



European hoverflies:

moving from assessment
to conservation planning





European hoverflies:

Executive Summary and Summary of Threatened Species Data

Contact point for individuals and organisations wanting to support the development or implementation of this preliminary plan: **hoverflySG@gmail.com**

Organising team: C. Lees, C. Gibson, G. Flinn, K. Leus, A. Vujić, A. Ssymank, M. Speight, M. Miličić, C. Ferreira.

Report contributors (alphabetically): Andrea Aracil, Monika Bohm, Jordi Domingo, Catarina Ferreira, Gabrielle Flinn, Ann-Katrine Garn, Joseph Garrigue, Claudine Gibson, Francis Gilbert, Andrea Green, Axel Hochkirch, Marina Janković, Vujadin Kovacevic, Thomas Lebard, Caroline Lees, Kristin Leus, Libor Mazánek, Marija Miličić, Radu Mot, Gerard Pennards, Snežana Popov, Snežana Radenković, Santos Rojo, Ellen Rotheray, Alberto Arroyo Schnell, Daniele Sommaggio, Martin Speight, Axel Ssymank, Leendert-Jan van Ent, Jeroen van Steenis, Wouter van Steenis, Ante Vujić, Sally Wren.

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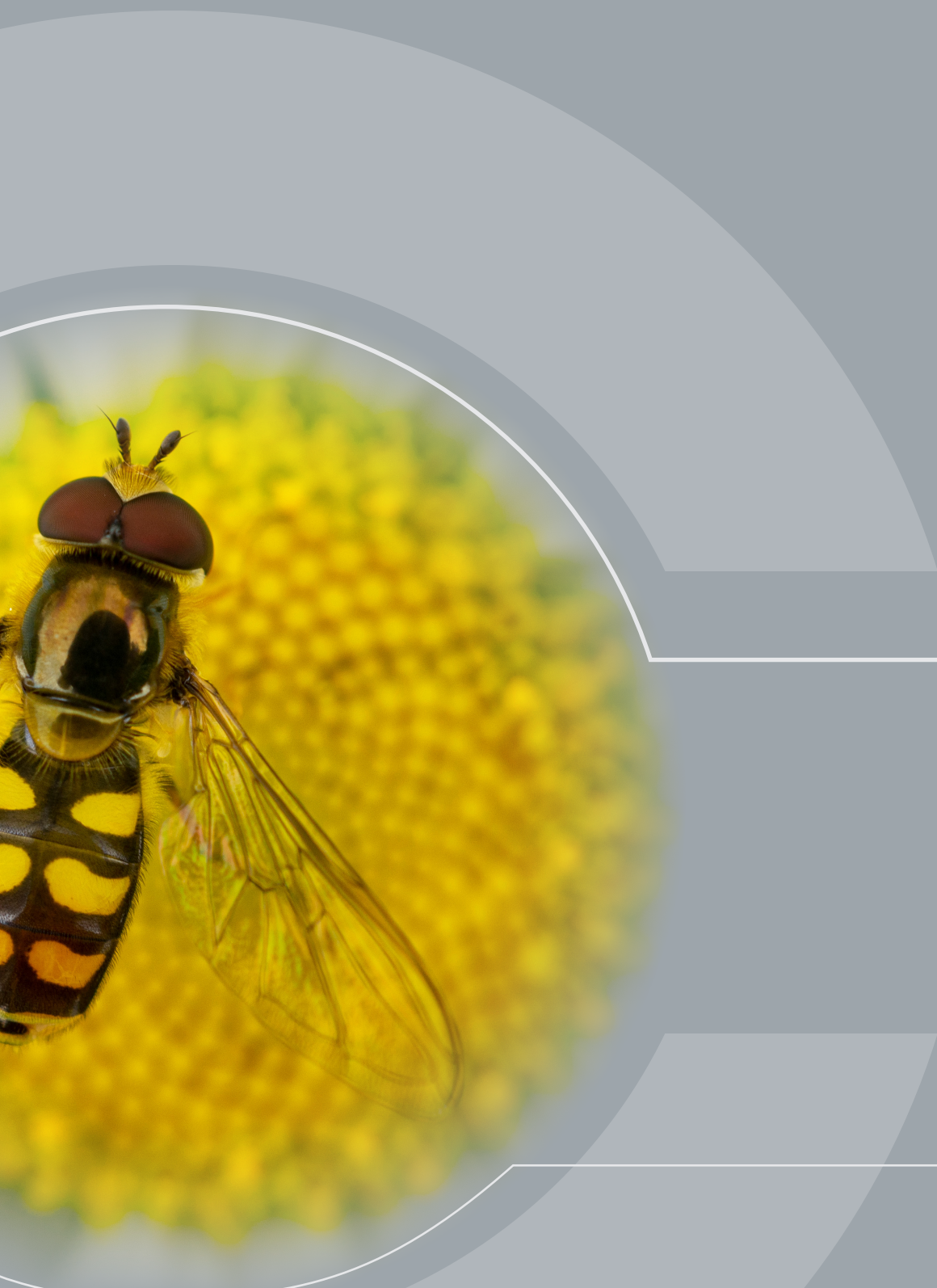
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StN (Syrph the Net): was first published in 1997. Its primary objective is to provide an analytical tool for standardising the degree of association between European hoverfly species and their habitats, micro-habitats and other attributes, thereby providing predictive capability. The latest version fully codes 800 of the known European species with the remaining approximately 150 species partially coded. The database is free, distributed electronically and its files are now accessible from all parts of the continent by naturalists, students, conservation practitioners and researchers. It is maintained by Martin Speight and an editorial team comprising Emmanel Castella, Jean-Pierre Sarthou and Cédric Vanappelghem.

ACRONYMS & ABBREVIATIONS

A2P	Assess to Plan
AOO	Area of Occupancy
BCE	Butterfly Conservation Europe
BfN	Bundesamt für Naturschutz - German Federal Agency for Nature Conservation
BIOSENSE INSTITUTE	Institute based in University of Novi Sad, Serbia
BOLD178	Barcode of Life Database
BR	Bulbs, Roots
CAP	Common Agricultural Policy
CORINE	European Habitats Classification System
DINA	Diversity of Insects in Nature Protected Areas
EAZA	European Association of Zoos and Aquaria
EDF	Electricité de France
EFI	European Forestry Institute
EOO	Extent of Occurrence
EPI	European Union Pollinators Initiative
EC	The European Commission
EU PLEDGES	Pledges made by informal groups / organisations in an European Union Member State, to undertake green action
EU POMS	European Union Pollinator Monitoring Scheme
EU27	27 European Countries
EUNIS	European Nature Information System
EVKr	Entomological Association Krefeld
FAP	Farming with Alternative Pollinators
HD	Habitats Directive
HSG	Hoverfly Specialist Group
I-Naturalist	Nature Application (App) for mapping and sharing biodiversity observations
IBA	Important Bird Area
iBOL	International Barcode of Life
IPA	Important Plant Area
LIFE	L'Instrument Financier pour l'Environnement – European Union's funding instrument for the environment and climate action
LUOMUS	Finnish Museum of Natural History
MAEC	Mesures Agro-Environnementales et Climatique – Measures supporting farms engaging in practices that combine economic & environmental performance
MHEP	Marketable Habitat Enhancement Plants
N2000	Natura 2000 : Network of protected areas covering Europe's most vulnerable threatened species and habitats
NATURALIS	Netherlands National Research Institution for Biodiversity
NOx	Nitrogen Oxide
ONF	National Forests Office, France
PA	Protected Area
PBA	Prime Butterfly Area
PHA	Prime Hoverfly Area

