Pollinators on the edge: our European hoverflies

The European Red List of Hoverflies

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Picture credits on cover page: *Chrysotoxum bicinctum* (Least Concern), male © Frank Vassen

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Contents

Foreword

Hoverflies are a large, beautiful, and exceptionally diverse family of insects. As the second most important pollinator group behind bees, they are also essential to our lives, providing an ecosystem service that forms the very foundation of our food system and indeed our lives.

In 2018, recognising the looming crisis of pollinator declines, the European Commission adopted the EU Pollinators Initiative, which made it possible to comprehensively assess the extinction risk of the continent's hoverflies for the first time, following the criteria of the IUCN Red List of Threatened Species™.

This publication, which is the result of these assessments, is entitled "Pollinators on the edge" - so it is hardly surprising that the news it brings is deeply concerning. Out of almost 900 different species of hoverflies assessed, more than 37% are threatened with extinction in Europe.

Europe's rich natural and cultural heritage has been shaped over centuries by its diverse farming and forestry traditions, many of which are rightly cherished and upheld. However, there is overwhelming evidence that the way we go about producing food, timber, energy and many other goods and services today is not sustainable and threatens the planet's biodiversity and our very existence.

This is particularly evident in the case of hoverflies. The main threats they face read like a catalogue of destructive human impacts on natural systems. They 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.

While the news it portends is troubling, "Pollinators on the edge" can also be read in a more hopeful way. When you are approaching an edge, you have two options – let the momentum carry you down into the abyss, or change course before it is too late. Fortunately, this publication not only warns us of the looming danger, but also provides clear instructions on how to avoid it.

As a key first step, we urgently need targeted habitat conservation measures for hoverflies, especially to protect ancient woodlands with veteran trees and wetlands. Safeguarding these critical parts of our landscapes in networks of well-connected protected and conserved areas should receive priority attention as Europe tackles the challenge to protect at least 30% of its land and sea areas under the Post-2020 Global Biodiversity Framework.

Secondly, we need to reform our food systems. Agricultural policy has long favoured intensive, large-scale farming that is often highly productive, but leads to pollution, loss or degradation of habitats and over-use of land and water resources. Europe must eliminate incentives that encourage such practices and instead accelerate the transition to agricultural practices that are environmentally, socially and economically sustainable and contribute to conservation instead of driving biodiversity loss.

Thirdly, to address the threat posed by increasing wildfires, it is essential that we rapidly and dramatically decarbonise our economies and maximise the potential of Nature-based Solutions to climate change.

It is my hope that this publication works as a catalyst for action. Let us bring hoverflies – and all other pollinators – back from the edge.

Dr Bruno Oberle,
IUCN Director General

Preface

This publication has been prepared by IUCN (International Union for Conservation of Nature), led by the Hoverfly Specialist Group of the IUCN Species Survival Commission, and funded by the European Commission Service Contract 'Status assessment of European Hoverflies (Syrphidae) – European Red List of Hoverflies (EU and pan-Europe)' (No. 07.0202/2018/792937/SER/ENV.D.2).

The knowledge upon which it is based is the product of collaboration between European hoverfly specialists. Large-scale collaboration started in 1998 with the development of Martin Speight's 'Syrph the Net' database, which distilled into an expert system that shared experiences of hoverfly collectors about what kinds of habitat one had to look for to encounter each hoverfly species. But it was the First International Workshop on the Syrphidae at the State Museum of Natural History in Stuttgart (Germany) in July 2001 (Schmid et al., 2001) that really started the process of generating collaboration. It was attended by 95 participants from 24 countries and became a biennial meeting: there have been 11 such meetings so far, held in Germany, Spain, the Netherlands, Finland, Serbia, UK, Russia, Germany, Brazil, Greece and France. Strong relationships and collaborations have characterised the community of hoverfly workers ever since, and as a result, the team was willing and happy to come together to develop this European Red List of Hoverflies.

The 'Syrph the Net' (Speight, 2018, 2020 and earlier versions) database, is an expert system initially funded by the European Union (Science and Technology for Environmental Protection; STEP/CT90/0084). It has contributed enormously to the success of this endeavour, providing the taxonomic and nomenclatural reference for the development of the list of species included in the project, and a wealth of associated data.

Chrysotoxum festivum (Least Concern) © Frank Vassen

Acknowledgements

All of IUCN's Red Listing processes rely on the willingness of scientists to contribute and pool their collective knowledge to make the most reliable estimates of the status of a species. Without their enthusiastic commitment to species conservation, this kind of regional overview would not be possible. Hoverflies are no exception, and the knowledge mobilized through the Europe-wide network of members of the Hoverfly Specialist Group of the IUCN Species Survival Commission. The 'Syrph the Net' database has contributed enormously to the success of this endeavour, providing the taxonomic and nomenclatural reference for the development of the list of species included in the project, and a wealth of associated data. We are therefore indebted for their support and contributions.

Thanks go to the Red List Unit, in particular David Allen, Caroline Pollock, Kate Harding and Ackbar Joolia for their support in the coordination of the European Red List of Hoverflies.

Anna Rosenberg and Jennifer Da Paixao provided substantial assistance with financial management of the project. A word of thanks goes to Vittorio Bellotto and Ana Marta Viegas Tremoceiro for their support on communication-related matters and other general issues. We are thankful for Sarine Barsoumian and Konstantin Gospodinov for their support in managing the coordination of the assessment. We are also grateful to the many photographers, who provided photos for the species assessments and the photos in this publication. We also thank Snežana Popov and Gabriel Nève for peer-reviewing this publication.

The European Red List of Hoverflies, and consequently this publication, are required as part of the European Commission Service Contract 'Status assessment of European Hoverflies (Syrphidae) – European Red List of Hoverflies (EU and pan-Europe)' (No. 07.0202/2018/792937/SER/ENV.D.2). IUCN gratefully acknowledges the funding received by the European Commission. In particular, we would like to thank Vujadin Kovacevic (European Commission) for his support throughout the project, allowing for a smooth implementation.

Executive summary

Aim

This European Red List provides a summary of the conservation status of the European species of hoverflies (Diptera: Syrphidae), evaluated according to the IUCN *Red List Categories and Criteria* (2012a) and IUCN's global (IUCN Standards and Petitions Committee, 2022) and regional (IUCN, 2012b) guidelines. It provides the first comprehensive, region-wide assessment of hoverflies, and identifies species threatened with extinction at the European and EU27 Member State levels so that appropriate policy measures and conservation actions can be taken to improve their status, based on the best available evidence.

Scope

The geographical scope of the assessment is continent-wide, extending from Iceland and the European Macaronesian Islands in the west to the Urals in the east, and from Franz Josef Land in the north to the Canary Islands in the south. The Caucasus region, including the Russian Northern Caucasus, is not included. Red List assessments were made at two regional levels: for geographical Europe and for the 27 Member States of the European Union (hereafter, EU27). Because the United Kingdom's exit from the European Union occurred during this project, the EU27 level assessments do not consider the United Kingdom. However, the United Kingdom is included at the geographical Europe level.

All hoverfly species native to or naturalised in Europe (a total of 892 species) were considered for this European Red List. In Europe, 890 species were assessed, with two species considered Not Applicable (NA) for being recent introductions to the European region; these were also considered NA in the EU27 region. For the EU27, 859 species were assessed, with 29 species found in pan-European countries not currently reported from the EU27 Member States.

Results

Overall, 37.2% (314 species) of the European hoverfly species assessed in this study were considered threatened (assessed as CR, EN or VU) in Europe, with one species (*Helophilus bottnicus*), a Holarctic species that previously occurred in Sweden, Finland and possibly Poland, classified as Regionally Extinct (RE). A further 6.9% (61 species) are considered Near Threatened and 52.7% (469 species) are assessed as Least Concern. For 5.1% (45

Caliprobola speciose (Least Concern) © Frank Vassen species) there was insufficient information available to be able to evaluate their risk of extinction, and thus they were classified as Data Deficient (DD).

The main threats to European hoverflies were found to be the impacts of intensive agriculture (including extensive livestock farming and ranching), commercial/productive forestry, residential and commercial development (tourism development and housing development), natural system modifications (such as fires, exacerbated by climate change, and the exploitation of water sources for dams or use in agriculture) and changes to the way habitats are managed (becoming more mechanical and on a larger scale).

Recommendations

Policy measures

The key habitats on which hoverflies rely require greater protection overall. There are three major areas on which policy-making must focus to ensure that hoverflies cease to decline and start to recover. Firstly, veteran trees and ancient woodland (extant in old-growth forests) must be strictly protected. Forestry policy should also endeavour to enable the creation and long-term protection of diverse native woodlands to ensure habitat continuity and connectivity. Secondly, wetland and aquatic habitats require greater levels of protection, and more environmentally sustainable approaches to water management should be taken. Finally, agricultural policy has previously promoted, and continues to promote, intensive and large-scale farming which has negative impacts on hoverflies through pollution, loss of habitat, degradation of habitat and over-use of water resources. Agricultural policy should move towards a more sustainable approach to ensure the healthy populations of pollinators, such as hoverflies, on which the industry partially relies. An additional issue is improved protection of important habitats from residential and commercial development.

Research and monitoring

While Europe is probably one of the continents where hoverfly science is most advanced, there are still a lot of unknowns and considerable taxonomic and regional biases in knowledge. Much more research is urgently needed into the habitat requirements and distribution of European hoverflies. Because hoverflies have differing ecological needs during various stages of their life cycle, it is crucial to understand these needs in order to protect and restore the habitats on which they rely. While population trends of hoverflies are largely unknown, there is increasingly concerning research suggesting dramatic population declines. To understand these declines better, and to enable action, monitoring should be scaled up across the European region, as proposed in the EU Pollinator Monitoring Scheme (EU-PoMS; Potts et al., 2020). For species particularly at risk, or difficult to monitor (either due to taxonomic challenges or elusiveness), species-specific monitoring programmes need to be established. Furthermore, the nature and importance of threats impacting hoverflies need to be better understood. This includes both discovering what the threats are to species whose ecology is poorly understood and, for particular threats that are better known, improving understanding of the degree to which they affect hoverfly species and their habitats. Specifically, the impacts of pesticides and commercial forestry practices on hoverflies need increased research attention.

Action on the ground

This European Red List should be used to guide conservation initiatives throughout Europe, including the establishment of new protected areas and recognition of '*Other effective area-based conservation measures*' (OECMs) and Key Biodiversity Areas (KBAs), reform of agricultural practices and land management, and pollution reduction schemes. Alongside habitat restoration and rewilding, the preservation of remaining habitat continues to be a crucial requirement for the continued survival of many European hoverfly species. Bees and butterflies are still the predominant focus when creating pollinator-friendly habitats: this needs to change to include the needs of hoverflies, by ensuring the protection of suitable habitat for the very varied larval stages. Hoverflies should therefore be included as part of any core work on pollinator conservation that takes place, including changes to land management plans aiming to help pollinators. Additional recommendations to promote European hoverfly conservation were included in a taxon-specific conservation planning report that is complementary to the European Red List of Hoverflies (IUCN SSC HSG/CPSG, 2022).

1. Background

1.1 The European context

Europe is the world's second-smallest continent in terms of area after Australia, covering approximately 10.4 million km^2, or 2% of the Earth's surface. However, in terms of human population, Europe is the third-largest continent (after Asia and Africa) with a population of about 748 million (UN DESA, 2019), about 10% of the world's population. Europe is therefore one of the smallest and one of the most densely populated continents in the world.

The European Union (EU), consisting of 27 Member States (EU27), is Europe's largest political and economic entity. The EU27 is estimated to use around 20% of Earth's 'biocapacity' (i.e. "the capacity of ecosystems to produce useful biological materials and to absorb waste materials generated by humans, using current management schemes and extraction technologies"; WWF, 2012). This means that the average EU27 citizen lives far beyond the continent's ecological limits (WWF, 2019).

Europe has a great diversity of landscapes and habitats, and a wealth of flora and fauna. For example, the Mediterranean Basin has been recognised as a global biodiversity hotspot because it is especially rich in plant and animal species, many endemic to the region (Mittermeier et al., 2004; Cuttelod et al., 2009). However, for the most part, Europe is a highly fragmented landscape, with up to 80% of its land currently used for settlement, industry, production systems (including agriculture and forestry) and infrastructure (Pedroli & Meiner, 2017; EEA, 2020).

Because humans dominate the European landscape, their influence has resulted in the loss of species and reduction of wild populations. For instance, modern intensive land management has resulted in increased homogenisation of the landscape (Jongman, 2002), causing great loss of biodiversity. The 'dehesa' ecosystem, which relies on traditional methods of land management, is a good illustration of the consequences of such landscape homogenisation (Ricarte et al., 2018). If abandoned for more intensive ways of using the land, the 'dehesa' will be lost together with its rich biodiversity. Land conversion to intensive agriculture and forestry (Jongman, 2002) can also result in vast swathes of land becoming monocultures reliant on chemical use and water abstraction. Conversely, some historic human activity has added to landscape diversity through the creation of new habitats. Several studies have shown that in Mediterranean landscapes, species diversity depends on a diverse mosaic of habitats which are, to some extent, created and maintained by traditional human activities (Ricarte et al., 2011). Many semi-natural habitats (such as species-rich grasslands) are crucial for pollinators, including hoverflies.

Although considerable efforts have been made to protect and conserve European habitats and species (see sections 4.1 and 4.2), biodiversity decline and the associated loss of vital ecosystem services (such as water purification, pollination, flood protection and carbon sequestration) continue to be major concerns in the region. In addition, with Europe being such a diverse region, the relative importance of different threats varies widely across the landscape. Despite having more than 18% of its terrestrial territory protected through the Natura 2000 network (EC, 2016), the impacts of pollution, invasive alien species and climate change are cumulative and becoming harder to buffer.

1.2 The EU policy context

Biodiversity is integral to sustainable development by providing vital goods and services, which are currently being degraded at an alarming rate. Biodiversity loss is one of the world's most pressing crises. The causes of biodiversity loss are complex and solutions require the involvement of multiple groups, from international bodies to governments to civil society. However, without reliable and timely information on the status and trends of biodiversity, it is not possible to build the actionable knowledge and evidence base for curbing the extinction crisis. Effective action hinges upon both rapid and consistent monitoring of the status of species and measuring impacts of human activities.

In May 2011, the European Union (EU) adopted a strategy entitled '*Our life insurance, our natural capital: an EU biodiversity strategy to 2020*', designed to halt biodiversity loss in the region. It set out 6 targets and 20 actions to halt the loss of biodiversity and ecosystem services in the EU Member States by 2020. An evaluation of the progress made by the EU towards meeting biodiversity targets is currently being completed, but a mid-term assessment of the Strategy in 2015 has already predicted failure in attaining many of its goals and targets (EC, 2015; IPBES, 2018). This has propelled a renewal of the EU's environmental commitment to embark on '*a path to recovery by 2030*' through the EU Biodiversity Strategy for 2030, that contains specific actions and commitments to protect nature and reverse the degradation of ecosystems by 2030. A core part of the European Green Deal, the Biodiversity Strategy will also support a green recovery following the COVID-19 pandemic, and it is the proposal for the EU's contribution to the ongoing international negotiations on the post-2020 global biodiversity framework.

Within this policy context, pollinators have been gaining a prominent place in the spotlight. Animal pollination service is one of the key regulating ecosystem services globally, because pollinators play a vital role in the health and functioning of ecosystems. In the EU alone, four in every five crop and wildflower species depend on insect pollination. Between €5 and 15 billion of the EU's annual agricultural output is directly attributed to insect pollinators (Vysna et al., 2021). In June 2018, the European Commission (EC) adopted the *EU Pollinators Initiative* (EPI), the first-ever EU framework to tackle the decline of wild pollinators. The initiative set objectives for 2030 to improve knowledge about, and tackle the causes of, pollinator decline, as well as to promote stakeholder and societal engagement in building solutions to the problem. In May 2021, evaluation of progress in the implementation of the EPI concluded that overall, the initiative remains a valid policy tool that enables the EU, Member States and stakeholders to tackle the decline of wild pollinators. However, significant challenges remain in addressing the drivers of decline, and the EC is currently undertaking a formal revision of the EPI to ensure it fulfils its commitments while contributing to the goals and targets of the EU Biodiversity Strategy for 2030.

One of the most relevant actions outlined in the EPI is the strengthening of monitoring of pollinator species, and the assessment of their status and trends. One of the available tools to assess the status and trends of species is the *The IUCN Red List of Threatened Species*™, a highly authoritative and objective methodology for classifying species by their extinction risk. The European Red List Initiative has already assessed butterflies (2010) and bees (2014). Action 1B of the EPI stipulated the development of a European Red List of Hoverflies so as to have a better understanding of the status and trends of these species in Europe and to assist in the setting of priorities for conservation measures and policy action. The assessment also holds the potential to inform the development of a European Set of Biodiversity Indicators (SEBI) and to help improve the general understanding among policy makers, the interested parties and general public of the need for European conservation action on biodiversity and ecosystem services. This is the context for the development and publication of this European Red List of Hoverflies.

1.3 European hoverflies

1.3.1 Taxonomy and biology

Sometimes also known as flower flies, hoverflies are "*the most beautiful flies in the world*" (Parvu, 2011), forming a large and exceptionally diverse family of the true flies (the Diptera). The scientific name of the family is Syrphidae, taxonomically distinguished from other flies by the diagnostic arrangement of wing veins. They are well known as prominent flower visitors and pollinators, and by their obvious hovering flight that most species display.

With more than 6,700 recognised species worldwide (Courtney et al., 2017; Dunn et al., 2020), they are one of the largest of the 130 families of Diptera – only six others have more described species. A leading hoverfly specialist, Chris Thompson (recently deceased), considered that there may be a further 10,000 unknown species waiting to be collected and described. For this reason, only a few species – other than the most visually distinctive – actually have common names. Hoverflies are divided into four subfamilies: the Eristalinae (62% of the described hoverfly fauna), the Syrphinae (29%), Microdontinae (7%) and Pipizinae (3%). In total there are 892 species recorded from Europe, and 859 from the EU27. Compared to their share of the world fauna (43 genera, mainly Neotropical), there is a noticeable deficit of microdontines recorded from Europe, with just six species belonging to a single genus (0.7% of the European syrphid fauna).

They are an astonishingly diverse group from several standpoints, but especially in larval form and feeding type (Rotheray & Gilbert, 2011). Hoverflies, like all Diptera and many other insects, show four distinct developmental stages: egg, larva, pupa and adult (see Box 1), with the larvae being very different from the adults. It is in the larval stage that great differences appear among hoverfly species in their mode of feeding and associated morphology, and as a result, their habitat and ecological needs (Box 1).

The adults are very diverse in size, shape and colour pattern, but most have similar feeding habits in that they take nectar and pollen from flowers. Adults are most active in sunshine, and many species are remarkably quick fliers. Although they may appear to be motionless in the air while hovering, actually they are maintaining their position with up to 300 wingbeats per second, and with slight adjustments of their wing position they can accelerate at an amazing speed in almost any direction. Therefore, when surveying hoverflies, entomologists require "exceeding quickness of action for their capture" with a net (Verrall, 1901). The most well-known adult hoverflies are generally rather bare, shiny, brightly coloured insects, often large or very large in size, with some species being close in size to the largest fly species in the world.

Many of the distinctive colour patterns of the adults are more or less obviously mimetic, with noxious insects such as bees and wasps providing the commonest models, probably because hoverflies are always very exposed and obvious to predators while feeding on flowers. Hoverfly mimics of bumblebees have thick long hair covering most of the body, with colours that copy one of the common bumblebee patterns: several of these species are polymorphic, i.e. they have two or more colour morphs each mimicking a different bumblebee pattern. An example is *Volucella bombylans* with two common morphs: one is black with an orange-red 'tail' (mimicking the *Bombus lapidarius* pattern), and the other has yellow and black bands with a white 'tail' (mimicking the *Bombus terrestris* pattern). Hoverflies with no obviously mimetic pattern are often coloured dark brown to black, usually smaller species that live in colder regions and use their dark colouration to absorb heat from the sun.

Figure 1. *Caliprobola speciosa* (Least Concern) adult male resting on leaf litter. This species is called 'saproxylic' because its larvae feed on bacteria in the rotting wood of mature trees and deadwood in evergreen oak forests. © Frank Vassen

Box 1: The varied life-histories of hoverflies

The four life stages of hoverflies are the egg, larva, pupa and adult. Contrary to most insect families, the feeding strategies of larval hoverflies are very diverse: some are predators (of aphids, and even of ant larvae and pupae), some filter bacteria or fungi (from clean or stagnant freshwater, dung, decaying wood (Figure 1), sap and other decaying material, etc.), some feed on living plant material (usually in the roots or leaves of herbaceous plants), and the larvae of a few species feed in fungal fruiting bodies (mushrooms).

Figure 2. The larvae of the Limestone Ant Fly *Microdon mutabilis* (Vulnerable) © Geoff Wilkinson

Microdontinae: the adults and larvae of Microdontinae seem very specialised relative to other species. Most of the adults have reduced mouthparts compared to other hoverflies, and hardly feed at all. In contrast, the known microdontine larvae are highly specialised to feed on the early stages of their ant hosts (eggs and pupae) inside ant nests. For example, the predatory larva of *Microdon mutabilis* feeds on ant eggs and pupae in the brood chamber of its host ant, *Formica lemani* (Figure 2). The female emerges, mates and lays her eggs back into the same natal nest. Males do not move much either, creating extreme host specificity to the natal nest (Schönrogge et al., 2008). **Syrphinae:** this subfamily contains some very familiar species in Europe, including the Marmalade Fly *Episyrphus balteatus* (Figure 3), the most important hoverfly in Europe for the ecosystem services it provides. Like microdontines, syrphine larvae are also predators, but they live externally on plants or in leaf litter where they mostly feed on colonial aphids, or sometimes on a range of other insects. Unusually for fly larvae, they are often coloured for disguise (e.g. like the faeces of a bird – Figure 4), a cryptic defence mechanism against visually hunting predators such as birds.

The Marmalade Fly feeds on aphids as a larva. It is by far the most common hoverfly in Europe, with most individuals migrating south in autumn in vast numbers, including across the Alpine passes, to spend the winter

Figure 3. An adult Marmalade Hoverfly (Least Concern) (*Episyrphus balteatus*). © Hans Hillewaert (Wikimedia Commons)

Figure 4. Larva of *Melangyna triangulifera* (Least Concern) © Geoff Wilkinson

or reproduce in warmer areas of the Mediterranean and North Africa. Some individual adults overwinter further north. Its life cycle involves the following:

(a) Gravid females (i.e. females with mature eggs) are attracted by the odour of aphid colonies. A single egg is laid that hatches in two days.

(b) The newly hatched larva is almost blind and legless, moving about on the plant using a fluid to help it stay attached via surface tension. Once an aphid is contacted and identified with the sensors of the larval antenna, the stiletto-like mouthparts pierce the aphid and secure it, and then the head lifts the aphid clear of the plant surface to consume the body fluids. The larval stage lasts about ten days, depending on the temperature.

(c) As with all the higher flies, pupation takes place within the final (third) stage of larval growth. Within the pupa, the larval body is dismembered and much is dissolved, and then the adult body is constructed from islands of cells that have been dormant throughout the larval stage. This takes about a week to ten days. Emergence occurs when the front section of the pupa comes off due to pressure from within. The new adult takes up to 30 minutes to expand, harden and dry its wings, and some hours before the full colour develops.

(d) An adult female spends her first 10–15 days feeding from flowers (mostly on pollen) and maturing her reproductive system, before mating and then becoming ready to lay her eggs. A very wide variety of flowers in a great variety of habitats are used.

The predatory larva of *Melangyna triangulifera* (Figure 4) usually feeds on aphids from a wide variety of shrubs and trees. Its colours make it look like a bird dropping, and thus hide it from visual predators such as birds (Rotheray, 1986).

The members of the small subfamily **Pipizinae** are also largely aphid predators as larvae, but normally occur in enclosed places, such as underground feeding on ant-tended aphids, or within aphid galls (such as the spiral galls on the petioles of poplar tree leaves caused by the aphid *Pemphigus spirothecae*: Kurir, 1963; Dusek & Kristek, 1967).

Eristalinae: this subfamily is very diverse, with the larvae being found in a very wide range of microhabitats. The adults are some of the smallest and also the largest species, and some have outlandishly long tongues. One of the longest-tongued species is common throughout Europe, the Common Snout Hoverfly *Rhingia campestris* (Figure 5), with a tongue almost or as long as its body (7–11 mm): it feeds from similar flowers to bumblebee species.

Figure 5. An adult female *Rhingia campestris* (Least Concern) in the Forêt de Soignes, Brussels; the adult is much more specialised in its flower-visiting than most other hoverflies. © Frank Vassen

Eristaline larvae are mostly saprophages (those that consume decomposing dead plant or animal material) but include some phytophages (herbivorous) and a few predators as well. The saprophagous larvae feed on microbes such as yeasts and bacteria involved in the decay of a vast range of mostly plant-based material, from tree sap to decaying wood to compost to material in ponds and streams. They can usually only develop in moist to wet conditions, and many are fully aquatic with a long narrow elongate breathing tube at the rear end of the body – these are known as 'rat-tailed' larvae. The long 'tail' of the saprophagous larva of *Mallota cimbiciformis* (Figure 6) allows it to feed at the bottom of large water-filled tree-holes where it filters bacteria and/or protozoa from the water. Other species with similar larvae feed in ponds and ditches.

Those in damp but not aquatic habitats usually have short 'tails', but short-tailed larvae can also occur in very wet habitats such as water-filled tree-holes (e.g. *Callicera rufa*). The short-tailed saprophagous (probably mycophagous) larva of *Brachyopa insensilis* (Figure 7) lives in the sap flowing from wounds in the bark of trees. The sap flow can dry up and restart unpredictably, and so the larvae are supremely resistant to desiccation, surviving for long periods without moving (Rotheray, 1996). Other species with short-tailed larvae feed in decaying heartwood of trees, in stumps and roots and other decaying plant parts and in compost heaps.

