structure which aims to promote synergies between actors and is based on a national monitoring committee. The first section devotes considerable space to providing an overview of relevant EU and national policies for biodiversity and agriculture, and how objectives for promoting pollinating insects pertain to them.

The plan's second part details the plan's 19 actions, which are structured around six axes. These axes are:

- Improved scientific knowledge
- Economic support levers for farmers, beekeepers and foresters
- Support for other sectors of activity (urban development, linear infrastructure, industrial sites, sites with large land holdings, protected areas)
- Preservation of the good state of health of bees and other pollinators
- Regulations for the protection of pollinators when authorizing and using plant protection products
- Sharing agricultural practices favourable to pollinators

Each axis consists of a set of between one and six specific actions. The text for each axis includes a general introduction that provides some content for the proposed actions. Actions are then presented in a table form, which includes information on the objective, the justification, the contents of the actions (i.e. the sub-actions that constitute the overarching action, the global follow up of the actions, the entities that could potentially lead the action, the prospective partners, a calendar detailing in which years of the plan the action will be implemented, and which indicators can be used to assess progress towards the envisioned results. The calendar elements appear to be somewhat unnecessary, since the plan indicates that actions will be implemented in all years of the plan's 5-year period. The level of detail provided in the content of the actions means that tables for actions can spread over several pages.

The presentation of these key actions provides an imprecise description of the specific actions for each axis proposed in the plan. "Establish IUCN Red Lists for wild pollinating insects" is a word-for-word repetition of a specific sub-action (Action 1.2.1) under the action intended to document the decline of wild pollinating insects (Action 1.2). Whereas "Gain new insights into pollinator stressors" combines nearly all of the sub-actions for Action 1.3, including "Characterize the impacts of global changes" (Action 1.3.1), "Feeding behaviors and resources" (Action 1.3.2), "Better understand the interactions between species" (Action 1.3.3), "Better understand the ecological function and sustain the ecosystem service of pollination" (Action 1.3.4) and "Avoid or minimize the effects of pesticides" (Action 1.3.5).

A press release accompanying the publishing of the national plan identifies eight key actions, which indicate the areas this plan intends to prioritize (but do not correspond with axis numbers):

1. Establish IUCN Red Lists for wild pollinating insects
2. Better understand the behaviour and food resources of pollinators
3. Gain new insights into pollinator stressors
4. Mobilize a diversity of actors and widely disseminate pollinator-friendly practices
5. Establish a partnership with the national council of towns and villages in order to strengthen the consideration of pollinating insects and pollination by communities
6. Maintain good health of bees
7. Support the beekeeping sector
8. Reinforce the protection of pollinators when using plant protection products

5.2.4 Germany

Germany does not presently have an action plan or strategy specifically for pollinators. However its Action Programme for Insect Conservation (*Aktionsprogramm Insektenschutz*), published in September 2019, contains substantial amounts of text addressing the challenges faced by insect pollinators and the actions needed to reverse their declines (BMU 2019). The program's primary objective is to reverse the trend of declining abundance and species diversity of all insect groups.

The action program sets out the following key measures:

- Binding statutory requirements under an Insect Conservation Act *(Insektenschutz-Gesetz)* and parallel statutory ordinances with regard to changes to nature conservation law, law on plant protection products, legislation on fertiliser use, and water law[13]
- An additional 100 million Euro per year to promote insect conservation and expand insect research, to be made available by the competent departments
- Conservation and restoration of insect habitats in all areas of the landscape and in urban spaces with special consideration to be given to transition and boundary habitats (ecotones)
- Clear guidance on environmentally and ecologically compatible applications of pesticides and a significant reduction in the deposition of pesticides and other harmful substances in insect habitats
- Mitigation of light pollution and insects' attraction to light
- Promotion and support of civic commitment in all areas of society for the benefit of insects

The measures detailed in the action plan are those that will be enacted at the federal level. The action plan also calls for additional support from both regional states (Länder) and municipal authorities, as well as the public, to halt the current trends in insect decline.

Photo by Francesco Ungaro on Unsplash

[13] The Programme's text does not specific what laws are being referred to, whether these are national laws or European-level (e.g., the EU Water Framework Directive).

5.2.5 Ireland

The All-Ireland Pollinator Plan (AIPP) was published by the National Biodiversity Data Centre (NBDC) and launched in September 2015 (PPSG 2015). It was developed by a 15-member stakeholder steering group, with support from 68 governmental and non-governmental organizations from the Republic of Ireland and the UK region of Northern Ireland. When the steering group developed the partnership initiative it was not funded. Partner organizations signed up voluntarily, acknowledging the lack of public funding. The NBDC coordinated its implementation. Since 2016, the initiative has received modest funding through the Heritage Council and Bord Bia (Irish Food Board) and the Department of Agriculture, Food and the Marine. The 2015 AIPP identified 81 actions organized under the following objectives:

- Making farmland, public land and private land in Ireland pollinator friendly
- Raising awareness of pollinators and how to protect them
- Managed pollinators – supporting beekeepers and growers
- Expanding our knowledge on pollinators and pollination service
- Collecting evidence to track change and measure success.

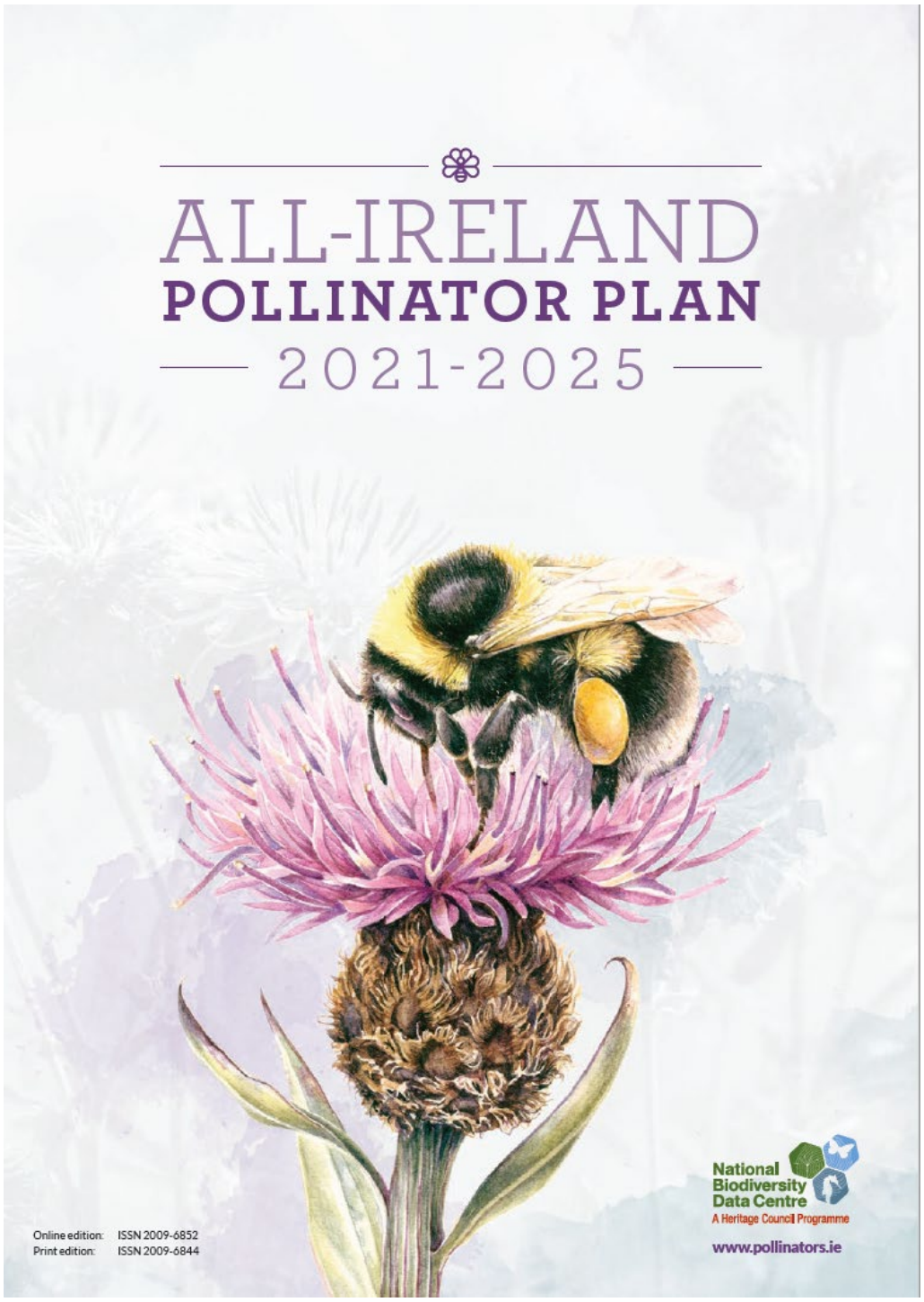
An updated version of the AIPP for 2021-2025 expanded the number of actions to a total og 186 (PPSG 2021). The new version also uses a different structure for the overall objectives, expanding the number of objectives from five to six:

- Making farmland in Ireland pollinator friendly
- Making public land in Ireland pollinator friendly
- Making private land in Ireland pollinator friendly
- All-Ireland Honeybee Strategy– supporting beekeepers and growers
- Conserving rare pollinators
- Strategic coordination of the Plan

The AIPP sets targets within each objective, and the actions are designed to contribute to meeting those targets. Progress can therefore be measured according to the number of actions achieved. There are a total of 37 targets, ranging between five to ten targets for each objective.

