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Safeguard

Safeguarding European wild pollinators



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Introduction

Urban ecosystems pose different environmental constraints on plant and animal communities than natural ecosystems, affecting pollinators and their ecological interactions. Anthropogenic land use change is one of the main drivers of terrestrial biodiversity decline, including that of insects. One such change, urbanisation, has been identified as a threat to global biodiversity, including pollinator biodiversity. However, appropriately managed cities can contribute to the conservation of pollinators by providing them with habitats and benefiting from the many services that pollinators deliver.

Aim of this guidance

This guidance aims to bring tools and knowledge for cities to use pollinators as indicators of their urban greening and carry out pollinator monitoring. It builds on the EU Commission <u>guidance for pollinator-friendly cities</u>, and explores options for pollinator monitoring in more depth. This guidance provides a gateway for cities to access resources on the topic, provides background on the different monitoring options available, and gives good practice examples from successful monitoring schemes in the EU.

Urban habitats could enhance the conservation of pollinators.

Green spaces in urban and peri-urban areas can be important habitats for wild pollinators, providing them with food resources and foraging, reproductive, shelter and nesting sites that may not be available in surrounding agricultural areas (Baldock et al, 2019). A city can be rich in pollinators. For example, Fortel et al (2014) found 31% of France's bee fauna in a survey of Lyon.

The main groups of insect pollinators include bees (around 2,000 species in Europe),

hoverflies (979 species), butterflies (482 species), moths (8,000 species), beetles (29,000 species) and wasps, although members of other taxa may also be pollinators, such as thrips (Potts et al, 2020).

Pollinators can forage on wild and cultivated, ornamental and non-ornamental, native and non-native flowering plants (Plascencia and Philpott, 2017), as well as city trees (Hausmann, Petermann and Rolff, 2016). A recent study of bees in Berlin found 57 species



on just four common tree species, representing 19% of all known bee species of Berlin. And 17% of these species are endangered nationally (Hausmann, Petermann and Rolff, 2016).

Evidence has shown that a native plant mix is best, with a selection of flowers rich in pollen and nectar, including a mixture of flowers that are attractive to generalist and specialist pollinators and that are available over the full activity season of pollinators (Wilk, Rebollo and Hanania, 2019). Cities can also provide nesting sites, especially in green spaces, patches of undisturbed bare soil and dead logs, and artificial cavities (Fortel et al. 2014). The availability of nesting sites is a crucial element for the persistence of bee species in urbanised areas (Fortel et al, 2016). Pollinators thrive in heterogenous landscapes where various habitats are assembled (Wilk, Rebollo and Hanania, 2019), and cities often offer such landscapes, with parks, gardens, balconies, cemeteries, alley trees, brownfield sites and unused urban spaces, green corridors, green roofs or verges, to name a few. Insect abundance is higher on these infrastructure verges than in surrounding agricultural and urban areas.

Urban areas could become refuges and corridors of favourable habitats for pollinators and to some extent, contribute to improving pollinator populations in nearby agricultural lands (Hall et al, 2017).

Pollinators are essential for providing ecosystem services.

Pollinators are usually good biodiversity indicators in urban environments (Bellamy et al, 2017a). Vice versa, high floral richness consistently comes with high pollinator abundance and/or species richness (Burdine and McCluney, 2019).

Pollinators provide pollination and plant reproduction services for gardens, parks, allotments and other urban green spaces (Geslin et al, 2016; Gunnarsson and Federsel, 2014; Hausmann, Petermann and Rolff, 2016). Without pollinators, agricultural economies, our food supply, and surrounding landscapes would collapse. Pollinators provide essential indirect ecological benefits through their influence on plant communities, including shaping chemical-physical and biological processes in the soil, mediating competition in and diversity of plant communities (Johnson, Dutt and Levine, 2022), and stocks and flows of energy and matter through ecosystems, food webs and the atmosphere (Breeze et al, 2022).

Promoting pollinators in urban areas is linked to citizens' well-being.

There is good evidence of the well-being associated with spending time in places with high biodiversity. There are so many benefits of being exposed to nature and healthy ecosystems that some researchers refer to the 'feel good factor' of biodiversity (Dallimer et al, 2012).

Beyond the positive effects of being surrounded by a natural environment, pollinators are directly associated with important aspects of our lives. They enable leisure and recreational activities (like gardening, butterfly recording, and noncommercial beekeeping), the celebration of cultural identity and heritage (wildflower meadows), aesthetics (pollination-dependent flowers in landscapes), as well as emotional and spiritual values (Breeze et al, 2022).

Urban planners are increasingly recognising the social and ecological benefits of nature-rich green spaces. There are many opportunities to identify 'win-win' areas where green infrastructure supports pollinator habitat quality and societal health and wellbeing.

Why do we need to monitor pollinators?

Pollinator abundance and species richness are positively associated with the quality of urban green spaces for nature in terms of plant richness or insect diversity (Burdine and McCluney, 2019; Zaninotto, Fauviau and Dajoz, 2023). Considering that pollinators can be an indicator strongly related to the nature quality of urban green spaces and the countless benefits pollinators provide to our wellbeing and society, pollinator monitoring could become a key component of EU urban green planning policy.

EU urban policy sets out the framework for planning, designing, supporting, and managing urban green spaces and can potentially be a key instrument for wild pollinator protection. Although urban



policy and spatial planning is mostly a member state competency, the EU has relevant policies that set the context and framework for local action for urban pollinator communities.

Urban greening plans

The EU Biodiversity Strategy to 2030 (EUBDS) highlights that cities with over 20,000 inhabitants are expected to develop Urban Greening Plans. These should outline the city's strategy to protect and restore biodiversity and mitigate climate change. They are expected to include measures to create new urban green spaces such as urban forests, public green areas, gardens, urban farms, and green infrastructure (e.g., green roofs and walls), and to improve the management of existing green spaces for biodiversity, such as eliminating pesticide use and regulating mowing. In addition, they should outline the policy, regulatory and financial framework needed to deliver these measures.

The revised European Pollinator Initiative

The revised EU Pollinator Initiative is a nonbinding strategic framework adopted by the EU Commission in January 2023 to reverse the decline of wild pollinators. The initiative includes two actions connected to pollinators in urban areas:

"The Commission and Member States should encourage cities to implement the guide for pollinator-friendly cities (7.1). Continuous until 2030"

"(7.2) When developing Urban Greening Plans, European cities should take into account pollinator conservation requirements (continuous until 2030)." Urban greening plans will set cities' strategies to support biodiversity, including pollinators. In addition, they will be an essential vehicle to deliver on other relevant EU BDS commitments, such as "eliminating chemical pesticides in sensitive areas such as EU urban green areas".

Urban greening plans will need to pay a particular attention to pollinator monitoring to assess the state and trend of pollinators in the municipality, which will be critical for implementing conservation activities and adequate planning.

Resources: Urban greening platform, EU Biodiversity Strategy for 2030

Pollinator monitoring is an essential focus of the new pollinator initiative: Actions include the finalisation of a standardised methodology for an EU pollinator monitoring scheme (EU-PoMS) (by 2026), the systematic collection of data on significant threats to pollinators by 2026, and the support of research and innovation on the state of pollinators, the causes and the consequences of their decline, as well as effective mitigation measures (continuous until 2030).

Resources: <u>Revised Pollinator Initiative</u> (European Commission, 2023), EU PoMS

In this policy context, it becomes apparent that pollinator monitoring and increasing understanding of drivers of their decline, its impacts on society and potential responses is essential in the European wide framework for pollinator conservation. But why should cities invest in pollinator monitoring?

1. Making green spaces and interventions work for pollinators

Measuring or monitoring pollinator populations is key to informing evidence-based policy and practical conservation actions. It allows urban planners to make informed decisions on where interventions can be most effective. Sometimes, cities implement measures in favour of pollinators without having the complete picture of the state of pollinators in their city, which can lead to potential adverse effects on pollinator populations, for example, missing opportunities to maximise benefits for rare pollinator species and flower-rich habitats.

Measuring the impact of management interventions on pollinators in Budapest

In 2021, the Hungarian Centre for Ecological Research started a pollinator monitoring project in Budapest. Pollinators were recorded at morpho-species level in urban green areas on pollinator-promoting interventions and conventionally managed sites. The comparison of data from these different sites allowed researchers to evaluate the impact of their pollinator-promoting management methods (less mowing and sowing flower mixes) on pollinators and wildflowers. The project results fed into a scientific publication (Süle et al, 2023) giving recommendations about urban pollinator-promoting interventions to green space managers, scientists, and citizens. Guidance for the general public and decision-makers provides an overview of the opportunities for pollinator conservation in cities (in HU).

Using pollinators as indicators of biodiversity on green roofs in Paris

In 2021, the Regional Agency for Biodiversity in Paris region published a report (Barra and Johan, 2021, available in FR and EN <u>here</u>) showcasing the results of a study (2017-2019) verifying the ecosystem services provided by green roofs. This study aimed to check that green roofs make a genuine contribution in providing ecosystem services in cities: water retention, cooling and pollination on 36 green roofs in the Paris region. The main questions motivating the study were: *how much biodiversity can be found on green roofs? What are the associated ecological functions? What differentiates roofs from other planting systems? Are roofs comparable to other urban natural spaces? What is the best way to advise project sponsors and managers on the most effective design and management solutions promoting biodiversity?*



The protocol used to make the inventory of invertebrates

revealed that Hemiptera (bugs), Hymenoptera (bees, wasps, ants), spiders and beetles are the most abundant taxonomic groups. However, compared to other urban green spaces, roofs host significantly fewer species of pollinators. The study showed that diversity fluctuates widely from top to roof with significant differences between the less diverse sites (20 species) and those with the most species (up to 107 species). These results bring valuable information for the design of green roofs (intensive, semiintensive, and extensive roofs), depending on conservation objectives.