Figure 6. The larva of *Mallota cimbiciformis* (Least Concern) © Geoff Wilkinson

Figure 7. The larva of *Brachyopa insensilis* (Least Concern) © Geoff Wilkinson

Many eristaline larvae develop as phytophages in living plants, feeding inside bulbs, roots, stems and even the leaves as leaf-miners. Such larvae have strengthened mouth-hooks to fragment the plant tissues. The fragmented tissues enhance the microbes of decay on which many hoverfly species feed (e.g. *Eumerus* and some *Cheilosia*), but there are also many true phytophages feeding directly on living plant material (e.g. many *Cheilosia*, *Merodon*, *Portevinia*). The phytophagous larva of *Cheilosia grossa* (Figure 8) feeds in the base of the stem of a thistle (*Cirsium palustre*). The larva scrapes plant particles with its powerful mandibles, causing the plant to rot, as shown in Figure 8. When several larvae feed, the tip of the growing stem is killed, and the plant responds by producing a mass of basal stems in which the larvae feed. Infested plants are thus obvious from a distance (Rotheray, 1988).

Figure 8. The larva of *Cheilosia grossa* (Least Concern) feeding in the stem base of *Cirsium palustre* © Geoff Wilkinson

An important number of eristaline larvae are saproxylic, meaning they feed in the decaying wood of over-mature trees. Although isolated old trees are used, the general habitat of 'ancient forest' (i.e., old-growth) is their stronghold, and the loss of this habitat throughout Europe is a major reason why so many of these species are threatened.

1.3.2 Distribution, habitats and ecology

Hoverflies occur almost everywhere, on all continents except Antarctica, and in most terrestrial habitats. They do require plants to be growing and flowering, and many need open water for their larvae, and so they are least common in real deserts – although even a well right out in the desert can harbour *Eristalinus sepulchralis*. They are important pollinators of flowers right up to the High Arctic, and also on the tops of mountains – even above 4,000 metres above sea level.

The distribution of a species reflects its response to environmental gradients as well as the presence or absence of other species of animal and/or plant. This report documents for the first time the continent-wide distributions of most hoverfly species, and it is striking how many species are endemic to mountain areas or confined to northern or southern parts of Europe.

Individuals of most hoverfly species live in a relatively small area and are essentially non-migratory. Aphid-feeding hoverflies tend to make undirected flights in search of oviposition sites for the prey of their larvae, and in search of food. In contrast, around 50–60 hoverfly species are seasonal long-distance migrants, capable of flying up to 250 km or more within three days, including over the Alpine passes in the autumn (Aubert et al., 1976; Gatter & Schmid, 1990), with a less obvious return migration in spring by their offspring.

Distributions are gradually changing all the time due to many causes including climate change, but only long-standing recording schemes are able to capture these changes in hoverfly distribution. Implementing this kind of monitoring takes commitment and sustained resources, which is probably why only a handful of European countries have such schemes (the UK, Belgium, the Netherlands, etc.). Interpreting the causes of such distributional changes takes even longer. For example, *Volucella zonaria* was primarily a southern species in Europe, recorded for the first time in the UK only in 1908, and then sporadically until 1938 when suddenly it began to be reported every year. The species became established in the UK after 1945, and subsequently has expanded enormously in range and numbers and is now common throughout southern and central England. A similar expansion occurred in mainland Europe, and it was only much later that scientists suggested that this expansion was a likely consequence of climate change (Morris & Ball, 2004).

While southern species may benefit from climate change, northern species can suffer. A hoverfly example is *Leucozona glaucia*, a species occurring throughout the north-western part of the UK in well-wooded lowlands where their favourite flowers *Heracleum* and *Angelica* bloom in late summer. Its distribution has retreated to the northwest over the last 20 years, by declining in abundance in the south and east, but increasing in the north and west. Over the last 70 years the northern range margin of this species has moved northwards by about 90 km (S. Ball & R. Morris pers. comm. 2018).

Many researchers have studied the distribution across different habitats of adult hoverflies, including along gradients of anthropogenic activity. Some of the best such studies have mapped the plant communities in detail and quantitatively sampled the associated hoverfly communities (e.g. Ssymank, 1991, 2001). For example, the hoverfly community of forests in southern Germany can be separated into:

- Eurytopic species with no habitat preference, including migrants (e.g. *Eristalis tenax*) and mobile species with generalist larvae (e.g. *Sphaerophoria scripta*);
- Forest species, divided into species whose adults live in open areas but whose larvae are found in the forest (e.g. *Syrphus*), and species whose adults live in shaded path edges and larvae in the forest (e.g. *Sphegina*);
- Species whose larvae and adults live in the same habitat, sometimes where both adults and larvae feed on the same plant (e.g. *Cheilosia albitarsis* on buttercups *Ranunculus*), to those merely preferring forest habitats in both adult and larval stages (e.g. *Portevinia maculata*).

There are many such studies detailing the preferred habitats of hoverflies in many different areas of Europe. The knowledge gained from such studies and the accumulated experience of dedicated collectors was distilled into the 'Syrph the Net' database.

The proportion of eurytopic species in the hoverfly community has been proposed as an indicator of disturbance, and hence of the adequacy of a habitat patch to support an undisturbed forest fauna. This is one way in which knowledge of the distribution of hoverflies per habitat type can help conservation efforts.

1.3.3 Ecosystem services and commercial use

Public awareness of the roles that insects play as providers of ecosystem services (especially in pollination) is slowly increasing (MEA, 2005; Boerema et al., 2017). About 35% of crops worldwide depend on insects for some or all of their pollination requirements. While some insects excel at the provision of a single service (e.g. social and solitary bees for pollination, parasitoid wasps for pest control), hoverflies are part of a very small group of insects that provide multiple services simultaneously (Dunn et al., 2020; Rodríguez-Gasol et al., 2020). The two most important ecosystem services provided by hoverflies are those of *pollination* and *biocontrol of aphids*.

The ability of any insect to effect pollination depends on the number of pollen grains it can carry, its rate of flower visitation and whether through its behaviour it can deposit pollen on the stigma of the relevant flower. Carrying pollen depends on size and hairiness, particularly of the face (Doyle et al., 2020); since bees are generally much hairier than hoverflies, they usually carry more pollen. However, hoverflies can carry substantial amounts of pollen, and can be just as or more effective than honeybees at depositing pollen, for example on field mustard (*Brassica rapa*) crops (Rader et al., 2009, 2020) and the flowers of fruit trees (Kobayashi, 1979). They often have higher rates of visiting flowers than bees and can also carry pollen for very long distances when they migrate (Doyle et al., 2020), an important function. Unlike solitary bees, they can fly in cooler weather conditions (although not as well as bumblebees) and are good at visiting flowers at low densities either spatially or over time (for example, at the beginning or end of the flowering season). *Eristalis* species have regularly been used for pollination of glasshouse crops, and a protocol exists for mass rearing (Kobayashi, 1979; S. Rojo, pers. comm. 2021), but they are not yet available commercially (although this will happen very soon).

As the transition to sustainable agriculture is made, biological pest control will become increasingly important. Pest aphids are especially problematic for many crops. Laboratory experiments on feeding rates show that aphid-feeding hoverfly larvae are perfectly capable of eating enough aphids to suppress populations (e.g. Ankersmit et al., 1986), but in the field aphid reproduction rates sometimes outstrip predation by hoverflies or the gravid females arrive too late to stop aphid colonies from outgrowing control (e.g. Tenhumberg, 1995). Well-designed experiments have clearly shown that hoverfly larvae can control aphid populations in many circumstances (for example, in wheat fields (Tenhumberg, 1995), lettuce fields (Nelson et al., 2012) and on apple trees (Dib et al., 2010; Gontijo et al., 2015)). A few species are commercially available for release as biocontrol agents (for example, *Episyrphus balteatus*, *Sphaerophoria rueppellii*), usually as pupae (see EPPO, 2021). Effective aphid biocontrol by hoverflies needs specific landscape elements (such as hedgerows, flower strips and larval habitats in the vicinity of the fields) to encourage their presence at the beginning of the mass multiplication of aphids. Hoverfly importance in aphid control is particularly well illustrated in the '*Farming with Alternative Pollinators*' (FAP) project in North Africa (Christmann, 2019). Making systematic use of these landscape elements, the project has implemented habitat enhancement measures on 25% of the field area, which consequently showed a higher total harvest and income for farmers compared to fields without habitat enhancement.

The mass migration of high-flying hoverflies northwards in spring and south in autumn provides an opportunity for quantifying their contribution to ecosystem services, because they are detectable by radar (Wotton et al., 2019). The enormous numbers recorded are equivalent to about 380 per hectare across the entire 70,000-km² study area of southern Britain. Interestingly in the light of the strong declines in hoverfly populations reported from many places across Europe (see section 3.5), there was no sign of any decline in the immigrants to the UK over the ten years of the study (2000–2009). The difference between the small spring and large autumn flows of migrants represents net reproduction over one or more generations. Each hoverfly larva consumes about 400 cereal aphids during development under field conditions (Tenhumberg, 1995), but only about 2% of hoverfly eggs eventually make it to produce adults; however, many aphids are eaten by larvae that die before adulthood. Given some assumptions about these numbers, the progeny of the spring immigrants consume more than one million cereal aphids per hectare over southern Britain, or about 20% of the typical aphid densities in the fields early in the season (Wotton et al., 2019).

A similar calculation can be done for pollination services (Wotton et al., 2019). On average the Marmalade Hoverfly carries 10–11 pollen grains per flight from up to three plant species, implying that individuals immigrating into the UK brought up to 8 billion pollen grains from the continent in the spring, and emigrants returned with up to 19 billion grains in the autumn.

Thus, migrant hoverflies make enormous contributions to two crucial ecosystem services, biological control of pest aphids, and pollination of wild flowers and crops. Although less so than bees, most hoverflies are selective in their flower-visiting behaviour, visiting flowers that provide the nectar or pollen they require for the least effort. This makes them suitable for pollination of many species of wild flowers. Some hoverflies, such as *Melanostoma* and the *Platycheirus clypeatus* group of species, are specialist feeders on grass and sedge pollen. In colder regions, either at higher altitudes or latitudes, hoverflies can be the dominant pollinators, giving way to other kinds of flies (mainly Muscidae and Anthomyiidae) at even higher altitudes and latitudes (McCabe & Cobb, 2021).

A less well-known ecosystem service provided by hoverflies is the recycling of dead organic matter. There is a group of hoverflies whose larvae live in decaying wood (Box 1), either in over-mature living trees (in tree-holes, rotting heartwood, rotting roots, under bark, in sap-runs, etc.) or in fallen branches or whole trees that have fallen into water (for instance, genera *Mallota*, *Chalcosyrphus*).

Some saproxylic hoverflies could be reared to provide other ecosystem services. For example, *Eristalis* larvae are fully aquatic saprophages in waters containing a variety of kinds of decaying organic matter, so they could be used for cleaning up sewage water. Furthermore, the resulting larvae could provide food for humans to eat.

1.4 Assessment of extinction risk

The conservation status of plants, animals and fungi is one of the most widely used indicators for assessing the condition of ecosystems and their biodiversity. At the global scale, the primary source of information on the extinction risk of plants and animals is *The IUCN Red List of Threatened Species*™ (www.iucnredlist.org), which contributes to understanding the conservation status of assessed species.

The *IUCN Red List Categories and Criteria* (IUCN, 2012a) are designed to determine the relative risk of extinction of a taxon, with the main purpose of cataloguing and highlighting those taxa that are facing a high risk of extinction. The IUCN Red List Categories are based on a set of quantitative criteria linked to population trends, size and structure, threats, and geographic ranges of species. When conducting regional or national assessments, the IUCN Red List Regional Guidelines (IUCN, 2012b) must be applied (Figure 9).

As the extinction risk of a species can be assessed at global, regional or national levels, a species may be classified under different Red List Categories depending on the scale of assessment, considering the population of that species at each geographical level. Logically, a species that is endemic to the EU27 region would have a single assessment, as it is not present anywhere else in the world.

1.5 Objectives of the assessment

The European Red List of Hoverflies had five main objectives:

- To provide a baseline conservation status for each of the European species of hoverfly;
- To identify those priority geographical areas and habitats in need of urgent protection to prevent extinctions and to ensure that European hoverflies reach and maintain a favourable conservation status;
- To identify the major threats to European hoverflies and to propose potential mitigating measures and conservation actions to address them;
- To use the knowledge mobilised to contribute to regional hoverfly conservation planning; and
- To strengthen the network of hoverfly experts in Europe, so that the knowledge can be kept current and expertise can be recruited to address the highest conservation priorities.

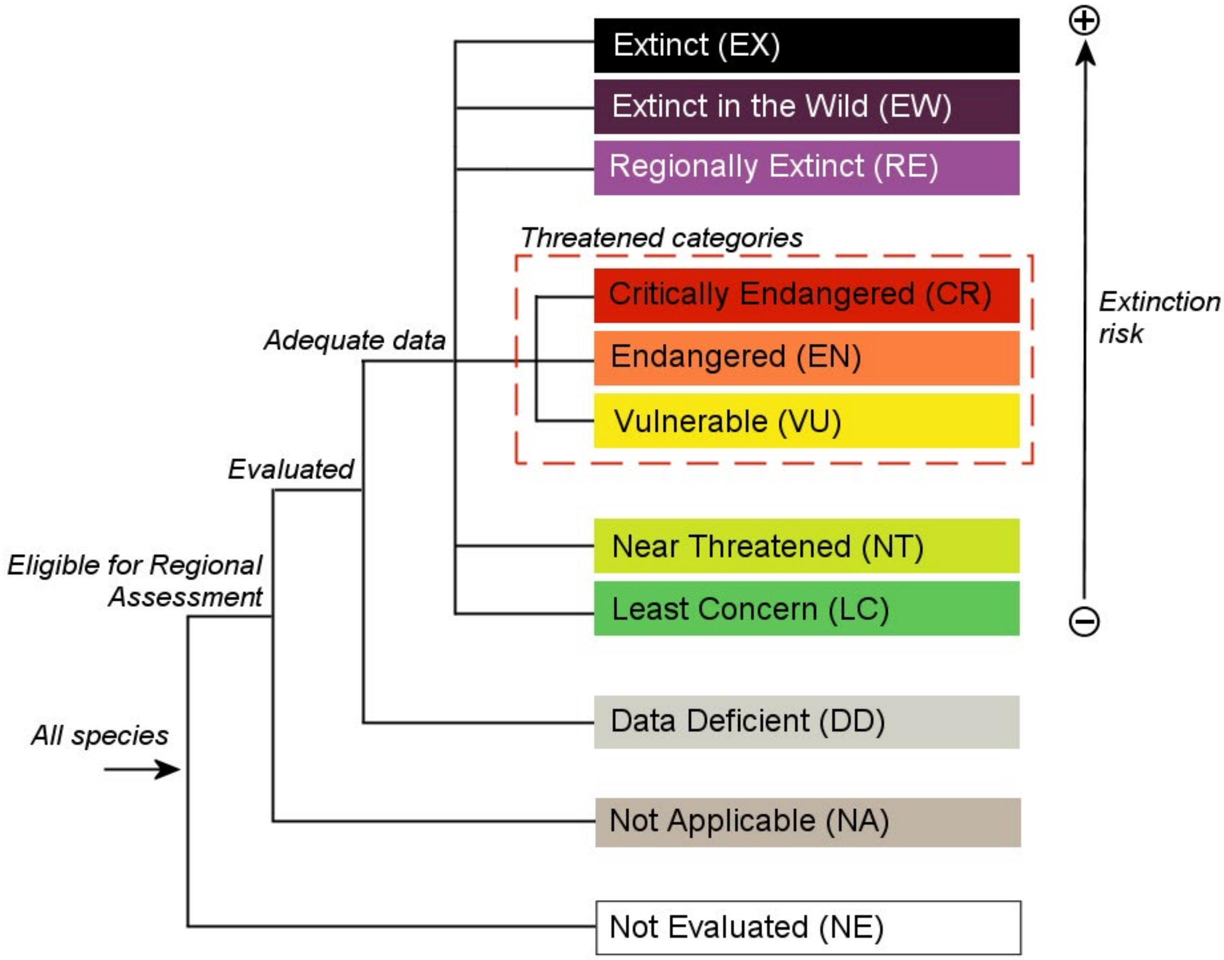

Figure 9. The IUCN Red List Categories at the regional scale (IUCN, 2012b)

This assessment produced four main outputs:

- Summary reports on the status of all European hoverfly species.
- A freely available database holding the baseline data on the status and distribution of European hoverflies.
- A website and data portal (https://ec.europa.eu/environment/nature/conservation/species/redlist/index_en.htm and https://www.iucn.org/regions/europe/our-work/biodiversity-conservation/european-red-list-threatened-species) showcasing these data in the form of species factsheets for all European hoverflies included in this study, along with background and other interpretative material.
- The development of a separate European Hoverfly Conservation Plan coordinated by the IUCN Species Survival Commission (SSC) Conservation Planning Specialist Group that complements the European Red List of Hoverflies publication.

This European Red List provides the first comprehensive, region-wide assessment of hoverflies and builds on the previous work of hoverfly specialists and 'Syrph the Net'. The enormous amount of fieldwork, data and accumulated knowledge means that this assessment is robust and authoritative.

2. Assessment methodology

2.1 Geographic scope

The geographic scope of this assessment is continent-wide, extending from Iceland in the west to the Urals in the east (including European parts of the Russian Federation), and from Franz Josef Land in the north to the Mediterranean in the south (Figure 10). The Canary Islands, Madeira, the Azores, Malta and Cyprus are also included. In the southeast, European Turkey west of the Bosporus is included, while the Russian Northern Caucasus in southern European Russia is excluded.

Red List assessments were made at two regional levels: 1) for geographical Europe (limits described above); and 2) for the area of the 27 Member States of the European Union (EU27) (as of 2022, i.e. excluding the UK).

2.2 Taxonomic scope

The European Red List of Hoverflies has assessed the status of all 890 hoverfly species considered native to or naturalised (introduced prior to 1500 CE) in Europe. The original list of species was based on Peck (1988) and 'Syrph the Net' (Speight, 2018, 2020) supplemented by recent published taxonomic revisions. The inclusion of newly described species or species which have undergone taxonomic change (up to the end of 2020) was undertaken following consultation with relevant experts. The descriptions of a number of species were still in progress by the end of 2020 and were not included here.

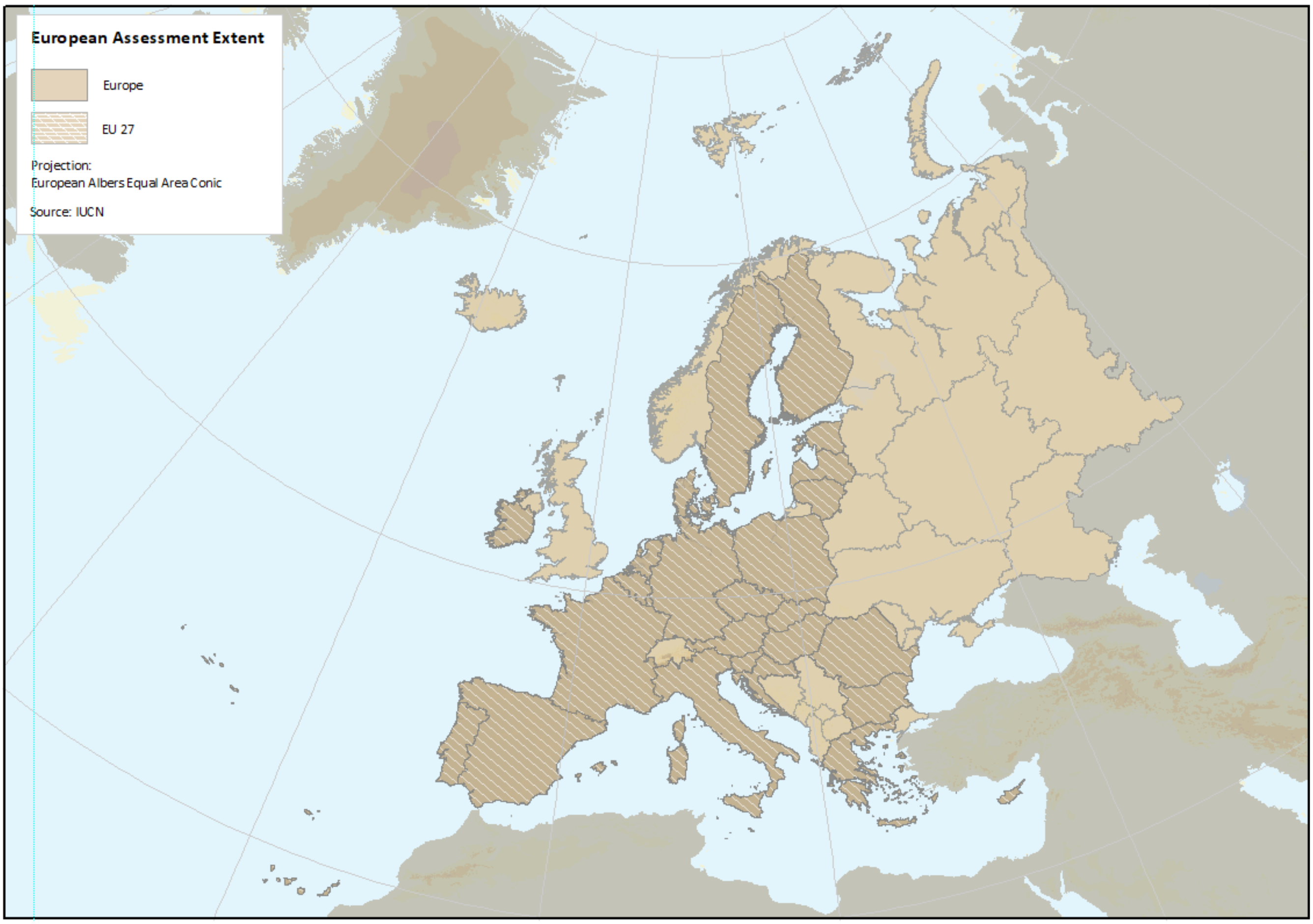

Figure 10. The European Red List assessment boundaries. Regional assessments were made for two areas: for geographical Europe, and for the EU27 Member States (hatched area).

2.3 Assessment protocol

For all species, the following data were compiled, as available:

- Taxonomic classification and notes.
- Distributional range and list of countries of occurrence (including a range map).
- Population information and overall population trends.
- Habitat preferences and primary ecological requirements, including pertinent biological information (for example, larval feeding mode and habitat, number of generations, etc.).
- Species use and trade (although trade and use of species currently plays no role in the threats to hoverflies).
- Major threats.
- Research needs.
- Conservation measures (in place and needed).
- IUCN Red List Category and Criteria and rationale.
- Key literature references.

Some critical terms such as 'severely fragmented' were interpreted in a pragmatic and consistent way: expert knowledge of the dispersal ability of the species and their specific habitat requirements was applied. Expert knowledge and data were used to understand the probable full distributions of species, informed by the hoverfly surveys that have taken place across Europe, obtained from the well-connected community of hoverfly experts and the IUCN SSC Hoverfly Specialist Group. This expert knowledge made it possible to understand which species were truly Data Deficient.

Information on each species was based on published and unpublished data, including expert knowledge. The IUCN Species Information Service (SIS) online database was used to enter and store all species data.

The task of collecting the initial data was divided taxonomically between 12 Lead Assessors and 11 Contributors (Appendix 2). An in-person training workshop was held in April 2019 in Novi Sad (Serbia) to train the Lead Assessors in the IUCN Red List methodology and the use of IUCN's SIS online database. After the preliminary information was compiled by the Lead Assessors for each species, a total of five assessment workshops were held to review and discuss the assessments and distribution maps, add new information to the assessments, and agree on the final IUCN Red List Category and Criteria for each species. The workshops assessed sets of selected genera, and took place in Lesbos, Greece (in-person; September 2019; 10 experts), and Novi Sad, Serbia (in-person; December 2019; 5 experts). The remaining workshops were held online using digital platforms due to the Covid-19 pandemic: April 2020 (9 experts); August 2020 (5 experts); and September 2020 (6 experts).

Following the workshops, the assessments underwent internal editing by IUCN staff and remaining questions were resolved through communication with the Lead Assessors. A final peer-review process was performed, with all assessments checked by external reviewers not previously involved in the assessment process. Consistency in the application of the IUCN Categories and Criteria was checked by the IUCN European Regional Office staff and the Red List Unit. The resulting finalised set of IUCN Red List assessments is a product of scientific consensus concerning species status supported by relevant literature and data sources (see example in Appendix 3). The final list of species assessed can be found in Appendix 1.

2.4 Species mapping

Distribution data were mainly obtained from published literature, collections of entomological specimens (public and private) and internet sources (for example, the Global Biodiversity Information Facility (GBIF) and the 'Syrph the Net' database). The individual assessors provided the distribution data which was then compiled to produce the final distribution maps in a geographic information system (GIS; ESRI ArcMap).

Range maps were created using the available distribution data, which varied in terms of quality; for some regions, data were available as point localities (latitude/longitude) or in grid-cell format, and were therefore spatially precise and able to be projected in GIS. Polygons were then drawn manually, clustering occurrence data where appropriate. Where habitat data were uncertain and polygons could not be created, only point data were used. Sometimes, a mixture of point data and polygons were used. In cases where no point data were available and it was only possible to assign presence at the country level, the distribution was mapped for the whole country, but this was noted in the assessment. For species that are truly widespread and ecologically generalist (found in a wide variety of habitats), entire administrative areas or countries were mapped where appropriate. Whole administrative areas or countries were also mapped where a record from the country/area was known but without precise locality data.

Metadata coding was used to distinguish 'presence', 'origin', and 'seasonality' across the spatial extent of a species distribution. These codes differentiate between:

- the species presence (options include 'extant', 'possibly extant' and 'extinct');
- seasonal presence of the species in the location (the default setting of 'resident' was assigned); and
- the origin of the species (options include 'native', 'introduced', 'reintroduced' or 'uncertain').