RSPB	Royal Society for the Protection of Birds
RZSS	Royal Zoological Society of Scotland
SAFEGUARD PROJECT	Safeguarding European wild pollinators
SIT	Syphidae In Trees
SLF	Stem, Leaves, Fungi
SPRING	Strengthening Pollinator Recovery through INdicators and MonitorinG
STING	Science and Technology for pollinating Insects
StN	Syrph the Net
TAXO-Fly	Taxonomic Resources for European Hoverflies Monitoring Scheme
UNSPMF	University of Novi Sad Faculty of Sciences, Serbia
WCPA	World Commission on Protected Areas
ZFMK	Zoological Research Museum Alexander Koenig
CETAF	European organisation of Natural History Museums, Botanic Gardens and Research Centres



EXECUTIVE SUMMARY

WHY HOVERFLIES NEED THEIR OWN PLAN

Around 980¹ hoverfly species (Syrphids) have been reported for Europe (Speight & Castella, 2020). Adults feed mainly on pollen and nectar (Thompson & Rotheray, 1998) and range from large bumblebee mimics to tiny, hairless species, with mimicry of bees and wasps widespread (Howarth *et al.*, 2004; Penny *et al.*, 2012). Their ecology is largely determined by the needs of the larvae, which vary substantially in biology and feeding requirements. Hoverflies visit at least 72% of global food crops (estimated to be worth around US\$300 billion per year) and over 70% of animal pollinated wildflowers (Doyle *et al.*, 2020). In Europe they are the most important pollinator group together with native bees and some wildflowers are almost exclusively hoverfly pollinated. Hoverflies generally ensure better pollination than bees at higher altitudes, under Nordic climatic conditions, or in cool microclimate or weather situations. However, their contributions to healthy ecosystems extend beyond simple pollinator services to roles in biocontrol, water purification, and long-distance pollen transfer: adults feature in the diets of insectivorous birds, spiders, ants, solitary wasps, dragonflies, robber flies and even carnivorous plants; many parasitic wasps lay their eggs in hoverfly larvae; and about 40% of species have aphid-feeding larvae that can protect crops by keeping aphid levels at much lower levels than without hoverflies. For this reason, some species are commercially grown². 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. Their wide distribution and varied larval requirements make hoverflies good bioindicators.

Despite their environmental and economic significance, pollinator conservation efforts to date have been dominated by activities related to bees and butterflies. Fortunately, in 2018, the European Union (EU) launched a comprehensive Pollinators Initiative to extend action to all main pollinator groups. However, given their unusually diverse life-histories and microhabitat requirements, hoverflies will need additional and different measures from those of other groups, to ensure that they are adequately conserved and to realise the full range of benefits provided by them. In short, they need their own plan. Recognising this, the International Union for Conservation of Nature (IUCN) European Red List of Hoverflies initiative extended its work to draft a preliminary multi-species plan of action for European hoverfly species identified as threatened with extinction. This preliminary plan integrates IUCN European Red List data with information from other sources, notably Syrph the Net (StN³) and expert opinion to:

- describe the broad needs of hoverfly species recently assessed as threatened;
- consolidate existing recommendations for conservation of European hoverflies from the EU Pollinators Initiative;
- describe remaining gaps and challenges;
- recommend relevant action;
- identify organisations who, resources permitting, might be able and willing to assist implementation.

The aim is to complement other EU work in this area by providing additional information and detail on hoverfly conservation needs and solutions, to decision-makers, funders, and nature conservation implementers.

THE PLANNING APPROACH

The core of this document was drafted during a virtual planning workshop, held on September 18-19th 2020, and attended by 19 participants. The workshop followed the final European Red List Assessment for Hoverflies workshop and was an initiative of the Global Species Programme Team in the IUCN European Regional Office and IUCN Species Survival Commission (SSC) Hoverfly Specialist Group (HSG), supported by the IUCN SSC Conservation Planning Specialist Group (CPSG) in the role of neutral planning facilitator. Following the workshop, both workshop participants and additional experts were consulted on successive drafts (see inside cover for details).

¹ Of these, 890 have been assessed for the European Red List because the others have been either found to be introduced, not yet published or are in some other way not applicable (G. Flinn).

² For instance at Knoppert biological systems: <https://www.knoppert.nl/syrphidend/>

³ The StN database documents the habitat and micro-habitat associations of European hoverflies.

Planning followed the IUCN SSC CPSG *Species Conservation Planning Principles and Steps*⁴ and used CPSG's *Assess to Plan* approach for addressing multi-species datasets. Red List assessments can be freely accessed one species at a time, from the online IUCN Red List website. The Assess to Plan (A2P) process supports the viewing of available data on biology, distribution, habitats, and major threats across many species at once, to help identify groups likely to benefit from the same kinds of conservation activity performed either in the same places or involving the same conservation agencies and actors. For hoverflies, experts identified the most valuable groupings as those relating to larval feeding types and their associated microhabitats (see Box 1). These were the focus of subsequent discussions. Throughout the planning exercise the StN database, which includes fine-scale and comprehensive information on hoverfly ecology, was a major complementary resource.

WORKSHOP SCOPE

The workshop covered 30 Critically Endangered (CR), 170 Endangered (EN) and 60 Vulnerable (VU) hoverfly species either endemic to Europe or whose distribution falls mostly within Europe. However, as planning discussions focused mainly on the microhabitats known to be critical to the larvae of this group, recommended actions should benefit other taxa with overlapping larval feeding traits. Experts noted that there are species categorised in recent assessments as Near Threatened or as Least Concern, which may also require urgent conservation attention to prevent their progression to a higher category of threat in the near future. Recommendations were also made to address this need.

BOX 1. Major feeding trait categories and associated microhabitats for 260 threatened European hoverfly species.

1. SAPROPHAGES

- Saproxyllic (decaying wood, sap runs, tree- holes, etc.) (30 spp.).
- Semi-terrestrial (decaying organic matter, not dead wood) (2 spp.).
- Aquatic (not feeding on dead wood) (17 spp.).

2. ZOOPHAGES

- Feeding on other organisms, mainly aphids (57 spp.).

3. PHYTOPHAGES

- Feeding on or in bulbs/roots (103 spp.).
- Feeding on stems, leaves, fungi (51 spp.).

CHALLENGES TO HOVERFLY CONSERVATION IN EUROPE

Challenges to the conservation of hoverflies in Europe are complex but converge on a number of themes: changes in land-use and land management practices (including forestry and agriculture) that favour removal of microhabitat complexity and heterogeneity; shifts in hydrology due to water body management, water abstraction, and the impacts of climate change that have resulted in the loss or alteration of small water bodies essential to larval development; widespread use of pesticides and harmful fertilisers including toxic seed coatings, and a general lack of awareness and understanding of the problems associated with all of these practices, which affect many invertebrate species; gaps in knowledge, tools and expertise which prevent some of these issues from being addressed; and some gaps and conflicting incentives in EU environmental and agricultural policies, that exacerbate the challenge of conserving species such as hoverflies. Further details are included in the report on the European Regional Red List assessments (Vujić *et al.*, 2022)

SUMMARY OF PRIORITIES FOR ACTION

Sufficient habitat and habitat diversity are needed to enable species to breed, feed and mature undisturbed and recommendations were made for each larval feeding trait category. In general, small-scale mosaic landscapes are ideal, with less agricultural and forestry pressure and with large areas or proportions free of pesticides, harmful fertilisers and seed coatings. Habitat fragments such as small patches of woodland within heavily grazed areas, small water bodies and veteran trees and their associated microhabitats are essential to many species and require urgent protection. Pursuing ways to make these issues visible to stakeholders that manage habitats, engaging them at scale and equipping them to implement positive changes, must form an important theme of future activities,

⁴ <http://cpsg.org/sites/cbsg.org/files/documents/CPSG%20Principles%20and%20Steps.pdf>

as well as campaigning for a general shift towards the pursuit of biodiversity values across all land management systems. Finally, enabling the effective conservation and ongoing monitoring of syrphids across Europe will require a significant increase in the availability of and access to, tools, databases, and experts, assisted by the conservation results from the European Red List of Hoverflies and the outputs of the A2P planning exercise. These various needs are distilled into the six goals shown in Figure 1, with further details and associated actions provided in later sections of this document.

