Policy levers and financial mechanisms to action European Hoverfly conservation on the ground

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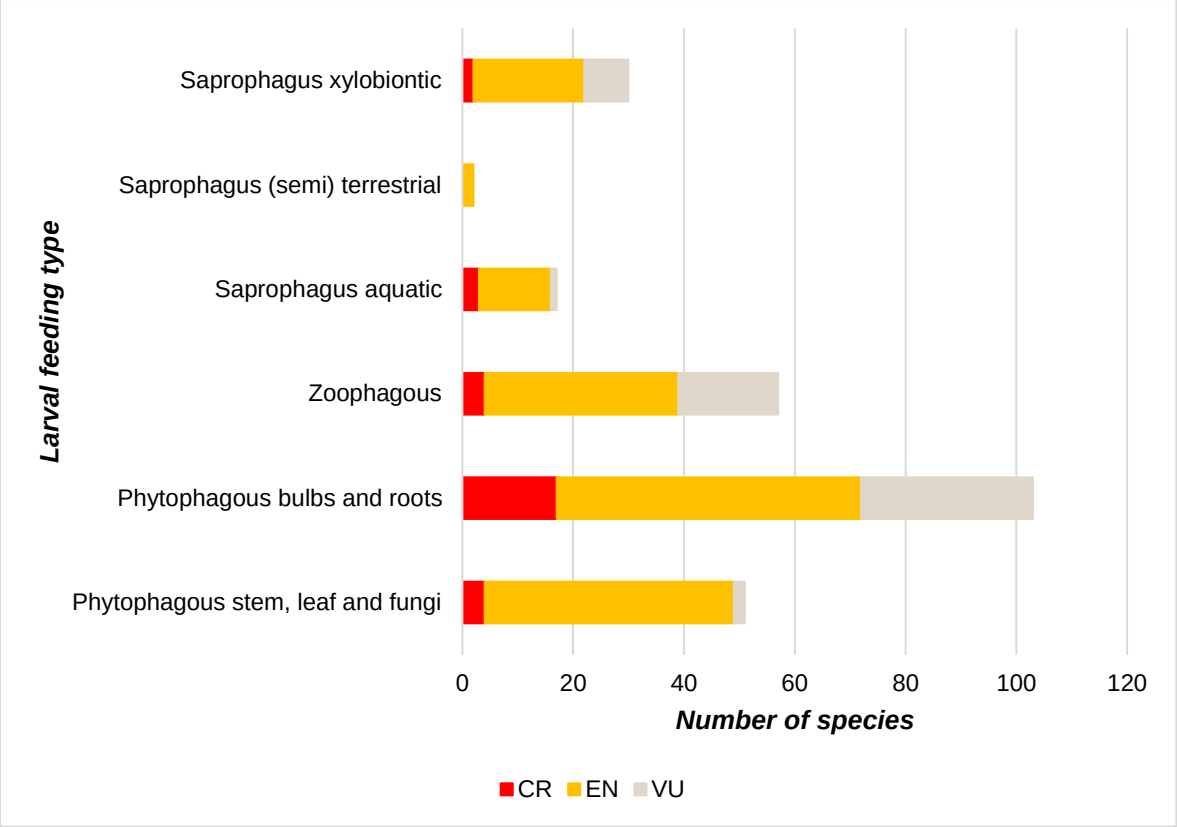
TABLE OF CONTENTS

Framing wild pollinator conservation in Europe

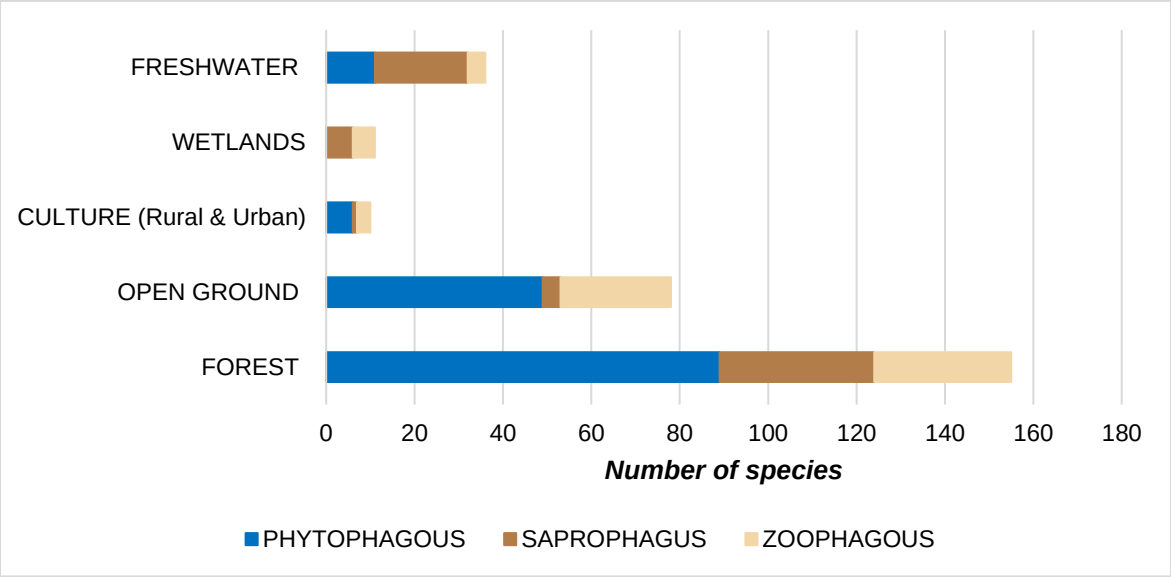
- Mirroring global trends, wild pollinators have been declining in Europe over the past decades, due to a combination of converging pressures including habitat loss, pesticides, disease caused by pathogens, invasive species, and climate change.
- For years now, Europe has been at the forefront of wild pollinator conservation efforts worldwide. Since 2014, the European Commission has been strategically increasing knowledge on wild pollinators by funding multiple European Red Lists on groups like bees, butterflies, and hoverflies (moths are underway), as well as on Insect Taxonomists (i.e., the people who can identify and describe these species). These have helped frame the magnitude of the problem of wild pollinator decline in Europe triggering, as a response, the adoption of the first European Union (EU) Pollinators Initiative (EPI) in 2018, which was subsequently revised in 2023. Additional policy and programmatic scaffolding and support for European wild pollinators continues to be built under the European Green Deal through different Strategies, Plans and Laws.
- More recently, the EU adopted the Kunming-Montreal Global Biodiversity Framework (GBF) in December 2022, which sets out an ambitious pathway to reach the global vision of a world living in harmony with nature by 2050. The Framework includes 4 goals for 2050 and 23 targets for 2030. The importance of wild pollinators is enshrined in Target 11 of the GBF, with pollination considered one of the critical contributions from biodiversity to people's well-being or quality of life.
- Societal pressure and support for European wild pollinator conservation has also grown in the last 5 years, with multiple initiatives prompting calls for decisive action to address the causes of their decline. A key action of the EPI that laid the foundation to address more systematically threats to pollinators was the establishment of an EU Pollinator Monitoring Scheme (EU POMS), with indicators to enable evaluation of actions taken to tackle declines.
- While knowledge gaps about stressors and species-specific conservation assessments continue to exist, we know enough about the problem and attendant solutions to act with sound conservation policy. However, a non-integrated, "bewildering" array of policy instruments administered by different levels of governance (European, Member-State, regional, etc.) complicates the ability to coordinate the multiscale, multisector actions needed to achieve wild pollinator conservation goals. Hence, overall success implementing science-based solutions hinges on understanding how and where to exact policy levers in existing governance structures.