2. Finding out how cities affect pollinators

There are significant knowledge gaps concerning threats and pressures on pollinators and the state of populations, also in urban areas. During an expert workshop (data and research for pollinators) organised to revise the EU Pollinators Initiative in July 2022, it was highlighted that *"there are comparatively fewer studies of pollinators in urban areas than in agricultural or natural landscapes and many knowledge gaps exist. Further studies are, for example, essential to evaluate the impact of urban management on pollination, the value of pollination for food production in cities, and the efficient and economical options for managing right-of-way infrastructure to support pollinators".* There are also many different types of [unexpected] habitats that pollinators can benefit from in urban areas (like brownfield sites or railways) that further research could contribute to map and integrate into urban planning decisions (Baldock et al, 2019; Baldock et al, 2015; Stockhammer and Schindler, 2022a).

What is the impact of temperature on wild pollinators in urban areas?

There are very few studies documenting the effects of heat on urban pollinators. Geppert et al (2023) conducted a <u>study</u> in Rome in 2022 to fill some of these knowledge gaps. The aim was to determine the effects of surface temperature on wild bee abundance, species richness, community evenness, changes in community composition, functional diversity and shifts in trait values within communities. Wild bees were sampled on 36 sites. Temperature was found to be the main driver shaping wild bee communities, more important than the amount of open habitat cover and distance from the city centre. Under future climate change, it is expected that heat-tolerant wild bee species will benefit from increasing temperatures in urban settlements and that small-bodied bees will dominate warm-temperature communities. Other bees, particularly bumblebees, have a low heat tolerance and are expected to disappear from southern regions of Europe. Considering that cities are increasingly seen as refuges for pollinators, it is important to document such impacts to adapt cities' strategies for managing heat for both citizens and pollinators.

3. Raising awareness on pollinators – the importance of citizen science

Pollinator conservation is increasingly gaining interest among EU citizens, with the development of various grassroots initiatives to reverse their decline. The EU Commission released in 2020 practical guidance on <u>Citizens for pollinator conservation</u>, providing tools and information for citizens to undertake pollinator conservation. In the EU Pollinators Initiative, awareness raising on pollinators is one of the core priorities (Tsvetelina and Underwood, 2020).

Pollinator decline has also become a symbol of growing public concern about the impact of pesticides on the environment and their health. In 2021, the EU Citizen Initiative <u>Save the Bees and farmers</u>, asking for an 80% reduction in pesticide use by 2035, gathered 1.1 million signatures, to which the Commission responded in April 2023.

Citizen-science-led pollinator monitoring schemes can be an excellent way to raise public awareness of pollinator conservation, increase understanding, and harness enthusiasm. Citizen science can also play an essential role in school science education (Saunders et al, 2018), through local observation of global challenges, getting in touch with scientific processes or engaging with specific pollinator conservation problems.

OPTIMOW: study in the UK on the contribution of pollinator friendly mowing regimes

In the Horizon project Safeguard framework, Royal Holloway University of London is carrying out a citizen science survey in private gardens to find out the optimal mowing regime to improve the community of flower-visiting insects. The 6-week survey involves private gardeners, who monitor pollinators and plant species in their lawns once every week for six weeks (without mowing). The project is also conducting a more extended study in over 50 UK Ministry of Justice sites.

Morgan Morrison (OPTIMOW study leader, Royal Holloway



University) underlines citizen science's potential to raise pollinators' awareness: "Generally, citizen science is a great way to get participants to allow themselves to see biodiversity. In my case, butterflies and bee species fly around most UK gardens, but making participants look for them for 10 minutes a week opens their eyes to the diversity possible and raises awareness. In my study, we used opportunistic recruitment since many individuals were already naturalists or gardeners, so there was already a high awareness of insects and garden biodiversity. One of the powerful things we found from the study is real discontent in participants who did not see a benefit to their pollinator communities for the intervention or who had gardens barren from pollinators. There was real anger and sadness from some participants, and we believe this could have a powerful lobbying potential in interventions and policy".

More info here.

Tallinn Pollinator Highway – promoting the value of pollinators to citizens

Pollinator Highway is a meadow-like natural environment rich in species, a green corridor and a space for people to move through six city districts of Tallinn. The Pollinator Highway runs along a former railway embankment and the city's 50-meter-wide high-voltage line corridor. When the high-voltage lines were moved underground, a city-wide linear park project was born.

The 14-kilometer-long Highway is now a pollinator-friendly green corridor for residents to spend time in a nature-rich environment. Different green space management interventions are being tested along the corridor, like different mixes of flower meadows, mowing reduction, allotments for residents, etc.

Studies conducted by entomologists at the University of Tartu have shown that most of the Highway's linear space functions as a pollinator corridor, already providing habitat for 42 different butterfly species and 22 bumblebee species. Monitoring is still being carried out.

The project was co-created with the local population through consultation with various target groups (school visits, pop-up events, public discussions, etc) and crowdsourcing. The city administration's intention with the Highway is to create a sense of community through increased connection with the natural environment. The project 'Place Buzz' embodies that vision by bringing art to the Pollinator Highway with environmentally sensitive contemporary installations or architectural objects, raising awareness on ecology and pollinators.



More info <u>here</u>.

4. A way to understand different pollinator needs

Several studies have studied the suitability of different habitats for pollinators across the city scale. Baldock et al (2019) studied floral resources and pollinators in 360 sites incorporating all major land uses in four British cities (Bristol, Reading, Leeds, Edinburgh). Residential gardens (due to their extensive area) and allotments (community gardens) were found to be pollinator 'hotspots', contributing significantly to city-scale plant-pollinator community robustness.

Pollinator monitoring can also reveal important information on the nectar and pollen resources needed by pollinators (Hicks et al, 2016). This kind of information can be helpful for selecting and fine-tuning pollinator-friendly flower-seed mixes for example.

It is important to note that most studies only provide evidence of the suitability of habitats for pollinators in terms of food resources. There is for example a lack of information on what are the nesting requirements for pollinators in urban environments. In addition, most studies focus on just one urban land use (like allotments) and/or focus on subsets of potential pollinators rather than entire pollinator communities. This makes it difficult to fully understand the urban plant-pollinator ecology.

In Edinburgh, Bellamy et al (2017b) developed an habitat suitability model to predict which areas are best suited as "core" habitats for bees and hoverflies incorporating remote sensed vegetation data. This model suggests specific conservation efforts need to focus on green infrastructure that supports pollinator habitat quality and connectivity.

Options for monitoring schemes

What is your objective?

Your pollinator monitoring approach will differ according to the overall objective you are trying to assess and the indicators you can use to measure your objective.

Gain basic knowledge of how many pollinators are present in different places:

- Basic monitoring or surveying of abundance
 - Use simple citizen science approach for example with Flower-Insect Timed Count (FIT Count). The organisation *Pollinating London Together* has set up <u>such an</u> <u>approach</u> (see their <u>brochure</u>).



A citizen doing a FIT count in Kew gardens (UK), credits: Pollinating London Together.

Monitor changes in pollinator species richness across the city:

• City wide monitoring of targeted sites to help identify those land uses which are most beneficial for different pollinators

Suggested indicators: Pollinator species richness, presence/absence and abundance

- Monitor bees, butterflies, moths, hoverflies or all?
- Some cities may be able to use data from national monitoring

• Focused monitoring of rare and specialised species: the European Red List, compiled by IUCN, provides knowledge on the status of species in Europe by assessing which species are threatened with extinction¹.

Find out more about the causes of declines in pollinating and beneficial insect species:

• Systematic monitoring linked to evidence of pressures

Suggested indicators: might include measures of pesticide use in green areas, the prevalence of light pollution, the conversion of pollinator habitats to other land uses.

Find out which interventions or areas host most pollinators:

- Monitoring flowers visited by pollinators
- Monitoring of management interventions to assess how effective they are in promoting pollinators by surveying a site before and after a management action has been implemented (this may require one or more years of observation), for example monitoring effects of changes in mowing frequency.

Suggested indicators: Mowing regimes and the budgets available for changing mowing regimes and related equipment; urban green space area, vegetation percentage, biological valuation map, pollinator species richness, presence/absence and abundance in comparison to control sites.

• Monitoring different habitat types and different green space types

Suggested indicators: Pollinator habitats (incl. landscape elements) and their composition configuration (including corridors)

• Monitoring particular habitats or nest sites e.g. bees nesting in pavement cracks or walls, hoverflies in veteran trees, pollinators on brownfield sites

Suggested indicators: Relevant plant species, especially food plants (because surveying plants is more robust with less noise in the data)

It is important to keep in mind, that monitoring which interventions or areas host the most pollinators, control sites without management actions are necessary.

Monitor pollination function:

• Monitor pollination in urban agriculture (e.g., garden fruits and vegetables) or of wild and ornamental flowers

Monitoring schemes may also be designed with these objectives in mind:

- Raise awareness among the various (public and private) actors and educate use citizen science approaches such as <u>Insect Summer (Natuurpunkt.be)</u>
- Provide data contributing to local, regional and national monitoring schemes
- Early detection of invasive alien species (such as Asian Hornet).

¹ As part of it, four pollinator groups have been assessed: <u>butterflies</u>, <u>bees</u>, <u>saproxylic beetles</u>, <u>dragonflies</u> and <u>hoverflies</u>.

A national network for coordinating actions on the Vespa Velutina in Portugal.