The AIPP strategy is somewhat unique in its emphasis on inclusivity and participation. Page 6 of the 64-page document presents a list of the partner organizations that have committed to delivering the actions in the AIPP. New partners, or supporting organizations, are encouraged to sign up at any point in the five years this version will be in effect. The strategy also states that the AIPP had 278 business supporters that are organized as a distinct subgroup of partners who committed to taking action to help pollinators. For each of the three objectives pertaining to land use types, the first target is straightforward: Increase the area of land that is managed in a pollinator-friendly way. Each of these objectives also has similar final targets: to track changes in pollinators within that land use. Other targets either address subcategories of land use or relate to information sharing. The chapters for each main objective in the strategy organize the information on actions within tables. Each action is presented as a single sentence, with a handful of bullet points detailing how progress can be measured and a field designating who has responsibility for the action. In this sense, the bulk of the strategy reads like a straightforward to-do list.

Because the current AIPP is an updated version of a previous plan, it can provide a summary of the progress made through implementation of the first version. In a 2-page summary, the 2021 AIPP provides 18 examples of progress made since the initial AIPP was published. The new version contends that all 81 actions from the first plan have been implemented and delivered, and that the AIPP is "*internationally regarded as an example of best practice, and recommended as a template for the development of national pollinator strategies by EU member states*" (page 12, PPSG 2021). This progress report concludes by stating "*The first phase of the Plan has been successfully delivered and has started a process of widespread change to land management to better support pollinators and other biodiversity*." However, it also acknowledges that "The success of the Plan in reversing declines cannot yet realistically be assessed."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5.2.6 Luxembourg

Luxembourg's "National Action Plan for the Preservation of Pollinating Insects" was released in October 2021. It is a 61-page pdf, written in French. The process of developing the plan began in 2019 and is described as consisting of two components:

1. a gathering of actors directly or indirectly involved in the protection of insects and / or impacted by their disappearance
2. a participatory and interdisciplinary exchange centred on the definition of essential measures and priorities.

Following a general introduction in chapter 1, the plan devotes its second chapter to describing the current state and scientific basis for establishing the national action plan. This chapter includes a description of the diversity of pollinating insects found in the country—with a table listing the number of species in each of the major taxonomic subgroups within Hymenoptera, Diptera, Lepidoptera, and Coleoptera which together total several thousand species. The authors also identify how pollinating insects are connected to both provisioning, regulating and cultural ecosystem services. In addition to assisting reproduction of flowering plants, they "contribute to the diversified and colourful aspects of our landscapes, the attraction of which is the source of approximately 65% of tourism in Luxembourg." Accordingly, the plan's authors contend that pollinating insects' contributions must be assessed at several different levels: maintaining natural ecosystems, crop production and food security, preservation of revenue in rural landscapes and the cultural and intrinsic value.

The introduction also provides some general descriptions of the resource needs of pollinating insects, as a means to communicate how human land use limits these resources and threatens pollinator populations. The plan devotes an entire page to identifying important habitats for wild bees, citing Zurbuchen and Müller (2012). The plan devotes a chapter to presenting the scientific evidence that describing pollinating insects' declines with the key points from Sánchez-Bayo and Wyckhuys (2019), Seibold et al. (2019), Hallmann et al. (2017), van Swaay et al. (2019), Winfree et al. (2009) and Soroye et al. (2020). The text then identifies and briefly describes the four main causes of decline: loss of natural habitats, use of pesticides, diseases and invasive alien species (grouped together as 'biological causes') and climate change. A sub chapter then explores the evidence addressing whether pollinators in Luxembourg are in danger. While data from Luxembourg are scarce, the text presents key findings from countries surrounding Luxembourg: Germany (Hallmann et al. 2017, Seibold et al. 2019), the Netherlands (Biesmeijer et al. 2006, van Strien et al. 2019), Switzerland (Altermatt et al. 2019), and Belgium (Maes et al. 2010).

The plan's third chapter lays out the objectives of the action plan, stating the aim to not only "preserve and restore pollinating species but also the communities in which they are integrated." Further, it elaborates on this aim with the following conservation objectives:

- avoid the decline and disappearance of rare and vulnerable species
- to conserve, restore and reconnect the communities of pollinating insects
- to conserve, restore and reconnect the habitats that host pollinating insects
- preserve and restore the ecosystem services provided by pollinators

This chapter also draws the connection between the overarching goals in the Luxembourg action plan and those of the European Pollinators Initiative (European Commission Directorate-General for Environment 2019): improve knowledge of the decline, tackle the causes of the decline and raise awareness and engage the public to promote collaboration towards finding solutions.

The fourth and fifth chapters describe the administrative structure of the action plan. It first identified the various participating parties (identified as public authorities, civil society, agricultural professionals, private companies, land managers and property owners). The fifth chapter presents the structure for participatory dialogue: an online platform (planpollinateur.org, initiated by

an non-profit association), and the five idea sharing workshops that were used to develop the measures that constitute the action plan.

The action plan itself is presented in Chapter 6, presenting 21 actions "*aimed at combating the decline of pollinating insects and providing solutions to improve the living, housing and feeding conditions of pollinating insects.*" These actions are divided into three pillars that mirror the focal areas in the European Pollinator Initiative:

a) Protection, conservation and management (11 actions)
b) Improvement of knowledge (4 actions)
c) Training, knowledge sharing and awareness raising (6 actions)

Actions within the first pillar address the management of specific focal habitat categories: agricultural landscapes, forests, linear structures (e.g., hedgerows), natural areas, public green spaces, private green spaces. Additional actions either address causes of insect declines (pesticides, light pollution, encourage development of indigenous seeds and plants), or general management strategies (species action plans for threatened species, and establishing a regulatory framework for pollinating insects). The four actions for improving knowledge include measures for long term monitoring, supporting pollinator research and assessing extinction risk for threatened species. Finally, the awareness-raising actions identify target groups for knowledge transfer: the public, schoolchildren, professionals (e.g., green space managers, farmers) and beekeepers.

Table 3 illustrates the structure used presented in a structured table format. Many of the action sheets fill several pages.

Table 3. Information contained in the action sheets for the Luxembourg action plan for pollinating insects

Pillar	Which of the three pillars the action belongs to
Objective	Qualitative and/or quantitative objective of the action
Context	Brief description of the context in which the action takes place
Description and sub-actions	What the action will entail
Associated action(s)	Links to other actions within the plan
Monitoring indicator(s)	Indicators for evaluation and measuring progress
Deliverable(s)	Product(s) to be delivered by the action
Calendar	The action's implementation period
Pilot(s) of the action	Which entities or individuals will coordinate and or guide the implementation work
Potential partner(s)	Organizations that can be associated with the action implementation

The plan's seventh and final chapter addresses the implementation and progress monitoring, identifying the Ministry of the Environment, Climate and Sustainable Development (MECDD) as the authority responsible for its implementation. The MECDD designates a steering committee that will meet once a year and will be responsible for 1) monitoring progress, 2) annual evaluations of the actions, and 3) defining the priority actions for the following year. The MCESS is responsible for disseminating the plan and inviting participation from partners and national actors relevant for proposed actions. The online platform established to create the plan will remain as a place for sharing information concerning measures for pollinator protection, and the MECDD will organize meetings every 2 years to bring together plan partners and report progress. These meetings will be open to the public.