Full coding information can be found in the Red List digital distribution metadata guidance (IUCN, 2017).

The spatial analyses presented in this publication (see section 3.3) were done using a geodesic discrete global grid system, defined on an icosahedron and projected to the sphere using the inverse Icosahedral Snyder Equal Area (ISEA) Projection (S39). This corresponds to a hexagonal grid composed of individual units (cells) that retain their shape and area (864 km^2) throughout the globe. These are more suitable for a range of ecological applications than the most commonly used rectangular grids (S40). The known current distributions of extant and possibly extant species were converted to the hexagonal grid for the purposes of the analysis. Coastal cells were clipped to the coastline.

Sericomyia lappona (Least Concern) © Frank Vassen

3. Results

3.1 Threat status

At the European level, 890 species of hoverfly were considered native or naturalised. Of these, 314 species were found to be threatened (assessed as either VU, EN or CR), i.e. having an elevated risk of extinction in the near future. Additionally, 45 species (5.1%) were classified as Data Deficient (DD) because there was insufficient information available to assign them a conservation status (Table 2). The proportion of threatened European hoverfly species could range between 35.3% (if no DD species were found to be threatened) and 40.4% (if all DD species were found to be threatened) (Table 1). The mid-point figure (37.2%) provides the best estimate of the proportion of threatened hoverflies in Europe (IUCN, 2016).

At the European scale only one species was assessed as Regionally Extinct (*Helophilus bottnicus*; Table 2, Figure 11). Two species were assessed as Critically Endangered (Possibly Extinct) (*Platycheirus meridimontanus* and *Riponnensia daccordii*), 32 species (3.6%) as Critically Endangered, 204 species (22.9%) as Endangered and 76 species (8.5%) as Vulnerable (Table 2). A further 61 species (6.9%) were classified as Near Threatened. Over half of hoverfly species in Europe were assessed as Least Concern (52.7%).

Three species were considered Not Applicable (NA) for Europe. Two are apparently introduced after 1500 CE and now established: *Copestylum melleum* (a Neotropical species native to Mexico that in the European region has been introduced to the Canary Islands) and *Melangyna pavlovskyi* (native to the Russian Far East and Japan) – the origin of this species in the European region is uncertain, but it was assessed as NA on the grounds of probable introduction following Bygebjerg (2011). Neither would be considered threatened (LC). *Criorhina brevipila* was considered NA because of its doubtful presence at its only European site, the Ural mountain range.

In the EU27, 313 species were found to be threatened and 33 species were considered DD, which implies that the proportion of threatened hoverflies in the EU27 ranges between 36.5% and 40.4% (Table 1), with the mid-point value being 38.0%. Appendix 1 lists all hoverfly species assessed under the current European Red List, their corresponding conservation status in Europe and the EU27, and indicates where the species is endemic to Europe and/or to the EU27.

In the EU27, two species were assessed as Regionally Extinct (*Ischyroptera bipilosa* and *Helophilus bottnicus*; Table 2, Figure 12), one as Critically Endangered (Possibly Extinct) (*Riponnensia daccordii*), 42 species (4.9%) as Critically Endangered, 200 species (23.3%) as Endangered, and 70 species (8.1%) as Vulnerable. A further 68 species (7.9%) were classified as Near Threatened. In the EU27, 51.6% of hoverfly species were assessed as Least Concern.

There are 31 species not recorded in the EU27 ('Not recorded') but recorded elsewhere within continental Europe.

Table 1. Proportion of threatened hoverflies in Europe and the EU27 following the IUCN *Guidelines for reporting on proportion threatened* (IUCN, 2016). *Note*: Extinct (EX), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Data Deficient (DD).

	% threat **Pan-Europe**	% threat **EU27**
Lower bound (CR+EN+VU) / (assessed – EX)	35.3	36.5
Mid-point (CR+EN+VU) / (assessed – EX – DD)	37.2	38.0
Upper bound (CR+EN+VU+DD) / (assessed – EX)	40.4	40.4

Table 2. Summary of numbers of hoverfly species within each Red List Category (numbers of endemic species are shown in brackets).

IUCN Red List Categories	No. species Europe (no. endemic species)	No. species EU27 (no. endemic species)
Extinct (EX)	0	0
Extinct in the Wild (EW)	0	0
Regionally Extinct (RE)	1 (0)	2 (0)
Critically Endangered (Possibly Extinct) (CR (PE))	2 (1)	1 (1)
Critically Endangered (CR)	32 (20)	42(13)
Endangered (EN)	204 (123)	200 (57)
Vulnerable (VU)	76 (30)	70 (16)
Near Threatened (NT)	61 (26)	68 (8)
Least Concern (LC)	469 (66)	443 (1)
Data Deficient (DD)	45 (17)	33 (9)
Total number of species assessed	890 (282)	859 (105)
Not Applicable (NA)	2 (0)	2 (0)
Not recorded		31
Total number of species considered	**892 (282)**	**892 (105)**

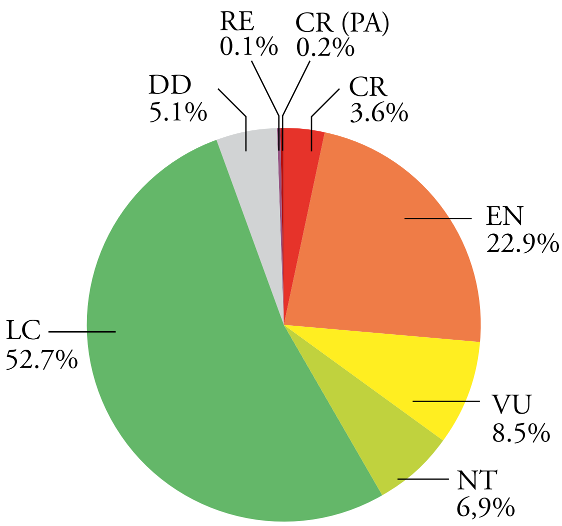

Figure 11. IUCN Red List status of hoverflies in Pan-Europe

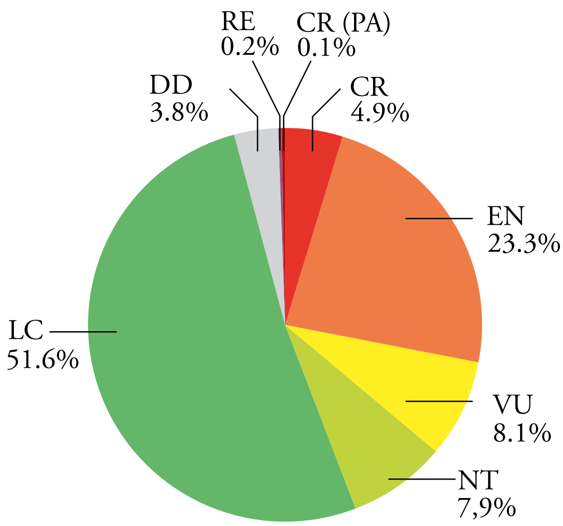

Figure 12. IUCN Red List status of hoverflies in the EU2

3.2 Threat status by taxonomic group

There were significantly fewer threatened species in the subfamily Syrphinae (52 of the 208 species, 20%) than in the Eristalinae (236 of the 574 species, 41.1%). This is probably a reflection of the distribution of these groups and the threats to the larval habitats: all of the Syrphinae larvae are predatory, feeding mainly on aphids, with few being highly specialised, and they have also a more northern distribution with broader ranges. In contrast, the larvae of the Eristalinae feed in many habitats that are threatened, from over-mature trees to marshes and bulb plants, and many occur in the Mediterranean with restricted distributions. The other two subfamilies are rather small to make a comparison, but the Pipizinae (22 of 50 species, 44%) was similar to the Eristalinae. Four of the six Microdontinae were assessed as threatened (67%).

3.3 Spatial distribution of species

3.3.1 Species richness

The geographic distribution of hoverfly species richness in Europe is shown in Figure 13 and is based on all native and naturalised species with 'extant' and 'possibly extant' occurrence. As the mapping approach involved mapping entire countries or administrative regions when specific locality data were not available, the species richness analysis is somewhat affected. This will improve with increased data collection in the light of future Red List reassessments (expected in 10 years) and pollinator monitoring schemes (through the implementation of EU-PoMS at Member State level).

The areas with the highest species richness include central Europe, namely mountainous areas in the Alps, Pyrenees and the Dinaric Alps. There is also reasonably high richness in southern Scandinavia and other parts of eastern Europe, including the Carpathians. Species richness gradually declines towards the west and the north of Europe and in the south along parts of the Mediterranean shores. Mountainous areas score most highly in terms of species richness, but it would be beneficial to examine these spatial patterns further in conjunction with the distribution of intact and healthy habitats across Europe to gain a greater understanding of the relationship between land use and species richness. Some aspects of the map pattern reflect intensity levels of research into hoverflies.

3.3.2 Endemic and near-endemic species richness

In Figure 14, the richness of endemic European hoverfly species is shown based on the presence of 275 species (the analysis does not include species where their presence is uncertain). The incidence of endemic species is reasonably constant throughout most of Europe, with an increase in central Europe and in mountainous areas such as the Alps, Pyrenees and the Dinaric Alps.

In geographically isolated areas such as the Azores, Madeira and the Canary Islands, there are species that are endemic specifically to those islands. It is expected that sampling effort may have affected these distributions, and with a better understanding of hoverflies across Europe further endemism hotspots may be revealed.

To be endemic to a certain region means that a species occurs there and nowhere else in the world. Some of the species considered endemic to Europe in this European Red List have been reported from outside the region, but these records are considered to require further validation, and because of this uncertainty, these species have been included amongst the endemics of Europe in this assessment.

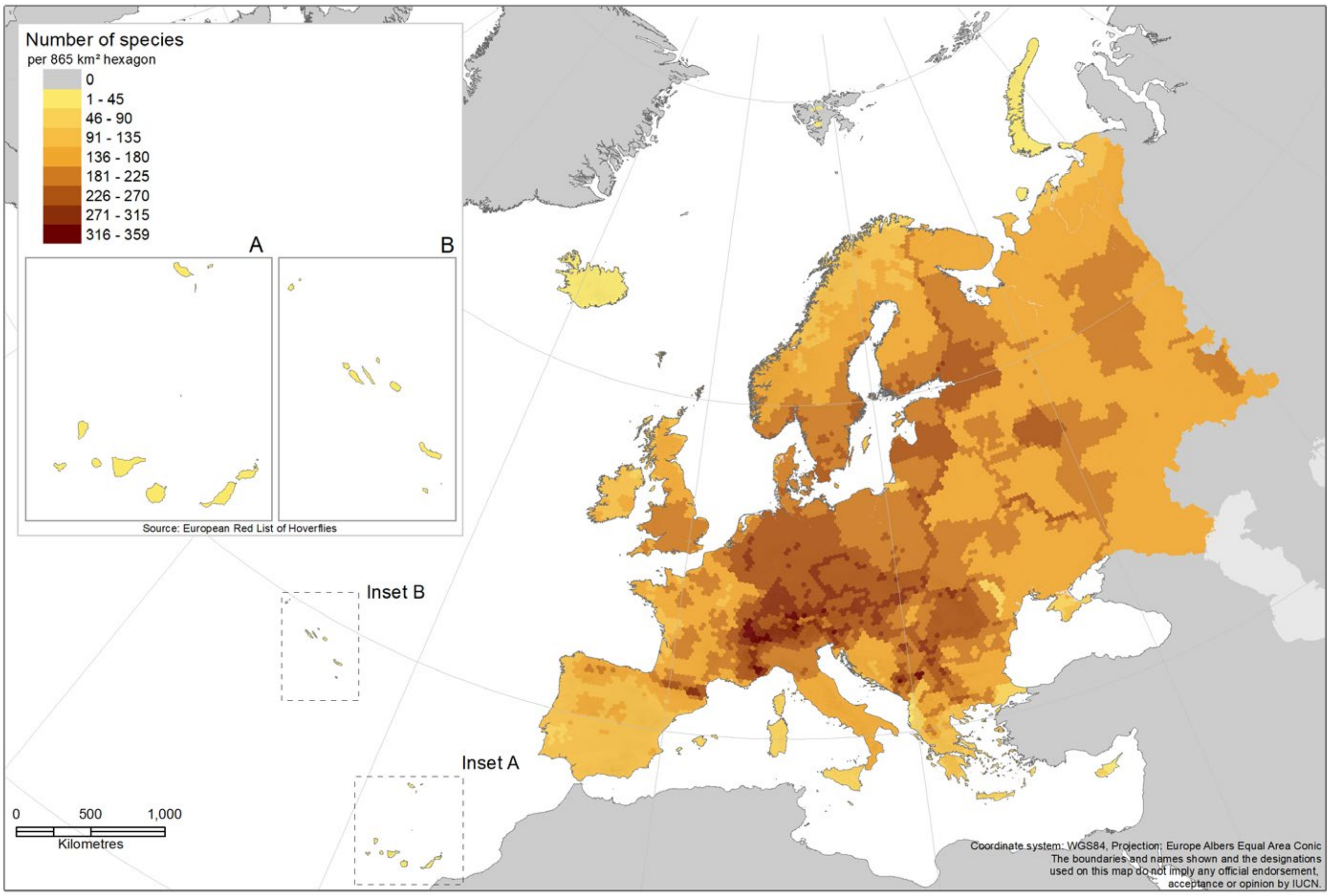

Figure 13. Species richness of all European hoverflies – darker colours indicate higher richness of species. Note the country or administrative-boundary discontinuities caused by the nature of some of the data (see section 2.4).

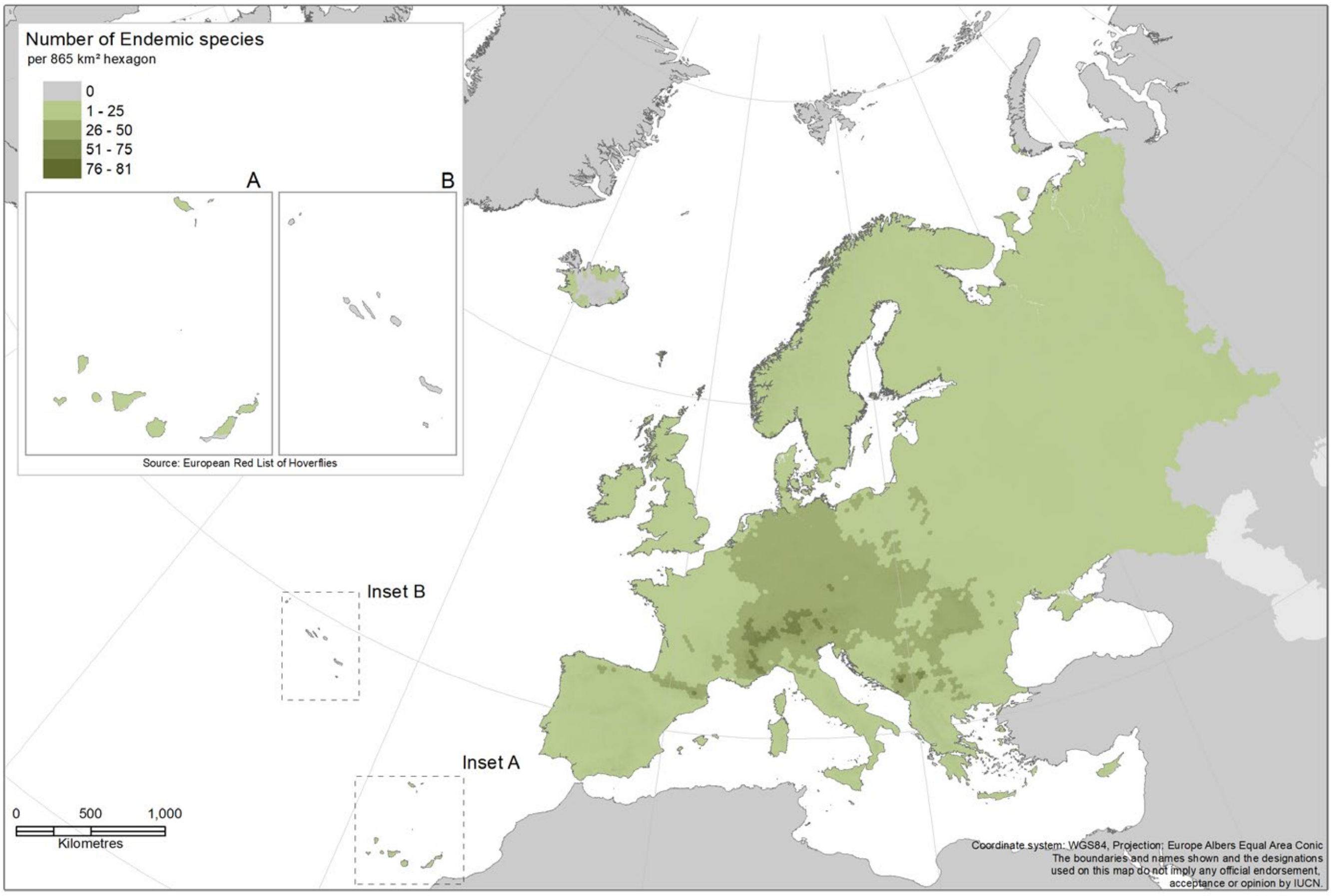

Figure 14. Distribution of endemic European hoverflies – warmer darker colours indicate a higher concentration of endemic species.

3.3.3 Distribution of threatened species

Figure 16 shows the current distribution of threatened European hoverflies (assessed as either VU, EN or CR), represented as the number of species per unit area (865 km^2 hexagons), based on the 312 species considered threatened at the Pan-European scale (the analysis does not include species whose presence was uncertain).

The distribution of threatened species is fairly evenly spread throughout Europe, with a concentration in the Alps and the Dinaric Alps, the Balkan region, the Rhodope Mountains and on the island of Lesbos in Greece. In the Alps, overgrazing by livestock, increased tourism pressure (associated with the ski industry) and climate change are all major drivers of decline in this key area for European hoverflies (see section 3.4).

The spatial data are not informative about the relative pressures from regional threats. For this, the number of threatened species would need to be represented as proportions of total species number per region, a level of analysis that should be done in future work. It is likely that lowland areas, which have experienced massive changes in land use due to agricultural intensification and rural development since the early 20th century, still face greater negative impacts than many mountainous areas. In these heavily used lowland regions, many threatened species only occur in protected areas.

3.3.4 Distribution of Data Deficient species

Figure 17 shows the distribution of Data Deficient (DD) species based on 40 species (the analysis does not include the five species whose presence was uncertain). Some species were listed as DD because they have only been recently described and there is too little information with which to assess their trends or to define their distribution, while others have been considered DD due to taxonomic uncertainty and the difficulty of differentiating among closely related species unless studied genetically.

The incidence of DD species seems highest in mountainous areas (particularly in the Alps), which could be attributed to the fact that they are the most species-rich areas (Figure 13) with high numbers of endemic species (Figure 14), but also because they are more remote, less populated and more difficult to survey than the lowlands. There are also more DD species in relatively under-recorded parts of Europe, such as European Russia and other parts of

Box 2: *Pelecocera lusitanica* (Near Threatened): a European endemic

Figure 15. Pelecocera lusitanica (Near Threatened) © Ole Bidstrup

Pelecocera is a genus of small to very small slender flies (4–5 mm) with a unique shape of antenna. All are species of areas of open heathland with pine trees, usually by the sea or in mountainous habitats.

Pelecocera lusitanica (Figure 15) is endemic to Europe, with a fragmented distribution across a band from the southern Iberian Peninsula to Lithuania, Latvia, Finland and European Russia. It can be common where it occurs, but overall it is rare and declining. It lives in the transition zone between dry pine forest and heather on poor sandy soil or coastal dunes, habitats that have been lost or damaged in many parts of Europe. Adults fly in the early morning, often sitting on the ground or visiting flowers of *Calluna* spp., *Galium verum* and others at the junction between sunny and shaded areas of the forest. There are two generations, in late spring (May–June) and again in late summer (July–August). The size of subpopulations varies greatly from year to year, perhaps indicating that development takes more than one year.

After years of speculation about the larval lifestyle of this species (e.g. a 'phytophage': Kuznetsov, 1992), research has finally determined that they are mycophages feeding on fungi. Perhaps the most important piece of evidence came recently from Japan, where larvae of the closely related *P. japonica* were discovered in underground 'false truffle' mushrooms (*Rhizopogon* spp.) that are symbiotic (ectomycorrhizal) on the roots of pine trees (Okada et al., 2021). Larvae were found in liquifying inner tissues of the mushrooms, and their guts contained many mushroom spores, which were apparently still viable. Because the mushrooms are partially or wholly under the ground, spore dispersal probably relies on being eaten and then transported by vertebrates (birds) and possibly by the hoverflies too as they move to pupation sites some distance away in the soil. Thus, the distribution of *Pelecocera* hoverflies may rely on the presence of these ectomycorrhizal fungi on pine roots. This crucial piece of information will enable conservation plans to be developed.

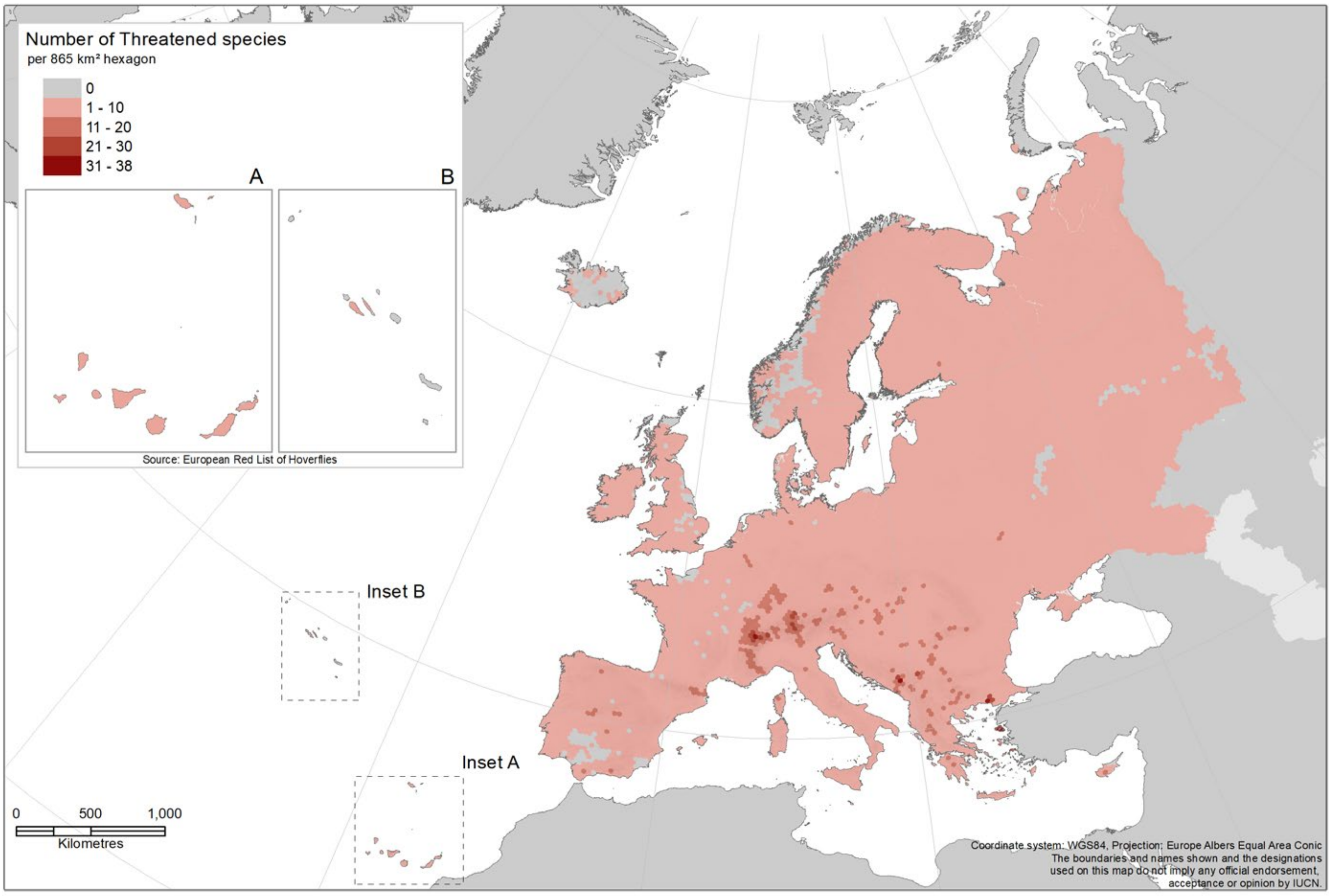

Figure 16. Distribution of threatened hoverfly species in Europe – darker colours indicate high concentration of threatened species.