In Portugal, the National Institute for Agricultural and Veterinary Research (INIAV), via the <u>Atlantic</u> <u>Positive Interreg project</u>, is coordinating a national network for detection and response to the Asian hornet (Vespa velutina). The network is actively collaborating with municipalities on the monitoring of the hornet. The online platform <u>stopvespa</u> has been set up for the public to report observations of the species. The <u>Vigia vespa</u> platform provides up to date cartography of the invasion.



Vigia Vespa website

As a general recommendation, any group interested in monitoring should reach out to both professionals, such as universities and museums, and volunteer schemes and societies, who run established monitoring schemes for butterflies and other insects.

What monitoring technique to use?

The choice of method is almost entirely driven by your agreed indicator(s), and what resources are available to support the scheme both in terms of technical capacity and also human resources for carrying out the fieldwork and the identifications. To make the choice, it is useful to answer these questions:

What do you want to measure? Different monitoring protocols and tools are suitable for different species groups. No single method will capture everything, so you have to choose a focus.

What is your objective – what do you want to find out? The choice of method greatly depends on the objective: do you aim to assess pollinator species richness or the presence of specific rare or special species? Do you aim to monitor population trends to detect declines and gains? The different techniques have varying degrees of data accuracy, which means they can only provide answers to some of the questions that you might want to answer.

Challenges to keep in mind - Project managers need to navigate between these different options depending on the advantages or drawbacks they present, the financial resources and expertise available, volunteer availability and other practical aspects (see 'cost efficiency' and 'pros' and 'cons' in the table below).

Consider the fact that an increasingly large proportion of citizen scientists are reluctant to use methods that kill specimens (such as pan traps) and would rather just make observations in the field. While this may be possible for certain taxa, it is difficult to get species level identifications without killing some specimens (bees and hoverflies in particular). The availability of taxonomic expertise to identify specimens and/or train volunteers is also often a major challenge.

The table below provides a summary and comparison of the most used pollinator monitoring techniques, their respective cost efficiency, whether they require killing insects or not, and recommended applications. Results are based on research from O'Connor et al, 2018; Breeze et al, 2020; Carvell et al, 2016; and Potts et al, 2021.For an in-depth cost-effectiveness analysis of monitoring schemes as well as recommendations for practitioners, see the report of the EUROPABON project: <u>Cost-effectiveness analysis of monitoring schemes</u> (Breeze et al, 2023).



Scheme name	Target	Aim	Pros	Cons	Recommendations	Cost efficiency
	group					
Transects	Bumblebees,	-non lethal	 less standardised than 	- fewer species	 Characterizing plant– 	- relatively cheap if
	other wild	sampling	pan traps (weather	sampled than pan	pollinator interactions or	skilled volunteers are
	bees (mainly	technique which	conditions may differ	traps.	identifying which species	available
	solitary bees), hoverflies, butterflies, day-active moths	allows recording butterflies, day- active moths and bumblebees -For selective lethal sampling of specimens (mainly solitary bees and hoverflies) that cannot be identified in the field can be collected for identification in the lab.	 across sites) identification of most butterfly or bumble bee species feasible for volunteers with small amount of training this method represents the pollinators of an area well, captures more individuals than transect walks -when combined with sampling for further identification, this 	 - impossible to properly standardize the sampling effort, potential for miscounts or misclassifications, particularly for hoverflies - potentially strong - observation bias: highly skilled observers will see more than normal observers will 	of insect are delivering pollination service to crops and wildflowers -transects could be suitable for novices to collect group level abundance data of bumblebees and possibly hoverflies, with basic instructions -only butterflies and most of bumblebees can be identified at the species level without killing. The	- If expert identification is required for captured specimens, costs are higher
		-widely used for butterflies, bees and hoverflies	identification, this method is extremely efficient.	 potential for counting individuals more than once 	majority of wild bees and hoverflies will need to be killed for identification	
Floral observation plots	Bumblebees,	Similar as with	- accessible and enjoyable	- Collects data on	This method is probably	If records are not
(timed pollinator counts)	other wild bees (mainly solitary bees), hoverflies, butterflies, day-active moths	transects, but the observed area is smaller.	approach to generating data on abundance and visitation rates - low-cost method, limited material needed - citizen science: participants require little to no training	broad insect groups (e.g. bumble bees, hoverflies, other flies etc.) - data generation can be spatially quite random if operated under citizen science model	most effective as one component (e.g. as an entry level) within a wider suite of methodologies which come together to form a wider pollinator monitoring protocol	verified, there are no costs associated with this method. + Cost of photographic verification of specimens to a coarse taxonomic resolution

			 good way to engage the wider public in data collection, and raising awareness on pollinator conservation can be combined with collection of flower visitors (not citizen science) 	 Volunteers require engagement, including feedback, and training to maintain quality data collection many pollinator species cannot be identified consistently from photographs 		- low cost compared to professional monitoring
Sweep netting	Small wild bees, hoverflies	Lethal sampling technique. This is not a standard method for pollinators, but can be useful if currently used to monitor leaf visiting insects or if flowers are not easily damaged, abundant and regularly distributed.	 equipment is lightweight, cheap, and simple to use easy for a volunteer to do and very little training is required provides information on many groups of insects, and does not depend upon flight or attraction of insects 	 - usually requires an expert due to the wide variety of taxa collected and because insects are often damaged - more labour intensive than a simple transect walk, finding sufficient volunteers can be difficult - bias towards leaf and flower visiting insects, and hence is strongly affected by weather conditions 	-could be used as complement of transects to identify additional small species which are otherwise overlooked.	moderately expensive (including data collection and identification per visit).
Pan traps	Other wild bees than bumblebees (mainly solitary bees), hoverflies	a lethal sampling technique designed to survey foraging pollinators (particularly solitary bees and hoverflies) or	 High taxonomic resolution greater sampling of individuals than transects does not require expert knowledge and can be 	 inverse relationship between pan trap catch and floral density ('competition') very sensitive to the immediate floral environment 	Pan traps and transects have different utility and efficacy for monitoring different aspects of pollinator biodiversity, depends on the objective. Provide species resolution data independent of	- relatively inexpensive and easy to make but can be costly due to the labour required to set up, collect and remove multiple trapping stations across a site.

		designed to survey flower- visiting insects	readily implemented by volunteer networks -very standardised in sampling effort	 risks under- representing certain pollinator species due to biases in the species caught -potentially more species groups sampled than wanted (additional sorting work) 	expertise and require less person effort to achieve equivalent sample sizes when compared to transects	
Russell yellow traps	best for bumblebees, but also for solitary bees, hoverflies during late summer and other flower- visiting insects	Lethal sampling technique. Attracts day- active pollinators through its yellow colour -monitoring species richness during spring	Fairly large samples of bumble bees can easily and simultaneously be collected from multiple locations, and hoverflies (in late summer) -pollinator samples remain in good condition	efficiency of the traps decreases substantially during the summer when natural flowers become more available (competition) - destructive for bumble bee populations - do not sample solitary bees very effectively -efficacy of individual traps can vary a lot -not suitable for continuous, annual monitoring of species abundances	Could be useful to map changes in bumble bee occurrence and distribution, but that it is not suitable for continuous, annual monitoring of species abundances	inexpensive when working with volunteers needs to be checked at 2 weeks intervals -need experts for identification (but samples can be frozen and identified at later stage)
Light traps	night active insects (mostly moths)	Lethal sampling technique, or non-lethal if	-most effective way to monitor night active insects that have an	 must be checked weekly by a professional recorder 	low powered traps can give highly detailed information on	When a killing agent is used, an expert has to analyse all collected specimens, which

		moths are directly counted on a net around the light	important role in pollination - easy to deploy and the specimens are easily collected	 Dead specimens are dissimilar in their pose to living specimens, likely difficult to identify only attracts night- active insects, and only the subset that is attracted to light. 	population trends in moths in a particular location	brings up costs. Otherwise, it is fairly inexpensive.
Flight interception traps (malaise traps, window traps)	Flying insects	Passive lethal sampling technique designed to survey flying insects - often used to collect insects for biodiversity surveys aiming to inventory the community of sites	does not include the biases associated with methods that rely on attracting insects or relying on human observers	 quality of the data strongly depend upon the standardisation in sampling design and the way they are deployed requires experts for identification, which makes it expensive and time-consuming requires sorting, only a small proportion of insects are actual pollinators 	 should be combined with pan trapping When the design and use of Malaise traps is standardised for a scheme, and numerous traps are deployed for a sufficient length of time, a comparative assessment in space and time of pollinator trends is possible 	relatively expensive as both the trap and the data processing are costly.
Sugar bait traps	Attracting insects that are looking for aphid honeydew or rotting fruits to feed on - targets foraging insects, noctuid and	Lethal sampling technique.	easier to place than light traps (no electricity needed)	Attractiveness of sugar baits varies between seasons, and it is generally lower during spring - more demanding to operate than light traps - not standardised - only attract a limited number of species	potential for large-scale trapping schemes to run over multiple years	relatively cheap.