5.2.7 The Netherlands

The Netherlands (NL) Pollinator Strategy ("Bed and Breakfast for Bees") was published in January 2018. It is available as an 83-page report (also available in English). Whereas its predecessor (the NL Bee Health Action Programme from 2013) focused primarily on the honeybee, the 2018 strategy is explicitly aimed at all pollinators—with a particular emphasis on wild bees. A range of divergent parties have reached agreements to cooperate and contribute to initiatives identified within the strategy. These parties include the Dutch Federation of Agricultural and Horticultural Organisations (LTO), farmers' cooperatives, beekeepers' organisations, Natuur & Milieu (Nature & Environment), Dutch Butterfly Conservation (De Vlinderstichting), Society for the Preservation of Nature in the Netherlands (Natuurmonumenten), the Dutch Water Authorities, the provinces, the national forestry management agency in the Netherlands (Staatsbosbeheer), Bayer, BASF, Syngenta, and research institutions such as Naturalis, Stichting EIS and Wageningen University & Research (Wageningen UR). This is just a partial list. Page 7 of the strategy document lists all 42 signatories of the NL Pollinator Strategy: both the 35 partners who contributed to developing the strategy and seven partners who joined prior to its publication. The full text of the strategy offers details on precise official agreements between relevant partners. The strategy also provides a full list of over seventy "social" (i.e., both governmental and non-governmental) initiatives that the participants in the strategy have committed to implementing in the coming years.

The strategy document begins by providing brief context and justification for a national pollinator strategy (*"Why do we need an NL Pollinator Strategy?"*), describing the declines in pollinator diversity in very general terms at both a global and national scale. The authors report that more than half of the 360 wild bee species found in the NL are red listed. The strategy then states that its primary objective is "*to have populations of bees and other pollinators that are stable and/or developing in a positive direction by 2030*." To achieve this overarching objective, it identifies three key themes among the many different initiatives it proposes pursuing: 1) promoting biodiversity, 2) improving agriculture-nature interaction and 3) helping beekeepers to improve the health of honeybees. It further identifies three subjects that concern the aforementioned themes: 1) expansion and dissemination of scientific knowledge, 2) developing and applying pollinator friendly measures within the context of the new Common Agricultural Policy (CAP) for post-2020, 3) establishing a network of countries within the *Coalition of the Willing on Pollinators* and recruiting additional members from both within and beyond Europe.

The NL strategy presents its plan for implementation by identifying the role that national and local government authorities can have—including communication, consultation, financial support, research and appropriate regulations. "*The Ministry of Agriculture, Nature and Food Quality (Landbouw, Natuur en Voedselkwaliteit, LNV) will facilitate the implementation of the strategy by bringing parties together by organising annual meetings, among other things, having knowledge developed and promoting the implementation of the NL Pollinator Strategy, also in the new Common Agricultural Policy. In addition, the Netherlands continues to play a pioneering role in the network of like-minded countries, the* Coalition of the Willing on Pollinators*."*

The NL strategy presents measurable targets, using 2023 and 2030 as benchmark years for assessing whether the actions have yielded demonstrable results. These targets apply to reducing the number of bee species with downward or sharply downward trends in their abundance, achieving growth in the geographic distribution of bee species within NL, and achieving conditions where pollination is no longer a limiting factor for seed set of crop production and wild plants.

5.2.8 Norway

The ministries of the Norwegian government published the Norwegian National pollinator strategy, “A strategy for viable populations of wild bees and other pollinating insects,” in 2018. The 52-page document is available in both Norwegian and English and was developed at the request of the Norwegian parliament. The national ministries contributing to the strategy included the Ministry for Climate and the Environment, Ministry for Local Government and Modernization, Ministry for Transport and Communications, Ministry for Defence, Ministry for Education and Research, and Ministry for Petroleum and Energy. The Norwegian Agriculture Agency and the Norwegian Environment Agency, with contributions from defence and transport agencies, have prepared the technical report for the strategy. Experts and organizations have contributed with their knowledge and experience.

The primary goal for the strategy is presented as “Ensuring viable populations of wild bees and other pollinating insects in order to sustain pollination in food production and natural ecosystems.” The strategy identifies three focus areas: increasing knowledge, ensuring good habitats and communicating information about pollinators to all target groups—with each of the focal areas presented in its own chapter to provide context and suggest measures and actions that can be useful.

The strategy document provides over 10 pages of background information on pollination, its ecological and economic importance, the extinction risk of pollination and the threats and challenges pollinators face. It lists loss of and degradation of habitats, climate change, alien species, and the use of pesticides and environmental toxins as the most important factors underlying the decline in numbers and distribution of pollinators both globally and in Norway. The strategy also provides short descriptions of initiatives the organizations presently working towards conservation of both wild bees and honeybees, with hyperlinks to online resources.

The Norwegian strategy for increasing knowledge about pollinators includes a description of the current understanding identifying the knowledge gaps about pollinating insect populations and changes in the amount and condition of suitable habitat. It makes the case for improved monitoring efforts, particularly in open lowlands, and for more research directed at pollination-driven systems. It also identifies how knowledge gaps and proposed actions apply to agriculture, transport, and municipal sectors. It concludes with nine specific actions that can increase knowledge, most of which address either continuation or strengthening of research and monitoring efforts.

The strategy structures its proposed actions for ensuring good habitats according to sectors: private landowners, environmental authorities, agriculture, transport, municipalities (including the energy sector) and defence. It also identifies cross-sector actions such as sustainable use of pesticides, preventing the spread of alien species, and improving access to seeds from pollinator-friendly plants. The chapter includes 12 specific actions directed at either individual sectors or several sectors together.

The chapter on communication is brief (two pages). It identifies target groups for outreach efforts: farmers, forestry enterprises and beekeepers; garden owners, residents of housing cooperatives and other private landowners; managers of transport land areas; managers of municipal and government green spaces; schools and kindergartens; managers of land areas in the defence and energy sectors; and architects and landscape architects. It further proposes four actions and designating a sector responsible for its implementation and the focal group the activity should reach.

5.2.9 Poland

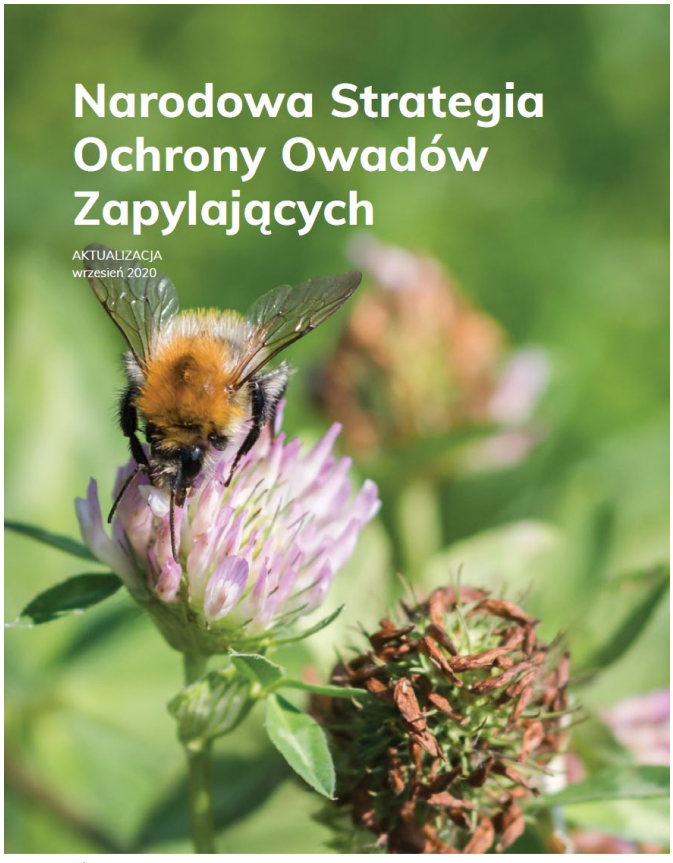
In 2018, a group of scientists working with Greenpeace Poland published a document called the National Strategy for the Protection of Pollinating Insects (Narodowa Strategia Ochrony Owadów Zapylających). An updated version was published in September, 2020 (Zych et al. 2020). The 111-page document was the result of workshops held in major Polish cities, and the draft version of the Strategy was open for public consultation. Stakeholders supporting the strategy included the Polish Beekeepers Association, Association of Professional Beekeepers, the Biebrzański and Słowiński National Parks, State Forests, Urban Forests in Warsaw, some of the agricultural advisory centres in Poland, the Faculties of Biology at the Jagiellonian University and the University of Warsaw and the University of Warsaw Botanical Garden.