All you need to know about Hoverflies

- In Europe, hoverflies are the most important pollinator group (alongside native bees) with some wildflowers being almost exclusively hoverfly-pollinated. They visit at least 72% of global food crops (estimated to be worth around € 275 billion per year) and > 70% of animal-pollinated wildflowers.
- Hoverfly contributions to healthy ecosystems extend beyond simple pollinator services to roles in biocontrol, water purification, and long-distance pollen transfer. Some species are commercially grown. In addition, hoverfly larvae have an important role in the natural decomposition of materials such as dead wood, compost, dung, and rotting aquatic vegetation, and can be used to decompose organic material from agricultural and industrial processes.
- There are approximately 980 hoverfly species reported for Europe. Of the nearly 900 species assessed in 2022 through the IUCN European Red List of Hoverflies, more than 37% are threatened with extinction.
- The main threats they face include intensive agriculture and livestock farming, unsustainable use of pesticides, unsustainable commercial forestry, urban development and pollution, and increasing wildfires as a result of climate change. Among other impacts, these pressures collectively deteriorate (or remove completely) microhabitat heterogeneity critical for hoverfly persistence, cause loss or alteration of small water bodies essential to larval development and contaminate hoverfly habitat and populations.
- Hoverflies have unusually diverse life-histories and microhabitat requirements. Adults feed mainly on pollen and nectar and range in size, many looking like bees and wasps. Their ecology is largely determined by the needs of the larvae, which also vary substantially in biology and feeding requirements.
- Deciduous and coniferous forests are the two most common macrohabitats for threatened European hoverfly species, whereas open ground macrohabitats are very important for hoverflies with phytophagous and zoophagous traits. Forest macrohabitats are more important for hoverflies with saprophagous larval feeding traits. Microhabitats can be shared by multiple species and can straddle different macrohabitats.
- Due to their specificities, hoverflies require conservation strategies that are considerably different from those targeting other pollinators, such as bees and butterflies - which is why a preliminary multi-species plan of action for European hoverfly species identified as threatened with extinction was put together in 2022 (IUCN SSC HSG/CPSG, 2022, also known as the Hoverfly ‘Assess to Plan (A2P)’ report).



The number of species in each of the six larval feeding type groups and the IUCN Red List categories within each group (n = 260 species). *Note: **Saprophagous**: larvae that feed on decaying wood, sap runs, tree-holes, etc. (xylobiontic: 30 species), or that feed on decaying organic matter, not dead wood ((semi) terrestrial: 2 species), or that do not feed on dead wood (aquatic. 17 species); **Zoophagous** - larvae that feed on other organisms, mainly aphids (57 species); **Phytophagous** – larvae that feed on vegetable material [can be on or in bulbs and roots (103 species), or on stems, leaves, fungi (51 species)]. **Source**: IUCN SSC HSG/CPSG (2022).*



Major macrohabitat associations of 260 threatened European hoverfly species indicating three larval feeding types (Phytophages, Saprophages and Zoophages). *Note: Few threatened species are found in rural and urban environments, or in wetlands. Most are associated with forests and open ground*. ***Source**: IUCN SSC HSG/CPSG (2022).*

The goals of this report

This report distils the main take away messages from the Hoverfly A2P Report, with two main goals:

1) To condense the science-based priorities identified in the Hoverfly A2P Report in a way that promotes their alignment with existing financial instruments, and
2) To signal the policy levers that need to be effected for a successful implementation of the recommendations provided in the Hoverfly A2P Report.

This report is not meant to be an exhaustive list of policy and funding options that could support European hoverfly conservation on the ground. Instead, it provides a snapshot of the main levers and instruments available and how these could be integrated to support European Hoverflies. Such an exhaustive list is more appropriate for the design of a funding roadmap which is out of the scope of this report; however, it will be a crucial exercise to undertake for effective implementation on-the-ground of the recommendations in the Hoverfly A2P Report.

This document is structured around the five main conservation priorities identified for European Hoverflies by experts, through consensus building, in the Hoverfly A2P Report, with minor adjustments to promote alignment with multi-scale policy and financial frameworks.

Summary of conservation priorities

Hoverfly experts have pinpointed five main conservation priorities for advancing European hoverfly conservation on the ground, based on the knowledge mobilized through the IUCN European Red List of Hoverflies assessments (2022), as follows:

The following sections provide a more detailed proposal for the implementation of each conservation priority.

Conservation Priority 1. Improve knowledge mobilization and build capacity

The following are two major proposed approaches that can make a significant contribution to fulfilling this conservation priority in a cost-effective way while leveraging from existing efforts.

Building a Community of Practice for European Hoverflies

The best way to promote the use of existing and future Hoverfly knowledge products, while filling knowledge gaps and improving species identification tools, is building a strong **Community of Practice for European Hoverflies**. The foundation is already quite solid, with the community's epicentre rooted in the IUCN SSC Hoverfly Specialist Group. The existent community is also quite well-connected across Europe and extremely collaborative. Building a true Community of Practice for European Hoverflies

(CoPEHov), however, means expanding the current network to also fill inter-generational, disciplinary, geographical and sectoral representativeness gaps, making it more resilient to political and funding sways of support to hoverfly conservation (at the European or Member-State level).

The A2P report presents an exhaustive checklist of activities that could fall under the mandate of such a CoPEHov (see Section 1.4 - IUCN SSC HSG/CPSG, 2022). These include replenishing the European syrphid identification literature, improving identification tools for European hoverfly genera, and mobilizing resources to address knowledge gaps. Additional outputs of such a community could include the ***design of a funding roadmap for European Hoverflies***. The latter is particularly relevant in a context of limited ability by many Member States in capturing EU funding. An example is France, where there are several entomologists able to work with syrphids but there is no overarching structure, under which they could operate, with enough money and administrative competence, that can design and implement, for example, a *L'Instrument Financier pour l'Environment* (LIFE) - or other EU-funded projects. Consequently, a coordinating body, like the CoPEHov, that has an interdisciplinary, cross-sectoral capacity and is collaborative in nature, would be strongly suited to spearhead the design of such a roadmap and increase European fundraising expertise for European Hoverflies.

The Natura 2000 Biogeographical Process could provide the ideal starting point to build a CoPEHov, as its purpose is precisely to provide a cooperative platform between EU Member States, stakeholders and experts, at the scale of biogeographical regions, to support discussions on how to meet the targets set under the EU Biodiversity Strategy for 2030. This science-policy interface is a fundamental forum to target, and where critical multidisciplinary and multi-sectoral support for Hoverfly conservation on the ground could be garnered. Another important platform to engage with to build rapport with the agricultural sector (one of the most impactful to hoverflies), is the EU CAP Network. This is a forum through which National CAP Networks, organisations, administrations, researchers, entrepreneurs and practitioners can share knowledge and information (e.g. via peer-to-peer learning and good practices) about agriculture and rural policy. Its aim is to support the design and implementation of CAP strategic plans, innovation and knowledge exchange, including EIP-AGRI, and evaluation and monitoring of the CAP. Ensuring engagement with this platform will be extremely beneficial to effectively mobilize the scientific knowledge produced through the

European Red List of Hoverflies and the Hoverfly A2P Report into conservation action on the ground.