Trap nests	geometrid moths cavity nesting species of above- ground nesting bees	-lethal or non- lethal. -monitoring of local bee and wasp diversity and species	-capture information on the environment where the bees and wasps live and other aspects of the bee community	-only catch a small fraction of solitary bees and wasps (5% of all bee and wasp species)	-trap nests can be used without killing of insects, if are counted: closed nests of different nest types or open nests to identify bees (and their	-species experts need to go through the collected nests for the identification. -relatively cheap
	species of above- ground nesting bees and wasps	-monitoring of local bee and wasp diversity and species richness -collecting information on multi-trophic interactions and the needs of the species studied -information on parasitoids	the bees and wasps live and other aspects of the bee community -low effort during field season (traps collected in autumn), can be used in combination with other methods -Volunteers could be involved in placing, monitoring and gathering the trap nests, and perhaps also in building them	bees and wasps (5% of all bee and wasp species) -the handling of trap nests is time and space demanding	if are counted: closed nests of different nest types or open nests to identify bees (and their parasitoids) to species, genus, or family level. Abundance can be recorded by counting larvae within nests, or by counting occupied nests -trap nests may require killing if individuals are to be identified (the adults emerging from the nest are killed for identification the next season).	collected nests for the identification. -relatively cheap

There are emerging new technologies such as visual and audio sensors, and also eDNA methods which will soon help volunteers in identifying pollinators. There is already a suite of useful apps available and these will continue to improve in the near future.

Some recommendations for designing monitoring schemes

1. Identify where you are starting from

Identify the baseline situation (ideally)

In order to establish a meaningful baseline for monitoring, the only way is to do some preliminary monitoring (preferably for multiple years). However, if you do not have the time and resources for this, even a year or two of preliminary monitoring will give you useful information.

A baseline can also be established using species occurrence data and information about species threat status. It might be possible to establish a species list if there is a national or local biodiversity data centre which has collated records. However, this is likely to be incomplete due to low sampling intensity, or comprise of opportunistic observations rather than through any standardised methodology.

It may be possible that some recording schemes have already collected some historical data which could be used for comparison, but it is unlikely that these will include the same sites or the same taxa that are planned to be monitored.

Hoverfly ecological diagnosis in urban grassland habitats in Besançon (France):

In Besançon, the city administration manages 2,408 hectares of green spaces, including 2,000 hectares of forests. The city commissioned the Conservatoire d'espaces naturels de Franche-Comté (CEN) to carry out a "Syrph the Net" hoverfly diagnosis in urban green spaces managed in a biodiversity-friendly way. This method aims to compare the observed population of hoverflies (flower-feeding diptera) with an expected population in a hilly meadow in a good state of conservation. The aim was also to find out whether the trees of these green spaces are likely to be home to certain remarkable saproxylic species. For two consecutive years (2019/2020), four interception traps (Malaise tents) were set up to survey the population of One of the four malaise traps installed in the city hoverflies, and additional sight-hunting was carried out.



The diagnosis highlighted certain strengths and weaknesses of the open environments of Besançon's green spaces for hoverflies. The diagnosis revealed that the shrub layer was underdeveloped in the most heavily managed areas, which explained the absence of certain hoverfly species. The diagnosis for old trees identified the most typical tree species hosting hoverflies and their dynamics.

The *Syrph the Net* methodology is detailed <u>here</u> and <u>here</u>.

Wild bee atlas in Brussels, Belgium

The aim of the Atlas of Wild Bees in the Brussels-Capital Region, financed by Brussels Environment for 2019-2020 and implemented by Prof. Nicolas Vereecken's team at the Agroecology Laboratory of the Université Libre de Bruxelles, is to gain a better understanding of the diversity, distribution, abundance and needs of the 208 species of wild bees present in Brussels and to produce a document accessible to the general public summarising the current state of knowledge. The atlas is a valuable tool for the consideration of wild bee habitats in urban planning decision. It also gives recommendations on the management of urban green spaces for the optimal conservation of wild bee species. The coordinators



see the Atlas as the foundation stone for a more systematic and standardised monitoring of wild bee species at regional scale, in the middle and long-term.

Extract from the atlas, distribution map of Andrena albofasciata (endangered) in Brussels

More info on the project's website here, and the full atlas here.

Identify existing monitoring schemes and knowledge gaps

Making contact with Natural History museums, universities, and wildlife recording societies and schemes is a good initial step in any urban area. There may also be a national record centre which would allow to identification of ongoing or historical monitoring schemes.

2. Make sure the design of the monitoring scheme is robust

Monitoring schemes should as far as practical try and meet the following criteria (Buckland and Johnston, 2017):

- Representative sampling locations: to ensure there are low or no bias in the biodiversity trends towards particular habitats or locations. There are two ways to approach this: designbased (simple random or stratified random site selection) or model-based (reweighting the contribution of each sample) representativeness.
- Sufficient sample size to ensure reasonable precision.
- Sufficient detections of target species: it may be necessary to have separate schemes for key species, for example to ensure that the range of a rare and restricted species is adequately sampled, or to allow different field methods to detect a particular species. Suggested analytical methods to estimate detectability: distance sampling methods, double-observer methods, repeat visits and occupancy modelling.

- A representative sample of species: they should be representative of all species in the community of interest.
- A sound temporal sampling scheme: ideal design might be annual surveys conducted at the same time each year. Otherwise, a rolling survey might be possible, in which a portion of the sites are surveyed each year. If only one survey per year is conducted, it is probably better to standardise it via phenology than via date (i.e. conduct it during plant xxx flowering). In the case of solitary bees and hoverflies, which often fly less than one month per species, several surveys per year might be needed to record all species (ideally monthly between April and August in Central Europe).
- **Reliable baseline state identification:** Inaccurate baseline year estimates might lead to inaccurate estimates of population trends. The first year of the time series does not need to be the baseline year. For example, choosing a year for which more data is available might reduce bias and increase precision.
- Ensure open access to data
- Get advice: A practical recommendation would be to team up with a local Research Institute, University, or established recording scheme to help in the design, site selection, methods and training needed to set up monitoring.

3. Plan urban management based on monitoring data and target identification

This step is important as it makes the link between monitoring and conservation actions. Closely connecting monitoring to management decisions can also be a way to strengthen commitment to conservation actions (for example from the green space management staff).

For example, monitoring data could help testing the effectiveness of a new green space management practice, or help assessing the impact on pollinators of a planned development by looking at a similar development elsewhere. Project managers may need to consider the following elements:



• Define specific conservation objectives

It is important to define short- and medium-term targets to strengthen commitment to conservation actions. For example, if a city decides to find out more about the causes of declines in pollinating and beneficial insect species, the **identification of thresholds of 'acceptable and unacceptable change'** (x% of decline in a specific species in y years, reduction in distribution of species, etc) is recommended by Lindenmayer, Piggott and Wintle (2013).

• Have a plan linking monitoring and conservation actions

It should detail how the monitoring information will be used and how it aims to solve uncertainties about potential conservation actions. For this, it might be useful to identify a 'state variable' (population size, etc) that closely relates to the conservation action that is being implemented.

• Identify challenges and failures

In general, monitoring should also be adaptive, and be used as feedback loop to learn about management decisions (James et al, 2008). This should include documentation of failures, which provide useful suggestions for improvement.

In the perspective of pollinator monitoring and planning of conservation actions, setting up a strategy for conserving wild pollinators or a biodiversity strategy at city scale (or wider scale) might be an important step. The Commission <u>guidance for pollinator-friendly cities</u> provides useful information on how to develop a pollinator-friendly city vision and programme, and how to integrate pollinator concerns into existing policies and policy instruments (Wilk, Rebollo and Hanania, 2019).

Strategy for pollinating and auxiliary insects in the Brussels-Capital Region 2023-2030

The overall target of Brussels' pollinator strategy is to reduce by 50% the number of species showing a negative trend in terms of population size and distribution and increase by 50% the number of species showing a positive trend, compared with 2019, by 2030.

One of the three axes of Brussels's strategy for achieving this target is focusing on increasing knowledge on pollinators via monitoring. The strategy also to actively monitor insect population dynamics, improve knowledge of the state and development of honeybee populations, assess the quality and quantity of food resources available for pollinators, assess the impact of managed pollinator and auxiliary inputs, and assess the interactions and interdependencies between regional agriculture and pollinators and auxiliary insects.

This monitoring axis should help assess the baseline situation and evaluate the effectiveness of pollinator conservation and restoration actions in order to report on whether or not the other objectives set and commitments made have been achieved.

Strategy available <u>here</u>.

More resources:

- Ireland Pollinator Plan 2021-2025
- <u>National Pollinator Strategy for England 2014</u>
- Berlin pollinator strategy (2019)
- Pollinators Strategy for Scotland (2017-2027)
- Pollinator Strategy for Scotland Progress Report

- Green Infrastructure Action Plan for Pollinators of South-East Wales •
- Dutch Pollinator Strategy "Bed & Breakfast for Bees"
- Norwegian National Pollinator Strategy

4. Identify sources of funding

A recent study found that, contrary to common belief, pollinator monitoring "more than pays for itself", when the full costs of running monitoring schemes are evaluated against the benefits that pollinators provide to research and society (Breeze et al, 2021). Researchers compared costs for implementing four different types of national-level monitoring schemes (professional monitoring scheme, professional pollination monitoring scheme, volunteer collected pan traps, and volunteer focal floral observations). When paying attention to various aspects of the monitoring scheme design, monitoring schemes could save at least €1.7 on data collection per €1 spent. This study provides a strong economic and scientific argument that monitoring is both affordable and highly beneficial for ecological research, decision-making and conservation action.

Since the setting up of a pollinator monitoring programme might be costly for city administrations, the Commission guidance for pollinator-friendly cities suggests the participation in EU funded research projects (Wilk, Rebollo and Hanania, 2019). For example, the proGireg project (productive Green Infrastructure for post-industrial urban regeneration; 2018-2023) focuses on the creation of pollinator habitats through nature-based solutions, and gives a central role to pollinator monitoring. Turin, Dortmund, Cascais and Piraeus, that are part of the project, implemented pollinator-focused naturebased solutions.