The strategy specifies four goals:

(1) make people aware of the role of diversity and the role of pollinators in nature and society,
(2) identify hazards that would be the result of a loss of pollinators,
(3) propose solutions (both through management and the legal framework for enacting policies) for improving the state of the pollinator population, that can be implemented both at the national level as well as through contributions by individual citizens,
(4) identify gaps in our knowledge that often hinder effective protection this important group of animals

While the Ministry of Environment initially expressed interest in the preparation of the strategy, it ultimately chose to not support the document. Similarly, the Ministry of Agriculture and Rural Development did not support the strategy. We were unable to find information explaining why the Polish government decided to not support the strategy.

Perhaps because Poland's proposed strategy is not a government document, the vast majority of its text presents a justification for why a pollinator strategy is necessary. Its first 85 pages provide readers with background information on pollination and the drivers generating negative impacts on pollinating insects. The strategy concludes with a 10 page "Call to Action", which identifies sector-specific actions for improving conditions for pollinating insects. These sectors include the national government, local governments, research institutions and academia, NGOs, industrial organizations, (i.e., agricultural and beekeeping), business enterprises, farmers and members of the public. This section also includes eight areas where the authors propose changes to existing laws and regulations that can reduce threats to pollinating insects.



5.2.10 Scotland

Scotland's national strategy consists of three separate documents: The Pollinator Strategy for Scotland 2017 – 2027 (NatureScot 2017a); its Implementation Plan (Revised March 2021, NatureScot 2021), and the Technical Annex (NatureScot 2017b). The strategy is a relatively concise, 16-page document presents a brief rationale for the strategy, its aims, and the intended outcomes it hopes to achieve by 2027. A group led by Scottish Natural heritage began work on developing the strategy in 2015. Other group participants included Bee Farmers Association, Buglife, Bumblebee Conservation Trust, Centre for Ecology & Hydrology, Scottish Environment LINK, National Farmers Union Scotland and Scottish Lands & Estates. Scottish Natural Heritage, which has since changed its name to NatureScot, is an executive non-departmental public body that is the Scottish government's advisor on all aspects of nature, wildlife management and landscape.

The strategy presents its aim as "To address the causes of decline in populations, diversity and range of our pollinator species, and to help them thrive into the future." It then lists five objectives for their strategy:

1. Make Scotland more pollinator-friendly, halting and reversing the decline in native pollinator populations;
2. Improve our understanding of pollinators and their pollination services;
3. Manage the commercial use of pollinators to benefit native pollinators;
4. Raise awareness and encourage action across sectors; and
5. Monitor and evaluate whether pollinators are thriving.

The strategy also describes the connections between its objectives and the Scottish Government's strategic objectives for the nation as a whole, as well as highlighting connections to national policies and international agreements on biodiversity.

The Technical Annex (eight pages, including three pages of references) presents background information for Scotland's pollinator strategy in greater detail than what is presented in the primary strategy document. It presents the different taxonomic groups of pollinators, with estimates of their relative importance for pollination within the Scottish landscape. It also reports some results of insect monitoring work that describes the status and trends of pollinators in Scotland and elsewhere in the United Kingdom. These estimates are based on observed changes in species' ranges, since abundance data is lacking. Finally, the technical annex discusses the factors that threaten pollinators in the following order: habitat loss and degradation/fragmentation, pesticides, diseases, and climate change.

The strategy's implementation plan (Revised March 2021) sets out key pollinator-oriented management measures and initiatives needed in achieve the strategy's five objectives. For each objective, the plan presents a list of bullet points that describe first specific measures ("What are we going to do?") and then their implementation ("How are we going to do it?"). Descriptions of measure's implementations also include a mention of the timescale over which implementation will occur (short, medium, or long).

Scotland has also published annual reports detailing progress in the implementation of its strategy, with the most recent being released in January 2022. These reports go through the strategy's five objectives and tracks progress made towards meeting them. Annual reports also provides lists of the projects and actions currently underway, including the organizations involved, whether the project is completed, and plans for future work.

5.2.11 Spain

Spain published its national pollinator strategy (*Estrategia Nasjonal Para la Conservasión de los Polinazadores*) in 2020. The 93-page document was drafted by the Ministry for the Ecological Transition in collaboration with the Ministry for Agriculture, Fisheries and Food. Regional authorities, NGOs, farmers, the private sector, and academia also contributed to the strategy's development—in addition to at least some public consultation.

The action plan for the strategy identifies six objectives:

- Protection of threatened pollinator species and their habitats
- Support of favourable habitats for pollinators (addressing both agricultural habitats and "urban areas and infrastructure margins")
- Improvement of beekeeping management and implementation of risk mitigation measures regarding the impact of pests, pathogens, and invasive species on pollinators
- Risk mitigation to pollinators in relation to the use of plant protection products (herbicides and pesticides) both in rural and urban areas
- Knowledge improvement through the support of research activities on the extinction risk of pollinators and the causes of their decline
- Ensure information access, promote citizens' engagement and raise awareness on the importance of pollinators

The strategy also proposes specific measures for achieving each objective, breaking each objective down into two or three subcomponents (for example, using subsections to address the measures for habitat management for agricultural habitats separately from "urban areas and infrastructure margins"). The text for each objective's subcomponent contains a brief justification for the objective, a description of the measure, and a plan for developing measures and their implementation. These plans include identifying the authorities who are responsible for implementation and the actors who will be involved.

The strategy proposes using a flexible approach to implementation, stating that the proposed measures will be subject to "*review, adaptation and development when there are new considerations (related to knowledge, legislation or others) that require it.*" The current strategy will be in effect until 2027. The strategy does not identify any indicators, and it presents its objectives in such a way that are mostly unmeasurable. Nonetheless, it does state that the strategy's general success will be evaluated towards the end of its period of implementation, and some of the measures are expected to be integrated into sectoral programs.

5.2.12 Wales

The Action Plan for Pollinators (APP) for Wales was launched in July 2013. The APP is a 28-page document that was developed through cooperation between the Welsh government, industry and other stakeholders (Welsh Government 2013). The APP is not a Welsh Government Action Plan, and there is no direct funding from the Welsh Government on pollinators. The APP states that its first step is to establish a Pollinators Taskforce that will be responsible for the plan's implementation. The APP specifies that the taskforce will publish a separate implementation plan, but there is no evidence that this has happened. The taskforce meets three times a year, where stakeholders provide updates on the activities stemming from the plan. The Pollinator Taskforce has recently established a Task and Finish group, which has been charged with the task of compiling evidence on the achievements of the APP. This group is also leading co-design of the future direction of the APP for the benefit of pollinators in Wales.

The APP's introduction identifies the governance and infrastructure contexts for improving conservation and management of pollinators. For managed pollinators (honeybees), this is the Welsh National Bee Unit. For wild pollinators, this includes both the Welsh government and nine NGOs who are concerned with wild pollinator management. Natural Resources Wales is the government's statutory advisor with responsibility for ensuring sustainable management of the natural resources of Wales, including biodiversity. The APP describes a "Vision for Pollinators", and puts this vision into the context of the Welsh government's priorities and policies. This includes identifying relevant legislation (for example Section 6 of the Environment Act 2016 obliges Local Authorities to seek to maintain and enhance biodiversity in the exercise of functions in relation to Wales, and the Well-being of Future Generations Act 2015).

Its Agenda for Action identifies four areas where action is needed, and the outcome it aspires to achieve for each:

- Outcome 1: Wales has joined up policy, governance and a sound evidence base for action for pollinators
- Outcome 2: Wales provides diverse and connected flower rich habitats to support our pollinators
- Outcome 3: Wales' pollinator populations are healthy
- Outcome 4: Wales' citizens are better informed and aware of the importance and management of pollinators.

The Task and Finish Group published its Review 2013-2018 and Future actions in 2019 (Welsh Government 2018). The 16-page report (46 pages including appendices) details all progress that has been made since the APP's publication and identifies future opportunities for conservation of both solitary pollinators and honeybee colonies—chiefly through land management strategies and public engagement. It seeks to "further the integration of bee health policy and activity, identifying future challenges and opportunities for solitary pollinators and honeybee colonies."