Another parallel effort should be steered towards expanding the current expert community through COST (European Cooperation in Science and Technology) Actions that fund interdisciplinary research networks. These Actions bring together researchers, innovators and other professionals including industry specialists, who are based in Europe and beyond, for a period of 4 years to collaborate on research topics. The funding a COST Action receives covers the expenses of networking activities rather than research and as such is used to organise and fund events, Short-term Scientific Missions, Training Schools, communication activities, and virtual networking tools. A couple of Actions that are relevant as a template, and whose outputs are pertinent, for a potential CoPEHov are CA18201 - An integrated approach to conservation of threatened plants for the 21st Century (ConservePlants) and CA15219 - Developing new genetic tools for bioassessment of aquatic ecosystems in Europe (DNAqua-Net). For example, the latter has published a guidance document for the implementation of DNA-based biomonitoring tools on different types of samples, including invertebrate collections.

The European Taxonomy Booster Program

Identifying reliably the hoverfly fauna of a European country requires familiarity with 300 to 500 taxa in most of the Member States. Experience shows that someone starting with no knowledge of insects, or of the identification literature, requires 2 – 3 years to develop the expertise necessary to identify a substantial proportion of these 300-500 taxa reliably, assuming the necessary identification tools are available. This estimate is also contingent upon the availability of experts that can prescribe the appropriate course load to trainees for them to reach the desired level of competence.

Capacity building is therefore urgent to action hoverfly conservation on the ground. However, this is an issue that continues to plague biodiversity in general in Europe and that would likely be more cost-efficient (and more amenable to resource) if it were designed in a more systematic and holistic way. Enter the European Taxonomy Booster Program. While initiatives like the Global Taxonomy Initiative are facilitating capacity-building on DNA barcoding for rapid species identification, few countries have their own large-scale, multidisciplinary tailored programs to abate the concurrent expert deficit in

fields like taxonomy, with Australia and New Zealand being two of those few[1]. Europe is lagging, missing out on opportunities not just in terms of research and innovation, but also in relation to meeting a desperate need to create jobs and promote job mobility. The later is particularly critical for early-career professionals (and even worse for under-represented groups) who get lost every year through leakages in the pipeline related to lack of prospects in academia.

Appendix 1 is a proposed description of how the European Taxonomy Booster Program could be framed to anchor commitment towards its establishment and funding. This initiative would require strong leadership from the European Research Executive Agency and resourcing from Horizon Europe. Community-driven and grass-root initiatives, such as the Research Data Alliance, also need to be involved to enable data sharing on a global scale (for example, through the European Open Science Cloud (EOSC) - an environment for hosting and processing research data to support EU science)[2].

Conservation Priority 2. Adequately protect, manage & restore priority microhabitats & populations

Hoverflies need sufficient and highly diverse habitat in order to breed, mature undisturbed, and feed, and habitat requirements vary with larval feeding traits. As such, sustaining a diversity of hoverfly species in a landscape requires the stable presence and continuity of diverse microhabitats. In general, small-scale mosaic landscapes are ideal, with low agricultural and forestry pressure and large tracts free of pesticides, harmful fertilisers and seed coatings. Conversely, habitat fragments, such as small patches of woodland within heavily grazed areas, small water bodies and veteran trees and their associated microhabitats, are also essential to many species. However, due to a range of natural resource management decisions and practices, these microhabitats continue to be lost, even where adequate macrohabitats are still present, and hence require urgent protection.

[1] Discovering Biodiversity: A decadal plan for taxonomy and biosystematics in Australia and New Zealand 2018–2027
[2] The Value of the Research Data Alliance to the European Open Science Cloud (EOSC)

Prime Hoverfly Areas and landscape-scale planning

Prime Hoverfly Areas (PHAs) are areas shown to be important for hoverfly diversity and persistence and are identified through the application of a set of well-defined criteria. With exclusive implementation in Serbia so far, these areas have been frequently integrated into national conservation planning and monitoring schemes. For example, 70% of PHAs identified in Serbia are now protected.

Other similar spatial designations (like Prime Butterfly Areas) have shown not to be good proxies for hoverflies in Serbia, suggesting different pollinator groups should be considered separately. On the other hand, there was high (72%) overlap with Important Bird Areas and almost 50% overlap with Important Plant Areas, so it should be possible to develop synergies. These are important findings, because one of the actions contemplated in the revised EPI (2023) is the identification and mapping by 2025 of Key Pollinator Areas in the EU (Action 2.3), which are meant to become the focus of conservation and restoration efforts. However, if the level of spatial overlap of different pollinator groups is not high, this direction could become problematic to operationalize on the ground. Therefore, the identification of PHAs needs to be extended across Europe, ideally within and outside Protected Areas (PA) networks and other area-based conservation formats (such as Natura 2000 Network, Key Biodiversity Areas and Other Effective area-based Conservation Measures) to improve their likelihood of protection.

Landscape-scale management planning, which addresses a range of ecosystem processes, conservation objectives and land uses, is particularly beneficial for groups such as hoverflies with their complex resource and habitat requirements which change during their life cycle and may be spatially separated. Planning at the landscape scale rather than for a single land-use system within the landscape, recognises the interdependence of the multiple systems operating and provides an opportunity for collaborative conservation that incorporates elements of critical importance to hoverflies. Some of the landscape elements most critical to connect for hoverflies include: a) optimal proportions of different land-use types to encourage sufficient abundance of suitable macrohabitats; b) a diverse mosaic of favourable microhabitats; c) corridors and gradual “ecotones” or transition zones between habitats; and d) adequate buffer zones around sensitive areas to prevent contamination from other systems.

Priority II of the new EPI includes an objective to be achieved by 2030 that states ‘*Pollinator habitats are effectively connected in the wider landscape, allowing pollinators*

to disperse across the territory and respond to adverse climate impacts'. Therefore, newly identified PHAs outside existing PAs should be protected under these networks, with Action 4.3 specifically calling on Member States to '*address the needs of threatened pollinator species in the management of existing protected areas, and in their pledges for new protected areas under the EU Biodiversity Strategy for 2030*'. In this context, Action 4.4 calls for the devise of '*a blueprint for a network of ecological corridors for pollinators – "Buzz Lines"'* and for an associated implementation plan. Important linkages need to be made here to the ongoing EU-funded project NaturaConnect[3], which brings together academia, government bodies, non-governmental organizations, and other key stakeholders to create targeted knowledge and tools, and build the capacity to realise a truly coherent Trans-European Nature Network (TEN-N) of conserved areas that protect at least 30% of land in the EU, with at least one third of it under strict protection. The goals of the project are perfectly aligned with multiple actions outlined in the EPI (2023), making it a perfect outlet for the integration of PHAs and landscape planning exercises beneficial for hoverflies at the European scale.