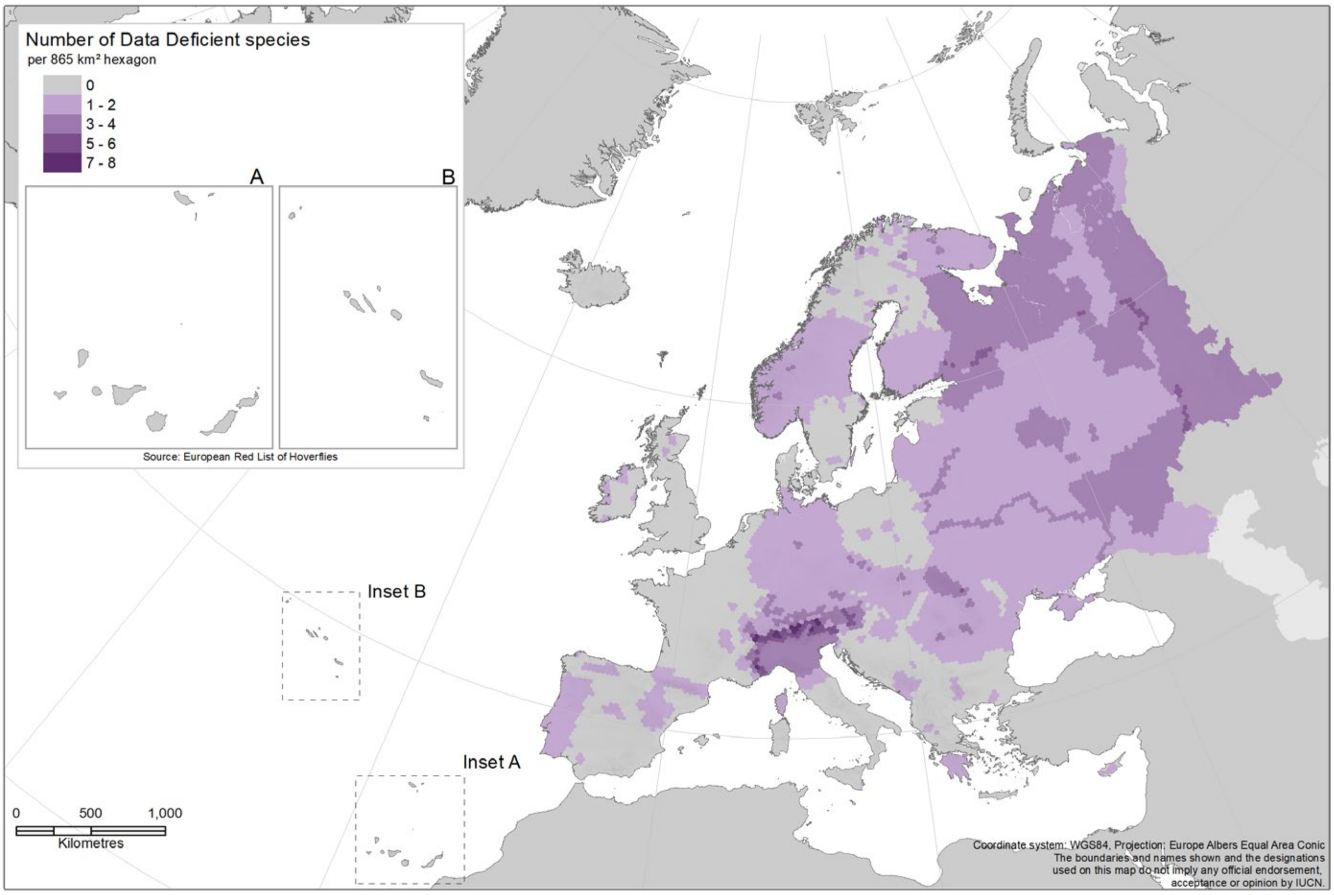

Figure 17. Distribution of Data Deficient (DD) hoverfly species in Europe – darker colours indicate higher concentrations of DD species.

eastern Europe, than there are in well-recorded areas such as western and parts of southern Europe.

3.4 Major threats to hoverflies in Europe

A comprehensive overview of the threats to hoverflies in Europe is not possible, as some threats or their impacts remain unknown. Out of the 890 hoverfly species assessed, threats were successfully identified for 805 species, with multiple threats often listed for a single species. Based on the best available evidence, 32 species are currently thought to be under no major threats, and for 53 species the threats are currently unknown.

Threats to hoverflies are complex and often difficult to categorise, especially because they occupy different niches throughout their life cycles and are therefore subjected to different pressures at different time points and at different life stages. In addition, some threats interact with others, for instance climate change with increased fire frequency, potentially magnifying their effect and adding to the uncertainty of their impact on hoverflies.

A summary of the major threats to threatened and non-threatened (DD, LC and NT) European hoverflies is shown in Figure 18.

This assessment found that the main threat to hoverflies, regardless of their conservation status, was agriculture (including commercial forestry). While aquaculture is also normally included with agriculture in IUCN assessments, it is not considered a major threat to hoverflies. A total of 475 species of hoverflies are impacted by agriculture, of which 214 are threatened. Notably, some threats associated with agriculture, such as pesticide use, are included under other threat classification categories (e.g. pollution) and therefore the number of species impacted by agriculture is likely to be even higher. Residential and commercial development ranked second in the list of threats to hoverflies in Europe (and was the most significant threat to species assessed as threatened); natural system modifications ranked third and climate change ranked fourth.

The following sections will explore these results in more detail.

3.4.1 Agriculture

Agriculture is considered the most common pressure impacting hoverflies across Europe, not just species assessed as threatened, but also Near Threatened or Least Concern species. A total of 475 species were found to be impacted by arable and livestock farming, including 214 species assessed as threatened (CR, EN or VU). Farming can impact hoverflies in a multitude of ways, including by land conversion of suitable habitat, habitat degradation by livestock overgrazing and the fragmentation of natural and semi-natural habitats. Fragmentation usually reduces

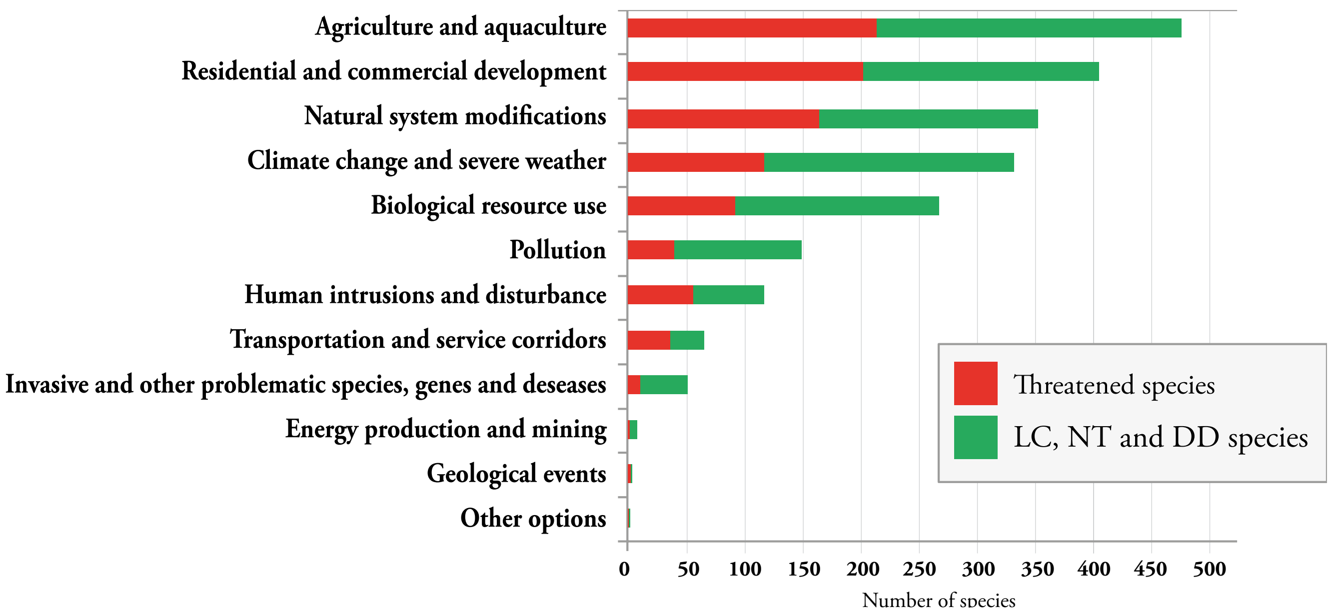

Figure 18. Major threats to all hoverflies in Europe. *Note*: Species can be affected by more than one threat.

patch area and increases distances between patches, a particular problem for hoverflies that are poor dispersers or highly habitat-restricted.

An example of a Critically Endangered species strongly impacted by agriculture is *Eumerus azabense* (Grković, 2021). It is currently considered endemic to a single locality in western Spain, the Biological Reserve of 'Campanarios de Azaba'. This 522-ha reserve has been managed as traditional savannah-like 'dehesa' habitat, a multifunctional agrosylvopastoral system used primarily for grazing cattle and pigs under oak trees. *Eumerus azabense* was only described in 2018 from ten specimens caught in 2011 in the reserve, and its life history is as yet unknown. The livestock and the oaks (mainly cork) provide economic benefits, but the habitat also enables the extraction of a variety of non-timber products such as wild game, honey and mushrooms. The 'dehesa' habitat is under pressure throughout the Iberian peninsula because of economic issues related to limited profitability, leading to pasture intensification and overgrazing (Olea & San Miguel-Ayanz, 2006), which may have had detrimental effects on this already endangered hoverfly.

Commercial forestry

Much of Europe was originally covered in functional natural forest ecosystems; however, over the course of history a large proportion of this landscape has been lost due to land conversion into urban, agricultural and sylvicultural areas. Commercial forestry can lead to large areas of natural and functional ecosystems being converted into intensively managed native and non-native monocultures (Stoate et al., 2001). Crucial hoverfly habitats, particularly microhabitats that occur in natural forest landscapes as a result of natural processes such as tree ageing and the opening of canopies as a result of tree cessation, can be lost forever (Miklín & Čížek, 2014).

Loss of ancient forest, veteran trees and the availability of deadwood is particularly detrimental to the survival of hoverfly species with saproxylic larvae, many of which depend on the occurrence of veteran trees or fallen stems and branches. The widespread but Vulnerable (Pennards et al., 2021a) Logjammer Hoverfly *Chalcosyrphus eunotus* is a good example of such a hoverfly; the eggs are laid in bark fissures and the larvae burrow into partially waterlogged fallen branches in small streams under a canopy of trees. This species thus depends on forest streams and the branches that have fallen into them, but can still survive in areas with tree-lined streams that are not woodland. While large tracts of forest have disappeared by being felled, small populations of many saprophagous hoverflies can remain breeding in the rot-holes, decaying branches and roots of the few remaining veteran and ancient trees.

Some tree agriculture/forestry management practices have been detrimental to saproxylic species because in many locations such trees have been consistently removed on the grounds of public or worker safety, and fallen timber has been 'tidied up'. Protection of this habitat is now a critical issue because cohorts of ageing trees have not been retained in managed forests to take the places of the current cohort of veteran and ancient trees when they die. Across Europe, this is one of the most important issues in the long-term conservation of hoverflies.

Logging and wood harvesting (also sometimes categorised as 'biological resource use') results in the direct removal of habitat on which hoverfly species rely: this threat is known to affect 264 European hoverfly species, 90 of which are threatened. The Endangered *Sphiximorpha petronillae* is endemic to Europe, occurring only in southeastern Europe (Greece, Montenegro and Serbia) and Italy (Aracil et al., 2021). Females have been seen ovipositing into bark crevices close to sap-runs on senescent oak trees of various species that also house a rare European ant, the Velvety Tree Ant *Liometopum microcephalum*. The larvae of the hoverfly feed in the decaying sap under the bark. Ancient oak trees with sap-runs are rare even in forests with many old trees, and often there are many rare saproxylic hoverfly species breeding in the same trees (van Steenis et al., 2019). Every individual ancient tree is important to the survival of saproxylic hoverflies.

A second example of a hoverfly threatened by logging is *Spilomyia diophthalma* (LC). Its larvae live in tree-holes, probably of Aspen *Populus tremula*. It is the most common of its genus in Europe, with widespread records across central and northern Europe. However, there are no recent records from central-lowland Europe, where it may be extinct, and it is rare in the Alps, but in Scandinavia it is seemingly not threatened. Its numbers are reduced or disappear wherever there is extensive commercial logging (van Steenis, 2000; Pennards, 2021a).

A further 140 species are at risk from land management associated with commercial wood and pulp plantations. Out of these, 47 species are considered to be threatened, many of them because of the replacement of ancient forest with commercial tree species, including non-native species such as Sitka Spruce (*Picea sitchensis*). Many species of hoverfly, such as the Vulnerable (Pennards, 2021b) *Callicera rufa*, are associated with particular tree species. *Callicera rufa* has a preference for ancient *Pinus sylvestris* forest in particular because its larvae live in the deep water-filled rot-holes that commonly develop where a pine stem has bifurcated during growth. This species is threatened by land conversion for commercial forestry and agricultural purposes. Increased forest conversion from diverse natural and native forest to non-native monocultures can negatively impact many hoverfly species.

Finally, commercial forestry often requires intensive management. Monocultures and clear-fell forestry practices can remove the specific habitat niches required by some hoverfly species, and reduce biodiversity (Liu et al., 2018) but also create perfect environments for a small number of insect species to thrive and go unchecked by natural ecosystem processes. These species, such as the Pine Weevil *Hylobius abietis* (a beetle), can become agricultural pests, resulting in the loss of timber productivity (Evans et al., 2004). To manage such pests, a combination of pesticides, physical barriers and biocontrol agents are used to protect the crops, and this can result in large areas being exposed to chemical pesticides and herbicides in order to manage the imbalance that has been created. The effect of these chemicals on hoverflies is poorly understood, but likely to be detrimental.

3.4.2 Residential and commercial development

A total of 403 species are affected by residential and commercial development, of which half (202) are threatened. Residential and commercial development can impact species in several ways by interacting with other threats affecting hoverflies, such as water abstraction (which tends to increase in areas that are developed).

Tourism and recreation

Tourism is the biggest threat to hoverfly species in this category, affecting a total of 265 species (167 threatened). Tourism related to winter sports, in particular, can impact montane species in several ways: the destruction of their natural habitat to create ski slopes; increased habitat disturbance by humans; and through building infrastructure in habitats that are already quite vulnerable due to the increasing impacts of climate change. Winter sports can result in further forest loss, pollution from human waste (and ski wax) and the drainage of freshwater habitats for human use.

Sphegina sublatifrons is an example of a hoverfly threatened by tourism associated with winter sports (van Steenis et al., 2021a). This very rare and endemic Balkan species is considered Endangered because of winter tourism which has resulted in the species being lost from its main site of Mt Kapaonik in southern Serbia, the place it was first discovered in 1986.

Housing, urban areas, commercial and industrial development

176 species (64 threatened) are affected by housing and urban areas, and 74 species are at risk from commercial and industrial development, 22 of which are threatened. Destruction of important sites for hoverflies for development has happened throughout Europe in the past and is now especially a problem in the Mediterranean and Alpine regions. Modern society has vastly improved its understanding of the value of the natural environment, its resources and services (Irvine et al., 2016), but this is not yet reflected in the way that we treat and manage it, particularly with regards to development. It is essential that natural capital (the resources and services provided by nature) is considered within planning processes. Until that is done, the advantages of urban, commercial and industrial development (amongst others) will always be perceived to outweigh the numerous short-term and long-term benefits of functioning ecosystems. Once destroyed, our society loses forever the ecosystems, the services they provide, their characteristic species and their locally adapted populations, with a suite of cascading consequences.

3.4.3 Modifications of natural systems

A total of 353 species are affected by modifications of natural systems, 164 of which are threatened.

Fire and fire suppression

Fire and fire suppression affect 206 species of hoverfly in Europe, including 123 threatened species. For most species (135) affected, the impact of fire and fire suppression is unknown. However, 70 species are negatively impacted by increasing fire frequency/intensity, 43 of which are threatened. This threat is also linked to climate change, which is increasing the frequency and intensity of wildfires across Europe. Because of this, expansion of the area impacted by fires is expected, particularly in southern

Europe (Forzieri, 2016; Fargeon et al., 2020). Further research is required to understand more accurately the expected risks posed by wildfires to hoverflies, and the projected scale of the threat.

The larvae of *Brachyopa* hoverflies feed on the yeasts and fungi in sap-flows of trees, making them susceptible to fire. On the island of Lesbos in Greece, *Brachyopa minima* was first discovered in 2007 amongst a collection of larvae from a sap-flow of a single tree of Black Poplar *Populus nigra*, and then again in subsequent years from the same tree but no others in the small grove of 15 trees. Despite intensive searches, other sap-runs have not been found on poplars or any other tree on Lesbos, and the original tree sap run remains the only place where this species has been found. Given the increasing frequency of fires in Greece, this Critically Endangered (van Steenis et al., 2021b) species is clearly at very high risk.

Dams and water management/use

A total of 118 species, 31 of which are threatened, are impacted by dams and water management. The specific water management threat with the largest impact on most species is abstraction of surface and ground water for various uses, including agricultural and domestic use. Our assessment showed that 110 species are affected by water abstraction, 26 of which are threatened. This threat can be particularly problematic for wetland hoverfly species that rely on this habitat for part or all of their life cycle. There are many such species amongst the hoverflies, but a good example is the Endangered *Melanogaster curvistylus*, a central European endemic with a highly fragmented distribution (van Steenis et al., 2021c). It is found close to bodies of standing water or slow-moving streams in forests or grasslands of floodplains, exactly the kind of habitat that has been lost all over Europe because of drainage and flood-defence schemes. The aquatic larvae live in freshwater bodies that contain decaying vegetation, and probably suffer when such water is polluted from agricultural runoff.

3.4.4 Other threats to hoverflies

Climate change and extreme weather events

Climate change is affecting the distribution of suitable conditions for many species, moving them to different places (Lenoir & Svenning, 2015; Kaloveloni et al., 2015; Radenković et al., 2017); montane species confined to the tops of just a few mountains are especially affected because they can only move upwards (Grytnes et al., 2014).

A total of 331 hoverfly species are considered to be either currently impacted by climate change or expected to be threatened by climate change in the future: this includes 118 threatened species. More specifically, 244 species are currently being impacted by habitats shifting and altering as a result of climate change, 81 of which are threatened. This can occur in a variety of habitats, including subarctic habitats in northern Europe, and montane habitats where habitats are decreasing or becoming less suitable as a result of increasing temperatures (Grytnes et al., 2014). The case of *Volucella zonaria* has already been mentioned: the way it spread along the south coast and into cities in the UK during the post-WW2 period has all the hallmarks of a species that requires the frost-free winters that are increasingly the norm under climate change. Morris and Ball (2004) suggest its distribution fits areas where the January minimum temperatures are greater than 1 °C and the July maxima are greater than 20.5 °C.

73 species are impacted by droughts, 37 of which are threatened. Drought can affect wetland species reliant on the natural cycles of wet habitats to complete their life cycle, but also species affected by the increasing fires resulting from drought. Hoverfly species can also be threatened by other impacts of climate change such as storms and flooding (five species, two of which are threatened). There are 23 species currently or projected to be impacted by temperature extremes (11 of which are threatened).

In the UK, the impact on hoverflies of the particularly intense heatwave and drought of May–July 2018 was very strong, particularly on species of *Melanostoma* and *Platycheirus* (Morris & Ball, 2019; 2021). These are grassland hoverflies with predatory larvae feeding on the aphids of grasses and herbs. Most have two emergence periods in the year, in April–May and again in July–November: in 2018 the first peak was normal, but the second peak all but disappeared. Species with a single summer generation were also negatively affected, such as three species of *Volucella* (*V. inanis, V. pellucens* and *V. zonaria*).

Biological resource use

The threat of biological resource use relates strongly to other threats, such as commercial and non-commercial forestry activities, with logging and wood harvesting having an impact on European hoverflies – these have been considered in the agriculture section (3.4.1).

A further two threatened hoverfly species are potentially impacted by a second threat related to biological resource use, the gathering of terrestrial plants. The Endangered *Cheilosia thessala*, endemic to southeastern Europe, probably has a larva that feeds on mushrooms, which are collected by people in the region (Miličić & Vujić, 2021). Both adults and larvae of the Vulnerable *Merodon luteihumerus* of Iberia and western North Africa feed on the Sea Squill *Drimia maritima*, the adults on the flowers and the larvae in the huge bulbs (Likov & Radenković, 2021). The plant contains cardiac glycosides, and has been used for thousands of years as a rat poison but also as a medicinal remedy by local people for dropsy (oedema) because of its diuretic properties. Bulb collection may therefore still constitute a threat to *Merodon luteihumerus*, but as with *Cheilosia thessala*, further research is required in order to understand the current threat from terrestrial plant collection.

Pollution

Hoverflies are affected by a range of pollutants that percolate through the ecosystems where they occur. A total of 149 species are currently directly impacted by pollution, 40 of which are threatened. The primary source of pollution affecting these species stems from agricultural and forestry effluents, which impact at least 142 species, including 37 threatened species. Pesticides and herbicides are currently known to be detrimental to 55 species, 12 of which are threatened, and excessive nutrient loads impact at least 39 species, 13 of which are threatened. A small number of species are known to be affected by other pollutants, such as air-borne pollutants (five species), domestic and urban waste water (four species), and garbage and solid waste (two species). Research on this subject, particularly on the impact of pesticides on hoverflies, is still very scarce, and many species present in and around agricultural landscapes are probably affected by this threat, especially in the light of the massive losses of hoverfly numbers over the last 50 years (see section 3.5, below).

As important biocontrol agents, hoverflies have been part of the standard testing regime for pesticide toxicity in Europe for a long time (cf. Hassan, 1985), but attention was focused solely on mortality rather than any sub-lethal side-effects. Most tests were done in the laboratory on easy-to-rear, polyvoltine and relatively insensitive species using unrealistic doses of the pesticide sprayed either onto the substrate or directly onto the larvae or adults (Uhl & Brühl, 2019). More subtle sub-lethal effects are now considered just as important, and attention is paid to levels of exposure appropriate to field conditions. Field-based studies are now more common, and the ecology of biological control is now much better understood, with renewed appreciation of the role of the entire community of natural enemies (Snyder, 2019).

Adult hoverflies are exposed to a very wide range of pesticides throughout the entire agricultural landscape while visiting flowers, and we know far too little about the population-level impacts of these chemicals (Uhl & Brühl, 2019). Claims in the literature range from no effect (e.g. for neonicotinoids: Zhang et al., 2015) to the idea that syrphids can detect pesticides by their taste (e.g. neonicotinoids in nectar as described by Clem et al. (2020). Alongside direct effects, more subtle sub-lethal effects can be just as detrimental to hoverflies (Uhl & Brühl, 2019). Currently, there are no available studies on the combined longer-term sub-lethal effects of lower concentrations of a variety of pesticides at the same time on hoverflies, especially the more sensitive species. The recent discovery of widespread contamination of nature conservation areas by multiple types of pesticides (Brühl et al., 2021) is a cause for great concern. Thus the known effects of pesticides are likely to be a gross underestimate of their real effects.

Human intrusions and disturbance

Human intrusions and disturbances can include a wide variety of activities, some of which strongly relate to other categories of threats (for instance, tourism and recreational activities). A total of 117 species are affected by this threat, including 56 threatened species, divided as follows: 47 species are impacted by recreational activities (28 threatened), 71 species are impacted by other human intrusions categorised as 'work and other activities' (27 threatened).

One hoverfly species, *Merodon alexandri* (VU), is impacted by war, civil unrest and military exercises (Radenković et al., 2021b). It is a European endemic occurring only in eastern Ukraine and southwestern parts of European Russia. It seems to be fairly stable in its Ukrainian distribution, but the small range coupled with the current conflict makes it vulnerable. It is important that studies on the larval habitat are undertaken: this is likely to be a bulb of the Hyacinthaceae because larvae hatched from eggs in the laboratory fed on such bulbs (Popov, 2010).

Additional threats
Hoverfly species are impacted by a suite of other wide-ranging threats. Transportation and other service corridors impact 65 species, including 36 threatened species: often these threats involve clear-cut corridors for servicing electricity or telephone lines.

Invasive and other problematic species, genes and diseases are impacting 52 species, 11 of which are threatened. Many of these are hoverflies with predatory larvae considered at risk from the invasive Harlequin Ladybird (*Harmonia axyridis*). Introduced into both North America and Europe to control aphids, it became established and then dominant in many aphid colonies. It not only feeds on aphids, but also kills and eats other aphid predators such as hoverfly larvae when these are small enough to subdue. As a consequence, ovipositing female hoverflies avoid laying their eggs when there are signs of other aphid-feeding predators in an aphid colony (Alhmedi et al., 2010).

Energy production and mining affects eight species, two of which are threatened. Finally, geological events are known to impact four species, three of which are threatened – there is one Endangered hoverfly (*Merodon nitens*) endemic to two sites on the slopes of the volcano of Mt. Etna on Sicily (Italy), and therefore vulnerable to volcanic eruptions (Radenkovic & Likov, 2021a). Furthermore, on the volcanic Canary Islands where several endemic hoverflies occur, volcanic eruptions such as the recent event on La Palma in 2021 may impact their survival.

3.5 Population trends

As shown in Figure 20, a staggering 62.4% of European hoverfly species have an unknown population trend (555 species, of which 45.6% (253 species) are considered threatened), which means that it is not known whether their populations are increasing, decreasing or stable. The major barrier to this knowledge is a general lack of systematic monitoring schemes that include hoverflies.

A total of 12.9% (115 species) of hoverfly species were assessed as having a decreasing population trend, including 55 threatened species. Conversely, 24.2% (215 species) are considered to have a stable population trend, 2.8% of which are threatened. Only five species, comprising 0.6% of European hoverflies, were assessed as showing an increasing population trend, none of which are considered threatened. The share of decreasing population trend could range between 12.9% (if none of the species with unknown population trends belong to this group) to as much as 75.3% (if all of unknown species are in fact experiencing population decline), with a mid-point of 44.1%.

The percentage decline over a specific period of time was difficult to assess for many species. Whilst with further understanding of their decline, many more species may qualify for assessment under Criterion A (population reduction, measured over the longer of 10 years or three generations), this was only done where there were adequate data and knowledge.

Pollinators in general are in decline, especially rare species (Powney et al., 2019), and there is evidence that the overall abundance of hoverflies is also declining (e.g. Barendregt et al., 2022). Studies from central Europe have demonstrated massive losses in hoverfly biomass of almost 50% over 10 years in Germany (Hallmann et al., 2021), and there were comparable results over the last 40 years in the Netherlands, where both abundance and species richness decreased significantly – the rarest species disappeared in the 1980s, whereas the most common species decreased more recently (Barendregt et al., 2022). Such decreases suggest that hoverflies as a taxon could be close to a Vulnerable, if not Endangered, status.