THIS DOCUMENT

This document shows five broad areas of work needed to support European hoverfly conservation, as recommended by A2P workshop participants. Each work area has a goal, a series of recommended actions, and a section of preceding text describing the topic, background and supporting evidence that sits behind the recommendations. In addition, for the actions recommended, information is provided on organisations or individuals that might be willing and able to implement or enable the necessary work, resources permitting. As this project extends across Europe, this list is often indicative and generalised and not exhaustive. This should be considered a working document, to be used and re-shaped for other purposes as needed and reviewed and updated as required.

AUDIENCE

The targeted audience is the diverse array of decision-makers, managers, practitioners and scientists required to implement recommended actions. Key audiences include: European and national government agencies and local management authorities, NGOs, policy makers (local, national and regional), developers (and their ecologists), the scientific community and places of learning (universities, institutes, schools), the main land-user groups (agriculture, grasslands, forestry), Natura 2000 site managers, municipal managers of public territory, parks and road-side verges, nature conservation area management bodies, groups with similar conservation interests (e.g. pollinators, veteran trees, small marshes, high mountains, specific host plants), and local communities in areas where action is most needed. Relevant business sectors are also included, such as the agrochemical and food retail industries.

IMPLEMENTATION

This preliminary plan is European in scope. Though much can be implemented at European level, most of the work identified will need to be implemented, supported, and enabled at national, sub-national and local levels and would benefit from dialogue and collaboration among the diverse stakeholder groups working there. National or sub-national planning workshops aimed at customising and operationalising this preliminary plan for the local context, could speed uptake and progress. The first pilot for this approach began in Denmark, in April 2022 and it is hoped that others will follow. Implementation of this preliminary plan will be monitored and encouraged through the Hoverfly Specialist Group.

Figure 1: summary of recommended goals and priorities.

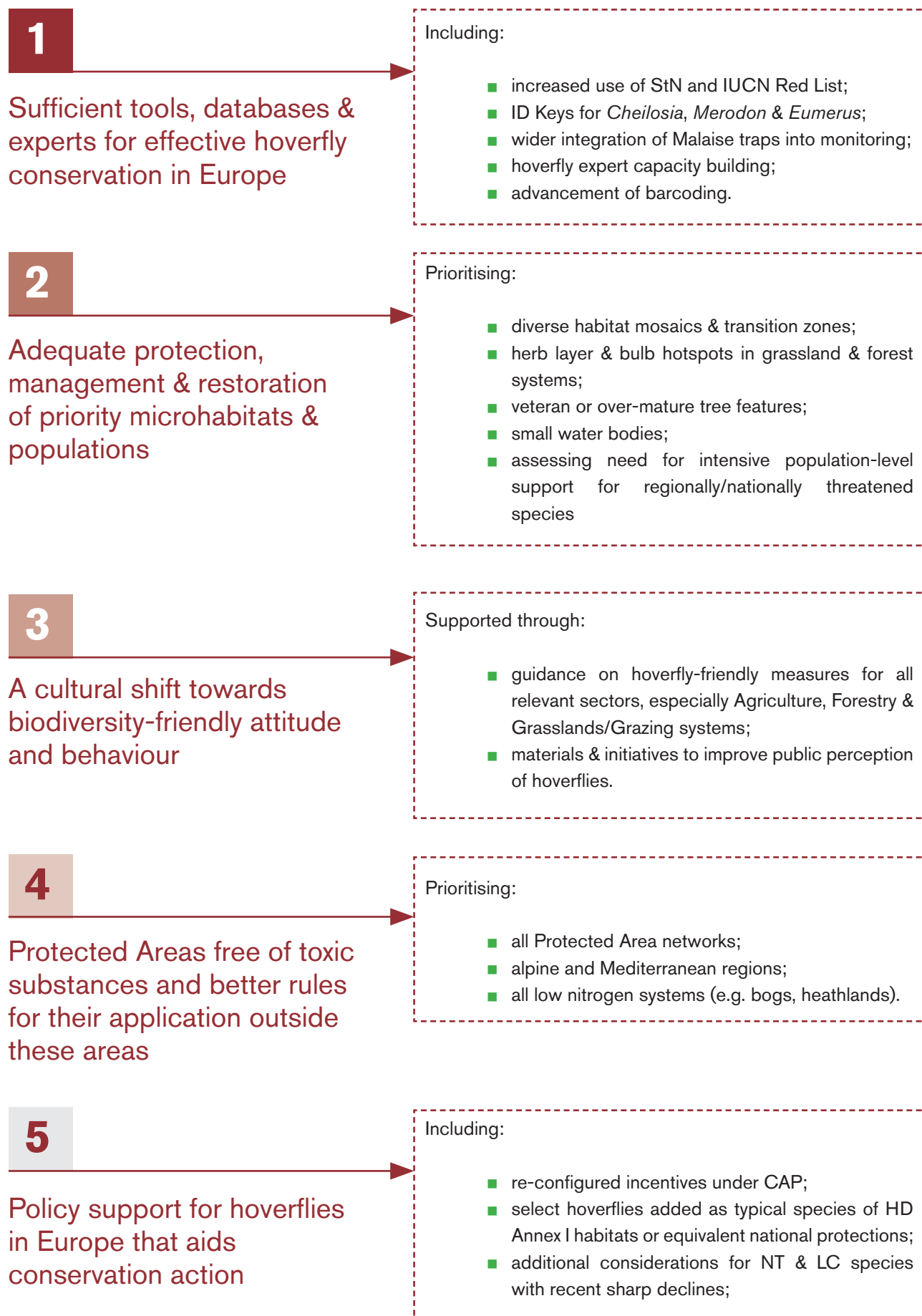


Table 1. Examples of microhabitat protection and restoration priorities, and key partners & implementing agencies.

Example of recommended measures	Who could take them	Enabling bodies
■ ID & protect Prime Hoverfly Areas across Europe (using Vujić <i>et al.</i> 2016); ■ Establish a Veteran Tree Taskforce to map & protect Veteran trees Europe-wide.	UNSPMF, IUCN SSC HSG, PA networks.	■ EU, national & local policy makers; ■ Universities & training institutes; ■ Research & data organisations; ■ Education & advocacy organisations; ■ Conservation NGOs; ■ Wildlife and farming charities; ■ Funding agencies.
■ Protect remaining old growth forest (no guarantee hoverfly diversity will return to new forest); ■ Support presence and continuity of veteran tree habitats (rot-holes, sap-runs, windthrows, tree stumps, fallen branches etc); and create artificial habitat where needed (e.g. by drilling holes in stumps); ■ Restrict drainage and maintain or restore small water bodies; ■ Maintain small open areas such as meadows, to increase forest edge habitat; ■ Protect and encourage the herb layer (build ground-level vegetation into management plans and restrict grazing) ■ Identify and protect bulb hotspots when reforestation.	Forestry & woodland managers & regulators.	
■ Establish, protect & manage Prime Hoverfly Areas; ■ Develop hoverfly inventories & ID priority species; ■ Identify and mitigate the main threats to these and monitor closely; ■ Implement “Biodiversity Farming” within-PA forestry & agriculture: ban application of pesticides and harmful fertilisers, ensure practices are net producers of biodiversity; ■ Manage number and distance between beehives.	Protected Area managers and regulators, farming bodies & partnerships.	
■ Use integrated pest management and support healthy populations of aphidophagous hoverflies for biocontrol; ■ Use only pesticides & seed coatings that are fully biodegradable within 1 yr & only on 50% of land each year; ■ Reduce fertiliser application & use semi-natural barriers to reduce aerial dispersal and run-off (e.g. hedgerows, buffer zones); ■ Grow multi-year flower strips & encourage habitat mosaics.	Farming bodies & partnerships, land managers & regulators.	