Measures are also needed to ensure that municipalities secure financial capacities, including (national) funding to avoid disruption (e.g. to continue employing experts when temporal EU funds/projects are finalised) and subsidising pollinator-friendly practices of public utility companies.

Based on semi-structured interviews with 67 biodiversity monitoring managers, Breeze et al, 2023 identified the following recommendations for increasing cost-effectiveness of biodiversity monitoring schemes:



- 1. Improving biodiversity monitoring requires **long-term financial commitment**: long-term funding will enable organisations to plan adequately and retain their established skill base
- 2. Monitoring organisations need **specialist expertise** to keep costs down and increase their outputs: due to lack of staff, organisations may need to use expensive contractors to carry out monitoring, while committing to recruiting and retaining staff would guarantee high quality and accessible data
- 3. Rising demands for data and from inflation are significant pressures on monitoring organisations: accounting for the time and cost burden of meeting increased demands for monitoring data should be considered to prevent a decline in the quality of data collected.
- 4. **Investing in volunteers** is extremely valuable: although volunteer training, engagement and coordination can be costly and require specialist expertise, the benefits in terms of data generation and longevity are likely to greatly exceed this investment.
- 5. **Supporting collaboration and diverse data collection** could greatly increase costefficiency: Identifying opportunities for monitoring efforts to collect additional data at sites they monitor, colocate and integrate their data collection efforts or readily access other data sources could improve the cost-efficiency of data collection.
- 6. **New technologies** beyond data collection are important cost-saving tools: genetic and remote sensing methods could improve data entry by reducing administrative burden.
- 7. There is **no single challenge or solution**: cost factors may vary considerably over time, which requires collaboration to identify needs and adapt strategies.

5. Create commitment

Provide training and expertise

As underlined in the <u>Proposal for an EU Pollinator Monitoring Scheme</u> (EU PoMS), taxonomic expertise is critical to setting up a monitoring scheme. Still, it is not necessarily available in each EU Member State². To fill this gap, identification courses are helpful to train amateurs in identifying pollinators as well as improving expert knowledge. For a voluntary monitoring scheme, good training in identification as well as good mentoring is crucial. There are also a number of apps that help citizen scientists with taxonomic identification (like <u>iNaturalist</u> for example). For a professional pillar, good taxonomic training is necessary to be able to process a large number of samples.

² The European Red List of Taxonomists assesses the status of taxonomic expertise capacity in Europe <u>https://op.europa.eu/en/publication-detail/-/publication/14039058-75ed-11ed-9887-01aa75ed71a1</u>

Biodiversity and pollinator training for green space management staff in Besancon (FR)

In Besancon, the green space management staff has followed in 2019 a 5-day training with the Lyonbased association <u>Arthropologia</u>, on biodiversity and pollinators. The aim was first to introduce the staff with the basics of plant knowledge and pollinator ecology. Then, the sessions focused on pollinator-friendly green space management. The training received very positive feedback from the staff. At the end of the training, the staff was able to identify the impact of differentiated management on biodiversity, identify functional groups, and ready to implement concrete actions with a view to maintain and promote biodiversity. Arthropologia has also developed a simple monitoring tool that enables managers of green spaces, roadways, landscaping and urban planning to independently assess the quality of a site for pollinators and identify areas for improvement to meet the basic needs of pollinators (more info <u>here</u>).

JOUR1- La Biodiversité : c'est quoi, ça (nous) sert à quoi ?

- Définitions, présentation en quelques chiffres : Faune, Flore, Habitats
- Services écosystémiques : sol, photosynthèse, protection des cultures, pollinisation...
- Déclin de la biodiversité et ses causes

JOUR2- Reconnaître et attirer la biodiversité fonctionnelle

- Les principaux groupes fonctionnels : cycles de vie, écologie
- Comment attirer et favoriser les auxiliaires

JOUR3- Focus sur les pollinisateurs

- Connaître la diversité des pollinisateurs, leurs cycles de vie
- Comprendre les causes du déclin
- Identifier des zones de nidification potentielles et favoriser les abeilles

Extract of the training programme (in French)

JOUR4- Les pratiques vues par la vie du sol et les plantes (bioindicatrices)

- Connaître la vie du sol
- Aborder les notions de caractères bioindicateurs et la levée de dormance
- Présenter la méthode de diagnostic des sols

JOUR5- Agir pour la biodiversité : (ré-)aménager et gérer en faveur de la biodiversité

- Appliquer ses connaissances pour reconstituer la mosaïque de milieux à différentes échelles
- Engager les espaces verts pour plus de biodiversité
- Atténuer les effets du changement climatique



Strengthening taxonomic capacity with the Pollinator Academy

The Pollinator Academy has been developed by the Dutch national natural history museum Naturalis as a resource to train citizen scientists in pollinator monitoring and taxonomy, in the English language. The website provides factsheets, training materials, identification tools, links to relevant resources, and training material for trainers. The Pollinator Academy also offers physical <u>advanced taxonomy courses</u> on bees and hoverflies across the EU.

Website <u>here</u>.

Get research advice and increase cooperation.

Setting up an effective monitoring scheme will often require city administrations to seek collaboration with research institutions that may help to identify specific, measurable, ambitious, realistic and timebound (SMART) monitoring targets and help to identify experts.

For example, the city of Paris recently co-funded <u>a study</u> on urban pollinators' ecology and the impact of pollinator management in urban green spaces that was conducted by researchers from the Institute of Ecology and Environmental Sciences-Paris (iEES-Paris) and Sorbonne Université (Zaninotto and Dajoz, 2022). Results confirmed the effectiveness of pollinator conservation policies, like the ban on the use of pesticides in urban green spaces or identifying levers of further action.

Collaboration between science and policy is crucial for a successful pollinator conservation scheme. In a paper identifying critical knowledge needs for evidence-based conservation of wild insect pollinators, the "experimental knowledge" [of policy makers] was found to be as important as the theoretical and empirical knowledge that experts bring (Dicks et al, 2013). Therefore, open discussion between stakeholder groups and scientists should be encouraged. The need for enhanced cooperation between public administration and ecologists was also underlined in the <u>report</u> of the expert workshop on local planning for pollinators in the context of the revision of the EU Pollinator initiative (Stockhammer and Schindler, 2022b).

Facilitating expertise sharing and cooperation with the Naturalist conferences in the Paris region (FR)

Paris Regional Agency for Biodiversity (ARB IDF) organises naturalist conferences each year, an opportunity to look back on the year's key naturalist events, the results of studies, and global naturalist issues at regional and extra-regional levels. They are also a chance for professionals to get together and exchange ideas and expertise.



Photo © Jeanne Rouillard. December 2022 Naturalist conference.

The 2022 edition included the ecology of sawflies, the presentation of the new regional Red List of Amphibians and Reptiles and the SOS Snake initiative, the monitoring of nocturnal bird migration, the population dynamics of the Great Horned Owl in France and the 10th anniversary of the Regional School of Ornithology. The meetings also provided an opportunity to review ten years of inventories of Odonata in the Paris region. More info here

Beyond science-policy collaboration, it is likely essential to ensure cooperation and information sharing at the city level, and between administrations. In an interview, Samuel Lelievre, director of green spaces management in the city of Besancon, underlined difficulties for getting the support from private companies and landowners managing private land in cities, which could likely affect the success of pollinator monitoring activities.

Such difficulties were also underlined by Gabriella Süle, researcher at the Centre for Ecological Research in Hungary, with the occasional management inaccuracies related to miscommunication between the Budapest green space management unit and the green space management staff. Subcontracting issues led to hiccups and interruptions in the researcher's monitoring activities in the city green spaces. Getting political support from the central city administration (ie. the mayor) was also noted as an important factor in encouraging the ambition or the creation of pollinator monitoring programmes. The EU-funded project <u>Biodiversea+</u> released a <u>Handbook on Stakeholder Engagement</u> (2014), which provides a framework for engaging with stakeholders, from stakeholder identification to conflict management or monitoring engagement (Durham et al, 2014).

Incorporate citizen science in the scheme

One of the best ways to **create commitment among citizens** for pollinator conservation is to include them in pollinator schemes via citizen science. There are numerous examples proving that citizen science programs can return scientifically valuable data on pollinators (see for instance (Le Féon et al, 2016)). Citizen-science-led studies can be a very cost-efficient way to collect data (see <u>Table 1</u> above

and Breeze et al, 2023), while raising awareness and understanding of pollinators, thereby increasing support for pollinator conservation actions.

Pilot citizen science project in Berlin: Bees, pollination and citizen science in gardens

In 2020, the Department of Ecosystem Science/Plant Ecology, represented by Dr Monika Egerer at the Technical University (TU) Berlin, and the Museum of Natural History (MfN), created a pilot citizen science project with Berlin gardeners from 18 community gardens. The aim was to understand more about biodiversity, ecology and the protection of wild bees in Berlin's gardens from a scientific point

of view and contribute to society's understanding of wild bees in Berlin.

During the 2020 summer season, community gardeners in Berlin observed pollination on selected tomato, pumpkin and/or pepper plants. They documented when their plant 1) blossoms, 2) is pollinated, and 3) bears fruit. At harvest, they measured the size of the fruits. Ecologists at the TU Berlin observed the wild bees in these gardens and documented the habitat features of the different gardens. The study results will be used to develop measures to encourage pollinators in community gardens. On 11 September 2020, "Bees, pollination and Citizen Science in Berlin's Dr. Monika Egerer and Martin Prenzel (right) from TU Berlin Gardens" was awarded the UN Decade on



Biodiversity Prize, which recognises projects and ideas contributing to the conservation of biodiversity in Germany. More info here.