Migrating hoverflies have been monitored over an even longer period (50 years) at Randecker Maar near Stuttgart in southwestern Germany (Gatter et al., 2020). Using standardised visual counts in July–August when most migrants are aphidophagous species, the average maximum number of individuals seen over the period 1970–1974 was about 10,000 individuals per hour. Over the period 2014–2019, the average maximum had reduced drastically to about 290 individuals per hour – just 3% of the 1970–1974 count. Later in the year, in September–October, the migrants are mainly saprophagous species: by 2014–2019 this group had declined less than the aphidophagous group but were still only 15% of their average value in 1970–1974. Maximum daily trap catches tell a very similar story, declining from an average of 700 individuals per day in 1978–1987 to only about 70 individuals per day in 2014–2019. Because the Alpine passes funnel migrating individuals moving south from over very wide areas, these declines are considered to represent a large-scale phenomenon over central Europe, not a trend local to Randecker Maar.

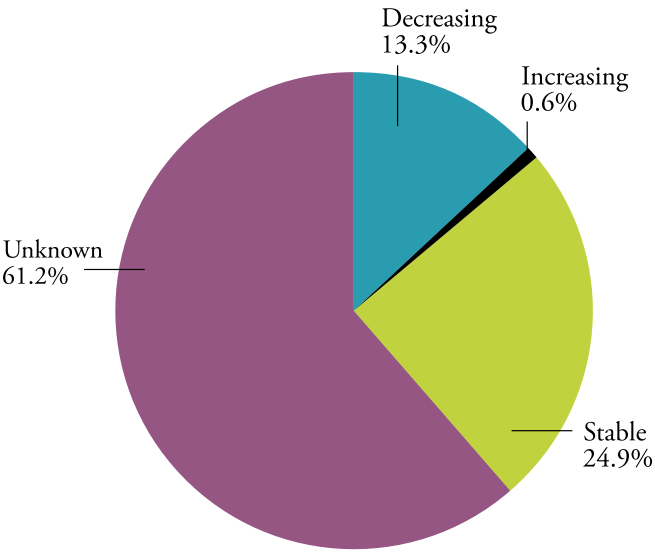

Figure 19. Population trends of hoverflies in the EU27

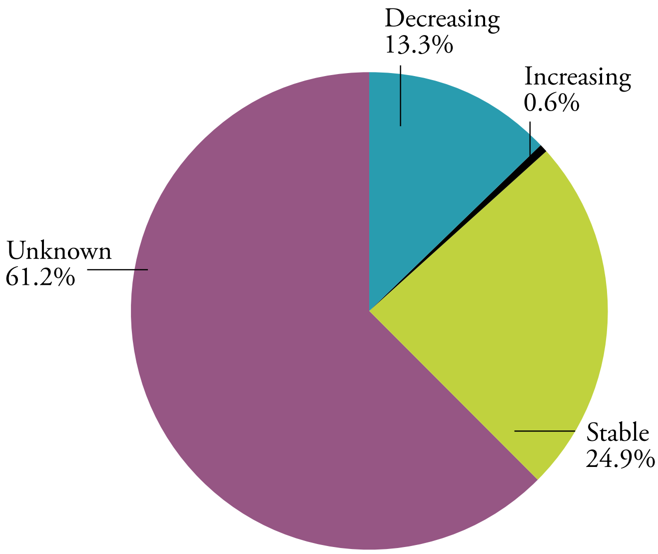

Figure 20. Population trends of Pan-European hoverflies

Changes in abundance and distribution of particular species can be documented by long-established hoverfly recording schemes, such as those in the UK, the Netherlands, Belgium and Denmark. In the UK scheme there are well over a million records, mostly from 1980 until the present day. This systematic monitoring scheme has shown that more than half (53%) of the UK species are declining in relative recording frequency (e.g. *Eumerus funeralis*), a third (33%) are apparently unchanged (e.g. *Didea fasciata*) and the remainder (14%) are increasing (e.g. *Volucella zonaria*) (R. Morris & S. Ball pers. comm. 2018; T. Taberer pers. comm. 2021). There are no differences across the larval feeding-trait types. Across all species the overall trend is downwards since 1980, with an average 45% decline over 35 years (Figure 21).

3.6 Gaps in knowledge

While there was not enough information to assign a Red List Category to 45 species (hence considered as DD), the information collected was sufficient to identify the major knowledge gaps for hoverflies in Europe (Figure 22).

Overall, the absence or paucity of data on population size and distribution, or their trends, were systematically highlighted as a knowledge gap for hoverflies by the expert community that assessed the conservation status of these species. This gap in knowledge affects both threatened and non-threatened taxa. It is hard to conserve species whose ecological requirements are not known, and for

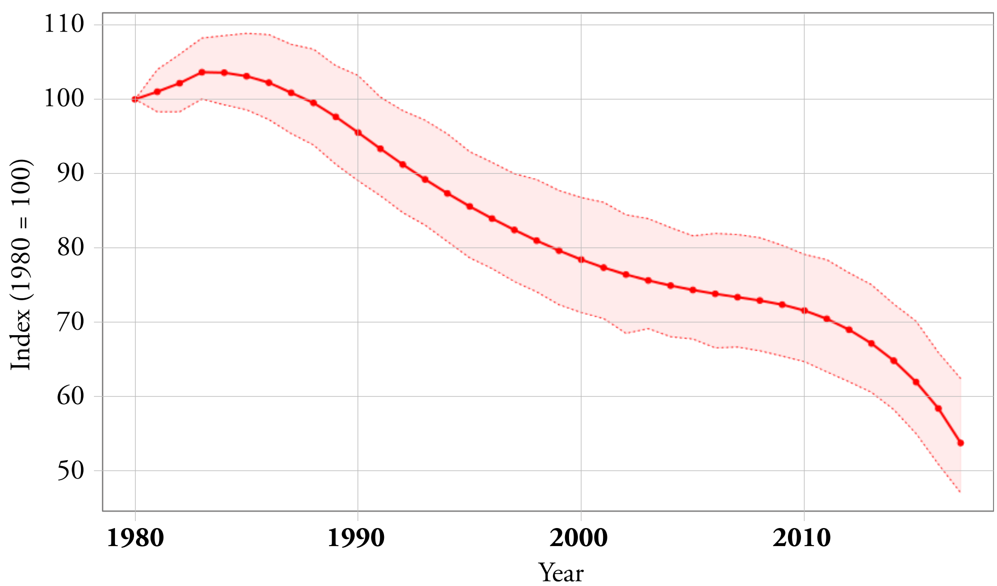

Figure 21. Index of relative frequency of recording averaged (geometrically) across 237 UK hoverfly species, standardised to give a value of 100 to the 1980 data. The dotted lines show the 95% confidence interval from bootstrapping (S. Ball & R. Morris pers. comm. 2018).

whom knowledge about their life history and ecology is rudimentary or lacking, with particular regions especially understudied (for instance, European Russia). While the lack of knowledge can be partially justified by the fact that some species have only recently been described, the reality is that monitoring efforts have either been non-existent or increasingly difficult to sustain and fund over time. This may improve through the establishment of a systematic field monitoring of hoverflies, such as proposed under the EU Pollinator Monitoring Scheme.

It should be noted that the impact of specific threats also requires further research in order to understand better their scale and mechanism so as to be able to manage and mitigate them effectively: pesticides and the impacts of commercial forestry are obvious examples. Additionally, the absence of baseline historical data on species' numbers and distribution hampers a comprehensive understanding of the threats to hoverflies in Europe, and how such stressors interact.

Collecting information on these topics is paramount for sound conservation planning and effective recovery of threatened taxa and will allow more concrete messages to be mainstreamed to the sectors with the most impact on hoverfly conservation. Despite the present knowledge gaps, relevant conservation and management measures should move ahead since the outlines of what is needed are already clear.

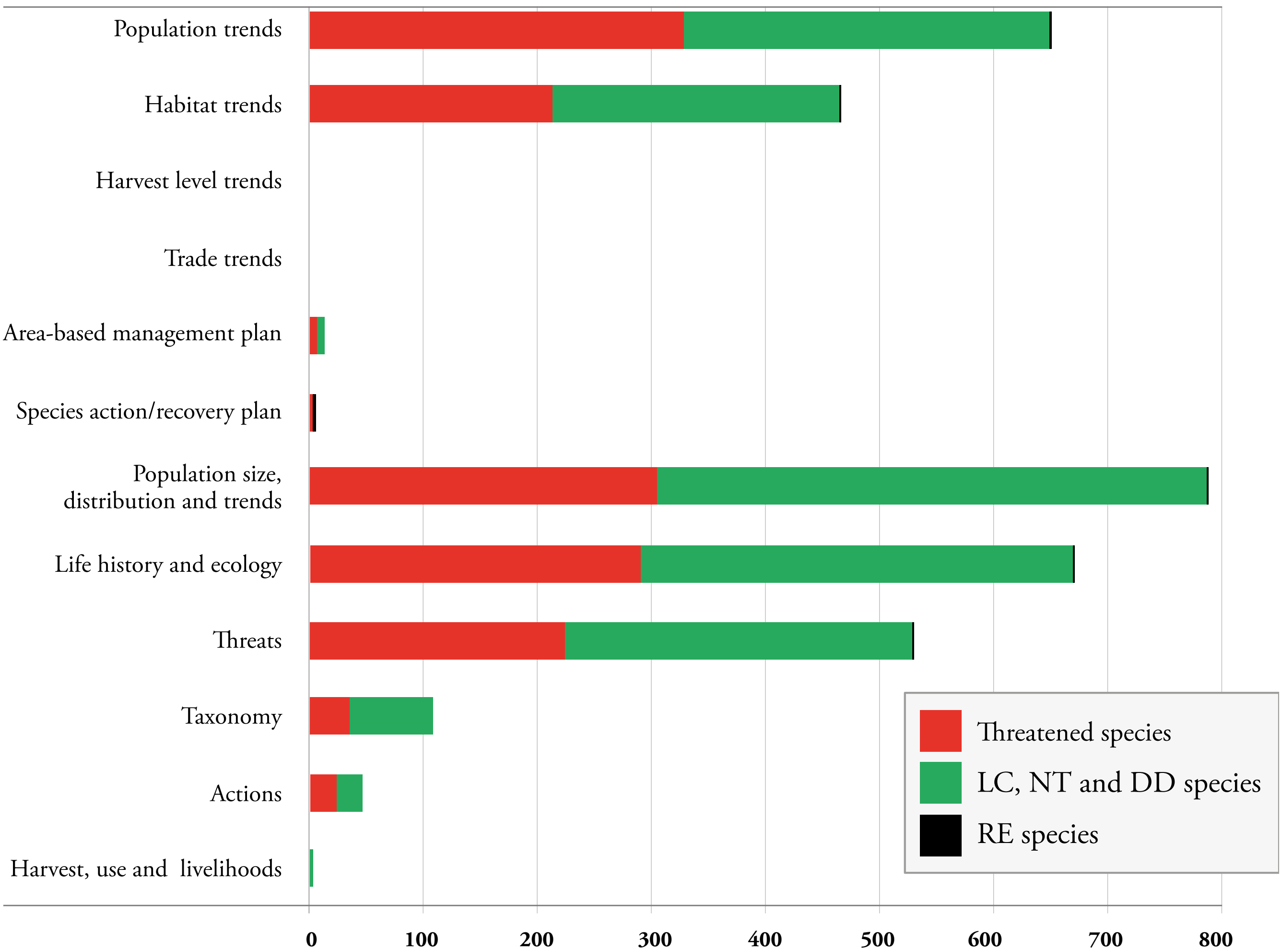

Figure 22. Research needs for pan-European hoverflies. *Note*: Species can be included in more than one category.

4. Conservation actions

4.1 Conservation of hoverfly species in Europe

The nature conservation policy of the European Union is based on two main pieces of EU legislation – the 1979 Birds Directive (Directive 79/409/EEC) and the 1992 Habitats Directive (Directive 92/43/EEC; jointly referred to as the Nature Directives). In addition, the 1979 Bern Convention on the Conservation of European Wildlife and Natural Habitats (hereafter, 'Bern Convention') is a binding international legal instrument that aims to conserve wild flora and fauna and their natural habitats and promote European cooperation towards that objective. It covers all European countries and some African states. European countries and EU Member States are also signatories to several other important conventions aimed at conserving biodiversity, including the 1992 Convention on Biological Diversity (CBD). Through the CBD, a Strategic Plan 2011–2020 was established, which included 20 targets (Aichi Targets) that guided the implementation of the CBD and all the other biodiversity conventions. In particular, Target 12 focused on preventing the extinction of known threatened species and improving their status (CBD, 2011). These targets will be revised in 2022 under the Post-2020 Global Biodiversity Framework. The outcomes of this European Red List will help to measure progress made towards meeting the future targets agreed within this Framework.

There are no hoverfly species currently listed in any of the Annexes of the Habitats Directive, nor are there any syrphids protected under the Bern Convention. Of the 859 hoverfly species present in the EU27, 12.3% are endemic to the EU27, highlighting the responsibility of the EU towards the conservation of these species and the need for legislation that offers them protection. Note that in the progress assessment of the EU Pollinators Initiative, in the LIFE multiannual work programme 2021–2024, the EC has committed to propose an increase in the EU co-funding rate for the most threatened species according to the European Red List (EC, 2021). This will help promote project actions for pollinator species that are not legally protected, but still face a high risk of extinction. The outcomes of this European Red List of Hoverflies will therefore be instrumental in informing the design of LIFE-funded conservation projects that target the most threatened hoverfly species and their habitats across Europe.

In the European Red List of Hoverflies, 72.4% of the species assessed (644 species, of which 240 are threatened) have been recorded in at least one protected area (including national parks, Natura 2000 sites or nature reserves). This is important because site protection was identified as the most common and crucial conservation action needed for European hoverflies (Figure 23). The second most important action was awareness raising and communication, because hoverflies are a group poorly understood by non-experts. Since hoverflies are important pollinators, many with specific habitat needs and affected by many different human activities, it is crucial to raise awareness of the role different stakeholders can play in their conservation. To that end, under the EU Pollinators Initiative, the EC has prepared a series of technical guidance documents with recommendations for action to help tackle the decline of wild pollinators broadly, which are expected to also benefit hoverflies. Additional conservation measures proposed for European hoverflies are shown below (Figure 23).

Area-based conservation

One of the main tools to enhance and maintain biodiversity in Europe is the Natura 2000 network of protected areas. In 2020, there were about 27,000 Natura 2000 sites, covering 18.5% of the EU's land area and 9% of its marine territory (EEA, 2022). Natura 2000 sites provide an important tool in hoverfly conservation even if the sites were not specifically designated for the preservation of hoverfly species. For example, the network has the potential to: enhance better urban planning to promote natural unmaintained vegetation beneficial for pollinators; design multi-species (integrated) action plans to communicate better with site managers; provide guidance for beekeepers to map the availability of resources, in order to determine the right density of beehives; and maintain spatial and temporal rotation of management techniques (i.e., not treating the whole habitat type simultaneously with the same management technique; IUCN, 2019). There are specific practices, such as field margins planted with wildflowers (see Albrecht et al., 2020; Konigslow et al., 2021), which form part of well-supported agri-environment

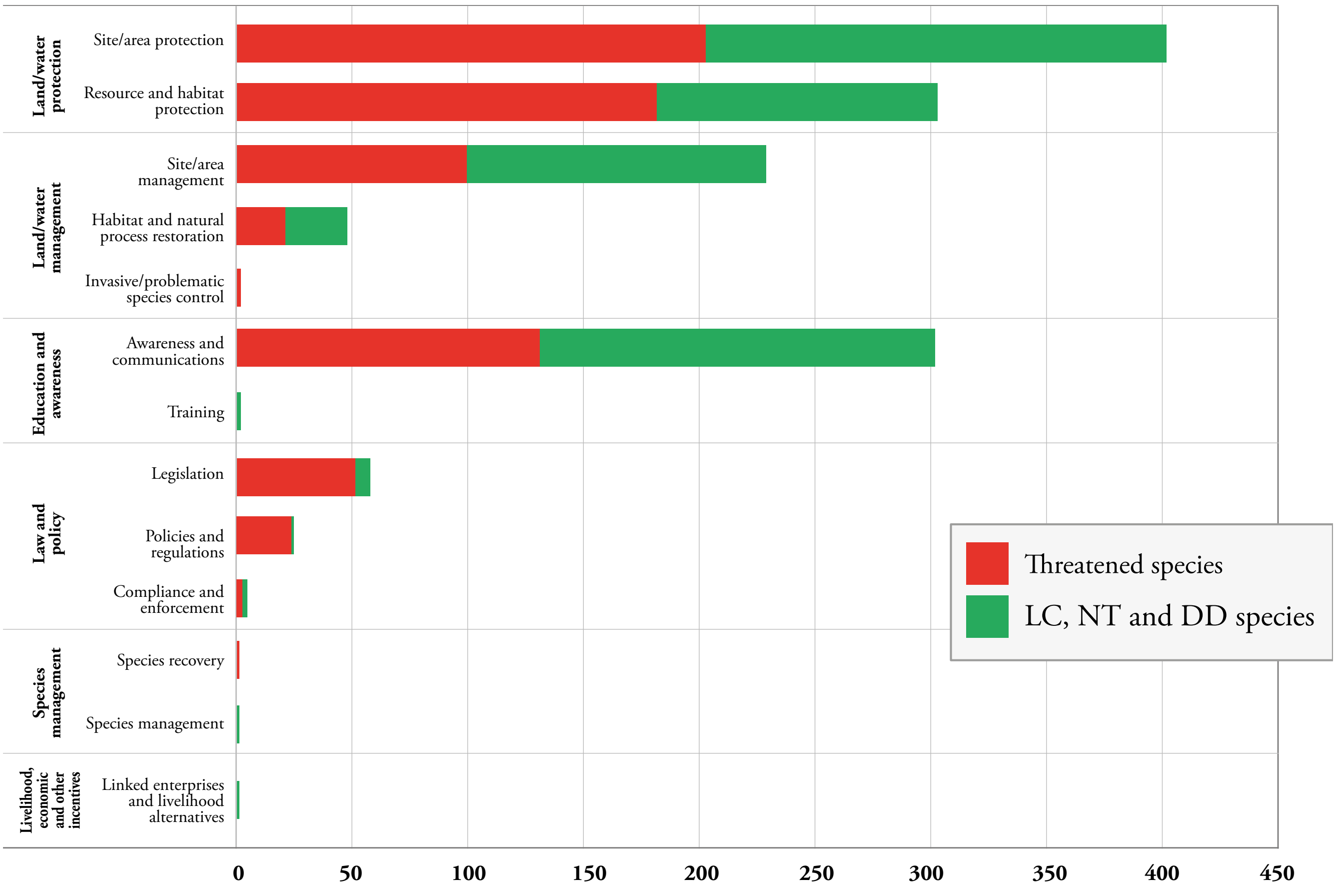

Figure 23. Main conservation actions needed for pan-European hoverflies. *Note*: Species can be included in more than one category.

schemes devised to promote sustainable farming across Europe: these successfully address the ecological needs of hoverflies (M'Gonigle et al., 2015). These and many other simple interventions (for example, hedgerow restoration, Morandin & Kremen, 2013) are known to benefit hoverflies.

Like other groups, many threatened hoverflies occur outside protected areas and therefore depend on the conservation of areas of semi-natural habitat and their connectivity: they usually also require certain microhabitats within these areas to maintain stable populations. For example, hoverflies with larvae feeding in decaying and dead wood need a certain amount of dead wood to be left *in situ* in managed forestry plantations, as well as in ancient forests with senescent trees, in order to provide a continuous supply of larval habitat. This means that the sympathetic wildlife-friendly management of the wider countryside is particularly important for hoverflies. Many of the existing protected areas are too small and have no buffer zones to protect them from, for example, pesticide drift from the surrounding agricultural lands (Brühl et al., 2021). Moreover, hoverflies fly long distances and can pick up pesticides and transport them into reserves. The EU Biodiversity Strategy for 2030, the EU Farm to Fork Strategy and the EU Zero Pollution Action Plan set specific objectives to address landscape connectivity and successfully restore habitats for wild pollinators, including by expanding protected areas, promoting organic agriculture, restoring high-diversity landscape features on farmland, while significantly reducing the use of pesticides and other environmental pollutants harmful to pollinators. More coordinated action among the key stakeholders is needed, however, to put these objectives into practice. More effective use of existing sectoral EU tools and policies is also needed, and this was the first impetus for the design of the EU Pollinators Initiative. Four years into the implementation of this initiative, many actions have been put in place to integrate and scale up the impact of the different policy instruments (EC, 2021), with a specific proposal for the future Common Agricultural Policy to include a number of instruments and features that Member States can use in their strategic plans to improve biodiversity in agricultural areas. While these guidelines have been broadly defined for wild pollinators, more concrete work will have to be done to understand exactly how they need to be translated to ensure hoverfly conservation on the ground (for preliminary work done on this, see IUCN SSC HSG/CPSG, 2022).

Although the next Convention on Biological Diversity (COP15) in Kunming (China) has been postponed several times due to the COVID-19 pandemic, the EU has made a huge step forward with the publication of the EU Biodiversity Strategy for 2030, adopted in 2021. This strategy sets out many clear targets for the year 2030, several of which could contribute to better area-based conservation outcomes for hoverflies. A protected area target foresees 30% protection of Europe's land and sea areas, with one third under strict protection. The criteria for selecting additional new protected areas include the occurrence of IUCN Red-Listed species. For the habitats and species of the EU Habitats Directive, the target is that one third of those currently not in good conservation status should be in good status by 2030 (including better management), and all negative trends in the rest should be stopped. Also helpful for hoverflies is the EC's commitment to take action to reduce the overall use and risk of chemical pesticides by 50% and the use of more hazardous pesticides by 50% by 2030. As these targets represent very big challenges and require quick action, the EU has asked Member States to put forward so-called 'pledges' by the end of 2022, listing the proposed new sites and the habitats/species which are to be improved, including the planned measures to reach these goals. Furthermore, the EC has published a legislative proposal 'EU Nature Restoration Law' in June 2022, which aims to help restore the nature lost within the EU territory. If passed, this new legal instrument could be a game-changer for biodiversity in Europe, including hoverflies, because it defines time-bound measures to implement restoration actions that support the achievement of the 2030 targets. More specifically, it sets the obligation to reverse the decline of pollinators by 2030 and achieve an increasing trend of pollinator populations until satisfactory levels are reached. It specifies that implementing acts will be adopted to establish methods to monitor pollinator populations, and it requires a standardised approach for collecting annual data on the abundance and diversity of pollinator species and for assessing pollinator population trends.

A world-first is the designation of areas protected specifically for hoverflies on the mountain of Fruska Gora near Novi Sad, Serbia. Following on from this designation, a systematic mapping of hoverflies at risk identified a set of 38 Prime Hoverfly Areas for conserving threatened Serbian species (Vujić et al., 2016; Miličić et al., 2017; Janković et al., 2020). While some of these areas coincide with protected areas, very often they do not, and so the task now is to bring these Prime Hoverfly Areas into the protected-area network (Box 3). Tools such as Key Biodiversity Areas and Other Effective Area-based Conservation Measures (OECMs) could be vital in safeguarding these areas for the long-term protection of European hoverflies. Extending this methodology to the rest of Europe would clearly be useful.

Education and awareness

Undoubtedly, the most important recent development for hoverfly conservation in Europe was the development and implementation of the EC Pollinators Initiative (EPI). Under the EPI, several awareness-raising events and communication campaigns were established across Europe. The EU Pollinators Information Hive, that owes its development to the EPI, is centralising core information on wild pollinators, implemented by a multitude of different stakeholders in every corner of Europe. It also serves as a repository of core documentation and guidance being developed at the EU level that focuses Member States on how to monitor and conserve wild pollinators better. While a lot of this information targets wild pollinators as a whole, there are parts that have some specificity related to hoverflies. Such is the case for the EU Pollinator Monitoring Scheme, which includes a module on monitoring hoverflies, which would enable the generation of data from hundreds of sites across Europe, radically improving our knowledge of the status of hoverfly species.

Species management

Disproportionately fewer pollinator conservation projects take place in southern and eastern Europe where the greatest pollinator diversity is found. However, with respect to the legal protection of hoverflies in particular, Serbia is leading the way, showing how translating hoverfly research into policy can happen. There is a list of 33 hoverfly species drawn up by experts that has been placed in Appendix I of the Serbian law providing for strict protection, and another list of a further 44 species in Appendix II providing general protection: soon these 77 will be expanded to 130 species. In other parts of Europe, active local communities are successfully raising the bar of hoverfly conservation on the ground, using integrative and collaborative approaches that tackle both the species decline and that of their habitats (Box 4).

The project team responsible for the European Red List of Hoverflies saw the development of this publication as an opportunity to trial the 'Assess to Act' framework of the IUCN SSC Conservation Planning Specialist Group (CPSG) for the first time in Europe, to connect knowledge produced by the species assessments with local action for European hoverflies. To further this aim, a separate publication (available in digital format only) was produced by the IUCN SSC CPSG, with support from the Project Team, to provide a clear roadmap for hoverfly conservation in Europe, with a focus on the threats and needs of the most threatened species in Europe (IUCN SSC HSG/CPSG, 2022).

4.2 Red List versus priority for conservation action

Assessing the extinction risk and setting conservation priorities are related but distinct processes. The purpose

Box 3: Prime Hoverfly Areas in Serbia

Building upon the designation of Important Bird and Plant Areas, and then Prime Butterfly Areas, Vujić et al. (2016) led a project to identify Prime Hoverfly Areas in Serbia based on detailed mapping of records of threatened species, coupled with expert opinion. Once the data were captured, species distribution models were created for all species with more than six records, and 38 Prime Hoverfly Areas were defined (Figure 24a).

Using an index of irreplaceability, the main hotspots for hoverfly conservation were found to be in the southwestern, eastern and southern parts of Serbia (Figure 24b). About 35% of the Prime Hoverfly Areas lie outside the designated Protected Area network – in fact the habitats of five supposedly strictly protected species (including *Sphiximorpha subsessilis* and *Psarus abdominalis*) are completely unrepresented in the Protected Area network. The addition of just 1.4% of Serbia's land surface to the Protected Area network would greatly improve hoverfly conservation by incorporating all the identified hotspots.