5.3 Common elements in national pollinator strategies

5.3.1 Introduction

All national strategy documents include an introductory chapter or chapters. These introductions vary in terms of length and corresponding level of detail and length and range from 1-2 partial pages in the Netherlands' strategy to over 80 pages in Poland's strategy. Other nations use separate documents for presenting more in-depth context than they present in the primary strategy document (e.g., Scotland's "Technical Annex," which contains 8 pages on the context of the national pollinator strategy). Information contained in these introductions generally include the following subcategories:

5.3.1.1 Historical background and process of developing a national strategy

Many refer to the IPBES Thematic assessment on Pollinators, Pollination and Food production, and the UN CBD decision XII/15 to promote implementation of actions to improve pollinator conservation (CBD 2016). National strategy documents also state whether the country has joined the International Coalition of the Willing for the Conservation of Pollinators, and the commitments that the country has made to protect pollinators and their habitats within the framework of a national action plan.

5.3.1.2 Importance of Pollination

Provides basic background on the ecological process, and some description of the species diversity involved in animal-mediated pollination. Strategies that are aimed at pollinators in general (i.e., Spain, Wales, Poland) have identified the four taxonomic Orders of insects that play an important role in pollination: Diptera, Lepidoptera, Hymenoptera, and Coleoptera. Some strategies attempt to estimate the country's species richness of actual pollinators (i.e., Spain, Poland). Virtually all make at least some mention of the proportional contributions honeybees and wild pollinators make to food crops and wild plant species, as a way of communicating the importance of wild pollinator conservation.

National strategy documents often include quantitative descriptions of the importance of pollination for both plant reproduction and food production. They often cite estimates from IPBES publications that report the percentage of all plant species that are dependent upon the transfer of pollen by animals (90% globally and 78% in Europe). They also use estimates for the percentage of crops that are either partially or completely dependent on pollination, both with respect to food crop types (75% globally, and 84% in Europe) and global food production (35%). These statistics are often (but not always) accompanied by estimates of the global (Gallai et al. 2009, IPBES 2016a), regional (i.e., European; Leonhardt et al. 2013) and country-specific monetary values of pollinators' contributions to food production. Countries that provide estimates for the monetary valuations of pollinators' contributions to their domestic agricultural production include England (500 million euro), Spain (2,4 billion euro), Poland (3 billion euro), Scotland (50 mill euro), Ireland (59 million euro).

5.3.1.3 Status and trends for pollinators

Many strategies reference the global situation as described by the 2016 IPBES assessment (IPBES 2016c), which identifies changes in land use, intensive agriculture, invasive alien species, pathogens and climate change as the primary drivers that negatively affect pollinator species. This information can include reference to the number of pollinator species on the IUCN list of threatened species in Europe (for example that 9.2% of bees are threatened), and the high amount of uncertainty surrounding these estimates (Nieto et al. 2014). Countries whose strategies include estimates of the how many of their own pollinator species are threatened include Spain (2.6 %; Nieto et al. 2014), The Netherlands (> 50% of all bee species; Peeters & Reemer 2003), Germany (41% of bee species; Germany's Red List), Ireland (30% of bee species; Irish red list) Norway (25%; Norway Red List).

5.3.1.4 Causes of decline

Strategy documents often provide descriptions of the causes of pollinator declines as identified in the IPBES thematic report. These drivers are also generally presented in the same order of presumed importance as presented in the IPBES report: habitat loss, use of pesticides and herbicides, pests and pathogens, exotic species, climate change, and occasionally a description of other factors. When describing pests and pathogens, almost all strategies list both *Nosema ceranae* and *Varroa destructor*—two pathogens that are notorious problems for beekeeping, but have less relevance for wild bee species.

The documents' text can also identify "other factors." This section can include a brief description of how individual factors can have sublethal effects on their own, but that the cumulative effects of several factors can be severe. One example of such additional factors is competition between honeybees and wild bee species. We found several strategies (e.g., Spain, Norway that mentioned the potential for high local densities of honeybees can have negative effects on wild pollinators, mentioning both competition for floral resources and increased risk of spreading pathogens. Other countries strategies (e.g. Poland) designate an entire subsection to address the negative effects that beekeeping can have on wild pollinators. At the same time, numerous strategies devoted little attention to the potential effects of competition between honeybees and wild pollinators.

5.3.1.5 Pollinator related research and initiatives

Names of research projects, size and source of funding, international collaboration, beekeeping outreach efforts. The NL strategy document includes a 50-page appendix to with brief descriptions of the initiatives already underway at the onset of the strategy: providing details on the objective, partners, status, duration and milestone for each initiative.

5.3.1.6 Governance and infrastructure

Documents can specify which government entities are responsible for implementation of strategies, as well as the NGOs who can be enlisted to make contributions. The text can identify relevant national legislation, as well as drawing connections to international agreements. Few of the strategy documents contain this detail.

5.3.2 Actions for addressing pollinator declines

All national strategies included descriptions of actions (also referred to as activities or measures) intended to improve conditions for pollinating insects. The presentation of the actions varied considerably between national strategies in terms of the organizational structure, the number included, and the level of specificity. However, all actions can be classified into three broad categories: actions designed to improve knowledge, actions designed to address the causes of pollinator decline, and actions designed to raise awareness and encourage broader engagement. ome plans chose to distinguish between knowledge improvement actions directed towards monitoring and those directed towards research, although this distinction is not always clear. Data collected through monitoring efforts is a useful approach for conducting research that improves our understanding of the impacts of the factors that cause pollinator declines, or assessing whether measures intended to improve living conditions actually result in greater pollinator abundance or diversity.

The European Pollinator Initiative (EPI) presents its set of actions in a relatively concise format, with 10 broadly defined actions that involve a total of 31 more specific sub actions. France and Ireland define their actions with a higher degree of delineation, and the number of specific actions for both plans is much higher. The Ireland Pollination Plan calls for 186 specific actions. Table 4 provides a comparison of the specific actions across the national pollinator strategies currently available for review. Both Poland and the Netherlands strategy documents presented proposed measures in a way that was less clearly defined, which was not amenable to comparison with the other strategies.

Table 4 is organized with a level of detail intended to facilitate comparison of the various strategies. The table includes several of the more common sub actions within more broadly defined action areas in cases where sub actions could be easily distinguished. Strategies that do not explicitly address specific actions may have elected to use a simpler presentation of the activities to be included. For example, the EPI makes only one mention of activities connected to beekeeping or apiculture: Within Action 9 – "Encouraging the business sector and citizens to act," Action 9C includes the text,

> "*The Commission will develop and disseminate educational material on pollinators. It will also develop guidance on how citizens can get involved in conservation of pollinators and citizen science on pollinators. Such engagement activities for the preservation of pollinators may be conducted in the context of the European Solidarity Corps, which supports young people to volunteer in projects that benefit communities and the environment around Europe. In addition, national* ***apiculture*** *programmes could complement these efforts through training to broaden public and professional understanding on the importance of wild pollinators."*

The EU contributes considerable amounts of funding for apiculture-related research, and the CAP includes measures that are applied to the apiculture sector. However, these activities are not explicitly addressed in the text of the EPI action plan, which provides an indication of the priority areas of the EPI strategy.

Table 4. Actions/activities/measures specified in pollinator strategies for the European Pollinator Initiative (EU) and ten European countries.