Accuracy in identifications made by citizen scientists tends to vary, as shown by various citizen-science led studies: precision rate of 44% in school children identifying bumblebees by colour type (Roy et al, 2016), <50% accuracy when citizen scientists identified bumblebees to species (Garratt et al, 2019) and a miss-identification rate of 34% for citizen scientists recording insects on focal plants (ibid).

Although observation-based volunteer data are often less accurate than professional observation data, it is still precious to identify strategic areas for conservation (ibid). For example, in Seoul (Korea), data was collected from 2016 to 2018 using a citizen science project monitoring pollinators with a standard protocol based on photography. A smartphone application dedicated to this program was developed to collect data from volunteers who were asked to take pictures of insects landing on flowering plants. An entomology expert validated them. Data collected allowed the identification of strategic areas for pollinator conservation and encouraged stakeholders to set up conservation actions, notably where ecological data are lacking (Serret et al, 2022).

Setting up a successful citizen science scheme may require establishing a strong relationship between the research team and the team of volunteers: a citizen science programme in a school for example may require to adapt schedules and tailor activities to the school curricula (Saunders et al, 2018). The accuracy of data collected by citizen scientists can be greatly improved with training and capacity building, which requires time and resources (Roy et al, 2016). Understanding where misidentifications frequently occur can indicate where volunteers face the most significant challenges and where training resources can be strengthened to improve their recording abilities. Bumblebees, for example, are difficult to identify, with multiple species of similar appearance and variation within species between individuals (Falk et al, 2019).

Participatory science to evaluate the impact of green spaces management in France: "Florilèges Paris – urban meadows" and "Propage."



Florilèges-prairies was co-developed in 2014 and then launched in 2015 by the Muséum national d'Histoire Naturelle, Plante et Cité, the Conservatoire Botanique National du Bassin Parisien, the Département Seine-Saint-Denis and the Agence Régionale de la Biodiversité en Ile-de-France to improve knowledge of the effect of management practices on the ecological quality of grasslands, but also of the dynamics of change in these environments through standardised monitoring of the flora of urban grasslands.

The protocol involves recording 60 plant species in 10 1m² squares in the heart of the grassland. Several tools are provided to green space managers: a booklet to accompany the protocol, field sheets and a plant identification guide (the "Key to Grasslands"). Since 2014, 368 grasslands have been monitored at least once. A total of nine regions have taken part in the programme.

Urban meadow in Mount Palatin, Rome (Italy)

Propage is a protocol that was created in 2009 by the National History Museum and the NGO Noe, for green space managers to monitor butterflies. The protocol consists of counting and identifying butterflies among the 38 species or groups of species proposed by moving around a green space for 10 minutes over a distance of around 100 to 300 metres. The protocol is simple and very cheap, which makes it easy to follow for managers. The data collected makes it possible to compare increases or declines in species and changes in community composition with environmental factors.



Video explanation of the Propage protocol on Noe's youtube channel

More info <u>here</u> and <u>here</u> about Florilèges, and <u>here</u> for Propage.

The UK Centre for Ecology and Hydrology (UKCEH) have provided guidance on engaging citizen scientists. It provides a <u>step-by-step</u> to implementing a citizen science project from establishing the project team to the analysis and reporting phase. The UKCEH also provides an <u>insightful report</u> based on a synthesis of citizen science projects with numerous case studies.

The EU-funded project <u>Biodiversea+</u> released a <u>citizen science toolkit (2020)</u>, which details the different kinds of citizen monitoring as well as insights and advice for practitioners on setting up a citizen science monitoring scheme.

Engaging citizens through enhancing knowledge on pollinators: free MOOC on pollinators in France

From March to May 2023, the French Office for biodiversity (OFB) and Natural Reserves of France, in partnership with various other organisations, delivered an online open access training course on pollinators, with expertise from 21 pollinator experts and professionals. The aim of this online training course was to raise awareness of the need to preserve pollinators by disseminating scientific and technical knowledge on the subject, as well as practical tools for taking action. The MOOC was followed by more than 12.000 people.



Extract from one of the MOOC videos

More info here.



Partners involved in the creation of the MOOC

Challenges

1. Funding

A lack of funding is usually the main barrier to setting up or maintaining a (long-term) pollinator monitoring scheme. In a recent <u>survey</u> of biodiversity monitoring scheme bottlenecks conducted within the EU project EUROPABON, respondents scored total budget as the most significant barrier, followed by volunteer recruitment, the availability of specialists and volunteer retention (Breeze et al, 2023).

Monitoring schemes often benefit from one-off funding programmes, or annual applications, which restricts the scope of monitoring objectives and methodologies and long-term planning. Besides a direct lack of financial support for monitoring schemes, difficulties regularly stem from a lack of monitoring-competent staff within the city administration, or dedicated time allocated to oversee pollinator monitoring schemes.

Setting up a pollinator monitoring scheme is usually not considered as a top priority for the city administration, which is related to the perception that monitoring data is not directly relevant to urban planning decisions.

This underlines the importance of monitoring schemes to define clear objectives and a connection to conservation decisions that should help cities adapt their green space management (see recommendation number 3 above). The benefits from the investment in monitoring are much more visible if this is done well.

2. Accounting for conflicting visions and coordination issues

• Navigating between urban planning priorities

Pollinator conservation is about setting objectives and taking conservation decisions that may involve trade-offs between urban planning priorities and pollinator conservation (like urban expansion reducing the surface of green spaces for example).

• Dealing with public perception

Urban planners may have to deal with conflicting public perception on adequate management of urban (green) spaces. In some cultures, the conflict between "neat and clean" aesthetics and pollinator friendly green space management is one of the biggest challenges that city administrations have to deal with³. Indeed, green spaces must supply multiple functions that are not always compatible. For instance, a park can offer many opportunities for pollinator, and broader biodiversity conservation. However they also need to be managed in a way that means that tall vegetation doesn't trap litter (which people tend to dislike), or vegetation does not overgrow so that it becomes a security risk (places where people hide).

Importantly some of these issues can be addressed through good communication with the public and community groups. Anja Proske, project manager for the <u>Berlin wildbee project</u> at the German Wildlife foundation noted the importance of communication and signage when recreating pollinator habitats:

³ from an interview with Gabriella Süle, researcher at the Centre for Ecological Research in Hungary and involved in a pollinator scheme in Budapest

"public perceptions have been changing over time, as illustrated by perceptions on mowing: citizens used to complain about the city not mowing – nowadays they complain about green areas being mown. It is important to repeat and simplify messages to effectively influence public perceptions on urban greening and pollinators."

A lack of awareness of pollinators and nature more widely makes it more difficult to find volunteers for citizen-science projects, partly due to lack of awareness on pollinators. For example, there is lack of awareness on the fact that pollinator abundance and pollinator diversity are very different notions: there may be a lot of a common species which might be viewed as a success when in fact, it's the diversity, and particularly the hidden diversity (e.g. cryptic species) which are the main conservation challenges.

Therefore, having pollinator conservation and/or biodiversity conservation as part of the priorities in the urban planning agenda might ease the development of a pollinator monitoring scheme.

Potential trade-offs between pollinator conservation objectives

Trade-offs can also occur between pollinator conservation objectives, which may lead to different conservation actions: for example focusing on common species or targeting rare species. Such trade-offs call for appropriate planning, which pollinator monitoring can support or help adjusting.

• Pollinator monitoring logistics issues

Pollinator monitoring in urban areas can also be challenging, since surveyors may have to consider additional considerations for the realisation of monitoring activities: dealing with green space management planning, city dwellers' presence potentially influencing pollinator activity, etc. This may require more flexibility (adapt monitoring activities on the spot, if needed), increased coordination and potentially awareness raising with the local population. In Budapest for example, the management of urban areas is multi-layered: municipalities are divided into government, metropolitan and district areas of decision-making. There are also different green-space management companies, that may or may not coordinate perfectly.

• Invasive alien species

Cities can be hotspots for invasive alien species because they have many disturbed areas and diverse habitats. For example, the invasive giant resin bee *Megachile sculpturalis* is rapidly spreading all over Europe and often takes over insect hotels set up in city green spaces.



Invasive alien plants can be attractive to generalist pollinators and pollinators may actually help to spread some species more widely {Vanbergen, 2018 #50620}.

Pollinator monitoring may help to detect changes in populations linked to the effects of invasive alien species.

• Beehives negatively affecting wild pollinators

The general public often see the support of pollinator populations as being the same as policies to support beekeeping and installation of honey bee colonies or hives (Ropars et al, 2019). A high density of honeybee hives can have negative impacts on wild pollinators, but the evidence is mixed. These negative impacts are usually associated with very high densities of hives and in particular contexts (see for example Mallinger, Gaines-Day and Gratton (2017)). There is a general lack of public awareness on this topic since people tend to see no difference between wild pollinator diversity and the keeping of honeybees. Therefore, city administrations may need to take public perceptions into account when managing honeybee hive installations. Oslo has developed a conceptual analysis tool (Estimap pollination) to estimate the city's beehive carrying capacity and use a zoning plan to manage honey beehive locations. Brussels is also actively working on this topic, with the recent launch of a plan to regulate the proliferation of beehives in the city. For instance, beekeepers are required since September 2019 to register three or more hives with the local authority.

Cities are currently producing their urban greening plans. For example, Barcelona has its own 'green infrastructure and biodiversity plan ', which seeks to create a network of green spaces within the city and targets 1m² of greenery per resident by 2030.

This guidance highlights the importance of pollinator monitoring in cities and sheds light on different aspects of the process they might need to go through for implementing monitoring schemes. There are so many ways to conduct pollinator monitoring, and this guidance aimed to capture some of its complexity and diversity. This guidance also meant to disseminate some of the good practices on pollinator monitoring, that might start conversations and inspire others.