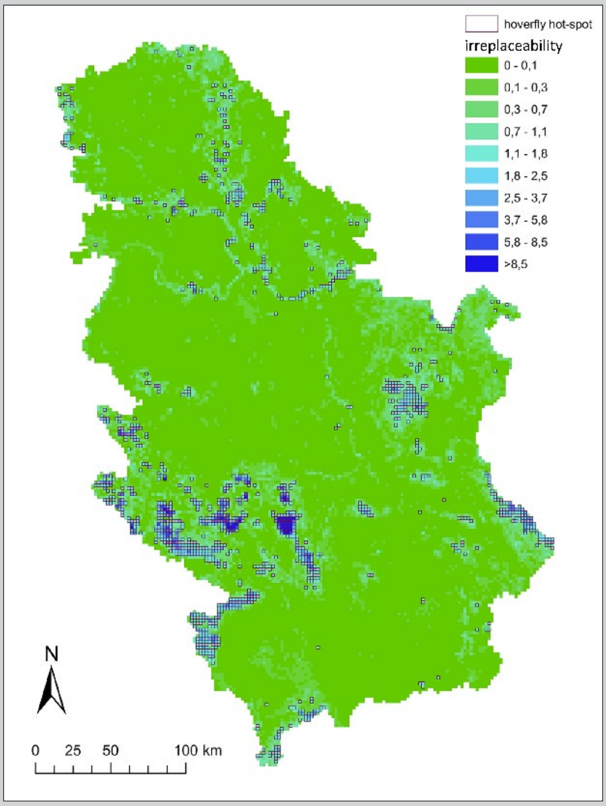

Figure 24a. Map of the Protected Areas (blue polygons) and Prime Hoverfly Areas (red polygons) of Serbia (from Vujic et al., 2016)

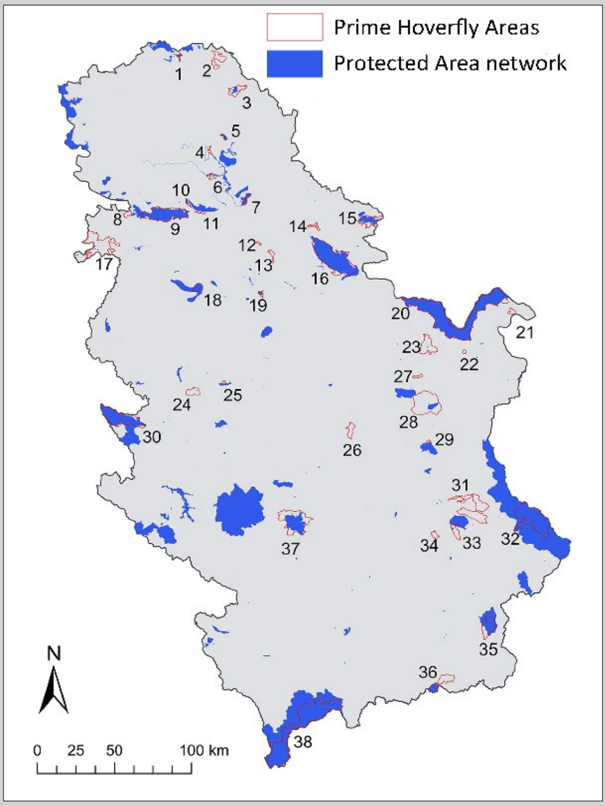

Figure 24b. Map of the hoverfly hotspots of Serbia, based on an index of the irreplaceability of sites (from Vujic et al., 2016)

of the IUCN Red List assessment is to produce an estimate of the likelihood of extinction of a species. On the other hand, setting conservation priorities also needs to consider other factors, such as ecological, phylogenetic, historical, economic or cultural preferences for some taxa over others. The probability of success of conservation actions, availability of funds or personnel, cost-effectiveness and legal frameworks for the conservation of threatened taxa are taken into account. In the context of regional risk assessments, a number of additional pieces of information are valuable for setting conservation priorities. For example, it is important to consider not only conditions within the region, but also the Red List status of the taxon from a global perspective and the proportion of the global population that occurs within the region. The decision on how these variables plus other factors are used for establishing conservation priorities is a matter for the regional or national authorities to determine, considering the Red List status of the species of concern.

Box 4: Conservation of the Aspen Hoverfly *Hammerschmidtia ferruginea*

Whilst targeted conservation action is a common occurrence for vertebrate species and even some invertebrates such as butterflies, it is not readily undertaken for hoverflies. However, there are some exceptions. In Scotland, targeted action is attempting to rescue local subpopulations of the Pine Hoverfly *Blera fallax* (LC; Pennards et al., 2021b) and the Aspen Hoverfly *Hammerschmidtia ferruginea* (Figure 25).

Hammerschmidtia ferruginea (LC; van Steenis et al., 2021d) is reliant on the dead wood of Aspen trees (*Populus tremula*) for survival because this is where the females lay their eggs, and where the larvae develop (Rotheray et al., 2008). In the Cairngorms National Park (Scotland) there is ongoing work to tag and survey Aspen deadwood to keep track of the habitat and ensure it is not destroyed for other purposes. Furthermore, there is regenerative work in the national park to restore Aspen woodland for the benefit of multiple Aspen specialists, including *Hammerschmidtia ferruginea*. The local authorities, experts, local community volunteers and conservation NGOs are working together to implement this important action (CNPA, 2019), a flagship example of the type of synergies and collaboration needed for successful hoverfly conservation across Europe.

Figure 25. Mating pair of Aspen Hoverflies (*Hammerschmidtia ferruginea*; Least Concern) on deadwood in the Cairngorms National Park © Steven Falk

5. Recommendations

5.1 Recommended actions

Policy measures

The main way to help to stop the decline in hoverfly populations is by strict protection of their habitats, and by addressing the landscape-scale issues of conservation. Strict protection of individual species can be very helpful for many vertebrate species, but is less useful for invertebrates including hoverflies. For instance, strict protection could limit the ability to survey them, because many need to be collected so that they can be identified. As an already under-recorded group, it is crucial that further monitoring is not hindered. Therefore, it is recommended that protection laws for hoverflies are area- or habitat-based rather than based on species.

The most urgent habitat-related issue in hoverfly conservation is the protection of over-mature trees which contain trunk cavities, tree-holes, sap-runs, fallen branches and tree stumps – the microhabitats where the larvae of a wide range of species feed, including many that are threatened. Across Europe, forestry practices have militated against such trees. Total clear-felling has drastically changed their abundance in the landscape, but removal of individual trees is just as bad since small populations of saproxylic hoverflies can persist as long as the trees remain. There is now more general awareness of the importance of over-mature trees and fallen timber, but enshrining their protection using legislation or working principles is more effective. In particular, all the relevant bits of legislation need to work in the same direction. Thus, for example, the public safety concerns that lead local authorities to cut down older trees should place much more weight on the retention and conservation of the trees, so that the latter are properly accounted for when considering options for action. A real and looming problem is the long-term assurance of the supply of over-mature trees. Since they can take up to 500 years or more to develop, and with their profligate destruction over the last 70 years, there will be a long period of scarcity even if adequate measures are enacted now.

The mix of tree species is also important. The trees considered to be most important for saproxylic hoverflies are Oak (*Quercus*), Willow (*Salix*) and Poplar (*Populus*); this is believed to be because of the type of fungal decay or the process of decay in these species, but there is little available research. The coppicing of these kinds of trees is in decline in favour of more lucrative kinds of forestry, with the consequent loss of habitat for hoverflies. Much more long-term thinking is urgently needed in the management of European forests.

A second urgent issue for hoverfly conservation is the loss of wetlands, the habitat for many species with aquatic saprophagous larvae. Alluvial floodplains have been reclaimed wholesale across Europe by drainage schemes and river-control measures. Again, attitudes towards flood control are changing, from straightening and canalising rivers and streams and removing fallen timber, to a more eco-friendly approach that uses natural methods to manage flooding, allowing designated areas to flood. The recent popularity of introducing Eurasian beaver (*Castor fiber*) as a flood-control measure is testament to such changes in public and private thinking. However, leaving this to public sentiment will not be enough and some legislative framework will be required.

Another major issue is the way agricultural policy has encouraged intensification of farming and overuse of the land. While perverse incentives are in place to encourage such behaviour, all conservation measures will fail. Under the EU Common Agricultural Policy, the eco-schemes instrument is seen as the most promising resource for pollinator conservation. Other key measures are enhanced conditionality, standards for Good Agricultural and Environmental Conditions (GAECs), and agri-environment-climate measures (AECMs), highlighted as specifically important in areas where the issue of land abandonment is widespread (EC, 2020).

The EU Nature Restoration Law proposal sets out restoration targets for terrestrial, coastal and freshwater ecosystems, stressing the importance of connectivity and quality of restoration measures. It aims to improve to good condition areas of habitat types listed in Annex I of the Habitats Directive, and to re-establish areas not covered by the habitat types listed in Annex I in areas not covered by those habitat types. Furthermore, it sets out targets for the restoration of agricultural and forest ecosystems as well as a target for reversing the decline of pollinators. To achieve this, the Law proposes to achieve an increasing trend in a proposed set of indicators, including standing and lying deadwood. Support for areas of Europe where traditional farming practices are privileged (e.g. 'dehesas' in the Iberian Peninsula, traditional Carpathian farms) would also be important.

Incentives for using pesticides need to be phased out, and indeed the use of pesticides and toxic seed coatings prevented in all but a few areas, and only used when actually necessary. The EC has also proposed a new Regulation on the Sustainable Use of Plant Protection Products, which sets legally binding targets at EU level to reduce by 50% the use and the risk of chemical pesticides, and also proposes the introduction of ecologically sensitive areas, which will be designated partly with respect to threatened pollinators, where application of these hazardous products will be prohibited. Such areas need to be large enough so that insect populations can recover properly from the devastating effects of pesticide use. Inevitably, pesticides leak and spread into areas outside the zones in which they are used, including nature conservation areas, and this needs to be better prevented. The EU Member States should consider the setting up of national targets to reduce pesticide use aimed at pollinator conservation and population recovery, and also the development of monitoring and indicators of risk or impacts on pollinators. They should introduce specific measures to control impacts on pollinators, ensure compliance and improve the knowledge base to assess the risks and impacts.

Research and monitoring

The dominant theme of the entire exercise of assessing the extinction risk of European hoverflies has been that we do not know enough about the current distribution and habitat requirements of the species. It is hard to conserve a species whose life history is unknown, and therefore whose ecological requirements are not understood. Larval and developmental sites are very important for the persistence of hoverfly species, as well as adult habitat, and understanding their ecology and life history is integral to conservation efforts. This is why it is essential to know more about the life histories of most European hoverflies. Most hoverflies are associated with forests and grasslands of various kinds, especially edge habitats between the two, but knowing the detailed microhabitat requirements of each species needs a lot more research. There are vanishingly few funds (and experts) available for such work, despite the fact that fast progress depends on the dedicated time of experts.

The case of the Large Blue Butterfly (*Phengaris arion*) in the UK is instructive. It declined from 91 colonies in 1800, to 25 in 1950, to just two in 1972 before extinction in 1979 and subsequent reintroduction. Financial support allowed sustained conservation research over a six-year period (1972–1978) that showed that the butterfly was completely dependent for the success of its life cycle on a particular species of ant, which itself depended on the short turf produced by grazing (Thomas et al., 2009). This applied research overturned decades of previously unsuccessful conservation practice for this species, that was actually doing precisely the wrong actions to maintain its populations. There is no substitute for sustained research to solve such problems, and conserving Europe's hoverflies is no exception.

Monitoring is in a better position under the Nature Restoration Law proposal and the EU Pollinators Initiative, with efforts to put in place systematic and geographically widespread monitoring of about two thousand sites across Europe as part of the EU Pollinator Monitoring Scheme. Thus, in the reasonably near future, good-quality data for many hoverfly species could be available. While such a scheme can show overall declines accurately, for individual species with narrow distributions there will be few or no monitoring sites with the potential to record specimens, and correspondingly the power to detect changes will be low or non-existent. Thus, specific monitoring schemes will always be needed to target rare species that only occur in particular habitats.

Finally, the threats facing hoverflies need to be better understood. A comprehensive understanding of how particular threats affect hoverflies and how to mitigate their impact would be advisable. As an example, there needs to be further understanding of the extent of the threat of pesticides and other chemicals on hoverflies. Some threats are not well understood and require more research, such as the impact of commercial honeybee-keeping on hoverfly species (Lindström et al., 2016).

Action on the ground

This European Red List should be used as evidence to support conservation initiatives throughout Europe, including the designation of protected areas, reform of agricultural practices and land management, habitat restoration and rewilding, and pollution reduction schemes. Hoverflies should be included as part of any key pollinator conservation work that takes place and this includes changes to land management plans to help pollinators. Currently, bees and butterflies are predominantly considered when creating pollinator-friendly habitats: this should also include the needs of hoverflies, ensuring suitable habitat for both the larval and adult stages.

Raising awareness about hoverflies

Widespread concern about pollinator declines has entered into public consciousness and debate, and now forms a strong part of actions and initiatives at local scales. This is slowly seeping into political debates as well, but has not yet created much large-scale action. The word 'hoverfly' was more or less unknown to the general public even twenty years ago, but now it seems as if everyone knows what they are: this is a great advance! However, such knowledge is restricted to the flower-visiting and pollinating behaviour of the adults.

The main task is now to convey the variety and diversity of the life cycles of hoverflies so as to emphasise the resources they need to maintain their populations. Individual species could be chosen and promoted to illustrate this diversity so that the same messages arrive in the various media and social media outlets.

5.2 Application of project outputs

The European Red List of Hoverflies is a direct outcome of the EU Pollinators Initiative, and complements the wider initiative of assessing the conservation status of all European species. It provides key resources for decision makers, policy makers, resource managers, environmental planners, NGOs and the concerned general public by compiling and distilling large amounts of data on the population, ecology, habitats, threats and recommended conservation actions for each hoverfly species.

Red List assessments are intended to be relevant to policy and can be used to inform the processes of conservation planning and priority setting. However, they are not intended to be prescriptive with respect to policy and are not in themselves a system for setting conservation priorities. The data are freely available on the IUCN Red List website (https://www.iucnredlist.org/regions/europe), on the website of the European Commission dedicated to European Red Lists (http://ec.europa.eu/environment/nature/conservation/species/redlist) and through paper publications (see the list of published European Red Lists at the end of this report).

Red Lists are a dynamic tool that will evolve with time as species are reassessed according to new information or situations. They are aimed at stimulating and supporting research, monitoring and conservation actions at local, regional and international levels.

5.3 Future work

The European Red List of Hoverflies offers, for the first time in the history of the European Red List Initiative, a complementary publication that focuses specifically on how the knowledge mobilised through species assessment can inform local conservation action for European hoverflies (IUCN SSC HSG/CPSG, 2022). This is a key tool that links evidence to action, and that needs to be integrated more systematically in European Red Lists.

European Union-funded projects, supported by the EU Pollinators Initiative, will continue to guide and aid conservation efforts and produce important knowledge for hoverfly conservation. There are already several projects currently underway to enact this crucial work. For example, the TAXO-FLY project is creating new taxonomic and identification tools for hoverflies on a European scale, something not attempted for almost 100 years, and putting them onto a publicly available web platform to make hoverfly identification easier and more accessible. This will be crucial when improving monitoring across the continent.

The project 'Action Plans for conservation of threatened pollinator species in the EU'[1] is currently building multi-species action plans to conserve the pollinator species most at risk in the EU, including hoverfly species, and working with stakeholders to generate agreement on these plans. Other projects include improving taxonomic monitoring and increasing the number of recorders (SPRING) and conservation actions (SAFEGUARD), including specific Species Action Plans.

1 Project number 07.0202/2020/839411/SER/ENV.0.2

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Appendix 1. IUCN Red List status of European hoverflies