Expanding mechanisms of protection

Even the smallest fragments of undisturbed habitat in overgrazed areas can support an entire population of some hoverfly species. There are existing EU financial mechanisms through which small habitat patches can be protected. For example, in France, shepherds can be duly compensated by the EU to implement biodiversity-friendly management actions through the *Mesures Agro-Environnementales et Climatiques* (MAEC) program. These management actions can range from delaying first grazing, cutting small trees to maintain open lands, or avoiding wetlands. Currently MAEC is available only for Natura 2000 sites and is focused on species listed in the EU Habitats Directive, which does not include hoverflies. However, to the extent that these measures can be implemented to promote good conservation status for an Annex I Habitat, then hoverflies could also indirectly benefit, due to their close association with some of these protected habitats.

The EU Habitats Directive requires the identification of typical species that reflect the structure and functions of habitat types, as well as early changes in the habitat condition. The identification of typical species is thus one of the main conditions to determine the

[3] NaturaConnect: Building a resilient ecological network of conserved areas across Europe for nature and people

conservation status of habitat types listed in Annex I of the Directive. Alpine grasslands and wetlands are especially fragile and vulnerable to the impacts of management activities, such as overgrazing. Most alpine grasslands and wetlands are EU Annex I Habitats, and hoverflies form part of their typical species. Therefore, Member States can use this requirement from the EU Habitats Directive to conserve hoverfly species, and remnant habitat patches of value to them, at least in some areas of Europe.

Other ongoing initiatives have the potential for upscaling at the European level. For example, in the UK, there is a long-term citizen scientist project to map old trees, that includes the development of predictive tools to identify where other old trees might be so that they can be protected. This exercise could be expanded across Europe to increase knowledge of where the last strongholds of these valuable habitats for hoverflies benefit protection.

Good practices to keep hoverflies and their habitats for generations to come

There are two sectors that can make the greatest contributions to promote the creation, management and restoration of pollinator-friendly habitats that accommodate the different ecological needs hoverflies have during the various stages of their life cycle. These are the forestry and agricultural sectors.

Forestry

Within forestry practices there are strategies and initiatives that enable a proportion of trees to get much older than the average harvesting age, thereby producing a continuous age distribution of trees to support habitat succession. In France, the Office National des Forêts (ONF) is undertaking actions to build and maintain a representative, connected and effectively managed network of large veteran trees and deadwood areas in public forests. The network also includes two kinds of “islands of ecological interest”: *îlots de sénescence* (senescence islands) and *îlots de vieillissement*. The former are similar to small biological reserves, where trees die without being removed or cut. The latter are areas where trees are not harvested until they have reached an extended rotation age. In addition to these islands, all public forests include trees marked as “*arbres bios*”, which are not harvested. All these elements work together to create a connected network of protected areas. In 2016, the ONF set targets to have 1% of public forests be *îlots de sénescence* by 2030 and 2% be *îlots de vieillissement* by 2069, and to have 3 bio trees per hectare by the end of the forestry cycle. At present, 2.36% of

public forests are already being managed as *îlots de sénescence* (above target) and 0.98% as *îlots de vieillissement*, and there is an average of 0.45 bio trees per hectare. In private lands, landowners can receive financial aid for creating these islands, to compensate for the loss in yield.

The current timeline for *îlots de sénescence* is, however, considered too short to secure veteran tree succession (trees are set aside for at least 30 years - maximum allowed is 50 years). Still, with an extended period of protection (old-growth forests typically represent > 200-year-old continuous forest cover), these practices could become valuable tools to maintain veteran tree habitats. The creation of small forest reserves has been experimented not just in France and Switzerland as senescence islands, but also in northern Europe as *woodland key habitats*. Once again, financial compensation Is available for forest owners to incur in these practices that promote the creation of hoverfly-friendly habitats; however, many of them are not common knowledge within the conservation community (sometimes even within the forestry sector itself) and/or go unspent due to inefficient integration[4]. Better dissemination of existing funding mechanisms is urgently needed to capitalize on available resources and galvanize cross-sectoral collaboration within the conservation community.

On the other hand, while in some cases some forest management practices have had positive impacts in saprophagous species, their impacts were negligible (if any) on phytophagous species because the measures do not result in improvements to the quality of the herb layer, or bulb and root microhabitats at ground level, on which these species rely. Ground-layer microhabitats and plant species in the forest important for these phytophagous species are often omitted in forestry management, which is generally focused on timber trees.

In July 2023, the European Commission further published the Guidance on the Development of Public and Private Payment Schemes for Forest Ecosystem Services which provides an overview of payment schemes for forest ecosystem services, including support available through EU funding, as well as case studies and good practices. These payment schemes are a tool to provide financial incentives to forest owners and managers to provide forest ecosystem services other than the provision of wood (through forest protection, restoration and sustainable forest management) and to increase the resilience of their forests. This aligns with the EU Forest Strategy for 2030

[4] Compensations environnementale, forestière et collective agricole: évaluation et mise en coherence (2021)

that preconises the development of financial incentives (particularly for private forest owners and managers) that compensate for the provision of these ecosystem services. For hoverflies, this presents an opportunity to benefit from EU, national and private resources that can be channelled to improve the quality of their habitats, **across all the stages of their life cycle**.

Agriculture

Improving outcomes for nature has become the focus of the Common Agricultural Policy (CAP) in recent years. This provides an opportunity to promote and expand hoverfly-friendly practices through methods such as organic farming, prescribed burning Integrated Pest Management and farming with alternative pollinators. Technical and financial assistance from different EU instruments is available to support agricultural activities broadly compatible with biodiversity, including hoverfly, conservation. For example, and to name a few, cohesion funds and the European Agricultural Fund for Rural Development, the InvestEU Fund[5] and 'Next Generation EU' funds[6].

Phytophagus species are known to be impacted by specific agricultural practices such as pesticide use and ploughing. Alternatives, such as organic farming (where no specific measures of habitat enhancement occur) can support high densities of hoverflies, but mainly of relatively common species of zoophagous larvae that benefit from feeding on aphids (and coccinellids). Many aphids are, however, crop pests and, thus, aphidophagous hoverfly larvae have a potentially significant role to play in natural biological control. This presents a good opportunity for building greater awareness of the value of hoverflies to the agriculture sector, and as a result, for encouraging hoverfly-friendly measures in an around crops. The new 'eco-schemes', under CAP, will offer a major stream of funding to boost sustainable practices, such as precision agriculture, agro-ecology (including organic farming), carbon farming and agroforestry[7]. The Farm to Fork Strategy states that Member States and the European Commission (EC) will ensure that these eco-schemes are appropriately resourced and implemented in the CAP Strategic Plans. The EC will further support the introduction of a minimum ring-fencing budget for eco-schemes. The Action Plan for the Development of Organic

[5] The InvestEU Fund will foster investment in the agro-food sector by de-risking investments by European corporations and facilitating access to finance for SMEs and mid-sized companies.
[6] 'Next Generation EU' funds could be used to support investments in the organic sector, provided that they meet the relevant conditions and objectives.
[7] Farm to Fork Strategy: For a fair, healthy and environmentally-friendly food system.

Production also puts forward an array of new actions, and mobilises different sources of funding that can support hoverfly conservation on the ground, with pollinators specifically addressed under Axis 3.