	Action	EU	BE	EN	FR	GE	IR	LU	NO	SC	WA
Monitoring	**Monitoring scheme for pollinators**	X	X	X	X		X	X	X	X	X
	Coordinate atlas/databases for registering abundance, life traits, plant interactions				X	X	X	X		X	X
	Promote use of new techniques (e.g. DNA, digital recognition tools)			X	X	X	X				
	Develop or maintain Red List (Bees, Butterflies, Hoverflies)	X	X		X	X	X	X	X		
	Develop list of important habitats and their condition	X	X	X	X	X	X	X	X	X	
	Monitor pesticide levels (e.g., through honey bee pollen)	X	X		X	X	X				
	Mapping and assessment of ecosystem services, including quantification of contributions	X	X	X	X	X	X		X	X	X
Research	**Support research and innovation**	X	X	X	X	X	X	X	X	X	X
	Analyze (quantify and characterize) impact of the factors driving pollinator decline	X			X	X	X	X	X	X	X
	Investigate feeding behaviors and resources				X	X	X	X	X	X	
	Investigate interactions between species				X	X	X	X	X	X	
	Investigate effects of pesticide use on pollinators				X	X	X	X	X	X	
	Evaluate effectiveness of policy measures		X			X	X	X	X		X
	Launch online platform on pollinators	X	X	X	X		X	X	X		
	Facilitate sharing of relevant data	X	X		X		X	X	X		
Address causes of pollinator decline	**Develop action plans for threatened species and habitats**	X				X	X	X	X		X
	Set limits on habitat loss through housing and transportation infrastructure development					X					
	Strengthen bee health policy				X		X			X	
	Identify conservation approaches for **endangered species and their habitats**	X			X		X	X	X	X	X
	Restoration	X			X	X	X	X	X	X	
	Improve pollinator habitats **on and around farmland**	X	X	X	X	X	X	X	X	X	X
	Reference to policy/financial support	X	X	X	X	X	X	X	X	X	X
	Improve pollinator habitats **natural areas**	X	X	X	X	X	X	X	X	X	
	Reference to policy/financial support	X	X	X	X	X	X	X	X		

	Action	EU	BE	EN	FR	GE	IR	LU	NO	SC	WA
Address causes of pollinator decline	Improve pollinator habitats in u**rban and peri-urban** areas	X	X		X	X	X	X		X	
	Maintain and restore habitat	X	X		X	X	X	X		X	
	Specific mention of light pollution				X	X		X			
	Reference to policy/financial instruments	X	X		X	X	X		X		
	Beekeeping		X	X	X		X		X		
	Research				X		X	X	X		
	Outreach involvement with beekeepers	X			X		X	X	X		X
	Policy/financial support instruments				X		X			X	X
	Potential conflicts between honeybees and wild pollinators				X		X	X		X	
	Addressing pests and diseases				X		X		X	X	X
	Reduce impacts of **pesticide** use on pollinators	X	X	X	X	X	X	X	X	X	
	Targets and measures in national action plans	X	X	X	X	X	X		X		X
	Risk assessment	X	X	X	X	X	X		X		
	Incentives for alternatives				X	X	X	X	X	X	
	Reduce impacts of invasive alien species on Pollinators	X	X		X		X		X	X	
	Technical guidance to member states prevention of alien invasives	X	X		X		X		X	X	
	Guidance to promote native plant species	X	X		X		X	X	X	X	X
Awareness rais-ing/ involvement	Raise awareness among stakeholders	X	X	X	X	X	X	X	X	X	X
	Involve Business sector and citizens to act	X	X	X	X	X	X	X	X	X	X
	Incentives for food sector (including honeybee products)	X	X		X	X	X	X	X	X	X
	Product labelling	X	X		X		X	X		X	
	Develop and disseminate educational materials on pollinators	X	X	X	X	X	X	X	X	X	X
	Financial support for citizen conservation initiatives					X	X		X		X
	Promote Pollinator strategies and collaboration	X	X		X	X	X	X	X	X	X
	Reference to policy	X	X		X	X	X		X		X

5.3.3 Reports on progress

Nations' strategies must generally be at least a few years old before it is possible to provide a meaningful assessment of what progress they have made. As such, progress reports are generally limited to updated strategies that have been in place longer (e.g., Ireland and Wales), or the few examples where annual progress reports have been prepared (e.g., England). A critical view of these reports is that they are generally limited to a list of measures that have been implemented. We found no examples where progress reports attempted to report quantitative gains in either the extent or quality of pollinator friendly habitat, or in actual gains with respect to abundance or diversity of pollinating insects.

6 Recommendations for establishing a Romanian pollinator strategy

A national pollinator strategy is an essential instrument for establishing common goals through a coordinated national commitment. The process of establishing a national pollinator strategy can strengthen the knowledge base, engage all relevant stakeholders—including both the private and the public sector, land managers, citizens, and NGOs. By operating at a national scale, Romania's pollinator strategy can identify which targeted measures will be most relevant for its own national context. A national strategy can identify coherent pollinator-friendly objectives, establish national priorities, and provide the support required for the implementation of effective conservation measures. Through encouraging participation from all sectors that are interested in the welfare of both wild and domestic pollinating species, the process of establishing a national strategy can draw on the skills, experience and enthusiasm that already exist among organisations and individuals to promote a national level effort capable of making positive changes for pollinators.

Romania has a National Apiculture Program[14] which has been in place since 2007. As its name implies, the program's main purpose is to support the countries beekeeping activities. The program's agenda includes improving the production and commercialization of apiculture products, providing financial support for renewal of bee colonies the purchase of beekeeping equipment, and administering honey quality testing. Aside from the measures that address pests and disease that are threats to honeybees, the program does not include measures directed towards improving foraging conditions for either honeybees or any other objectives that would provide indirect benefits to wild pollinator species.

The European Pollinator Initiative (EPI), the revised New Deal for Pollinators, and the national strategies developed by EU member states which we describe in Chapter 5 all provide several examples of measures that can improve the situation for both honeybees and wild pollinators. Over the past decade have witnessed a rapidly growing level of public awareness of the importance of wild pollinators and the challenges they face. Together with improved scientific and practical knowledge, this has produced a strong degree of engagement across several sectors (Underwood et al. 2017). The EPI stresses the importance of coordinating participation and facilitating multi-sector involvement: *"Action 10A: The Commission will develop common templates and tools to facilitate the development of pollinator strategies at national, regional and local level, building on existing best practice."* Better EU-coordination of national strategizing and action planning can bring the advantages of exchanging information about best-practice and successful strategies. While the New Deal for Pollinators no longer includes this specific action with a reference to common templates, it has retained actions that promote a similar approach: "Action 11.1: Member States should develop, in close collaboration with stakeholders and citizens, national pollinator strategies that will coordinate and stimulate efforts across all relevant sectors and policies to reverse the decline of pollinators by 2030. The Commission will support Member States in this regard, including through the EU Biodiversity Platform's working group on pollinators."

A pollinator strategy for Romania should be built around the three core objectives presented in the EPI and the New Deal for Pollinators: 1) improving knowledge of potential pollinator declines, 2) taking actions to address the causes of pollinator declines, and 3) mobilizing society and promoting strategic planning and cooperation at all levels through facilitating the exchange of information about pollinators—which includes engaging the public. These objectives are nearly universal components of the national strategies and action plans we have reviewed in this report (Table 4). We also recommend that a Romanian national pollinator strategy include an additional objective that is not included in the EPI or the New Deal for Pollinators, but is found in several

[14] National Beekeeping Program - Ministry of Agriculture and Rural Development (madr.ro)

national plans: namely identifying how progress towards goals in the national action plan can be assessed.

The EPI had recommended that a series of objectives in a national pollinator strategy should be defined and developed as specific “SMART” actions and targets: Specific, Measurable, Achievable, Realistic and Time-bound. To facilitate the implementation of the targets, lead organizations and partners should be defined, and a timeline for deliverables should be included. It is also recommended to provide a timeframe to review the strategy (e.g., every year or after two to three-year intervals). This will allow strategy administrators and engaged stakeholders to compare the progress made against the targets the strategy has set and to learn from the results obtained.

It is beyond the scope of this report to provide recommendations for which specific actions or targets might be most appropriate for addressing these main objectives within a Romanian national context. Those deliberations are best done by relevant stakeholders within Romania, using the most inclusive list of targets from the examples provided from other EU member states (i.e., France and Ireland). Both the number and organizing structure of the actions included in other nations’ plans vary considerably between countries—reflecting, at least in part, the process through which the plans were drafted and established, the participants involved, and the national culture surrounding the roles of legislative authorities and the stakeholders involved.

6.1 Promoting pollinator monitoring

The majority (56.7%) of European bee species are listed as Data Deficient (Nieto et al. 2014). For conservation and management of bee diversity to be undertaken effectively, it is critical to have a clear understanding of taxonomy and ecology of the species present. National governments, through the Convention on Biological Diversity, recognize the existence of a taxonomic impediment and, through the Darwin Declaration, intend to address the situation (Environment Australia 1998). This shortfall in taxonomic expertise is very apparent in our understanding of bees. A major threat to effective deployment of conservation actions for the bees of Europe is an inability to understand and identify the species present and to monitor the state of populations effectively.