■ Preserve even the smallest fragments of undisturbed habitat in grasslands (e.g. woodland patches); ■ Designate & protect bulb plant hotspots; ■ Prevent over-grazing in specific areas by establishing and maintaining sustainable numbers of grazing animals; ■ Delay first grazing/mowing until after peak bloom; ■ Reduce fertiliser input to support less competitive and late flowering plant species.	Grasslands and grazing system managers & regulators.	
■ Develop landscape management plans (rather than for single systems) to ensure habitat complexity, diversity, connectivity, and buffer zones for sensitive areas; ■ Regulate and manage fire frequency and intensity to reduce damage and maximise benefits, tailored to specific habitat types; ■ Maintain or restore natural hydrology and protect the integrity of small water bodies, all systems.	Managers & regulators, all systems.	



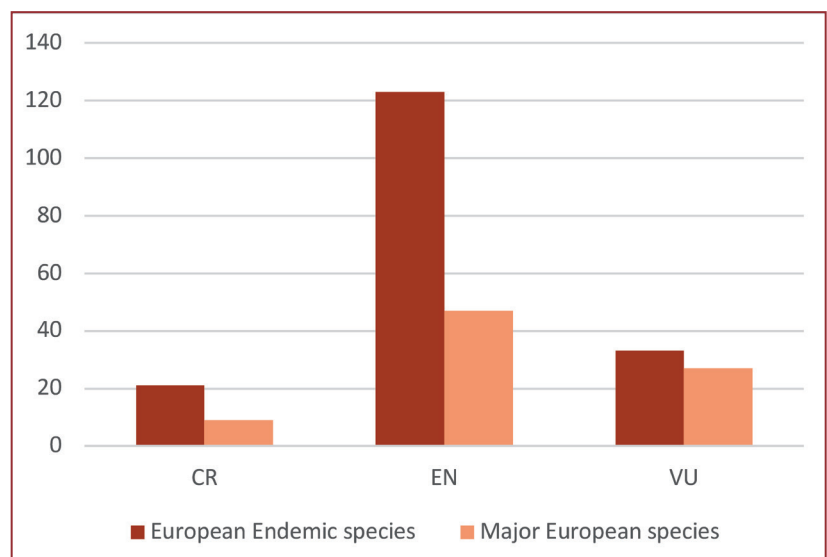
SUMMARY OF THREATENED SPECIES DATA

SCOPE AND CHARACTERISTICS OF THE A2P SPECIES SUBSET

This section explains the data and analyses that helped inform the preliminary planning discussions. For further explanation of the Red List assessment work see Vujić *et al.* (2022). Of the 890 species assessed, 314 species (25%) were placed into one of the IUCN threat categories (CR, EN, or VU). A further 59 species (7%) were assessed as Near Threatened (NT), 469 species (53%) as Least Concern (LC) and 45 species (5%) as Data Deficient (DD). One species, *Helophilus bottnicus*, was assessed as Regionally Extinct (RE) within Europe (though it still occurs elsewhere), and two introduced species were assessed as Not Applicable (NA) (*Copestylum melleum* and *Melangyna pavlovskyi*).

Of the 314 species of hoverflies assessed as threatened, 177 species are endemic to Europe. The global populations of an additional 83 species are mostly distributed within Europe, with just a small proportion of the population of these species occurring outside of Europe (these species are referred to as 'Major European' species throughout the remainder of this section). Eleven of the 314 threatened species occur predominantly outside Europe, but within a narrow distributional range, and the global populations of the remaining 43 threatened species are widely distributed outside Europe. **The Assess-to-Plan workshop focused only on the 260 European endemic and Major European hoverfly species that were assessed as threatened.** Figure 2 shows the numbers of European endemic and Major European species in each of the IUCN Red List threat categories. Thirty species (21 European endemic, 9 Major European species) are assessed as CR, 170 are EN, (123 European endemic, 47 Major European species) and 60 as VU (33 European endemic and 27 Major European species). A full list of the 260 species is provided in Appendix 1.

Figure 2. The numbers of European endemic and Major European hoverfly species in each IUCN Red List threat category ($n = 260$ species).



LARVAL FEEDING TRAITS

Conservation planning discussions focused on groups of species categorised by their larval feeding type and associated microhabitats. Figure 3 shows the distribution of the 260 focal species across the six larval feeding types used for this purpose (finer distinctions were discussed but discarded to reduce discussion complexity), and the number of species assigned to each of the IUCN Red List threat categories within each of those six groups. Of the 260 threatened focal species, 103 species (40%) belonged to the Phytophagous – bulbs and roots group. This group contained 57% of all focal hoverfly species assessed as CR. The Zoophagous larval feeding group contained 57 species (22% of the 260 focal species), sixty-one percent (35 species) of which were assessed as EN. The Phytophagous – stem leaf and fungi group contained 51 (20%) of the 260 focal species. The three Saprophagous larval feeding type groups contained the fewest species (49 species in total). The Saprophagous - xylobiontic group contained 30 species, the Saprophagous – aquatic group contained 17 and two species were in the Saprophagous – (semi) terrestrial group, both of which were assessed as EN.