Prescribed burning is commonly used as an agro-sylvo-pastoral practice to maintain open areas within dense habitats. In well planned and executed fire management the temperature in the soil can remain low just a few millimetres below ground and the litter will quickly burn down, presenting little or no threat to phytophagous hoverfly larvae with bulb and root feeding traits. Further, where fire is not used to burn large areas at once, and deliberately ensures part of the habitat is left to support recovery, other hoverfly groups can also be sustained. This style of managements is and was used, for example, for large heathland areas with *Calluna* (heather) and supports good insect populations. Hoverfly-friendly fire management may be designed or tailored for different habitats, where their fire response is well understood. Some European countries provide financial aids to farmers to implement this technique. For example, prescribed burning interventions in Portugal are financed through the Permanent Forest Fund, with a recent study suggesting that this practice can be more cost-effective than taxation alone from a carbon sequestration perspective, representing a benefit potentially in the order of hundreds of million euros for Southern European countries[8].

Integrated Pest Management (IPM) is an ecosystem-based strategy that focuses on managing pests through a combination of techniques applied in order of hierarchy to minimise the use of chemical plant protection products. It is also an important piece of how the EU plans to see the use and risk of pesticides reduced by 50% by 2030, a goal of the EU's flagship food policy, the Farm to Fork strategy. This renders IPM one of the best candidates to manage agricultural land for hoverflies. Although the application of the IPM principles has been around in Europe since 2009, the uptake of the techniques across Member States has been very uneven and slow to materialise due to a profusion of definitions, general lack of support measures, emergence of new pests, among others[9].

Despite the goal of IPM to relegate agrochemical use to the last possible resort, plant health programs still largely revolve around chemical control. It is, therefore, highly desirable to reinvigorate IPM extension services that have largely been replaced with mass communications that target growers and other stakeholders with synthesized

[8] Prescribed burning as a cost-effective way to address climate change and forest management in Mediterranean countries (2021)
[9] Integrated pest management: A snapshot of action across the EU (2023)

knowledge rather than field-level advice. Extension would provide more education, training, on-site visits and technical advice so growers have the skills and knowledge to implement IPM strategies and respond effectively to specific pest activity and trends. In-person interaction with rural landowners is more likely to inspire behavioural changes and innovation on the farm as opposed to one-way forms of communication (e.g., “fact sheets”, web-based information, etc.). Although a European IPM program including extension activities would require resources, much of the required network of grower organizations, pesticide coordinators, and researchers already exist and could be broadened to include regional IPM expertise to liaise with a (ideally larger) group of European IPM extension specialists to set priorities and devise knowledge mobilization strategies. Current programmatic European initiatives can be leveraged (for example, under the Candidate European partnerships - European partnership of Agriculture of Data, European Partnership for Safe and Sustainable Food Systems) to provide coordination and funding.

Water management

Shifts in hydrological regimes due to water management, water abstraction, and the impacts of climate change have resulted in the loss or alteration of small water bodies essential for hoverfly larval development. The alteration and simplification of waterways and the loss, reduction and degradation of small water body microhabitats, or water saturated ground, have implications for all three groups of hoverfly larval feeding types. Water management is also a condition for the transition towards sustainable agriculture. Maintaining or restoring natural hydrology and protecting the integrity of small water bodies (such as springs or seasonal brooks in forests) are, therefore, critical measures to maintain hoverfly populations viable. At the European level, the Water Framework Directive and the Floods Directive are the two main policies regulating water-related issues.

In June 2022, a series of workshops[10] on the economics of the implementation of the Water Framework Directive and the Floods Directive, co-convened by the OECD and the European Commission’s Directorate-General for Environment, was the first step in strengthening Member States’ capacity to deliver in an efficient manner on the Directives’ environmental objectives, making the best use of economic analysis and instruments –

[10] OECD – EC DG Environment Initiative on the Economic Aspects of Implementing the EU Water Framework and Floods Directives

which were also identified in this process. Understanding the implications of these findings will be crucial to make the most of the resourcing opportunities they provide for European hoverflies and their habitats.

Conservation Priority 3. Improve public perception of hoverflies to enable behavioural change

Improving understanding among the public about various roles biodiversity plays in different ecosystems is essential to achieving systemic change in human behaviours compatible with living in harmony with nature. When it comes to insects, some orders are favoured due to their charismatic appearance (for instance, butterflies) or appreciation for their (known) ecosystem services (such as bees), while unfortunately many are disliked. Research has shown that motivation for these different attitudes is rooted in lack of knowledge, awareness or appreciation for the role less charismatic insect species play in ecology and in the economy. Therefore, investing in increasing awareness and understanding of hoverflies is likely to play a valuable role in their conservation.

Hoverfly awareness raising campaigns

For any successful engagement with the public to take action for biodiversity conservation, tailored and consistent messaging are key. While some more targeted efforts should be made to shift specific behaviours within certain markets (agricultural and forestry value chains, for example), a basic tenet of science communication is to ensure the message and the way it's delivered are adapted to the audience. Hence, one aspect to consider under this theme is the extent to which it will be beneficial (or necessary) to single out (i.e., disaggregate) hoverfly conservation from pollinator conservation communications.

Certainly, one of the greatest and most impactful efforts the EC has made under the EPI was the launch and maintenance of the EU Pollinator Information Hive, which has sections dedicated to hoverflies. It is highly encouraged that any communications at the Member State level continue to be divulged through this platform (even if through links to other internet pages). Only then will this become a true hub for communications on pollinators, and a centralized outlet for knowledge mobilization and transfer to the public.

Not dispersing attention among too many communication platforms will increase credibility of the content and public trust in the impact of their actions. It's also important to note that while recognition at the European level is extremely valuable for small-scale organizations involved in hoverfly conservation, the best way to sustain their engagement and buy-in into European initiatives is to grant them proper compensation. As far as this author is aware, there is a shortage of EU-level dedicated mechanisms that can support financially conservation organizations in their communication and awareness raising efforts (but see the INFORM EU network, the Development Education and Awareness Raising (DEAR) projects and Science Europe). This is a gap that requires urgent attention.

Beyond the general public, raising relevant stakeholder awareness to manage hoverfly-friendly habitats is also needed, engaging them at scale and equipping them to enable positive change being a priority for the near future. A more formal multi-scale communication strategy for European hoverflies can be devised by the CoPEHov. While the scale of the task might make it sound insurmountable, if the CoPEHov is well resourced and representative of the most influential sectors on hoverflies conservation, the effort will not only be completely feasible but extremely cost-effective and impactful. In the interim, large-scale initiatives such as the Pollinator Week which will take place June 17-23, 2024, can be revived at the EU level and rotate the attention among different groups of pollinators.

Transversal to these endeavors (and the ones below under this theme) is translation of communication materials into the EU's 24 official languages. Some of these efforts can be plugged voluntarily and at no cost by interested parties (for example, the EC's A guide for pollinator-friendly cities was kindly translated to Portuguese, at no cost, by the Portuguese environmental NGO Quercus ANCN in recognition of the potential for this tool to raise awareness of Portuguese municipalities in their role protecting pollinators in cities). Translators without Borders is another platform that can be leveraged to engage translators in hoverfly conservation. Human migrations and refugee crises are invariably linked to environmental deterioration, so while the focus of this community is to offer language services to humanitarian and development organizations worldwide, there is an argument that supports the interconnectedness of these issues with nature conservation.