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Anasimyia	*contracta*	LC		No	LC		No
Anasimyia	*femorata*	EN	B2ab(iii)	Yes	CR	B2ab(iii)	No
Anasimyia	*interpuncta*	LC		No	LC		No
Anasimyia	*lunulata*	LC		No	LC		No
Anasimyia	*transfuga*	LC		No	LC		No
Arctosyrphus	*willingii*	DD		No	Not recorded		No
Baccha	*elongata*	LC		No	LC		No
Blera	*eoa*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Blera	*fallax*	LC		No	LC		No
Blera	*nitens*	DD		No	Not recorded		No
Brachyopa	*atlantea*	DD		No	DD		No
Brachyopa	*bicolor*	LC		No	LC		No
Brachyopa	*bimaculosa*	EN	B2ab(ii,iii)	Yes	EN	B2ab(ii,iii)	Yes
Brachyopa	*cinerea*	VU	B2ab(ii,iii)	No	EN	B2ab(ii,iii)	No
Brachyopa	*dorsata*	LC		No	LC		No
Brachyopa	*grunewaldensis*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Brachyopa	*insensilis*	LC		Yes	LC		No
Brachyopa	*maculipennis*	EN	B2ab(ii,iii)	Yes	EN	B2b(ii,iii)c(ii,iii)	No
Brachyopa	*minima*	CR	B1ab(i,ii,iii,iv,v)+2ab(i,ii ,iii,iv,v)	Yes	CR	B1ab(i,ii,iii,iv,v)+2ab(i,ii, iii,iv,v)	Yes
Brachyopa	*obscura*	LC		Yes	LC		No
Brachyopa	*panzeri*	LC		No	LC		No
Brachyopa	*pilosa*	LC		No	LC		No
Brachyopa	*plena*	NT	B2b(iii,v)	Yes	NT	B2b(iii,iv)c(ii,iii)	No
Brachyopa	*quadrimaculosa*	EN	B2ab(ii,iii)	No	EN	B2ab(iii)	No
Brachyopa	*scutellaris*	LC		Yes	LC		No
Brachyopa	*silviae*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Brachyopa	*testacea*	LC		No	LC		No
Brachyopa	*vernalis*	EN	B1ab(ii,iii)+2ab(ii,iii)	Yes	EN	B1ab(ii,iii)+2ab(ii,iii)	Yes
Brachyopa	*vittata*	NT	B2b(iii)c(ii,iii)	No	NT	B2b(iii)c(ii,iii)	No
Brachyopa	*zhelochovtsevi*	DD		No	DD		No
Brachypalpoides	*lentus*	LC		No	LC		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Brachypalpus	*chrysites*	VU	B2ab(ii,iii,iv)	No	EN	B2ab(ii,iii,iv)	No
Brachypalpus	*laphriformis*	LC		Yes	LC		No
Brachypalpus	*valgus*	LC		Yes	LC		No
Caliprobola	*speciosa*	LC		No	LC		No
Callicera	*aenea*	VU	B2ab(ii,iii,iv)	No	VU	B2ab(ii,iii,iv)	No
Callicera	*aurata*	VU	B2ab(ii,iii,iv)	No	VU	B2ab(ii,iii,iv)	No
Callicera	*fagesii*	EN	B2ab(ii,iii,iv)	No	EN	B2ab(ii,iii,iv)	No
Callicera	*macquarti*	EN	B2ab(ii,iii,iv)	No	EN	B2ab(ii,iii,iv)	No
Callicera	*rufa*	VU	B2ab(iii)	No	VU	B2ab(ii,iii,iv)	No
Callicera	*scintilla*	CR	B2ab(iii)	No	CR	B2ab(iii)	No
Callicera	*spinolae*	VU	B2ab(ii,iii,iv)	No	VU	B2ab(ii,iii,iv)	No
Ceriana	*conopsoides*	LC		No	LC		No
Ceriana	*glaebosa*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Ceriana	*vespiformis*	LC		No	LC		No
Chalcosyrphus	*eumerus*	DD		No	Not recorded		No
Chalcosyrphus	*eunotus*	VU	B2ab(ii,iii,iv)	No	VU	B2ab(ii,iii,iv)	No
Chalcosyrphus	*femoratus*	VU	B2ab(ii,iii,iv)	No	VU	B2ab(ii,iii,iv)	No
Chalcosyrphus	*jacobsoni*	EN	B2ab(ii,iii,iv)	No	EN	B2ab(ii,iii,iv)	No
Chalcosyrphus	*nemorum*	LC		No	LC		No
Chalcosyrphus	*nigripes*	EN	B2ab(ii,iii,iv)	No	EN	B2ab(ii,iii,iv)	No
Chalcosyrphus	*nitidus*	DD		No	Not recorded		No
Chalcosyrphus	*obscurus*	DD		No	Not recorded		No
Chalcosyrphus	*pannonicus*	EN	B2ab(i,ii,iii)	No	EN	B2ab(ii,iii,iv)	No
Chalcosyrphus	*piger*	LC		No	LC		No
Chalcosyrphus	*rufipes*	EN	B2ab(ii,iii,iv)	No	EN	B2ab(ii,iii,iv)	No
Chalcosyrphus	*valgus*	LC		No	LC		No
Cheilosia	*aerea*	LC		No	LC		No
Cheilosia	*ahenea*	DD		Yes	DD		No
Cheilosia	*alba*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*albipila*	LC		No	LC		No
Cheilosia	*albitarsis*	LC		No	LC		No
Cheilosia	*alpestris*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*alpina*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Cheilosia	*andalusiaca*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Cheilosia	*angustigenis*	LC		No	LC		No
Cheilosia	*antiqua*	LC		Yes	LC		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Cheilosia	*aristata*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	No
Cheilosia	*balkana*	EN	B2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	No
Cheilosia	*barbafacies*	EN	B1ab(iii)+2ab(iii)	Yes	Not recorded		No
Cheilosia	*barbata*	LC		No	LC		No
Cheilosia	*beckeri*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Cheilosia	*bergenstammi*	LC		No	LC		No
Cheilosia	*brachysoma*	DD		Yes	DD		No
Cheilosia	*bracusi*	LC		Yes	LC		No
Cheilosia	*brunnipennis*	LC		No	LC		No
Cheilosia	*caerulescens*	LC		Yes	LC		No
Cheilosia	*candida*	DD		Yes	DD		Yes
Cheilosia	*canicularis*	LC		No	LC		No
Cheilosia	*carbonaria*	LC		No	LC		No
Cheilosia	*chloris*	LC		No	LC		No
Cheilosia	*chrysocoma*	LC		No	LC		No
Cheilosia	*clama*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*clausseni*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*crassiseta*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*cumanica*	LC		No	EN	B1ab(iii)	No
Cheilosia	*cynocephala*	LC		No	LC		No
Cheilosia	*derasa*	LC		Yes	LC		No
Cheilosia	*fasciata*	LC		Yes	LC		No
Cheilosia	*faucis*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*flavipes*	LC		No	LC		No
Cheilosia	*flavissima*	LC		No	LC		No
Cheilosia	*fraterna*	LC		No	LC		No
Cheilosia	*frontalis*	LC		No	LC		No
Cheilosia	*gagatea*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*gigantea*	LC		No	LC		No
Cheilosia	*gorodkovi*	EN	B2ab(iii)	No	CR	B1ab(iii)+2ab(iii)	No
Cheilosia	*griseifacies*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*grisella*	LC		Yes	LC		No
Cheilosia	*grossa*	LC		No	LC		No
Cheilosia	*herculana*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*hercyniae*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*himantopa*	LC		Yes	LC		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Cheilosia	*hypena*	LC		Yes	LC		No
Cheilosia	*iberica*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Cheilosia	*illustrata*	LC		No	LC		No
Cheilosia	*impressa*	LC		No	LC		No
Cheilosia	*impudens*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*ingerae*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*insignis*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*katara*	CR	B1ab(iii,v)	Yes	CR	B1ab(iii,v)	Yes
Cheilosia	*kerteszi*	EN	B2ab(iii)	Yes	CR	B1ab(iii)+2ab(iii,v)	No
Cheilosia	*laeviseta*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*laeviventris*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*lasiopa*	LC		No	LC		No
Cheilosia	*laticornis*	LC		No	LC		No
Cheilosia	*latifrons*	LC		No	LC		No
Cheilosia	*latigenis*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	No
Cheilosia	*lenis*	LC		Yes	LC		No
Cheilosia	*lenta*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*limbicornis*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Cheilosia	*loewi*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*longula*	LC		No	LC		No
Cheilosia	*lucense*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Cheilosia	*luteicornis*	LC		No	LC		No
Cheilosia	*marginata*	NT	B2ab(iii)	Yes	VU	B2ab(iii)	No
Cheilosia	*melanopa*	LC		No	LC		No
Cheilosia	*melanura*	LC		No	LC		No
Cheilosia	*montana*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*morio*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Cheilosia	*mutabilis*	LC		No	LC		No
Cheilosia	*naruska*	NT	B2ab(iii)	Yes	NT	B2ab(iii)	No
Cheilosia	*nebulosa*	LC		No	LC		No
Cheilosia	*nigripes*	LC		No	LC		No
Cheilosia	*nivalis*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*orthotricha*	LC		Yes	LC		No
Cheilosia	*pagana*	LC		No	LC		No
Cheilosia	*paralobi*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Cheilosia	*pascuorum*	LC		Yes	LC		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Cheilosia	*pedemontana*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*pedestris*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*personata*	LC		Yes	LC		No
Cheilosia	*pictipennis*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Cheilosia	*pilifer*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*pini*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*proxima*	LC		No	LC		No
Cheilosia	*psilophthalma*	LC		Yes	LC		No
Cheilosia	*pubera*	LC		Yes	LC		No
Cheilosia	*ranunculi*	LC		Yes	LC		No
Cheilosia	*redi*	LC		Yes	LC		No
Cheilosia	*reniformis*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Cheilosia	*rhodiolae*	DD		Yes	DD		No
Cheilosia	*rhynchops*	LC		Yes	LC		No
Cheilosia	*rodgersi*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Cheilosia	*rufimana*	LC		No	LC		No
Cheilosia	*sahlbergi*	DD		No	DD		No
Cheilosia	*schnabli*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Cheilosia	*scutellata*	LC		No	LC		No
Cheilosia	*semifasciata*	LC		Yes	LC		No
Cheilosia	*sootryeni*	LC		No	LC		No
Cheilosia	*soror*	LC		No	LC		No
Cheilosia	*subpictipennis*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Cheilosia	*thessala*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Cheilosia	*tonsa*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*urbana*	LC		No	LC		No
Cheilosia	*uviformis*	LC		Yes	LC		No
Cheilosia	*vangaveri*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*variabilis*	LC		No	LC		No
Cheilosia	*varnensis*	CR	B1ab(iii)+2ab(iii)	Yes	CR	B1ab(iii)+2ab(iii)	Yes
Cheilosia	*velutina*	LC		No	LC		No
Cheilosia	*venosa*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*vernalis*	LC		No	LC		No
Cheilosia	*vicina*	LC		No	LC		No
Cheilosia	*vujici*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Cheilosia	*vulpina*	LC		No	LC		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Chrysogaster	*basalis*	VU	B2ab(ii,iii,iv)	No	VU	B2ab(ii,iii,iv)	No
Chrysogaster	*cemiteriorum*	LC		No	LC		No
Chrysogaster	*mediterraneus*	EN	B2ab(ii,iii,iv)	No	EN	B2ab(ii,iii,iv)	No
Chrysogaster	*musatovi*	DD		No	Not recorded		No
Chrysogaster	*rondanii*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Chrysogaster	*simplex*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Chrysogaster	*solstitialis*	LC		No	LC		No
Chrysogaster	*virescens*	NT	B2b(ii,iii)	Yes	NT	B2b(ii,iii)	No
Chrysosyrphus	*nasutus*	LC		No	LC		No
Chrysosyrphus	*nigra*	LC		No	LC		No
Chrysotoxum	*arcuatum*	LC		No	LC		No
Chrysotoxum	*bicinctum*	LC		No	LC		No
Chrysotoxum	*cautum*	LC		No	LC		No
Chrysotoxum	*cisalpinum*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Chrysotoxum	*elegans*	NT	B2ab(ii,iii,iv)	No	NT	B2ab(ii,iii,iv)	No
Chrysotoxum	*fasciolatum*	LC		No	LC		No
Chrysotoxum	*festivum*	LC		No	LC		No
Chrysotoxum	*gracile*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Chrysotoxum	*intermedium*	LC		No	LC		No
Chrysotoxum	*lineare*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Chrysotoxum	*montanum*	NT	B2ab(iii)	No	EN	B2ab(iii)	No
Chrysotoxum	*octomaculatum*	NT		No	NT		No
Chrysotoxum	*orthostylum*	VU	B2ab(iii)	No	Not recorded		No
Chrysotoxum	*parmense*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Chrysotoxum	*tomentosum*	LC		Yes	EN	B2ab(iii)	No
Chrysotoxum	*triarcuatum*	VU	B1ab(iii)+2ab(iii)	Yes	VU	B1ab(iii)+2ab(iii)	Yes
Chrysotoxum	*vernale*	LC		No	LC		No
Chrysotoxum	*verralli*	LC		No	LC		No
Chrysotoxum	*volaticum*	LC		No	LC		No
Claussenia	*hispanica*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Copestylum	*melleum*	NA		No	NA		No
Criorhina	*asilica*	LC		Yes	LC		No
Criorhina	*berberina*	LC		No	LC		No
Criorhina	*floccosa*	LC		No	LC		No
Criorhina	*pachymera*	LC		Yes	LC		No
Criorhina	*ranunculi*	LC		Yes	LC		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Cryptopipiza	*notabila*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Dasysyrphus	*albostriatus*	LC		No	LC		No
Dasysyrphus	*eggeri*	EN	B2ab(i,ii,iii,iv)	No	EN	B2ab(i,ii,ii,iv)	No
Dasysyrphus	*friuliensis*	LC		No	LC		No
Dasysyrphus	*hilaris*	LC		No	LC		No
Dasysyrphus	*lenensis*	LC		Yes	LC		No
Dasysyrphus	*neovenustus*	LC		No	LC		No
Dasysyrphus	*nigricornis*	NT	B2b(ii,iii)	No	NT	B2b(ii,iii)	No
Dasysyrphus	*pauxillus*	LC		No	LC		No
Dasysyrphus	*pinastri*	LC		No	LC		No
Dasysyrphus	*postclaviger*	LC		No	LC		No
Dasysyrphus	*tricinctus*	LC		No	LC		No
Dasysyrphus	*venustus*	LC		No	LC		No
Didea	*alneti*	LC		No	LC		No
Didea	*fasciata*	LC		No	LC		No
Didea	*intermedia*	LC		No	LC		No
Doros	*destillatorius*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Doros	*profuges*	LC		No	LC		No
Epistrophe	*annulitarsis*	LC		No	NT		No
Epistrophe	*cryptica*	LC		No	LC		No
Epistrophe	*diaphana*	LC		No	LC		No
Epistrophe	*eligans*	LC		No	LC		No
Epistrophe	*flava*	LC		No	LC		No
Epistrophe	*grossulariae*	LC		No	LC		No
Epistrophe	*leiophthalma*	EN	B2ab(i,ii,iii,iv)	No	EN		No
Epistrophe	*melanostoma*	LC		No	LC		No
Epistrophe	*nitidicollis*	LC		No	LC		No
Epistrophe	*obscuripes*	LC		No	LC		No
Epistrophe	*ochrostoma*	LC		No	LC		No
Epistrophe	*olgae*	LC		No	LC		No
Epistrophella	*coronata*	EN	B2ab(iii)	Yes	CR	B2ab(iii)	No
Epistrophella	*euchroma*	LC		No	LC		No
Episyrphus	*balteatus*	LC		No	LC		No
Eriozona	*erratica*	LC		No	LC		No
Eriozona	*syrphoides*	LC		No	LC		No
Eristalinus	*aeneus*	LC		No	LC		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Eristalinus	*megacephalus*	LC		No	LC		No
Eristalinus	*sepulchralis*	LC		No	LC		No
Eristalinus	*taeniops*	LC		No	LC		No
Eristalis	*abusiva*	LC		No	LC		No
Eristalis	*alpina*	LC		No	LC		No
Eristalis	*anthophorina*	LC		No	LC		No
Eristalis	*arbustorum*	LC		No	LC		No
Eristalis	*cryptarum*	LC		No	LC		No
Eristalis	*fratercula*	LC		No	VU	B2ab(iii)	No
Eristalis	*gomojunovae*	LC		No	VU	B2ab(iii)	No
Eristalis	*hirta*	LC		No	NT	B2ab(iii)	No
Eristalis	*horticola*	LC		No	LC		No
Eristalis	*intricaria*	LC		No	LC		No
Eristalis	*jugorum*	LC		No	LC		No
Eristalis	*nemorum*	LC		No	LC		No
Eristalis	*obscura*	LC		No	LC		No
Eristalis	*oestracea*	LC		No	LC		No
Eristalis	*pertinax*	LC		No	LC		No
Eristalis	*picea*	LC		No	LC		No
Eristalis	*rossica*	LC		No	LC		No
Eristalis	*rupium*	LC		No	LC		No
Eristalis	*similis*	LC		No	LC		No
Eristalis	*tecta*	CR	B1ab(iii)+2ab(iii)	Yes	Not recorded		No
Eristalis	*tenax*	LC		No	LC		No
Eumerus	*alpinus*	LC		Yes	LC		No
Eumerus	*amoenus*	LC		No	LC		No
Eumerus	*argyropus*	LC		No	LC		No
Eumerus	*armatus*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Eumerus	*aurofinis*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Eumerus	*azabense*	CR	B1ab(iii)	Yes	CR	B1ab(iii)	Yes
Eumerus	*banaticus*	CR	B1ab(ii,iii)+2ab(ii,iii)	Yes	CR	B1ab(ii,iii)+2ab(ii,iii)	No
Eumerus	*barbarus*	LC		No	LC		No
Eumerus	*basalis*	LC		No	LC		No
Eumerus	*bicornis*	CR	B1ab(iii)+2ab(iii)	No	CR	B1ab(iii)+2ab(iii)	No
Eumerus	*bifurcatus*	CR	B1ab(iii)	Yes	CR	B1ab(iii)	Yes
Eumerus	*canariensis*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Eumerus	*claripennis*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	No
Eumerus	*clavatus*	LC		No	LC		No
Eumerus	*consimilis*	LC		Yes	LC		No
Eumerus	*crassus*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Eumerus	*dubius*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Eumerus	*etnensis*	VU	B2ab(iii)	Yes	VU	B2ab(iii)	No
Eumerus	*flavitarsis*	LC		No	LC		No
Eumerus	*funeralis*	LC		No	LC		No
Eumerus	*gibbosus*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Eumerus	*grallator*	VU	B2ab(iii)	Yes	VU	B2ab(iii)	Yes
Eumerus	*grandis*	LC		No	LC		No
Eumerus	*hispanicus*	VU	B1ab(iii)	Yes	VU	B1ab(iii)	Yes
Eumerus	*hispidus*	VU	B1ab(iii)+2ab(iii)	Yes	VU	B1ab(iii)+2ab(iii)	Yes
Eumerus	*hungaricus*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Eumerus	*karyates*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Eumerus	*latitarsis*	VU	B1ab(ii,iii)+2ab(ii,iii)	Yes	VU	B1ab(ii,iii)+2ab(ii,iii)	Yes
Eumerus	*longicornis*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Eumerus	*lucidus*	NT	B2ab(iii)	No	NT	B2ab(iii)	No
Eumerus	*minotaurus*	VU	B1ab(iii)+2ab(iii)	Yes	VU	B1ab(iii)+2ab(iii)	Yes
Eumerus	*montanum*	EN	B1ab(iii)+2ab(iii)	Yes	CR	B1ab(iii)+2ab(iii)	No
Eumerus	*narcissi*	DD		Yes	DD		Yes
Eumerus	*niehuisi*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Eumerus	*nivariae*	CR	B2ab(iii)	Yes	CR	B2ab(iii)	Yes
Eumerus	*niveitibia*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Eumerus	*nudus*	LC		No	LC		No
Eumerus	*obliquus*	LC		No	LC		No
Eumerus	*olivaceus*	DD		Yes	DD		Yes
Eumerus	*ornatus*	LC		No	LC		No
Eumerus	*ovatus*	EN	B2ab(iii,iv,v)	No	EN	B2ab(iii,iv)	No
Eumerus	*pannonicus*	CR	B1ab(iii)+2ab(iii)	Yes	Not recorded		No
Eumerus	*pauper*	DD		Yes	DD		No
Eumerus	*phaeacus*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Eumerus	*pulchellus*	LC		No	LC		No
Eumerus	*purpurariae*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Eumerus	*purpureus*	VU	B1ab(iii)+2ab(iii)	Yes	VU	B1ab(iii)+2ab(iii)	Yes
Eumerus	*pusillus*	LC		No	LC		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Eumerus	*richteri*	EN	B2ab(iii)	No	CR	B1ab(iii)+2ab(iii)	No
Eumerus	*rubrum*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Eumerus	*ruficornis*	EN	B2ab(i,ii,iii)	No	EN	B2ab(iii)	No
Eumerus	*rusticus*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Eumerus	*sabulonum*	LC		No	LC		No
Eumerus	*santosabreui*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Eumerus	*sicilianus*	DD		Yes	DD		Yes
Eumerus	*sinuatus*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Eumerus	*sogdianus*	LC		No	LC		No
Eumerus	*strigatus*	LC		No	LC		No
Eumerus	*subornatus*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Eumerus	*sulcitibius*	LC		No	LC		No
Eumerus	*tarsalis*	EN	B2ab(i,iii,iv)	No	EN	B2ab(i,iii,iv)	No
Eumerus	*tauricus*	EN	B2ab(iii)	No	CR	B2ab(iii)	No
Eumerus	*tenuitarsis*	CR	B2ab(iii)	No	CR	B2ab(iii)	No
Eumerus	*torsicus*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Eumerus	*tricolor*	LC		No	LC		No
Eumerus	*truncatus*	EN	B1ab(iii)+2ab(iii)	No	EN	B1ab(iii)+2ab(iii)	No
Eumerus	*uncipes*	LC		Yes	LC		No
Eumerus	*vandenberghei*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Eumerus	*vestitus*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Eupeodes	*abiskoensis*	NT	B2ab(iii)	No	NT	B2ab(iii)	No
Eupeodes	*biciki*	CR	B2ab(iii)	Yes	CR	B2ab(iii)	No
Eupeodes	*borealis*	DD		Yes	Not recorded		No
Eupeodes	*bucculatus*	LC		No	LC		No
Eupeodes	*corollae*	LC		No	LC		No
Eupeodes	*curtus*	LC		No	LC		No
Eupeodes	*duseki*	LC		Yes	LC		No
Eupeodes	*flaviceps*	LC		No	LC		No
Eupeodes	*goeldlini*	LC		No	LC		No
Eupeodes	*lambecki*	DD		Yes	DD		Yes
Eupeodes	*lapponicus*	LC		No	LC		No
Eupeodes	*latifasciatus*	LC		No	LC		No
Eupeodes	*lucasi*	LC		Yes	LC		No
Eupeodes	*lundbecki*	LC		No	LC		No
Eupeodes	*luniger*	LC		No	LC		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Eupeodes	*nielseni*	LC		No	LC		No
Eupeodes	*nitens*	LC		No	LC		No
Eupeodes	*nuba*	LC		No	LC		No
Eupeodes	*punctifer*	LC		No	LC		No
Eupeodes	*rufipunctatus*	EN	B2ab(i,iii)	No	Not recorded		No
Eupeodes	*tirolensis*	NT	B2ab(iii)	Yes	NT	B2ab(iii)	No
Eupeodes	*vandergooti*	EN	B1ab(iii,iv)+2ab(iii,iv)	Yes	EN	B1ab(iii,iv)+2ab(iii,iv)	Yes
Eupeodes	*vockerothi*	DD		No	Not recorded		No
Eurimyia	*lineata*	LC		No	LC		No
Ferdinandea	*aurea*	LC		No	LC		No
Ferdinandea	*cuprea*	LC		No	LC		No
Ferdinandea	*fumipennis*	LC		No	LC		No
Ferdinandea	*ruficornis*	LC		No	LC		No
Hammerschmidtia	*ferruginea*	LC		No	LC		No
Hammerschmidtia	*ingrica*	EN	B2ab(iii)c(ii,iii)	No	DD		No
Helophilus	*affinis*	LC		No	LC		No
Helophilus	*bottnicus*	RE		No	RE		No
Helophilus	*continuus*	LC		No	NT	B1ab(iii)	No
Helophilus	*groenlandicus*	LC		No	LC		No
Helophilus	*hybridus*	LC		No	LC		No
Helophilus	*lapponicus*	LC		No	NT	B2ab(iii)	No
Helophilus	*pendulus*	LC		No	LC		No
Helophilus	*trivittatus*	LC		No	LC		No
Heringia	*adpropinquans*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	No
Heringia	*heringi*	LC		No	LC		No
Ischiodon	*aegyptius*	LC		No	LC		No
Ischiodon	*scutellaris*	VU	B2ab(iii)	No	EN	B1ab(iii)+2ab(iii)	No
Ischyroptera	*bipilosa*	CR	B1ab(i,ii,iii,iv,v)+2ab(i,ii ,iii,iv,v)	Yes	RE		No
Katara	*connexa*	CR	B1ab(iii)+2ab(iii)	Yes	CR	B1ab(iii)+2ab(iii)	Yes
Lejogaster	*metallina*	LC		No	LC		No
Lejogaster	*tarsata*	LC		No	LC		No
Lejops	*vittatus*	VU	A3c	No	VU	A3c	No
Lejota	*korsakovi*	DD		No	Not recorded		No
Lejota	*ruficornis*	LC		No	LC		No
Leucozona	*glaucia*	LC		No	LC		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Leucozona	*inopinata*	LC		No	LC		No
Leucozona	*laternaria*	LC		No	LC		No
Leucozona	*lucorum*	LC		No	LC		No
Mallota	*cimbiciformis*	LC		No	LC		No
Mallota	*dusmeti*	LC		No	LC		No
Mallota	*eurasiatica*	LC		No	Not recorded		No
Mallota	*fuciformis*	LC		No	LC		No
Mallota	*megilliformis*	LC		No	LC		No
Mallota	*rossica*	LC		No	Not recorded		No
Mallota	*tricolor*	LC		No	EN	B2ab(iii)	No
Melangyna	*arctica*	LC		No	LC		No
Melangyna	*barbifrons*	LC		No	LC		No
Melangyna	*cincta*	LC		No	LC		No
Melangyna	*cingulata*	LC		Yes	LC		No
Melangyna	*coei*	LC		No	LC		No
Melangyna	*compositarum*	LC		No	LC		No
Melangyna	*ericarum*	NT	B2ab(iii)	Yes	VU	B2ab(iii)	No
Melangyna	*guttata*	LC		No	LC		No
Melangyna	*labiatarum*	LC		No	LC		No
Melangyna	*lasiophthalma*	LC		No	LC		No
Melangyna	*lucifera*	LC		No	NT		No
Melangyna	*pavlovskyi*	NA		Yes	NA		No
Melangyna	*quadrimaculata*	LC		No	LC		No
Melangyna	*triangulifera*	LC		No	LC		No
Melangyna	*umbellatarum*	LC		No	LC		No
Melanogaster	*aerosa*	LC		No	LC		No
Melanogaster	*curvistylus*	EN	B2ab(ii,iii)	Yes	EN	B2ab(ii,iii)	No
Melanogaster	*hirtella*	LC		No	LC		No
Melanogaster	*jaroslavensis*	EN	B2ab(iii)	Yes	Not recorded		No
Melanogaster	*nigricans*	VU	B2ab(ii,iii)	No	CR	B2ab(iii)	No
Melanogaster	*nuda*	LC		No	LC		No
Melanogaster	*parumplicata*	LC		Yes	LC		No
Melanogaster	*tumescens*	DD		No	Not recorded		No
Melanostoma	*certum*	LC		Yes	DD		No
Melanostoma	*incompletum*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Melanostoma	*mellarium*	LC		Yes	LC		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Melanostoma	*mellinum*	LC		No	LC		No
Melanostoma	*scalare*	LC		No	LC		No
Melanostoma	*wollastoni*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Meliscaeva	*auricollis*	LC		No	LC		No
Meliscaeva	*cinctella*	LC		No	LC		No
Merodon	*aberrans*	LC		No	LC		No
Merodon	*abruzzensis*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Merodon	*adriaticus*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	No
Merodon	*aerarius*	LC		Yes	LC		No
Merodon	*alagoezicus*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Merodon	*albifasciatus*	LC		Yes	LC		Yes
Merodon	*albifrons*	LC		No	LC		No
Merodon	*alexandri*	VU	B2ab(iii)	Yes	Not recorded		No
Merodon	*ambiguus*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Merodon	*analis*	LC		Yes	LC		No
Merodon	*andriotes*	CR	B1ab(iii)	Yes	CR	B1ab(iii)	Yes
Merodon	*antonioi*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Merodon	*armipes*	LC		No	LC		No
Merodon	*arundanus*	CR	B2ab(iii)	Yes	CR	B2ab(iii)	Yes
Merodon	*atratus*	NT	B2ab(i,iii)	Yes	NT	B2ab(i,iii)	No
Merodon	*atricapillatus*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Merodon	*aureus*	LC		Yes	LC		No
Merodon	*aurifer*	LC		No	LC		No
Merodon	*auripes*	LC		No	LC		No
Merodon	*avidus*	LC		No	LC		No
Merodon	*balkanicus*	EN	B1ab(iii)+2ab(iii)	Yes	CR	B2ab(iii)	No
Merodon	*bessarabicus*	NT	B2ab(iii)	No	NT	B2ab(iii)	No
Merodon	*cabanerensis*	CR	B1ab(iii)+2ab(iii)	No	CR	B1ab(iii)+2ab(iii)	No
Merodon	*caerulescens*	VU	B1ab(iii)+2ab(iii)	Yes	VU	B1ab(iii)+2ab(iii)	Yes
Merodon	*calcaratus*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Merodon	*calidus*	LC		Yes	LC		No
Merodon	*chalybeatus*	LC		No	LC		No
Merodon	*chalybeus*	LC		No	LC		No
Merodon	*chrysotrichos*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Merodon	*cinereus*	LC		Yes	LC		No
Merodon	*clavipes*	LC		No	LC		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Merodon	*clunipes*	NT	B2ab(iii)	No	NT	B2ab(iii)	No
Merodon	*confinium*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Merodon	*confusus*	VU	B2ab(iii)	Yes	VU	B2ab(iii)	Yes
Merodon	*constans*	LC		Yes	VU	B2ab(iii)	No
Merodon	*crassifemoris*	NT	B2ab(iii)	No	VU	B2ab(iii)	No
Merodon	*crypticus*	VU	B2ab(iii); D2	Yes	VU	B2ab(iii); D2	Yes
Merodon	*desuturinus*	VU	B2ab(iii)	Yes	CR	B1ab(iii)+2ab(iii)	No
Merodon	*dobrogensis*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Merodon	*dzhalitae*	EN	B1ab(iii)+2ab(iii)	Yes	Not recorded		No
Merodon	*eques*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Merodon	*equestris*	LC		No	LC		No
Merodon	*erivanicus*	LC		No	LC		No
Merodon	*erymanthius*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Merodon	*escorialensis*	NT	B2ab(iii)	Yes	NT	B2ab(iii)	Yes
Merodon	*euri*	VU	B2ab(iii)	Yes	VU	B2ab(iii)	No
Merodon	*femoratoides*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Merodon	*femoratus*	LC		No	LC		No
Merodon	*flavicornis*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Merodon	*flavus*	NT	B2ab(iii)	Yes	NT	B2ab(iii)	No
Merodon	*funestus*	LC		No	LC		No
Merodon	*gallicus*	VU	B2ab(iii)	Yes	VU	B2ab(iii)	No
Merodon	*geniculatus*	NT	B2ab(iii)	Yes	NT	B2b(iii)	No
Merodon	*hamifer*	VU	B1ab(iii)+2ab(iii)	No	VU	B1ab(iii)+2ab(iii)	No
Merodon	*hirtus*	EN	B1ab(iii)+2ab(iii)	No	EN	B1ab(iii)+2ab(iii)	No
Merodon	*hoplitis*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Merodon	*ibericus*	NT	B2ab(iii)	No	NT	B2ab(iii)	No
Merodon	*italicus*	NT	B2b(iii)	No	NT	B2b(iii)	No
Merodon	*kozufensis*	EN	B2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	No
Merodon	*latifemoris*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Merodon	*legionensis*	NT	B2ab(iii)	Yes	NT	B2ab(iii)	Yes
Merodon	*loewi*	NT	B2b(iii)	No	NT	B2b(iii)	No
Merodon	*longisetus*	CR	B1ab(iii)+2ab(iii)	No	CR	B1ab(iii)+2ab(iii)	No
Merodon	*longispinus*	CR	B1ab(iii)+2ab(iii)	Yes	CR	B1ab(iii)+2ab(iii)	Yes
Merodon	*luteihumerus*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Merodon	*luteofasciatus*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Merodon	*luteomaculatus*	EN	B1ab(iii)+2ab(iii)	Yes	Not recorded		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Merodon	*medium*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Merodon	*megavidus*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Merodon	*minutus*	LC		No	LC		No
Merodon	*moenium*	LC		No	LC		No
Merodon	*nanus*	EN	B1ab(iii)+2ab(iii)	No	EN	B1ab(iii)+2ab(iii)	No
Merodon	*natans*	LC		No	LC		No
Merodon	*naxius*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Merodon	*neofasciatus*	LC		No	LC		No
Merodon	*neolydicus*	CR	B1ab(iii)	No	CR	B1ab(iii)	No
Merodon	*neonanus*	EN	B1ab(iii)+2ab(iii)	No	EN	B1ab(iii)+2ab(iii)	No
Merodon	*nigritarsis*	LC		No	LC		No
Merodon	*nisi*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Merodon	*nitens*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Merodon	*obscuritarsis*	LC		No	LC		No
Merodon	*olympius*	CR	B1ab(iii)	Yes	CR	B1ab(iii)	Yes
Merodon	*opacus*	VU	B1ab(iii)+2ab(iii)	No	VU	B1ab(iii)+2ab(iii)	No
Merodon	*orjensis*	CR	B2ab(iii)	Yes	Not recorded		No
Merodon	*ottomanus*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Merodon	*papillus*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Merodon	*parietum*	NT	B2ab(iii)	Yes	NT	B2ab(iii)	Yes
Merodon	*peloponnesius*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Merodon	*planiceps*	CR	B2ab(iii)	No	CR	B2ab(iii)	No
Merodon	*pruni*	LC		No	LC		No
Merodon	*pulveris*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Merodon	*pumilus*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Merodon	*puniceus*	EN	B1ab(iii)+2ab(iii)	No	EN	B1ab(iii)+2ab(iii)	No
Merodon	*quercetorum*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Merodon	*rasicus*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Merodon	*robustus*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Merodon	*rojoi*	VU	B2ab(iii)	Yes	VU	B2ab(iii)	Yes
Merodon	*rubidiventris*	VU	B2ab(iii)	Yes	VU	B2ab(iii)	Yes
Merodon	*ruficornis*	LC		No	LC		No
Merodon	*rufipes*	EN	B2ab(iii)	No	CR	B1ab(iii)+2ab(iii)	No
Merodon	*rufus*	LC		No	LC		No
Merodon	*sacki*	CR	B2ab(iii)	Yes	CR	B2ab(iii)	Yes
Merodon	*sapphous*	CR	B1ab(iii)	No	CR	B1ab(iii)	No