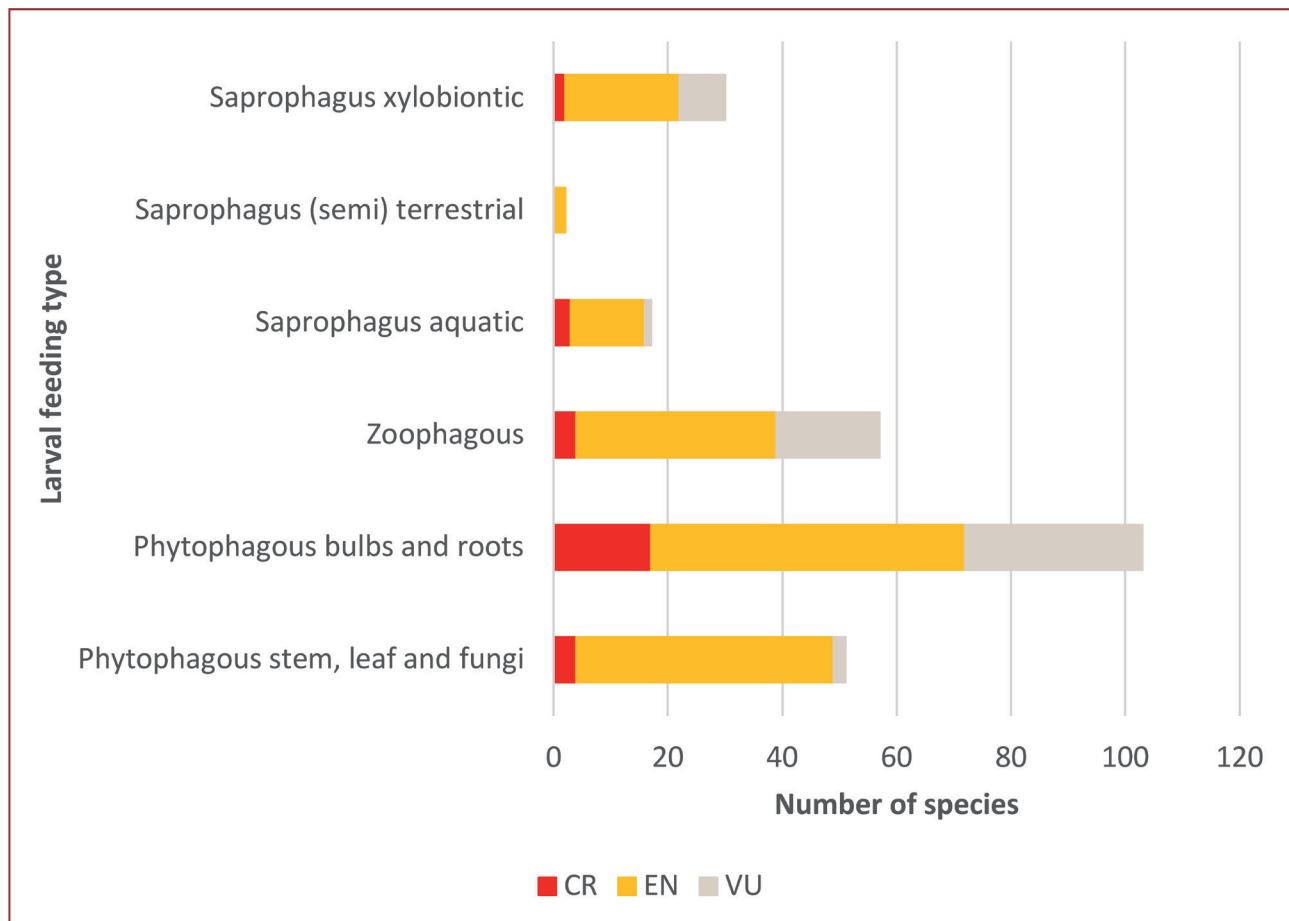


Figure 3. The number of species in each of the six larval feeding type groups and the IUCN Red List threat categories of species within each group ($n = 260$ species).

GEOGRAPHIC DISTRIBUTION & BIOGEOGRAPHIC REGIONS

Ninety-seven (37%) of the 260 focal threatened species are endemic to countries within the European Union (EU) and 157 species (60%) occur within one or more of the EU 27 countries, but also occur in counties outside of the EU. A total of 11 species (4%) do not occur in any EU countries and of these, 9 species are endemic to Europe. It is important therefore, that the knowledge from this in this Red List assessment is shared with European countries outside the EU. The distribution species across the 11 biogeographic zones of Europe is shown in Figure 4. The number of species whose distribution occurs within each of the biogeographic regions is shown in Table 1.

The Mediterranean region has the highest hoverfly species diversity, with 56% (145 species) of the focal threatened species occurring here. Furthermore, 72 (50%) of these species are endemic to that region. The Macaronesian region also has high hoverfly endemicity, with 15 of the 17 species (88%) that occur here, being endemic to it.

Of the 260 focal species, 186 occur only in one of the 11 biogeographic zones, with 138 of these species being endemic to Europe. Forty-two species occur in two zones and 21 species in three zones. Eleven species are more widely distributed across Europe with: six species occurring in four zones and five species distributed across five zones. The global distribution of all 11 species also includes countries outside Europe.

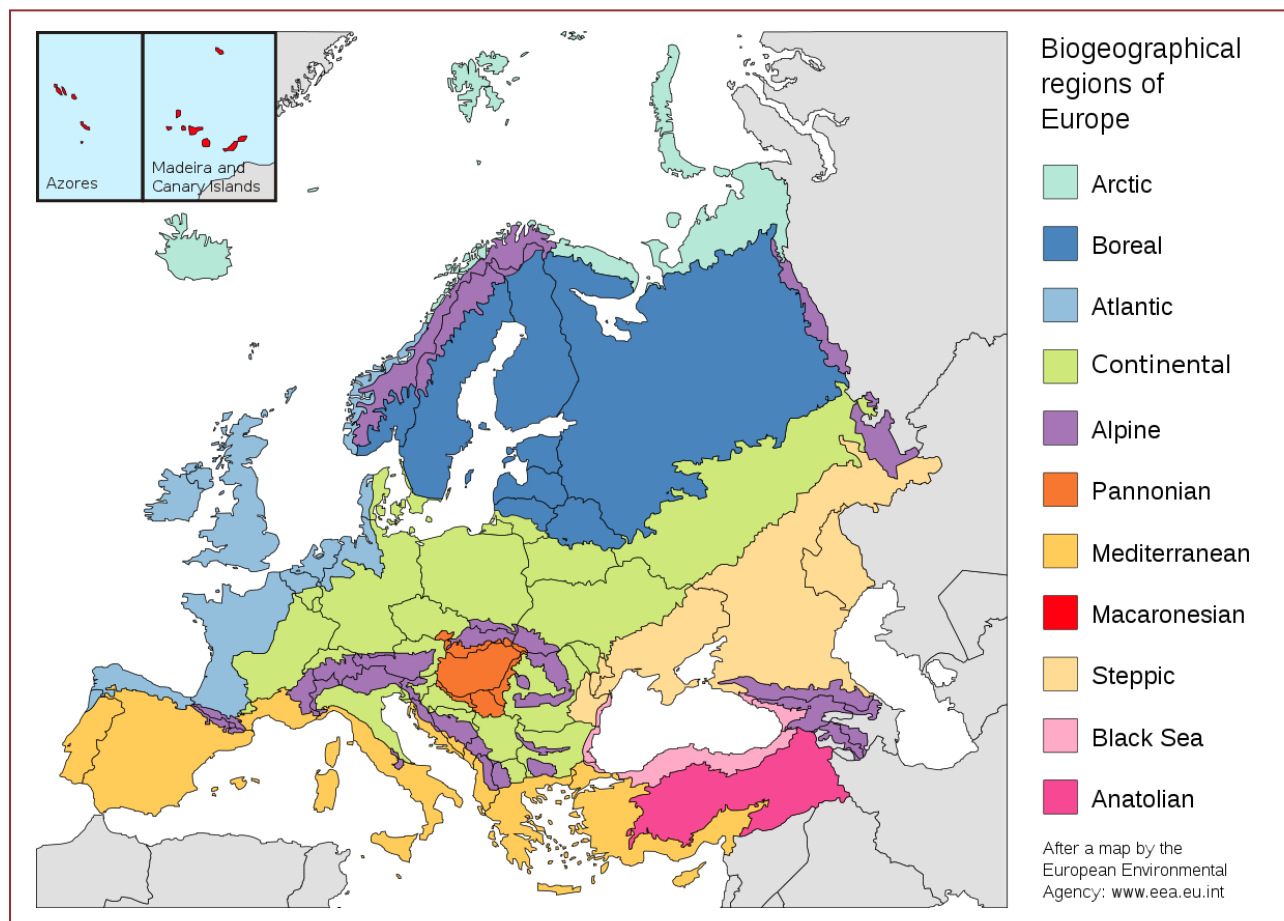


Figure 4. Map of the biogeographic regions of Europe, after the European Environment Agency's map (Júlio Reis, 2006⁵).

Table 2. The 11 biogeographic regions of Europe and the number of focal (threatened) species occurring in each (n=260 species).