A pollinator monitoring scheme is a crucial element of any strategy designed to prevent loss of insect pollinators and the services they provide. Robust data on the status and trends of pollinators is an indispensable prerequisite for effective conservation actions. Much of our understanding of the drivers of pollinator decline have been inferred through field research and statistical modelling that extrapolates information from historical records (Kerr et al. 2015, Senapathi et al. 2017, Sponsler et al. 2017). However, it is only through long-term abundance data we can reliably estimate the relative importance of the factors that in driving insect pollinator declines at multiple scales. Understanding how land management affects pollinator abundance and diversity in combination with other drivers is necessary to design more targeted, adaptive management strategies at national scales (Garibaldi et al. 2020, Lyons et al. 2008).

A pollinator monitoring scheme can provide economic benefits that far exceed the cost of its implementation. Breeze et al. (2021) concluded that the annual costs of a UK national monitoring scheme would be <0.02% of the economic value of pollination services that would be lost as a consequence of a 30% decline in the country’s pollination services. Furthermore, they calculate that, by providing high-quality scientific data, monitoring schemes would save at least £1.5 on data collection per £1 spent, and demonstrate how long-term systematic monitoring can be a cost-effective tool for both answering key research questions and setting action points for policymakers.

The *Proposal for an EU Pollinator Monitoring Scheme* (Potts et al. 2021a) presents a design for monitoring pollinating insects that will meet the information needs European countries have for sustainable management of its pollinators. The scheme utilizes and thereby compliments existing site networks used in LUCAS (Land Use and Coverage Area frame Survey) and EMBAL (European Monitoring og Biodiversity in Agricultural Landscapes) monitoring. Potts et al. (2021a) propose a network with a minimum of 2 000 to 3 000 sites across Europe, to be monitored every year. Their proposed schemes would involve 132 sites to achieve representative sampling, or roughly twice the national average for the EU scheme as a whole (France has the most sites with 288, whereas Malta and Luxembourg would have the fewest with 10 and 12). Romania's national pollinator strategy and action plan should call for the implementation of this monitoring scheme and for the necessary national financial and logistical support.

6.2 Promoting pollinator research

In addition to monitoring activities described above, improving our knowledge of the causes of pollinator decline involves research. Several national action plans identify the promotion of specific research efforts that will be initiated or continued through enhanced funding, as well as facilitating the sharing of information that these projects generate. Examples include England's "Disseminate findings of 'Modelling Landscapes for Resilient Pollination Services' research, including options for risk maps" and "Disseminate findings of new research on nutritional quality of pollinator seed mixes." France's action plan repeatedly calls for increasing the level of support for pollinator-related research. For example, Action 1.4: *Support scientific research related to the knowledge and conservation of pollinating insects* seeks coordination among funding bodies so that calls for projects on biodiversity are coordinated to facilitate cooperation among research groups. Such national strategies presuppose existing research groups and necessary infrastructure. Romania has a robust group of researchers conducting work on Lepidoptera, yet there is comparatively little work being done on other pollinator groups—specifically bees. A national strategy should seek to first establish and then strengthen a Romanian research community pursuing research questions on bees, with emphasis on international collaboration. Research activities should naturally be coordinated with pollinator monitoring, so that data collected through pollinator monitoring can be utilised to seek better understanding of the causes of pollinator decline and which measures are most effective for addressing them.

6.3 Measures for addressing the causes of pollinator decline

The action plans for other European nations provide many excellent examples of defining measures for addressing the threats facing insect pollinators. It is beyond the scope of this report to evaluate which ones are most appropriate within a Romania context. This exercise is best done by the actors who will be involved in implementing a national strategy and action plan for Romania. These groups and individuals will have the necessary familiarity with which initiatives (both government and private) are realistic and how these initiatives will fit within the existing policy context. We suggest that a consortium of interested parties use a set of actions from either France or Luxembourg—the two countries whose action plans involve the most inclusive list of measures—as a starting point.

A Romanian strategy should naturally call for actions that address how conditions for pollinators can be improved within agricultural landscapes. The Common Agricultural Policy and particularly rural development programs can support measures that benefit wild pollinator populations. According to Underwood et al. (2017), policies can be used to:

- *Create and maintain uncultivated patches of vegetation such as field margins with extended flowering periods; plant and maintain hedges, trees and scrub patches that provide flowers, nesting and hibernation habitat*
- *Change and extensify management of grasslands to increase flower abundance*
- *Support diversified farming systems and crop rotations, support organic farming*

Underwood et al. (2017) also point out that there are currently large differences between what EU Member States' rural development programs offer in terms of measures and funding that could benefit pollinators. They contrast the high levels of support in Austria with Denmark, where support is far lower. Identified actions involving agri-environment initiatives within a Romanian strategy should correspond with the current levels of Romania support for rural development. However, the national strategy also can, and perhaps should, call for increases in this type of funding.

Many of the agri-environment schemes targeted at pollinators that are already implemented focus on providing a limited range of nectar and pollen resources through simple management prescriptions for farmers (Stout & Dicks 2022). Such measures often provide resources for common, generalist pollinator species instead of supporting the more specialist pollinator species that are actually declining (Wood et al. 2017). These simpler schemes also often fail to provide resources at times in the year when resources are actually limiting (Timberlake et al. 2019). Ideally, the actions called for in a Romania plan will specify objectives for creating areas and linear elements with extended flowering periods, and call for increased utilization of "extensive" agricultural practices that increase overall floral abundance (e.g., Kovács-Hostyánszki et al. 2016)

The European Court of Auditors' report from 2020 was highly critical of the progress made by the European Pollinator Initiative with respect to protection of wild pollinators (European Court of Auditors 2020). Among the criticisms were that the EPI defined specific actions for only three drivers of pollinator decline: the loss of habitats in urban and agricultural landscapes; the use of pesticides; and invasive alien species. These are arguably the three primary threats to insect pollinators. However, the Court of Auditors found the EPI did not include measures on the other direct threats identified by the IPBES (2016c) report: climate change, environmental pollution, pollinator management (i.e., potential negative effects of competition with honeybees), and the additive effects of interacting threats. The Court of Auditors therefore recommended that the European Commission assess whether actions should be added to address threats currently not considered in the EPI in the follow-up actions and measures for the EU biodiversity strategy to 2030. It is therefore highly recommended that a Romanian national strategy includes actions directed at these threats from the outset.

The Court of Auditors found the EPI lacked integration between the actions intended to protect wild pollinators and EU policy instruments for addressing biodiversity conservation and agriculture. Therefore, the court also stresses the importance of setting up appropriate governance and monitoring mechanisms for these actions and measures, including assigning clear responsibilities between Commission departments involved in policy areas that are relevant for wild pollinators. Many of the more complete national pollinator strategy action plans make references to the relevant policy context for specific actions, including calls for enacting new policies where existing policy is considered lacking. We strongly recommend that the Romanian strategy do the same.

We found several different variations on how national strategies addressed pesticides, and it is not clear which one is most appropriate for use in a Romanian plan. At a minimum, the actions should stress observing the general principles of integrated pest management, as described in Annex III of Directive 2009/128/EC on the sustainable use of pesticides. Belgium's action plan calls for responsible use of pesticides to be included in a pesticide reduction plan, where pesticides are only allowed "when action levels are exceeded as part of pest monitoring. In this case, farmers should favour non-persistent active substances (DT50 less than 60 days) or whose metabolites have no negative effect on insects." They further call for providing farmers with better guidance on the use of appropriate substances.

Romania has a somewhat troubled history with pesticide use, and specifically the neonicotinoids that can damage neurological activity in pollinating insects. The European Court of Auditors

describe how in 2017 the European Food Safety Authority (EFSA) analysed emergency authorizations of neonicotinoid use granted by Bulgaria, Estonia, Finland, Hungary, Latvia, Lithuania and Romania (European Court of Auditors 2020). EFSA concluded that four Member States (Bulgaria, Hungary, Lithuania, and Romania) could have used suitable chemical or non-chemical alternatives (such as crop rotation or soil tillage) or could not scientifically justify the danger. In 2018, the European Commission asked these nations to stop granting authorizations for specific pesticide products containing the neonicotinoids imidacloprid, thiamethoxam and clothianidin. Lithuania and Romania continued granting emergency authorizations for cases in which suitable alternatives were available in 2018 and 2019. The Commission legally obligated Lithuania and Romania in February 2020 to stop granting emergency authorizations for those uses where EFSA had identified available alternatives.