Art and Science meet Hoverflies

It is particularly important to focus on environmental education in early childhood by offering stories about hoverflies as main characters that will resonate with children. This can help them to explore the unique characteristics, behaviours and roles hoverflies play, while at the same time addressing their potential confusions and misconceptions about these insects. These stories could use hoverflies as case studies to learn about how nature works, including understanding the impact that hoverfly species have on the ecosystem and human well-being, as well as the impact humans have (directly or indirectly) on species and their habitats. Focusing more on native nature on their doorstep, schools should use all opportunities to boost each nature connection journey, prioritising environmental awareness-raising at an early age. Educating children about the complexity of the environment needed for hoverflies is also a powerful way to advocate for a diverse variety of habitat types.

Creatives Unite is a tool that provides information on regional, national, specific project calls and finance providers for the creative and cultural sectors. In addition, the EU has collated information of financial instruments for the cultural and creative sectors (EU Funding Opportunities for the Cultural and Creative Sectors 2021-2027) that also highlights opportunities for multidisciplinary initiatives that include the environmental sector. Academics are also encouraged to invest more in communicating the outcomes of their research in non-traditional fora, as well as to explore synergies with artist collectives to increase the reach and impact of their science outside academia. A great outlet for that, which includes a special section for youth and facilitates the process of collaboration with artists, is the journal Current Conservation (see pieces on pollinators: Can only a few plants can make pollinators happy? and The mystery of the dead bees).

Bottom-up: Community-led pollinator initiatives

Next to environmental knowledge, connectedness to nature also has a great role in influencing environmental behaviour – people with a strong sense of connection to nature engage in a greater number of pro-environmental behaviours, which in turn improves their overall well-being and benefits nature. In this spirit, there are many simple nature activities and pathways to nature connectedness which could contribute to instigate more pro-nature conservation behaviour, such as creating a garden with plants that will support hoverfly communities, joining conservation projects or simply enjoying nature outdoors.

One way to accomplish this is to increase public engagement through citizen science projects dealing with hoverflies or their habitats. The Hoverfly A2P Report provides many examples of citizen science initiatives specifically aimed at hoverflies. Such projects could further involve the public in monitoring species or participating in conservation actions, directly affecting their knowledge, skills, and behaviour.

The EU Pollinator Information Hive has been mapping information on community-led initiatives to protect pollinators around the EU since 2019. This makes it easier to establish networks among stakeholders influential on hoverfly conservation, and better coordinate this type of initiatives on the ground.

Conservation Priority 4. Reduce contamination both inside and outside Protected Areas

Reshaping the culture of pesticide and fertiliser use across Europe will require significant changes to policy and to economic incentives at the EU and national levels, as well as to management principles, priorities, and methods at the level of individual sites. It will have significant implications for the agriculture and forestry sectors, as well as for the management of Natura 2000 sites and other legally protected areas. Much of this was beyond the scope of the Hoverfly A2P Report and is certainly outside this document too. However, there are a few pointers that can be provided in terms of the policy levers and financial mechanisms currently available to improve the situation.

What we know about hoverflies and toxic substances in Europe

As of 10 December 2021, there are 454 different pesticides approved for use in the European Union. There are still a lot of unknows in relation to the effects of single pesticides, and their combined effects, on insects, with most of available knowledge skewed towards bees (mostly honeybees). However, the assumption that pesticides are one of the major players in hoverfly decline is supported by data showing extremely high pesticide residues within some protected areas in NW-Germany in locations where dramatic insect declines, including those of hoverflies, were recorded.

Many hoverfly habitats, especially of rarer or threatened species, are dependent on low to medium nutrient levels. This is especially true for most open, species-rich grassland

habitats, for all heathland habitats and for oligo- to mesotrophic waterbodies and all bog systems. High loads of nitrogen are detrimental to specialised phytophagous and zoophagous hoverfly groups, with groups associated with ant nests disappearing in their entirety. In addition, all rare or threatened aquatic hoverfly groups which need oligo- to mesotrophic water conditions (like bog species) are affected. The potential effects of pesticides on hoverflies are manifold, with some of the most problematic linked to impaired reproduction success, increased vulnerability to disease, and trophic dynamics.

Insects themselves can carry pesticides deposited in one area across into neighbouring areas. For example, dry meadows used to be continuous in valleys but are now patchy between crop fields. Pollinators flying out of these patches are sprayed and carry the pesticide back into the patch before dying. Similarly, bees can nest in the soil of ploughed fields, moving back-and-forth during their visits to feed from flowers. Their typical foraging distance is 200-3000m, while most native pollinators usually travel <500m distance to feed, which gives a good indication of the size of the buffer zone required around sensitive areas to keep them free of pesticides. On the other hand, even if the application area is limited, there is no way of avoiding the insecticide cloud to move spatially into adjacent areas (for example, into a protected area), exterminating not just the insects in the target area but also those located outside the place of application. As such, current buffer-zone requirements are not adequate. In the EU, farmers are not allowed to spray within 10 m or 50 m of water bodies, but this will not prevent pesticide spread by insects. Furthermore, within Natura 2000 sites, all Annex 1 Habitat sites are strictly protected such that no degradation of quality is allowed. However, there are often crops within and adjacent to Natura 2000 sites, from which pesticides and nitrogen deposits can spread, causing slow degradation. The EU Biodiversity Strategy includes information about buffer zones around Protected Areas and encourages margins for pollinators around agricultural areas.

Solutions that (could) work

Safeguarding protected and conserved areas from the impact and occurrence of toxic substances, like pesticides, insecticides and fertilisers, will require a stronger understanding of the spatial dynamics of plant-pollinator interactions across a wide spectrum of pollinator groups, including hoverflies, to refine the size of buffer zones and increase the effectiveness of other management measures. Importantly the use of pesticides is not restricted to agricultural settings. It is also used for cosmetic purposes,

mainly herbicides for turf and turf industries which include, inter alia, golf courses, sports fields, sod farms, residential and commercial lawns, and cemeteries. In June 2022, in the context of achieving the goals of the Farm to Fork strategy, the EC introduced a pesticide ban in “public parks or gardens, playgrounds, recreation or sports grounds, public paths, as well as ecologically sensitive areas. This is likely not enough to safeguard hoverfly populations, and these restrictions need to be amplified in urban environments to include other public and private spaces. In addition, a recent study concluded that the 50% use and risk reduction of pesticides in Europe will be achieved only if the number (“pool”) of pesticide compounds available on the EU market is significantly reduced, or their uses strongly restricted[11]. A major contribution at EU level towards this goal is the, currently ongoing, revision of some elements of the Pesticides Package, namely the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation and the Directive 2009/128/EC on the sustainable use of pesticides (SUD). The former regulates the registration, evaluation and authorisation of dangerous substances and the restrictions applicable to them, and the latter is aimed at reducing environmental and health risks while maintaining crop productivity and improving controls on the use and distribution of pesticides. The ongoing revision process of these two pieces of EU legislation opens the door for hoverfly (and more broadly pollinator) experts and hoverfly conservation practitioners to push for a greater use of alternative ways to protect harvests from pests and diseases, and advocate for a better understanding of the impacts of these substances on pollinators. In this domain, financial instruments are available, for example, through the European Food Safety Authority (EFSA). EFSA may award grants to organisations which are designated by their Member State to assist EFSA with its mission (this list currently includes > 300 universities, institutes, governmental, public and other scientific bodies). The grants support knowledge production and mobilization to inform risk assessments, as well as capacity building activities. Horizon Europe is another avenue for potential funding as multiple calls have been dedicated to better understanding the impacts of pesticides on pollinators. There is, however, a shortage of local-scale funding mechanisms to promote the creation of pesticide-free environments for hoverflies (pollinators in general), although there is guidance and templates in other parts of the world that could be transposed to European municipalities[12].