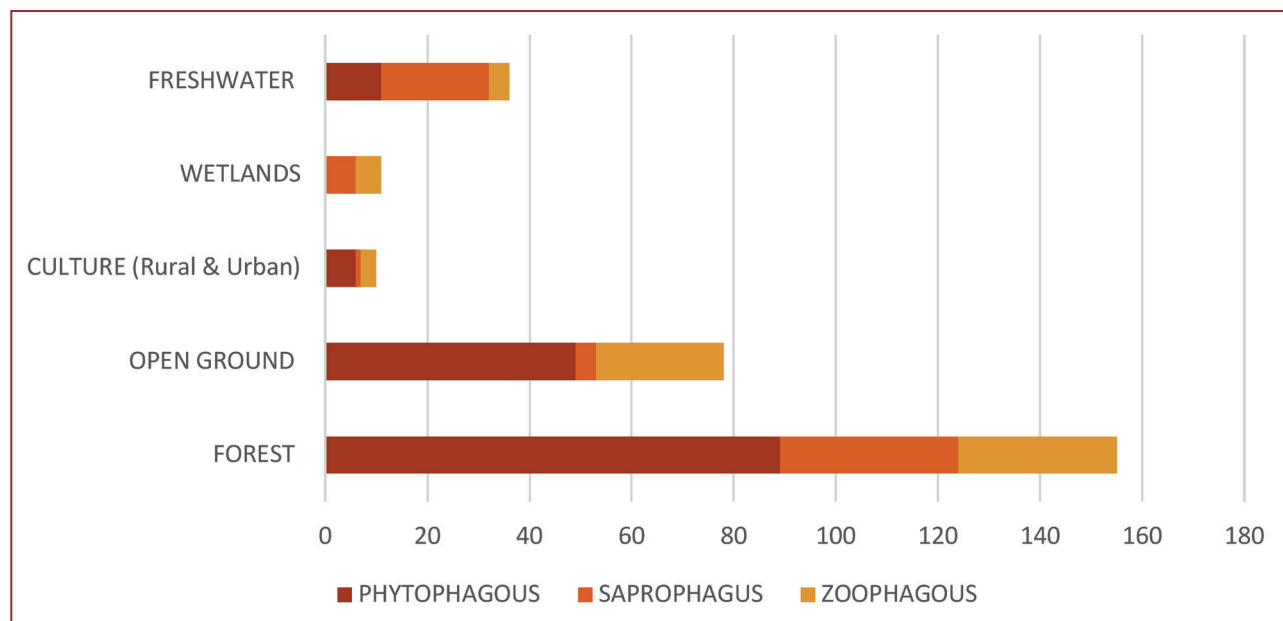
BIOGEOGRAPHIC REGION	NO. OF SPECIES
Mediterranean	145
Continental	85
Alpine	50
Pannonian	26
Atlantic	21
Macaronesian	17
Northern (Boreal)	17
Black Sea	9
Anatolian	5
Steppe	5
Artic	2

⁵ https://commons.wikimedia.org/wiki/File:Europe_biogeography_countries_en.svg

MACRO AND MICROHABITAT ANALYSIS & SUMMARY

StN provides detailed information about the macro and microhabitat associations of hoverfly species that occur across Europe and Turkey (Speight and Castella, 2020). Here, information from StN is used to illustrate the major macro and microhabitat types with which the 260 focal species are most associated. In this section, for simplicity, the size larval feeding type groups are collapsed into three (Phytophages, Saprophages and Zoophages)

Figure 5. Major macrohabitat associations of 260 threatened European hoverfly species indicating three



As shown above in Figure 5, few threatened species are found in rural and urban environments, or in wetlands. Most are associated with forests and open ground, which are further broken down using StN data, in Figures 6 and 7 below.

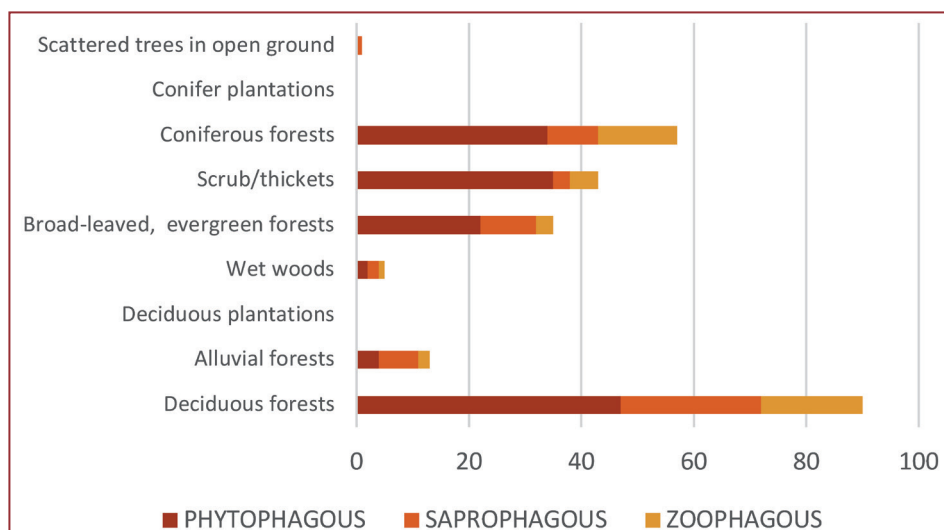


Figure 6. Number of threatened species associated with each of the major forest macrohabitat types shown, indicating proportions of the three major larval feeding traits.

As illustrated in Figure 6, though deciduous and coniferous forests are the two most common macrohabitats for threatened European hoverfly species, no threatened species are recorded from deciduous or conifer plantation forests, or from scattered trees in open ground.

Figure 7 illustrates the distribution of Threatened European hoverfly species across a range of open ground macrohabitats. As shown, these habitats are much less important than forest macrohabitats for hoverflies with saprophagous larval feeding traits but are very important for those with phytophagous and zoophagous traits.