Resources

Aszalós, R, Batáry, P, Deák, P, Kovács-Hostyánszki, B, Kovács, A, Máté, A, Edina, M, Török, K, Orsolya, V (2023). ELKH Centre for Ecological Research Pollinator-friendly cities. Opportunities to support pollinating insects in the urban environment (in Hungarian). <u>https://ecolres.hu/wp-content/uploads/2023/03/Beporzo-barat-varosok-online-0313.pdf</u>

Berlin citizen science project. <u>https://www.tu.berlin/en/research/understanding-wild-bees.</u>

Brussels wild bee atlas: More info on the project's website <u>https://www.wildbnb.brussels/</u>, and the full atlas <u>https://www.researchgate.net/publication/366216316_WildBnB_-</u>_____Atlas des abeilles sauvages de la Region de Bruxelles-Capitale.

Citizen science study OPTIMOW in the UK. Project website: <u>https://www.markjfbrown.com/general-</u><u>7</u>

In the US: Citizen science monitoring guide : <u>https://xerces.org/publications/id-</u> monitoring/maritime-northwest-citizen-science-monitoring

Guide to citizen science: developing, implementing and evaluating citizen science to study biodiversity and the environment in the UK, UK environmental Observation framework. 2012 <u>https://www.ceh.ac.uk/sites/default/files/citizenscienceguide.pdf</u>

LIFE in the city: green urban and periurban regeneration for biodiversity conservation through stakeholder engagement and citizen empowerment in the Lombardy region (Italy) https://webgate.ec.europa.eu/life/publicWebsite/project/details/5820 and https://www.istituto-oikos.org/landing/life-in-the-city

Life Pollinaction: Actions for boosting pollination in rural and urban areas <u>https://webgate.ec.europa.eu/life/publicWebsite/index.cfm?fuseaction=search.dspPage&n_proj_id</u> <u>=7631#EI</u>

Monitoring protocols Florilèges <u>https://www.vigienature.fr/fr/florileges, https://www.suivis-espaces-verts.fr/les-resultats-florileges-prairie</u>, and Propage <u>https://www.suivis-espaces-verts.fr/le-programme-propage</u>



NGO Arthropologia: https://www.arthropologia.org/

Pollinators MOOC, French Office for Biodiversity (2023) <u>https://mooc.tela-botanica.org/course/view.php?id=637</u> Pollinator Academy <u>https://pollinatoracademy.eu/</u>

Rencontres naturalistes d'Île-de-France 2022, more info <u>https://www.arb-idf.fr/rencontres-naturalistes-dile-de-france-2022/</u>

Strategy for pollinating and beneficial insects in the Brussels-Capital Region 2023-2030, https://document.environnement.brussels/opac_css/elecfile/STRAT_20221215_Insectes_Pollinisate https://document.environnement.brussels/opac_css/elecfile/STRAT_20221215_Insectes_Pollinisate https://document.environnement.brussels/opac_css/elecfile/STRAT_20221215_Insectes_Pollinisate https://document.environnement.brussels/opac_css/elecfile/STRAT_20221215_Insectes_Pollinisate

Tallinn pollinator Highway, project webpage <u>https://www.tallinn.ee/en/tallinnovatsioon/pollinator-highway</u>

The EU Citizen Initiative "Save the bees and farmers", <u>https://europa.eu/citizens-initiative/initiatives/details/2019/000016_en</u>

The STING Project (Science and Technology for Pollinating Insects), project webpage. <u>https://knowledge4policy.ec.europa.eu/projects-activities/sting-project_en</u>

The Syrph the Net methodology for the monitoring of hoverflies: <u>https://www.researchgate.net/publication/348408915_StN_KEY_FOR_THE_IDENTIFICATION_OF_TH</u> <u>E_GENERA_OF_EUROPEAN_SYRPHIDAE_2020_and</u> <u>https://biodiversityireland.ie/app/uploads/2015/03/StN-Database-past-present-and-future-Speight1.pdf</u>

Urban greening platform website. <u>https://environment.ec.europa.eu/topics/urban-environment/urban-greening-platform_en</u>

Understanding Citizen Science and Environmental Monitoring: Final Report on behalf of UK-EOF. NERC Centre for Ecology & Hydrology and Natural History Museum. 2012 <u>https://www.ceh.ac.uk/sites/default/files/citizensciencereview.pdf</u>

References

Baldock, K C R, Goddard, M A, Hicks, D M, Kunin, W E, Mitschunas, N, Morse, H, Osgathorpe, L M, Potts, S G, Robertson, K M, Scott, A V, Staniczenko, P P A, Stone, G N, Vaughan, I P and Memmott, J (2019) A systems approach reveals urban pollinator hotspots and conservation opportunities. *Nature Ecology & Evolution* No 3, 363–373. <u>https://doi.org/10.1038/s41559-018-0769-y</u>

Baldock, K C R, Goddard, M A, Hicks, D M, Kunin, W E, Mitschunas, N, Osgathorpe, L M, Potts, S G, Robertson, K M, Scott, A V, Stone, G N, Vaughan, I P and Memmott, J (2015) Where is the UK's pollinator biodiversity? The importance of urban areas for flower-visiting insects. *Proceedings of the Royal Society B Biological Sciences* No 282 (1803), online athttp://dx.doi.org/10.1098/rspb.2014.2849. http://rspb.royalsocietypublishing.org/content/282/1803/20142849

Barra, M and Johan, H (2021) Écologie des toitures végétalisées. Synthèse de l'étude GROOVES. [Ecology of green roof. Summary of the GROOVES (Green roofs verified ecosystem services) study]. https://www.arb-idf.fr/nos-travaux/publications/ecologie-des-toitures-vegetalisees-2021/

Bellamy, C, van der Jagt, A, Kennedy, S, Smith, M and Moseley, D (2017a) A spatial framework for targeting urban planning for pollinators and people with local stakeholders: A route to healthy, blossoming communities? *Environmental Research* No 158, 255-268.

Bellamy, C C, van der Jagt, A P N, Barbour, S, Smith, M and Moseley, D (2017b) A spatial framework for targeting urban planning for pollinators and people with local stakeholders: A route to healthy, blossoming communities? *Environmental Research* No 158, 255-268. https://www.sciencedirect.com/science/article/pii/S0013935117311982

Breeze, T, Fernandez, M, McCallum, I, Morán-Ordóñez, A, Pereira, H and Junker, J (2023) EUROPABON D3.4 Cost-effectiveness analysis of monitoring schemes. *ARPHA Preprints* No 4, ARPHA Preprints. <u>https://doi.org/10.3897/arphapreprints.e105599</u>

Breeze, T D, Bailey, A P, Balcombe, K G, Brereton, T, Comont, R, Edwards, M, Garratt, M P, Harvey, M, Hawes, C, Isaac, N, Jitlal, M, Jones, C M, Kunin, W E, Lee, P, Morris, R K A, Musgrove, A, O'Connor, R S, Peyton, J, Potts, S G, Roberts, S P M, Roy, D B, Roy, H E, Tang, C Q, Vanbergen, A J and Carvell, C (2021) Pollinator monitoring more than pays for itself. *Journal of Applied Ecology* No 58 (1), 44-57. https://doi.org/10.1111/1365-2664.13755

Buckland, S T and Johnston, A (2017) Monitoring the biodiversity of regions: Key principles and
possible pitfalls. *Biological Conservation* No 214, 23-34.https://www.sciencedirect.com/science/article/pii/S0006320717309023

Burdine, J D and McCluney, K E (2019) Interactive effects of urbanization and local habitat characteristics influence bee communities and flower visitation rates. *Oecologia* No 190 (4), 715-723. https://doi.org/10.1007/s00442-019-04416-x

Dallimer, M, Irvine, K N, Skinner, A M J, Davies, Z G, Rouquette, J R, Maltby, L L, Warren, P H, Armsworth, P R and Gaston, K J (2012) Biodiversity and the feel-good factor: understanding associations between self-reported human well-being and species richness. *Bioscience* No 62 (1), 47-55. <u>http://bioscience.oxfordjournals.org/content/62/1/47.short</u>

Dicks, L V, Abrahams, A, Atkinson, J, Biesmeijer, J, Bourn, N, Brown, C, Brown, M J F, Carvell, C, Connolly, C, Cresswell, J E, Croft, P, Darvill, B, De Zylva, P, Effingham, P, Fountain, M, Goggin, A, Harding, D, Harding, T, Hartfield, C, Heard, M S, Heathcote, R, Heaver, D, Holland, J, Howe, M, Hughes, B, Huxley, T, Kunin, W E, Little, J, Mason, C, Memmott, J, Osborne, J, Pankhurst, T, Paxton, R J, Pocock, M J O, Potts, S G, Power, E F, Raine, N E, Ranelagh, E, Roberts, S, Saunders, R, Smith, K, Smith, R M, Sutton, P, Tilley, L A N, Tinsley, A, Tonhasca, A, Vanbergen, A J, Webster, S, Wilson, A and Sutherland, W J (2013) Identifying key knowledge needs for evidence-based conservation of wild insect pollinators: a collaborative cross-sectoral exercise. *Insect Conservation and Diversity* No 6 (3), 435-446. https://resjournals.onlinelibrary.wiley.com/doi/abs/10.1111/j.1752-4598.2012.00221.x

Durham, E, Baker, H, Smith, M, Moore, E and Morgan, V (2014) *The BiodivERsA Stakeholder Engagement Handbook*. BiodivERsA, Paris. <u>http://www.biodiversa.org/577</u>

European Commission (2023) *Revision of the EU Pollinators Initiative: A new deal for pollinators*. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM/2023/35 final, European Commission, Brussels. <u>https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM:2023:35:FIN</u>

Fortel, L, Henry, M, Guilbaud, L, Guirao, A, Kuhlmann, M, Mouret, H, Rollin, O and Vaissière, B (2014) Decreasing Abundance, Increasing Diversity and Changing Structure of the Wild Bee Community (Hymenoptera: Anthophila) along an Urbanization Gradient. *PLoS ONE* No 9, e104679.