[11] Silva et al. (2022). Environmental and human health at risk – Scenarios to achieve the Farm to Fork 50% pesticide reduction goals. Environment International 165: 107296.
[12] PollinateTO Grants

Conservation Priority 5. Policy levers that support action for hoverfly conservation in Europe

Hoverflies are rarely explicitly considered in policy and, where included, they typically fall under the broad banner of “pollinators”, which means their specific needs are often not adequately addressed. Understanding how to interpret and leverage policy to raise awareness, support argumentation and/or mobilize resources for European Hoverflies is a critical skill that needs to be developed to action conservation of these species and their habitats on the ground. This is a role best suited for a centralized organization (like the CoPEHov) that can help focus the attention on the topic (instead of fragmenting it across multiple organizations), increase the credibility and trust in the expertise provided and evidence produced. The following is a non-exhaustive list of levers to consider when discussing hoverfly conservation action in Europe.

The Kunming-Montreal Global Biodiversity Framework

Under Goal B of the GBF (which encompasses Targets 9 to 12 of the Framework), two of the complementary indicators proposed include explicit pollinator-oriented metrics: the ***Red List Index*** ***(pollinating species)*** and the ***Green status index*** ***(pollinators)***. Several additional opportunities to support hoverflies will emerge in the coming years through **decision 15/7** (strategy for resource mobilization to implement the GBF, including the creation of a dedicated global instrument on biodiversity finance and the development of *national finance plans*), **decision 15/8** (long-term strategic framework for capacity building and development, and technical and scientific cooperation that will include the description of *mechanisms to facilitate and support* its implementation at the global, regional and country levels), and **decision 15/9** (through which a multilateral mechanism for benefit-sharing from the use of Digital sequence information was established, *including a global fund*).

Fulfilling 30x30 in Europe

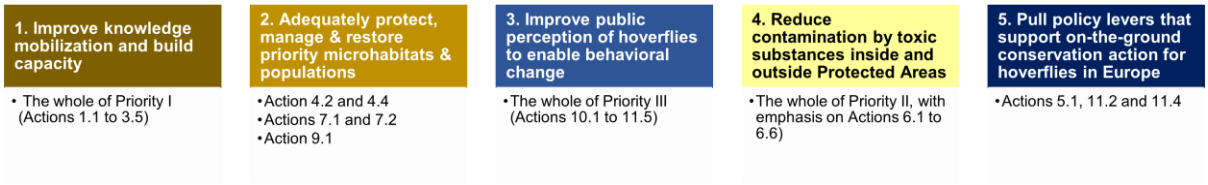
Section 2.1 of the EU Biodiversity Strategy for 2030 – Bringing nature back into our lives concerns the establishment of a truly coherent Trans-European Nature Network, by legally

protecting at least 30% of the land, including inland waters, and 30% of the sea in the EU, of which at least one third (10% of land and 10% of sea) is to be under strict protection. The way the EC plans to materialize this is through a "Pledges" process[13] whereby Member States submit to the EC a list of existing protected areas (in addition to Natura 2000) which fulfil the criteria as well as an initial pledge for new areas to be designated. The initial pledges of the Member States related to protected areas designations will be discussed in the framework of biogeographical meetings with the participation of national authorities, relevant stakeholders and experts. Member States may be asked to revise their pledges on the basis of the conclusions of those meetings so that they all contribute in a proportionate way to reaching the targets. Within this process there are opportunities to review existing national protected areas systematically, and threatened species should be considered within this. Red-listed hoverflies (nationally and EU Red Listed) as well as Prime Hoverfly Area analyses, could be important inputs into this process, to support supplementation of existing protected areas measures or to enhance their status to strict protection regimes. The strategy also states that, significant areas of other carbon-rich ecosystems, such as peatlands, grasslands, wetlands, mangroves and seagrass meadows, should also be strictly protected. National designation of additional areas hosting wild pollinating insects, such as semi-natural grasslands, will help deliver the strategy's objective of pollinator recovery in the longer term.

EU Pollinators Initiative

Alongside other critical pieces of EU legislation (EU Biodiversity Strategy for 2030, Farm to Fork Strategy, the Zero Pollution Action Plan, the Forest Strategy, and the Strategy on Adaptation to Climate Change), the EPI remains as one of the most targeted towards pollinators, with explicit mentions to hoverflies. The EPI was first launched in 2018, and was revised in 2021. The review showed that, while it remained a valid policy tool, significant challenges still needed to be overcome to halt and reverse pollinator decline, namely improvements in monitoring and governance mechanisms, and better integration of actions to protect wild pollinators in EU biodiversity conservation and agricultural policies. Broadly speaking, the priorities identified in the Hoverfly A2P report, and condensed here, are perfectly aligned with multiple actions outlined in the revised version of the EPI (2023), providing plenty of opportunities to support conservation of European hoverflies on the ground.

[13] Criteria and guidance for protected areas designations - Staff Working Document (2022)



High-level analysis of the alignment between actions outlined in the revised EU Pollinators Initiative (2023) and the conservation priorities identified for European Hoverflies in the Hoverfly A2P Report.

EU Nature Restoration Law

In June 2022, the Commission presented a proposal for a EU Nature Restoration Law, which combines an overarching restoration objective for the long-term recovery of nature in the EU's land and sea areas with legally binding restoration targets for specific habitats and species. These measures should cover at least 20% of the EU's land and sea areas by 2030, and ultimately all ecosystems in need of restoration by 2050. The proposal contains a specific target on pollinating insects – reversing the decline of pollinator populations by 2030, and achieving an increasing trend for pollinator populations, with a methodology for regular monitoring of pollinators (encapsulated in Article 8 of the proposal). EU Member States are expected to submit National Restoration Plans to the EC within two years of the Regulation coming into force, showing how they will deliver on the targets. They will also be required to monitor and report on their progress. In the period 2021-2027, the supporting expenditure (for implementation by Member States) will be covered by a Multiannual Financial Framework that includes, among others, the European Agricultural Guarantee Fund, the European Agricultural Fund for Rural Development, the Cohesion Fund, the Programme for the Environment and Climate Action (LIFE), Horizon Europe, national financing by EU Member States and private funding.

EU Common Agricultural Policy

The EU Common Agricultural Policy provides a range of subsidies, some intended to support species such as hoverflies. In some cases, these are not sufficiently informed by species' biology and as a result can have the opposite effect to that intended. Similarly, though the EU Farm to Fork Strategy includes important areas for attention, it does not necessarily go far enough in its advice to create the desired effect for species such as hoverflies.

The EU Common Agricultural Policy (CAP) has the potential to provide a mechanism and incentives for agriculture to be a biodiversity producer. For example, farmers can currently receive money from the EU for setting aside flower strips which are potentially beneficial to hoverflies. Unfortunately, CAP currently promotes annual measures and so these strips can be moved or ploughed over in year two, which destroys their longer-term value and helps common species but not rarer ones. If funding were contingent on a more permanent life for these strips (at least 2-3 years), their value could be significantly increased.