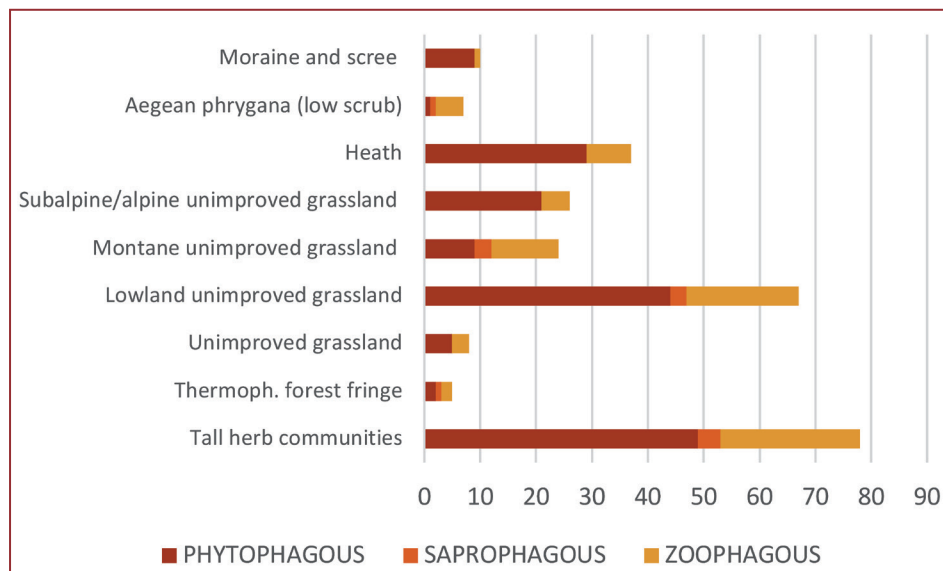
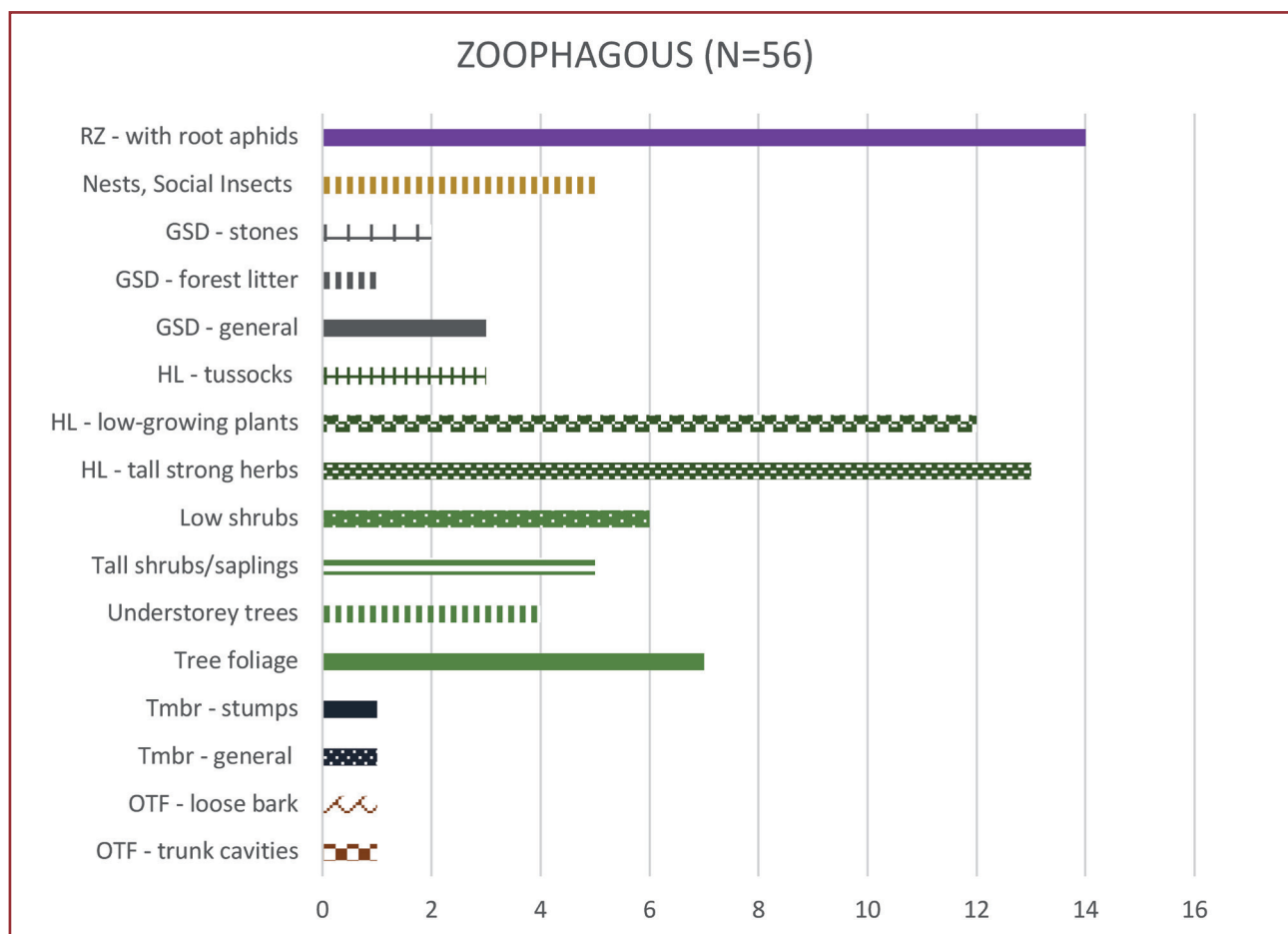
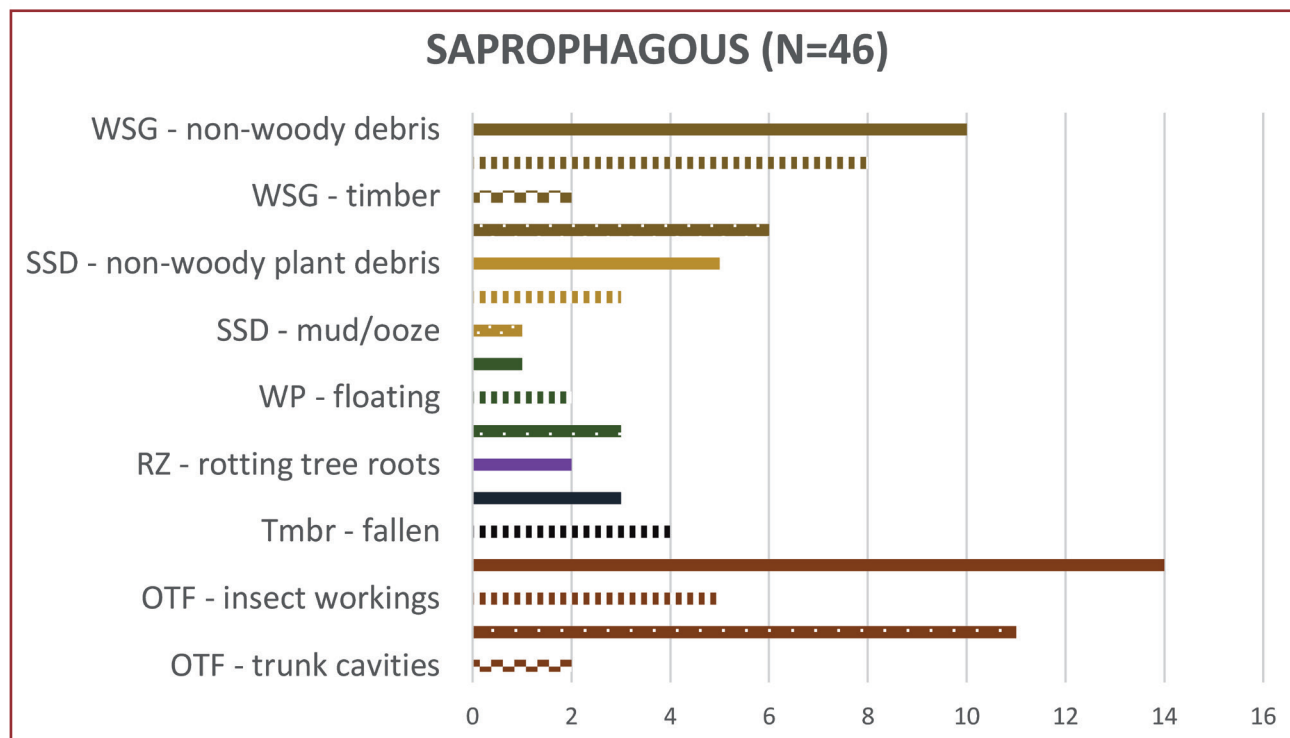


Figure 7. Number of threatened species associated with each of the major open ground macrohabitat types shown, indicating proportions of the three larval feeding traits.