In January 2023, the Court of Justice of the EU (CJEU) ruled that using neonicotinoids imidacloprid, clothianidin, and thiamethoxam as seed-coating treatment was illegal[15], and that member states could no longer grant temporary exemptions for their use. However, uncertainty remains about how the ruling might apply to other uses of neonicotinoids. The ruling did not eliminate all legal “loopholes” that member states might use to allow the continued use of neonicotinoids or insecticides that are harmful to pollinators. Moreover, these bans on the original neonicotinoids also create incentives for development of substitutes that exploit the same insect neural mechanisms, which carry a risk that the new products will be similar or worse than the pesticides they would replace (European Academies Science Advisory Council 2023). This potential danger underscores the need to promote Integrated Pest Management (IPM). An IPM approach utilizes information of pest species’ lifecycles, sometimes incorporating use of low-risk pesticides based on bacteria, fungi, or substances like limestone or pepper, to minimize crop loss without collateral harm to the environment (Barzman et al. 2015). Given the continued uncertainty concerning whether member states will seek exemptions to the CJEU ruling or what substitutes might take their place in the years to come, we recommend that a Romania pollinator strategy addresses the harmful effects that pesticides have on pollinating insects as context for specific actions that promote IPM.

6.4 Measures for public engagement

In their review of European pollinator initiatives, Underwood et al. (2017) provide several excellent examples of awareness raising activities by NGOs, citizen groups, foundations, protected areas, and beekeepers. These initiatives should not overlook the importance of including urban areas, as they have become more important as refuges for pollinators as their abundance in agricultural area has declined (Baldock et al. 2019). Practices like including pollinator needs in certifications or standards for public green spaces, setting up award schemes or other public recognition of community initiatives that benefit pollinators, and incorporating pollinators and habitat creation in school programs are all excellent ways to reach and engage large numbers of people through awareness raising activities in urban areas.

Private-public partnerships are also excellent ways to increase engagement in the campaign to protect pollinating insects. A Romanian strategy can seek to engage gardening shops and businesses, protected areas, beekeeper associations, large landowners such as water companies, food and drink businesses such as breweries and fruit producers, schools and churches. Underwood et al. (2017) highlight four examples of private-public partnerships that could serve as inspiration for a Romanian strategy:

[15] https://curia.europa.eu/juris/document/document.jsf?text=&docid=269405&pageIndex=0&doclang=en&mode=lst&dir=&occ=first&part=1&cid=5866

- In Austria, an NGO has set up a partnership with a supermarket chain to fund small projects for pollinators, such as on-farm research into ways to increase the role of pollinators in squash production.
- In Flanders in Belgium, an EU-funded project is bringing together fruit farmers with public municipalities and water boards who manage land around the farms to increase flower resources and nesting habitats for wild pollinators that could pollinate the fruits.
- In the Netherlands province of Zuid-Holland, a public-private partnership between beer brewer Heineken, Wageningen Environmental Research and the provincial government launched a project to build knowledge and practice of bee-friendly landscape management on public and private land.
- The Pollinators Network initiative set up by the European Landowners Organisation together with Syngenta has the aim of supporting farmers and landowners to create and maintain field borders such as flowering field margin strips and hedges for pollinators and other biodiversity benefits.

Stout and Dicks (2022) caution against focusing exclusively on raising awareness with simple actions that individual people can take. While this approach can motivate small-scale actions, and networks of actions at larger spatial scales (e.g. the All-Ireland Pollinator Plan), there is a danger of stimulate inappropriate actions like promoting beekeeping in areas that lack sufficient floral resources (Alton & Ratnieks 2013), and over-simplifying complex socio-ecological issues. Focusing solely on individual and local-scale action can allow larger actors like governments to downplay their own responsibility for action. Stout and Dicks (2022) call for knowledge co-production through the design of conservation actions at local scale, which can help to ensure not only more effective action, but also draw the connections between policy and practice, and integrate pollinator action into wider sustainability and political issues.

6.5 Evaluating progress

The Luxembourg plan provides an excellent template for identifying ways in which progress towards goals in the national action plan can be assessed[16]. To begin with, the descriptions of actions include both the objective itself, and "quantified objectives." For action #1: "*Protect, conserve and promote wild pollinating insects in agricultural environments*," the primary objective is:

> *Provide necessary floral resources and nesting sites for insect pollinators in the agricultural environment by ensuring that the issue of pollinating insects is taken into account in the national agricultural policy, by reducing the use of harmful chemicals and by supporting the relevant actors in the field.*

The quantified objectives include:

- *30% of surfaces (plowing[17] and grassland) with measures in favor of pollinators within "typical" agricultural landscapes, where agricultural production is the primary goal (intensive land use)*
- *40% of plowing areas and 50% of grassland areas with measures in favor of pollinators in agricultural areas constituting "hotspots" (i.e., protected areas such as Natura 2000 and ZPIN-designated areas that can serve as habitat for source populations of insect pollinators that can colonize the "typical" agricultural landscape"*

Each action specifies up to five *monitoring indicators*. Using Action #1 as an example again, these indicators are:

[16] Text printed in italic font represents direct quotes from the Luxembourg plan.
[17] i.e., arable or cultivated land

- *"Favorable surfaces (biotopes, topographic elements, fallow land, multi-annual flower strips, refuge areas, etc.) for pollinating insects maintained/created in the agricultural environment (measured in ha)*
- *Number of AECMs (Agro-Environmental Conservation Measures) and eco-schemes defined/adapted favoring pollinators*
- *Area under relevant contracts (ha)*
- *Number of pilot sites/farms set up*

Finally, the action also defines deliverables, or products that will be generated in connection with work on the action itself. These are generally technical guidance materials that support pollinator-friendly management and serve to share information: one of the central elements of the EPI's primary objectives. For Action #1, these are 1) *a good practice guide for farmers, including a decision support tool with a self-diagnosis sheet* and 2) *a honey crops calendar*.

Specifying these outcomes for each action within Romania's national pollinator strategy and action plan will enable Romania to evaluate the progress the country is making with respect to the measures intended to improve conditions for pollinators. Successful implementation of a measure intended to benefit pollinators will be of little use if the measure has no demonstrable effect on maintaining or improving insect pollinator abundance and diversity. It is therefore equally important to implement a monitoring scheme to evaluate the status and trends of the pollinator populations themselves, as a means to assess measures' effectiveness.

7 Conclusions

This report draws upon examples of the growing body of evidence documenting declining pollinator diversity and abundance global, regional, and local scales to communicate why Romania should develop and implement its own national pollinator strategy. Pollinating insects face threats from several interacting stressors, many of which are either caused or exacerbated by human activities. There are several compelling reasons to adopt a national strategy for the protection of this ecologically, economically, and socially important component of biodiversity. Perhaps the most pragmatic reason, and the one that is most likely to persuade policy makers to adopt measures to maintain pollinator biodiversity is food security. There is growing evidence that wild pollinators contribute to agricultural production in terms of the quality, magnitude and resilience of crop pollination, and that pollinator biodiversity plays a more important role than pollinator abundance in determining crop yield (Vasiliev & Greenwood 2020). A national pollinator conservation strategy that focuses on maintaining species diversity should be regarded as a key priority to ensure that Romanian agricultural production its ecosystems' structure and function are best equipped to withstand the challenges posed by future climate change.

A national pollinator strategy provides an essential instrument for establishing common goals through a coordinated national commitment. The process of establishing a national pollinator strategy should encourage participation from a wide swath of stakeholders—including both the private and the public sector, land managers, citizens, and NGOs. Through encouraging participation from all sectors that are interested in the welfare of both wild and domestic pollinating species, the process of establishing a national strategy can draw on the skills, experience and enthusiasm that already exist among organisations and individuals to promote a national level effort capable of making positive changes for pollinators.

We recommend that a national pollinator strategy for Romania's consist of four main objectives: 1) improve knowledge of potential pollinator declines, 2) take actions to address the causes of pollinator declines, 3) facilitate the exchange of information about pollinators—which includes engaging the public, and 4) assess progress towards the goals set in the strategy. We do not provide recommendations for which specific actions or targets would be most appropriate for addressing these main objectives within a Romanian national context. Instead, we encourage readers to use this report as an introduction to other national strategies and the European Commission's New Deal for Pollinators, and draw from those examples. This report attempts to identify where some strategies' materials and concept might be most relevant for Romania. Individuals and organizations who will participate in the development of a Romanian national strategy should consider the best practices provided in a range of strategies, rather than simply adopting another country's existing policy.

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2163

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