In the UK, Brexit may provide an opportunity to change the way that Common Agricultural Policy (CAP) farming subsidies work. A recent 25-year environment plan and associated legislation plan includes payments to farmers for taking action that benefits the environment, through a type of biodiversity restoration. These work through the adoption of a principle called, "*no net loss of natural capital*", that is incorporated into planning processes for land management. There are subsidies for public good and for the adoption of this natural capital principle. This will be a positive change for the UK with potential benefits for hoverflies, and it would be valuable to have similar changes at the EU level. In addition, there is a big trend towards rewilding areas of land, including many former farms, and this can be very helpful for hoverfly conservation by kick-starting the process of creating more space for nature and more connections between natural areas across the landscape.

The EU Habitats Directive

Under the Habitats Directive there are two routes through which threatened species can be effectively conserved.

One is by listing them on Annexes II or IV, which triggers an obligation to protect them either at certain sites (Annex II species within Natura 2000 sites) or more broadly (Annex IV, strictly protected species wherever they occur), as well as an obligation to monitor and report on their status at regular intervals to demonstrate there has been no deterioration in condition. Currently no bees or hoverflies are listed on these Annexes. While a recent fitness check of the Nature Directives concluded that this omission does not constitute a serious obstacle to achieving the Directives' general objectives, consideration should be given at some point to the cost-benefit of keeping these species not-listed under the most emblematic pieces of European environmental legislation. A

fine balance has to be made, nevertheless, with competing interests, as amending the Annexes of species and habitats that are triggers for the selection of Natura 2000 sites could have significant implications for the configuration of the network and is not recommended at this time.

The second route through which species at risk can be protected, is by listing the taxa as typical of one or more of the habitats at risk that are listed in Annex I of the Habitats Directive. Monitoring of those habitats should then incorporate monitoring of associated typical species, and the management of those habitats should include measures to support healthy populations of those associated typical species. Some hoverflies are already included as typical species of Annex I habitats and so receive attention through this route. More could be added and there is value in doing so for a select group with good bioindicator properties.

National Policy frameworks

Individual nations have a key role to play in supporting hoverfly conservation through national policy frameworks, supporting and acting on key research. In Serbia, there are some 30-40 species on the strictly protected list and 40 on the protected list. This is the only country in Europe that has this, along with three sites protected just for hoverflies. Lessons learned from the Serbian model could be extended to other nations across Europe.

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Appendix 1. The European Taxonomy Booster Program

Europe is home to an estimated >110,000 known species, excluding viruses and bacteria. The science of describing, documenting, naming and classifying each of these living species is the work of taxonomy. Taxonomists can be thought of as ‘mapmakers’ – they create the ‘map’ of biodiversity that other people use to navigate the tremendous complexity of nature. However, there are many unknown species in Europe, especially in deep-sea and microenvironments. Discovering and characterizing these species requires the people with the expertise, including scientists, curators, and naturalists, empowered by leading technologies.

Despite its invaluable benefits for society and the environment, taxonomy as a field of expertise is disappearing in Europe. Recent investigations suggest that while interest in taxonomy remains, most trainees emanate from a handful of labs, limiting expertise to certain groups of species only. Additionally, taxonomic expertise in highly diverse and poorly understood species groups has severely eroded, with retired taxonomists not being replaced. As current experts retire, increased collaboration is essential to help fill the expertise gap. European taxonomists in universities need to seek more opportunities to develop innovative partnerships with i) graduate-level taxonomists who perform species identifications for environmental assessments and monitor for invasive species; ii) naturalists and “citizen science” programs; and iii) government and industry scientists working on a range of, respectively, policy issues and biological applications.

If these skills continue to be lost, Europe faces increased biosecurity risks through a potential misidentification of introduced species and inaccurate information about their spread and potential for harm. This could negatively affect trade relationships with domestic and international partners, with associated significant economic impacts. Biodiversity conservation in Europe may also be affected by an inability to assess species decline in some native species, hampering informed decision-making. Pollinators, for instance, also provide crucial ecosystem services to agriculture (via fertilization of crops), yet there is a growing taxonomic expertise gap in pollinator identification, as documented in the European Red List of Insect Taxonomists. Another example is deep-sea taxonomy where a shortage of taxonomists in Europe is met with a high level of undescribed biodiversity. This is an environment particularly prone to pharmaceutical and medical biodiscovery with a tangible and substantial market value waiting to be unlocked.

Recently, the European Union joined other Parties in the ambitious commitment of halting and reversing biodiversity loss by 2030. Hence, strong taxonomic expertise has high strategic relevance to help Europe meet its national and international commitments to biodiversity conservation, alongside contributing to economic prosperity, research and innovation, and the protection of its natural resources.

The European Taxonomy Booster Program aims to encourage linkages to and integrate taxonomic knowledge into wider cross-sectoral initiatives to contribute to building the capacity of the taxonomic

community in Europe while promoting the discovery of new species and capitalizing on their commercial value. It is proposed as a unique multi-million-dollar partnership between the private sector, Eco-Schools, the European Citizen Science Association, the European Molecular Biology Laboratory's European Bioinformatics Institute (EMBL-EBI), the Consortium of European Taxonomic Facilities, the European Research Executive Agency, and the Network of European Museum Organisations (NE-MO). Its goal is to document biodiversity (at any level in any environment) across Europe. The program is proposed to provide funding to interdisciplinary and collaborative projects that must include collaborations with at least 5 of the following sectors: government officials (European, Member-State, and/or regional), academics, think tanks, private sector, not-for-profit, school boards, and citizen scientist organizations.

The program addresses the issue identified by:

1. promoting cross-sectoral partnerships that organize expeditions to document plants and animals across Europe for non- and commercial purposes thereby elevating taxonomy as a competitive research field and a fundamental building block of applied research and innovation;

2. supporting the creation of an European hub on taxonomic expertise, that leverages on the diversity of partnerships offered by the program, and serves as a matching tool for taxonomic expertise to foster cross-sectoral mobility, while promoting diversity and inclusion;

3. increasing knowledge of the European biota by funding primary research, especially to study important groups for which taxonomic capacity is inadequate in Europe, with a special emphasis on taxa with important role in ecosystems, provision of ecosystem services and human health, and promoting taxonomic knowledge-transfer opportunities.

These three work streams would represent a more cost-effective use of public funds as they address the key challenges in the field: creating tangible job opportunities, raising the profile of taxonomy as a competitive career while promoting diversity and inclusion in the field, and enhancing sustained opportunities for increased taxonomic knowledge and capacity in Europe. Unlike previous approaches, this program is integrative, and focuses on cross-sectoral collaboration which is integral to the revival of this science and the realization of all its benefits to European society and economy.

Some of the program performance metrics could include:

1. number of jobs created for taxonomists, with associated metrics on diversity and inclusion;
2. number of partnerships/collaborations developed under the program;
3. number of projects funded under the program;
4. number of connections made via the European hub; and
5. number of new species discovered under the program.

An advantage of the program would be that it would provide resources for infrastructure to support expansion of the taxonomic workforce for which there is often no private incentive or willingness to

invest. Conversely, commercialisation may introduce priorities into the biodiscovery research agenda that disadvantage species that are of environmental or other importance, and this is something that needs to be considered. However, the program could have real flow-on implications to numerous scientific, trade, industrial (biofuel and pharmaceutical) and environmental public policies, specifically impact assessments, endangered species conservation, and invasive alien species management. In the long-term, the program could have positive intergenerational welfare implications, and help generate greater prosperity of future economies.