Garratt, M P D, Potts, S G, Banks, G, Hawes, C, Breeze, T D, O'Connor, R S and Carvell, C (2019) Capacityand willingness of farmers and citizen scientists to monitor crop pollinators and pollination services.GlobalEcologyandConservationNo20,e00781.http://www.sciencedirect.com/science/article/pii/S2351989419304081

Geppert, C, Cappellari, A, Corcos, D, Caruso, V, Cerretti, P, Mei, M and Marini, L (2023) Temperature and not landscape composition shapes wild bee communities in an urban environment. *Insect Conservation and Diversity* No 16 (1), 65-76. <u>https://doi.org/10.1111/icad.12602</u>

Geslin, B, Le Féon, V, Folschweiller, M, Flacher, F, Carmignac, D, Motard, E, Perret, S and Dajoz, I (2016) The proportion of impervious surfaces at the landscape scale structures wild bee assemblages in a densely populated region. *Ecology and Evolution* No 6 (18), 6599-6615. https://doi.org/10.1002/ece3.2374

Gunnarsson, B and Federsel, L M (2014) Bumblebees in the city: abundance, species richness and diversity in two urban habitats. *Journal of Insect Conservation* No 18 (6), 1185-1191. https://doi.org/10.1007/s10841-014-9729-2

Hall, D M, Camilo, G R, Tonietto, R K, Ollerton, J, Ahrné, K, Arduser, M, Ascher, J S, Baldock, K C R, Fowler, R, Frankie, G, Goulson, D, Gunnarsson, B, Hanley, M E, Jackson, J I, Langellotto, G, Lowenstein, D, Minor, E S, Philpott, S M, Potts, S G, Sirohi, M H, Spevak, E M, Stone, G N and Threlfall, C G (2017) The city as a refuge for insect pollinators. *Conservation Biology* No 31 (1), 24-29. https://doi.org/10.1111/cobi.12840

Hausmann, S L, Petermann, J S and Rolff, J (2016) Wild bees as pollinators of city trees. *Insect Conservation and Diversity* No 9 (2), 97-107. <u>https://doi.org/10.1111/icad.12145</u>

Hicks, D M, Ouvrard, P, Baldock, K C R, Baude, M, Goddard, M A, Kunin, W E, Mitschunas, N, Memmott, J, Morse, H, Nikolitsi, M, Osgathorpe, L M, Potts, S G, Robertson, K M, Scott, A V, Sinclair, F, Westbury, D B and Stone, G N (2016) Food for pollinators: quantifying the nectar and pollen resources of urban flower meadows. *PLoS ONE* No 11 (6), e0158117. <u>https://doi.org/10.1371/journal.pone.0158117</u>

James, E L, Michael, C R, Harold, P L and William, L K (2008) Monitoring in the Context of Structured Decision-Making and Adaptive Management. *Journal of Wildlife Management* No 72 (8), 1683-1692. https://doi.org/10.2193/2008-141

Johnson, C A, Dutt, P and Levine, J M (2022) Competition for pollinators destabilizes plant coexistence. *Nature* No 607 (7920), 721-725. <u>https://doi.org/10.1038/s41586-022-04973-x</u>

Le Féon, V, Henry, M, Guilbaud, L, Coiffait-Gombault, C, Dufrêne, E, Kolodziejczyk, E, Kuhlmann, M, Requier, F and Vaissière, B E (2016) An expert-assisted citizen science program involving agricultural high schools provides national patterns on bee species assemblages. *Journal of Insect Conservation* No 20 (5), 905-918. <u>https://doi.org/10.1007/s10841-016-9927-1</u>

Lindenmayer, D B, Piggott, M P and Wintle, B A (2013) Counting the books while the library burns: why conservation monitoring programs need a plan for action. *Frontiers in Ecology and the Environment* No 11 (10), 549-555. <u>https://esajournals.onlinelibrary.wiley.com/doi/abs/10.1890/120220</u>

Mallinger, R E, Gaines-Day, H R and Gratton, C (2017) Do managed bees have negative effects on wild bees?: A systematic review of the literature. *PLoS ONE* No 12 (12), e0189268. https://doi.org/10.1371/journal.pone.0189268

Plascencia, M and Philpott, S M (2017) Floral abundance, richness, and spatial distribution drive urban garden bee communities. *Bulletin of Entomological Research* No 107 (5), 658-667. <u>https://www.cambridge.org/core/article/floral-abundance-richness-and-spatial-distribution-drive-urban-garden-bee-communities/A4389AF4AC64B8B04119946044F19043</u>

Ropars, L, Dajoz, I, Fontaine, C, Muratet, A and Geslin, B (2019) Wild pollinator activity negatively related to honey bee colony densities in urban context. *PLoS ONE* No 14 (9), e0222316. https://doi.org/10.1371/journal.pone.0222316

Roy, H E, Baxter, E, Saunders, A and Pocock, M J O (2016) Focal Plant Observations as a Standardised Method for Pollinator Monitoring: Opportunities and Limitations for Mass Participation Citizen Science. *PLoS ONE* No 11 (3), e0150794. <u>https://doi.org/10.1371/journal.pone.0150794</u>

Saunders, M E, Roger, E, Geary, W L, Meredith, F, Welbourne, D J, Bako, A, Canavan, E, Herro, F, Herron, C, Hung, O, Kunstler, M, Lin, J, Ludlow, N, Paton, M, Salt, S, Simpson, T, Wang, A, Zimmerman, N, Drews, K B, Dawson, H F, Martin, L W J, Sutton, J B, Webber, C C, Ritchie, A L, Berns, L D, Winch, B A, Reeves, H R, McLennan, E C, Gardner, J M, Butler, C G, Sutton, E I, Couttie, M M, Hildebrand, J B, Blackney, I A, Forsyth, J A, Keating, D M and Moles, A T (2018) Citizen science in schools: Engaging students in research on urban habitat for pollinators. *Austral Ecology* No 43 (6), 635-642. https://doi.org/10.1111/aec.12608

Serret, H, Andersen, D, Deguines, N, Clauzel, C, Park, W-H and Jang, Y (2022) Towards Ecological Management and Sustainable Urban Planning in Seoul, South Korea: Mapping Wild Pollinator Habitat Preferences and Corridors Using Citizen Science Data. *Animals* No 12, (11). https://www.mdpi.com/2076-2615/12/11/1469 Stockhammer, K and Schindler, S (2022a) *Workshop report on data and research for pollinators in the framework of the revision of the EU Pollinators Initiative.* <u>https://circabc.europa.eu/ui/group/3f466d71-92a7-49eb-9c63-6cb0fadf29dc/library/99cab351-ec45-491d-b2dc-c5f59b01b924/details</u>

Stockhammer, K and Schindler, S (2022b) *Workshop report on local and regional planning for wild pollinators-policy actions to conserve and restore* <u>https://circabc.europa.eu/ui/group/3f466d71-92a7-49eb-9c63-6cb0fadf29dc/library/99cab351-ec45-491d-b2dc-c5f59b01b924/details</u>

Süle, G, Kovács-Hostyánszki, A, Sárospataki, M, Kelemen, T I, Halassy, G, Horváth, A, Demeter, I, Báldi, A and Szigeti, V (2023) First steps of pollinator-promoting interventions in Eastern European urban areas – positive outcomes, challenges, and recommendations. *Urban Ecosystems* No 10.1007/s11252-023-01420-1. <u>https://doi.org/10.1007/s11252-023-01420-1</u>

Tsvetelina, F and Underwood, E (2020) *Citizens for pollinator conservation: a practical guidance*. IEEP guidance for European Commission, Brussels. <u>https://wikis.ec.europa.eu/display/EUPKH/Citizens</u>

Villemey, A, Jeusset, A, Vargac, M, Bertheau, Y, Coulon, A, Touroult, J, Vanpeene, S, Castagneyrol, B, Jactel, H, Witte, I, Deniaud, N, Flamerie De Lachapelle, F, Jaslier, E, Roy, V, Guinard, E, Le Mitouard, E, Rauel, V and Sordello, R (2018) Can linear transportation infrastructure verges constitute a habitat and/or a corridor for insects in temperate landscapes? A systematic review. *Environmental Evidence* No 7 (1), 5. <u>https://doi.org/10.1186/s13750-018-0117-3</u>

Wilk, B, Rebollo, V and Hanania, S (2019) *A guide for pollinator-friendly cities: How can spatial planners and land-use managers create favourable urban environments for pollinators?* Guidance prepared by ICLEI Europe for the European Commission. <u>https://wikis.ec.europa.eu/display/EUPKH/Pollinator-friendly+cities</u>

Zaninotto, V and Dajoz, I (2022) Keeping Up with Insect Pollinators in Paris. *Animals* No 12 (7). https://www.mdpi.com/2076-2615/12/7/923

Zaninotto, V, Fauviau, A and Dajoz, I (2023) Diversity of greenspace design and management impacts pollinator communities in a densely urbanized landscape: the city of Paris, France. *Urban Ecosystems* No 26 (2), 503-515. <u>https://doi.org/10.1007/s11252-023-01351-x</u>