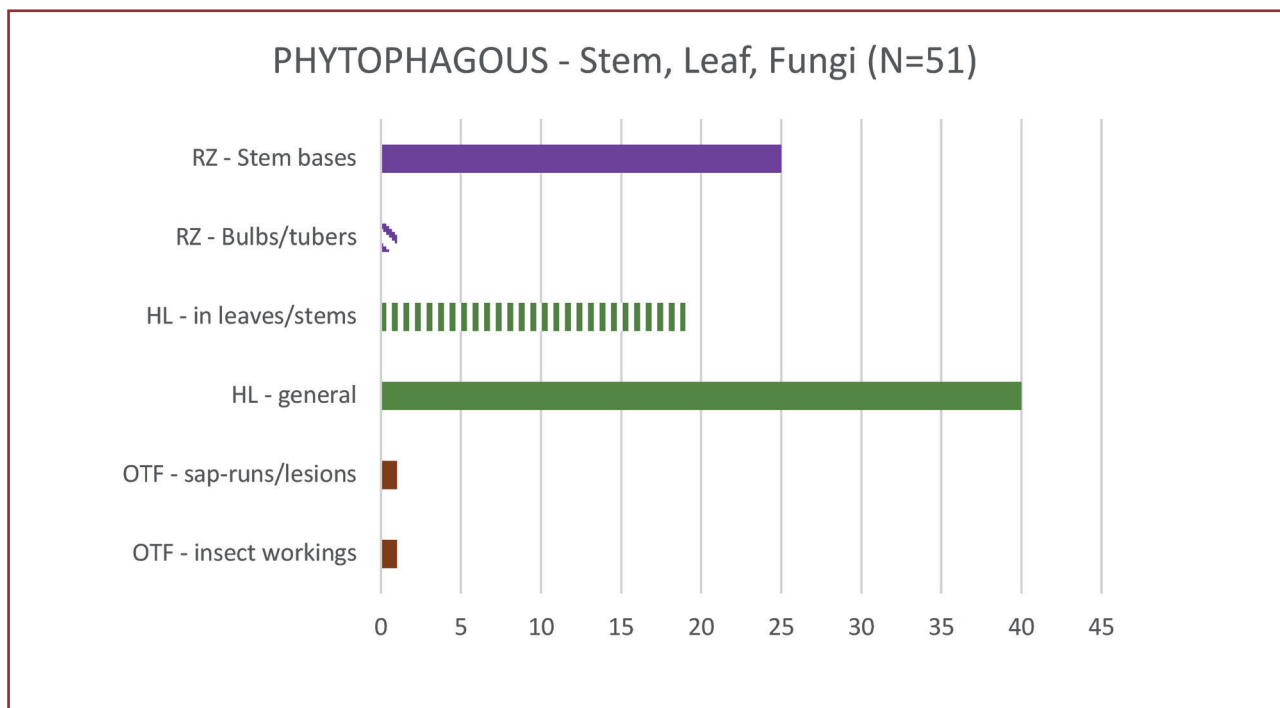
StN contains much more detail on distribution (by country and biogeographic region) and on macrohabitats than is shown here. For further information, and for an explanation and definitions of the habitat categorisation system used, see Speight and Castella (2020); Speight *et al.*, (2020).

As pointed out in Speight & Castella (2020), these reported macrohabitat associations may not on their own be useful to organisations wishing to understand which threatened hoverfly species should be present or managed for, in specific areas of interest. Many of the macrohabitat associations are conditional, that is a species may occur in a forest macrohabitat, but only in association with certain features (e.g. small water bodies such as springs or seasonal brooks) and not necessarily otherwise. In StN these qualifiers are referred to as supplementary habitats and they provide additional insight into the requirements of different species. Of the 675 macrohabitat associations described in Figures 8 and 9, 355 (53%) of them have a qualifying supplementary habitat. Given this, StN takes habitat association information a step further still, and describes in finer detail the microhabitat associations of each species (where known). Microhabitats can be shared by multiple species and can straddle different macrohabitats. Therefore, for the purpose of the A2P project, and on advice from the core organising team, the required microhabitats of the major larval feeding types of the threatened species were used as the focus for discussions and proved a useful way to approach planning for such a large and diverse set of species.

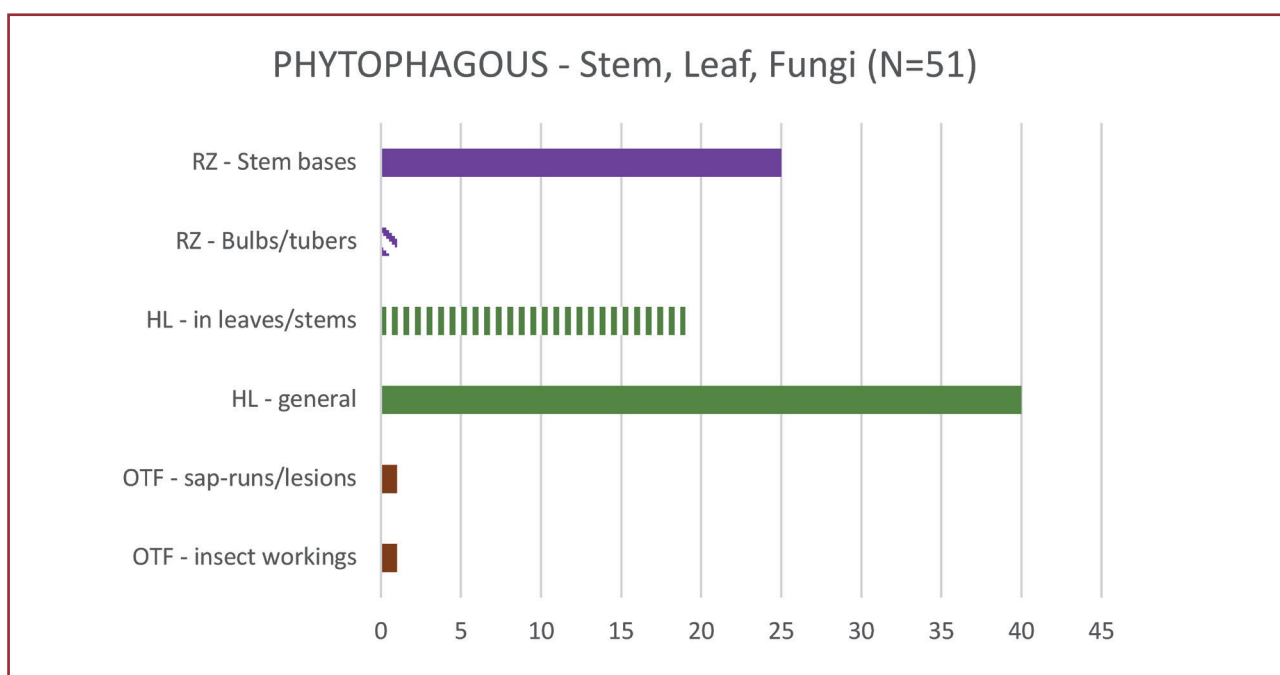
As an example of the level of detail available in StN, the “larval activity zones” (or microhabitats minus additional qualifying information on condition) for the three major larval feeding traits, are shown in Figures 8 - 11. These represent some of the microhabitats that will need to be more widely recognised, valued, and protected, in order to support the conservation of this group of pollinators.



Figures 8 (above) and 9 (below). Number of threatened species with Saprophagous or Zoophagous larval feeding traits, that are associated with each of the microhabitat types shown (WSG=water saturated ground; SSD=submerged sediment/debris; WP=water plants; RZ=root zone; Tmbr=Timber; OTF=overmature tree features; HL=Herb Layer; GSD=Ground Surface Debris). See Speight & Castello (2020) for further details.



Figures 10. Number of threatened species with Phytophagous (Stem, Leaf Fungi) larval feeding traits, that are associated with each of the microhabitat types shown (OTF=overmature tree features; HL=Herb Layer; RZ=Root Zone).



Figures 11. Number of threatened species with Phytophagous (Bulbs, Roots) larval feeding traits, that are associated with each of the microhabitat types shown (HL=Herb Layer; RZ=Root Zone).

[Note that 13 of the 260 species assessed as threatened are not included in the version of the StN database used and so are missing from the analysis above. These are: *Merodon orjensis*, *M. olympius*, *M. sacki*, *M. kozufensis*, *M. hirtus*, *M. medium*, *M. nitens*, *M. spineus*, *M. confinium*, *M. opacus*, *P. thracusi*, *P. bellierii*, *C. scintilla*].