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Merodon	*segetum*	EN	B1ab(iii)+2ab(iii)	No	EN	B1ab(iii)+2ab(iii)	No
Merodon	*serrulatus*	LC		No	LC		No
Merodon	*spineus*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Merodon	*spinitarsis*	NT	B2b(iii)	No	NT	B2b(iii)	No
Merodon	*telmateia*	EN	B1ab(iii)+2ab(iii)	No	EN	B1ab(iii)+2ab(iii)	No
Merodon	*teruelensis*	VU	B2ab(iii)	Yes	VU	B2ab(iii)	Yes
Merodon	*testaceus*	EN	B2ab(iii)	No	EN	B1ab(iii)+2ab(iii)	No
Merodon	*toscanus*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Merodon	*trebevicensis*	LC		No	LC		No
Merodon	*triangulum*	NT	B2ab(iii)	Yes	VU	B2ab(iii)	No
Merodon	*trochantericus*	LC		Yes	LC		No
Merodon	*unguicornis*	NT	B2ab(iii)	Yes	NT	B2ab(iii)	Yes
Merodon	*unicolor*	NT	B2ab(iii)	No	NT	B2ab(iii)	No
Merodon	*velox*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Merodon	*virgatus*	VU	B2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	No
Merodon	*vladimiri*	VU	D2	Yes	Not recorded		No
Mesembrius	*peregrinus*	LC		No	LC		No
Microdon	*analis*	NT	A2c+4c	No	NT	A2c+4c	No
Microdon	*devius*	NT	A2c+4c	No	NT	A2c+4c	No
Microdon	*major*	EN	B2ab(ii,iii)	Yes	EN	B2ab(ii,iii)	Yes
Microdon	*miki*	VU	A2c	No	VU	A2c	No
Microdon	*mutabilis*	VU	A2c+4c	No	VU	A2c+4c	No
Microdon	*myrmicae*	VU	A4c	Yes	VU	A4c	No
Milesia	*crabroniformis*	LC		No	LC		No
Milesia	*semiluctifera*	LC		No	LC		No
Myathropa	*florea*	LC		No	LC		No
Myathropa	*usta*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Myolepta	*difformis*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Myolepta	*dubia*	LC		No	LC		No
Myolepta	*nigritarsis*	LC		No	LC		No
Myolepta	*obscura*	LC		No	LC		No
Myolepta	*potens*	LC		No	LC		No
Myolepta	*trojana*	EN	B1ab(iii)+2ab(iii)	No	EN	B1ab(iii)+2ab(iii)	No
Myolepta	*vara*	LC		No	LC		No
Neoascia	*annexa*	LC		No	LC		No
Neoascia	*balearensis*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes

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Neoascia	*geniculata*	LC		No	LC		No
Neoascia	*interrupta*	LC		No	LC		No
Neoascia	*meticulosa*	LC		No	LC		No
Neoascia	*obliqua*	LC		No	LC		No
Neoascia	*podagrica*	LC		No	LC		No
Neoascia	*subchalybea*	NT	B2b(ii,iii)	No	NT	B2b(ii,iii)	No
Neoascia	*tenur*	LC		No	LC		No
Neoascia	*unifasciata*	EN	B2ab(iii,v)	Yes	EN	B2ab(iii)	No
Neocnemodon	*brevidens*	LC		No	LC		No
Neocnemodon	*fulvimanus*	DD		No	DD		No
Neocnemodon	*larusi*	LC		Yes	LC		No
Neocnemodon	*latitarsis*	LC		No	LC		No
Neocnemodon	*pubescens*	LC		No	LC		No
Neocnemodon	*verrucula*	LC		No	LC		No
Neocnemodon	*vitripennis*	LC		No	LC		No
Orthonevra	*auritarsis*	DD		Yes	DD		Yes
Orthonevra	*brevicornis*	LC		No	LC		No
Orthonevra	*elegans*	VU	B2ab(i,ii,iii,iv)	No	EN	B2ab(i,ii,iii,iv)	No
Orthonevra	*erythrogona*	LC		No	NT		No
Orthonevra	*frontalis*	NT	B2ab(ii,iii)	No	NT	B2ab(ii,iii)	No
Orthonevra	*gemmula*	CR	B2ab(iii)	No	CR	B2ab(iii)	No
Orthonevra	*geniculata*	LC		No	LC		No
Orthonevra	*incisa*	DD		No	DD		No
Orthonevra	*intermedia*	LC		No	LC		No
Orthonevra	*montana*	EN	B2ab(ii,iii)	Yes	EN	B2ab(ii,iii)	No
Orthonevra	*nobilis*	LC		No	LC		No
Orthonevra	*plumbago*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Orthonevra	*shusteri*	DD		Yes	DD		Yes
Orthonevra	*stackelbergi*	LC		No	LC		No
Orthonevra	*tristis*	NT	B2ab(iii)	Yes	NT	B2ab(iii)	No
Palumbia	*bellierii*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Paragus	*absidatus*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Paragus	*albifrons*	EN	B2ab(iii,iv)	No	EN	B2ab(iii)	No
Paragus	*albipes*	DD		Yes	DD		Yes
Paragus	*ascoensis*	VU	B2ab(iii)	Yes	VU	B1ab(iii)+2ab(iii)	Yes
Paragus	*bicolor*	LC		No	LC		No

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Paragus	*bradescui*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Paragus	*cinctus*	LC		No	LC		No
Paragus	*coadunatus*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Paragus	*compeditus*	EN	B1ab(iii)+2ab(iii)	No	EN	B1ab(iii)+2ab(iii)	No
Paragus	*constrictus*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Paragus	*finitimus*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Paragus	*flammeus*	LC		No	LC		No
Paragus	*glumaci*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Paragus	*haemorrhous*	LC		No	LC		No
Paragus	*hyalopteri*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Paragus	*kopdagensis*	EN	B1ab(iii)+2ab(iii)	No	Not recorded		No
Paragus	*majoranae*	EN	B2ab(iii,v)	Yes	EN	B2ab(iii)	No
Paragus	*medeae*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Paragus	*oltenicus*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Paragus	*pecchiolii*	LC		No	LC		No
Paragus	*punctulatus*	LC		Yes	LC		No
Paragus	*quadrifasciatus*	LC		No	LC		No
Paragus	*sexarcuatus*	VU	B1ab(iii)+2ab(iii)	Yes	VU	B1ab(iii)+2ab(iii)	Yes
Paragus	*strigatus*	LC		No	LC		No
Paragus	*testaceus*	LC		No	LC		No
Paragus	*thracusi*	CR	B2ab(iii)	Yes	CR	B2ab(iii)	Yes
Paragus	*tibialis*	LC		No	LC		No
Paragus	*vandergooti*	NT	B2ab(iii)	No	NT	B2ab(iii)	No
Parasyrphus	*annulatus*	LC		No	LC		No
Parasyrphus	*groenlandicus*	NT	B2ab(iii)	No	VU	B2ab(iii)	No
Parasyrphus	*kirgizorum*	DD		No	DD		No
Parasyrphus	*lineola*	LC		No	LC		No
Parasyrphus	*macularis*	LC		No	LC		No
Parasyrphus	*malinellus*	LC		No	LC		No
Parasyrphus	*nigritarsis*	LC		No	LC		No
Parasyrphus	*proximus*	LC		No	LC		No
Parasyrphus	*punctulatus*	LC		No	LC		No
Parasyrphus	*relictus*	LC		No	LC		No
Parasyrphus	*tarsatus*	LC		No	LC		No
Parhelophilus	*consimilis*	LC		No	LC		No
Parhelophilus	*crococoronatus*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Parhelophilus	*frutetorum*	LC		No	LC		No
Parhelophilus	*versicolor*	LC		No	LC		No
Pelecocera	*caledonica*	LC		Yes	LC		No
Pelecocera	*lusitanica*	NT	A3c	Yes	NT	A3c	No
Pelecocera	*nigricornis*	EN	B2ab(i,ii,iii,iv)	Yes	EN	B2ab(i,ii,iii,iv)	Yes
Pelecocera	*pruinosomaculata*	NT	A3c	No	NT	A3c	No
Pelecocera	*scaevoides*	LC		No	LC		No
Pelecocera	*tricincta*	LC		No	LC		No
Pipiza	*accola*	EN	B2ab(iii)	No	EN	B2ab(Iii)	No
Pipiza	*austriaca*	LC		No	LC		No
Pipiza	*carbonaria*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Pipiza	*fasciata*	LC		Yes	LC		No
Pipiza	*festiva*	LC		No	LC		No
Pipiza	*laurusi*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Pipiza	*lugubris*	LC		No	LC		No
Pipiza	*luteibarba*	EN	B2ab(iii)	Yes	CR	B2ab(iii)	No
Pipiza	*luteitarsis*	LC		Yes	LC		No
Pipiza	*noctiluca*	LC		No	LC		No
Pipiza	*notata*	LC		No	LC		No
Pipiza	*quadrimaculata*	LC		No	LC		No
Pipizella	*annulata*	NT	B2ab(iii)	No	NT	B2ab(iii)	No
Pipizella	*bispina*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Pipizella	*brevis*	VU	B1ab(iii)+2ab(iii)	Yes	VU	B1ab(iii)+2ab(iii)	No
Pipizella	*calabra*	VU	B2ab(iii)	Yes	VU	B2ab(iii)	Yes
Pipizella	*cantabrica*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Pipizella	*certa*	NT	B2ab(iii)	No	NT	B2ab(iii)	No
Pipizella	*divicoi*	LC		No	LC		No
Pipizella	*elegantissima*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Pipizella	*lyneborgi*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Pipizella	*maculipennis*	LC		No	LC		No
Pipizella	*mongolorum*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Pipizella	*nataliae*	EN	B1ab(iii)+2ab(iii)	No	Not recorded		No
Pipizella	*nigriana*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Pipizella	*obscura*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Pipizella	*pennina*	LC		Yes	LC		No
Pipizella	*siciliana*	VU	B2ab(iii)	Yes	VU	B2ab(iii)	Yes

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Pipizella	*speighti*	LC		Yes	VU	B2ab(iii)	No
Pipizella	*thapsiana*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Pipizella	*viduata*	LC		No	LC		No
Pipizella	*virens*	LC		No	LC		No
Pipizella	*zeneggenensis*	LC		Yes	LC		No
Pipizella	*zloti*	VU	B2ab(iii)	Yes	EN	B2ab(iii)	No
Platycheirus	*abruzzensis*	EN	B2ab(iii)	No	EN	B2ab(i,ii,iii,iv,v)	No
Platycheirus	*aeratus*	LC		No	LC		No
Platycheirus	*albimanus*	LC		No	LC		No
Platycheirus	*altomontis*	CR	B2ab(iii)	Yes	DD	B2ab(iii)	No
Platycheirus	*ambiguus*	LC		No	LC		No
Platycheirus	*amplus*	LC		No	LC		No
Platycheirus	*angustatus*	LC		No	LC		No
Platycheirus	*angustipes*	LC		No	LC		No
Platycheirus	*aurolateralis*	LC		No	LC		No
Platycheirus	*brunnifrons*	LC		No	LC		No
Platycheirus	*caesius*	EN	B2ab(iii)	Yes	CR	B1ab(iii)+2ab(iii)	No
Platycheirus	*chilosia*	LC		No	EN	B2ab(iii)	No
Platycheirus	*ciliatus*	CR	B2ab(iii)	No	CR	B2ab(iii)	No
Platycheirus	*cintoensis*	DD		Yes	DD		Yes
Platycheirus	*clausseni*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Platycheirus	*clypeatus*	LC		No	LC		No
Platycheirus	*complicatus*	LC		No	LC		No
Platycheirus	*discimanus*	LC		No	LC		No
Platycheirus	*europaeus*	LC		No	LC		No
Platycheirus	*fasciculatus*	NT	B2ab(iii)	Yes	NT	B2ab(iii)	No
Platycheirus	*fimbriatus*	DD		No	DD		No
Platycheirus	*fulviventris*	LC		No	LC		No
Platycheirus	*goeldlini*	DD		No	DD		No
Platycheirus	*groenlandicus*	LC		No	LC		No
Platycheirus	*hyperboreus*	LC		No	NT	B2b(ii,iii)	No
Platycheirus	*immaculatus*	LC		No	LC		No
Platycheirus	*immarginatus*	NT	B2ab(i,ii,iii)	No	NT	B2ab(i,ii,iii)	No
Platycheirus	*islandicus*	VU	B2ab(iii)	Yes	Not recorded		No
Platycheirus	*jaerensis*	LC		No	LC		No
Platycheirus	*kittilaensis*	LC		No	LC		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Platycheirus	*laskai*	NT	B2ab(iii)	Yes	VU	B2ab(iii)	No
Platycheirus	*latimanus*	LC		No	NT	B2ab(iii)	No
Platycheirus	*lundbecki*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Platycheirus	*magadanensis*	DD		No	DD		No
Platycheirus	*manicatus*	LC		No	LC		No
Platycheirus	*marokkanus*	VU	B2ab(iii)	No	VU	B2ab(iii)	No
Platycheirus	*melanopsis*	LC		No	LC		No
Platycheirus	*meridimontanus*	CR (PE)	B2ab(iii)	No	Not recorded		No
Platycheirus	*modestus*	CR	B1ab(iii)+2ab(iii)	No	CR	B1ab(iii)+2ab(iii)	No
Platycheirus	*muelleri*	EN	B2ab(ii)	Yes	EN	B2ab(iii)	Yes
Platycheirus	*naso*	LC		No	LC		No
Platycheirus	*neoperpallidus*	DD		No	DD		No
Platycheirus	*nielseni*	LC		No	LC		No
Platycheirus	*nigrofemoratus*	NT	B2ab(iii)	No	NT	B2ab(iii)	No
Platycheirus	*occultus*	LC		No	LC		No
Platycheirus	*parmatus*	LC		No	LC		No
Platycheirus	*peltatus*	LC		No	LC		No
Platycheirus	*perpallidus*	LC		No	NT	B2ab(iii)	No
Platycheirus	*podagratus*	LC		No	NT	A4c	No
Platycheirus	*ramsarensis*	LC		No	LC		No
Platycheirus	*scambus*	LC		No	LC		No
Platycheirus	*scutatus*	LC		No	LC		No
Platycheirus	*speighti*	DD		No	DD		No
Platycheirus	*splendidus*	LC		No	LC		No
Platycheirus	*sticticus*	LC		No	LC		No
Platycheirus	*subambiguus*	NT	B2ab(iii)	Yes	NT	B2ab(iii)	Yes
Platycheirus	*subordinatus*	LC		No	LC		No
Platycheirus	*tarsalis*	LC		No	LC		No
Platycheirus	*tatricus*	LC		Yes	NT	B2ab(iii)	No
Platycheirus	*transfugus*	LC		No	LC		No
Platycheirus	*urakawensis*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Platycheirus	*varipes*	EN	B2ab(iii)	No	EN	B2ab(iii)	No
Platynochaetus	*macquarti*	VU	B2ab(iii)	Yes	VU	B2ab(iii)	Yes
Platynochaetus	*setosus*	LC		No	LC		No
Pocota	*personata*	LC		No	LC		No
Portevinia	*maculata*	LC		Yes	LC		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Primocerioides	*regale*	EN	B2ab(iii)	Yes	EN	B2ab(i,ii,iii)	No
Psarus	*abdominalis*	VU	B2ab(i,ii,iii,iv)	No	EN	B2ab(i,ii,iii,iv)	No
Pseudodoros	*nigricollis*	EN	B1ab(iii)+2ab(iii)	No	EN	B1ab(iii)+2ab(iii)	No
Pseudopelecocera	*latifrons*	LC		No	EN	B2ab(i,ii,iii)	No
Psilota	*anthracina*	LC		Yes	LC		No
Psilota	*atra*	LC		No	LC		No
Psilota	*exilistyla*	DD		Yes	DD		No
Psilota	*innupta*	DD		No	DD		No
Psilota	*nana*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Pyrophaena	*granditarsa*	NT	A2c+4c	No	NT	A2c+4c	No
Pyrophaena	*rosarum*	LC		No	LC		No
Rhingia	*borealis*	LC		No	LC		No
Rhingia	*campestris*	LC		No	LC		No
Rhingia	*rostrata*	LC		No	LC		No
Riponnensia	*daccordii*	CR (PE)	B1ab(i,ii,iii)+2ab(i,ii,iii)	Yes	CR (PE)	B1ab(i,ii,iii)+2ab(i,ii,iii)	Yes
Riponnensia	*insignis*	DD		No	DD		No
Riponnensia	*longicornis*	EN	B2ab(ii,iii)	No	EN	B2ab(ii,iii)	No
Riponnensia	*morini*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Riponnensia	*splendens*	LC		No	LC		No
Rohdendorfia	*alpina*	VU	B2ab(ii,iii)	No	VU	B2ab(ii,iii)	No
Scaeva	*albomaculata*	LC		No	LC		No
Scaeva	*dignota*	LC		No	LC		No
Scaeva	*mecogramma*	LC		No	LC		No
Scaeva	*pyrastri*	LC		No	LC		No
Scaeva	*selenitica*	LC		No	LC		No
Sericomyia	*arctica*	VU	A3c	No	VU	A3c	No
Sericomyia	*bequaerti*	CR	B2ab(i,ii,iii)	No	CR	B2ab(i,ii,iii)	No
Sericomyia	*bombiformis*	LC		No	LC		No
Sericomyia	*hispanica*	NT	A3c	Yes	NT	A3c	Yes
Sericomyia	*jakutica*	VU	A3c	No	VU	A3c	No
Sericomyia	*lappona*	LC		No	LC		No
Sericomyia	*nigra*	LC		No	LC		No
Sericomyia	*silentis*	LC		No	LC		No
Sericomyia	*superbiens*	LC		Yes	LC		No
Sericomyia	*tolli*	DD		No	Not recorded		No
Spazigaster	*ambulans*	NT	B2b(ii,iii)	No	NT	B2b(ii,iii)	No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Sphaerophoria	*abbreviata*	LC		No	LC		No
Sphaerophoria	*bankowskae*	LC		No	LC		No
Sphaerophoria	*batava*	LC		No	LC		No
Sphaerophoria	*bengalensis*	DD		No	DD		No
Sphaerophoria	*boreoalpina*	LC		No	LC		No
Sphaerophoria	*chongjini*	LC		No	NT	A4c	No
Sphaerophoria	*estebani*	DD		Yes	NT	B2ab(iii)c(iii)	No
Sphaerophoria	*fatarum*	NT	A4c	Yes	NT	A4c	No
Sphaerophoria	*infuscata*	LC		Yes	LC		No
Sphaerophoria	*interrupta*	LC		No	NT	A4c	No
Sphaerophoria	*kaa*	NT	A3c	No	NT	A3c	No
Sphaerophoria	*laurae*	LC		No	LC		No
Sphaerophoria	*loewi*	NT	A2c	No	NT	A2c	No
Sphaerophoria	*nigra*	NT	B1b(iii)+2b(iii)	Yes	NT	B1b(iii)+2b(iii)	Yes
Sphaerophoria	*pallidula*	LC		No	EN	B2ab(iii)	No
Sphaerophoria	*philanthus*	LC		No	LC		No
Sphaerophoria	*potentillae*	VU	A4c	No	VU	A4c	No
Sphaerophoria	*rueppelli*	LC		No	LC		No
Sphaerophoria	*scripta*	LC		No	LC		No
Sphaerophoria	*shirchan*	NT	A2c	No	NT	A2c	No
Sphaerophoria	*taeniata*	LC		No	LC		No
Sphaerophoria	*virgata*	NT	A2c	No	NT	A2c	No
Sphecomyia	*vespiformis*	NT	A3c	No	NT	A3c	No
Sphegina	*atrolutea*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Sphegina	*clavata*	LC		Yes	LC		No
Sphegina	*clunipes*	LC		No	LC		No
Sphegina	*cornifera*	NT	B2ab(iii)	Yes	NT	B2ab(iii)	No
Sphegina	*elegans*	LC		No	LC		No
Sphegina	*latifrons*	LC		Yes	LC		No
Sphegina	*limbipennis*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Sphegina	*montana*	LC		No	LC		No
Sphegina	*obscurifacies*	EN	B2ab(ii,iii)	No	CR	B2ab(ii,iii)	No
Sphegina	*platychira*	NT	B2ab(ii,iii)	Yes	NT	B2ab(iii)	No
Sphegina	*sibirica*	LC		No	LC		No
Sphegina	*spheginea*	VU	B2ab(ii,iii)	No	VU	B2ab(ii,iii)	No
Sphegina	*sublatifrons*	EN	B2ab(ii,iii)	Yes	CR	B2ab(iii)	No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Sphegina	*varifacies*	EN	B2ab(iii)	Yes	EN	B2ab(iiii)	Yes
Sphegina	*verecunda*	LC		No	LC		No
Sphiximorpha	*euprosopa*	EN	B1ab(iii)+2ab(iii)	No	EN	B1ab(iii)+2ab(iii)	No
Sphiximorpha	*garibaldii*	LC		Yes	LC		No
Sphiximorpha	*petronillae*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Sphiximorpha	*subsessilis*	LC		No	LC		No
Spilomyia	*digitata*	VU	A3c	No	VU	A3c	No
Spilomyia	*diophthalma*	LC		No	LC		No
Spilomyia	*graciosa*	EN	B2ab(ii,iii,iv)	No	EN	B2ab(Ii,iii,iv)	No
Spilomyia	*manicata*	LC		No	LC		No
Spilomyia	*maxima*	DD		No	Not recorded		No
Spilomyia	*saltuum*	LC		No	LC		No
Spilomyia	*triangulata*	VU	B2ab(i,ii,iii,iv)	No	VU	B2ab(i,ii,iii,iv)	No
Syritta	*flaviventris*	LC		No	LC		No
Syritta	*pipiens*	LC		No	LC		No
Syritta	*vittata*	DD		No	Not recorded		No
Syrphocheilosia	*claviventris*	LC		No	LC		No
Syrphus	*admirandus*	DD		No	DD		No
Syrphus	*attenuatus*	LC		No	LC		No
Syrphus	*auberti*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	No
Syrphus	*niditifrons*	LC		Yes	LC		No
Syrphus	*rectus*	DD		No	DD		No
Syrphus	*ribesii*	LC		No	LC		No
Syrphus	*sexmaculatus*	LC		No	LC		No
Syrphus	*stackelbergi*	DD		Yes	Not recorded		No
Syrphus	*torvus*	LC		No	LC		No
Syrphus	*vitripennis*	LC		No	LC		No
Temnostoma	*angustistriatum*	EN	B2ab(ii,iii,iv)	No	EN	B2ab(ii,iii,iv)	No
Temnostoma	*apiforme*	NT	A3c	No	NT	A3c	No
Temnostoma	*bombylans*	LC		No	LC		No
Temnostoma	*carens*	NT	B2ab(ii,iii,iv)	Yes	NT	B2ab(ii,iii,iv)	No
Temnostoma	*meridionale*	NT	A3c	No	NT	A3c	No
Temnostoma	*sericomyiaeforme*	VU	A3c	Yes	VU	A3c	No
Temnostoma	*vespiformis*	LC		No	LC		No
Trichopsomyia	*flavitarsis*	LC		No	LC		No
Trichopsomyia	*joratensis*	LC		Yes	LC		No

Genus	Species	European Category	European Criteria	European Endemic	EU27 Category	EU27 Criteria	EU27 Endemic
Trichopsomyia	*lucida*	VU	B2ab(ii,iii,iv,v)	No	VU	B2ab(ii,iii,iv)	No
Triglyphus	*escalerai*	EN	B2ab(iii)	No	EN	B2ab(ii,iii)	No
Triglyphus	*primus*	LC		No	LC		No
Tropidia	*fasciata*	LC		No	LC		No
Tropidia	*scita*	LC		No	LC		No
Volucella	*bombylans*	LC		No	LC		No
Volucella	*elegans*	LC		Yes	LC		No
Volucella	*inanis*	LC		No	LC		No
Volucella	*inflata*	LC		No	LC		No
Volucella	*pellucens*	LC		No	LC		No
Volucella	*zonaria*	LC		No	LC		No
Xanthandrus	*azorensis*	NT	B1b(iii)+2b(iii)	Yes	NT	B1b(iii)+2b(iii)	Yes
Xanthandrus	*babyssa*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Xanthandrus	*comtus*	LC		No	LC		No
Xanthogramma	*aeginae*	EN	B1ab(iii)+2ab(iii)	Yes	EN	B1ab(iii)+2ab(iii)	Yes
Xanthogramma	*citrofasciatum*	LC		No	LC		No
Xanthogramma	*dives*	LC		No	LC		No
Xanthogramma	*laetum*	LC		No	LC		No
Xanthogramma	*marginale*	LC		No	LC		No
Xanthogramma	*pedissequum*	LC		No	LC		No
Xanthogramma	*pilosum*	EN	B2ab(iii)	Yes	EN	B2ab(iii)	Yes
Xanthogramma	*stackelbergi*	LC		No	LC		No
Xylota	*abiens*	LC		No	LC		No
Xylota	*caeruleiventris*	LC		No	LC		No
Xylota	*florum*	LC		No	LC		No
Xylota	*ignava*	LC		No	LC		No
Xylota	*jakutorum*	LC		No	LC		No
Xylota	*meigeniana*	LC		No	LC		No
Xylota	*segnis*	LC		No	LC		No
Xylota	*suecica*	VU	B2ab(ii,iii,iv)	No	EN	B2ab(i,ii,iii,iv)	No
Xylota	*sylvarum*	LC		No	LC		No
Xylota	*tarda*	LC		No	LC		No
Xylota	*triangularis*	LC		No	LC		No
Xylota	*xanthocnema*	LC		No	LC		No

Appendix 2. List of Lead Assessors by genera

Group 1: ***Merodon***

- **Main Assessor**: Snežana Radenković (Novi Sad University, Serbia)
- **Contributors**: Sanja Veselić (University of Novi Sad, Serbia), Marina Janković (University of Novi Sad, Serbia), Laura Likov (University of Novi Sad, Serbia), Dubravka Milić (University of Novi Sad, Serbia)

Group 2: ***Cheilosia, Claussenia, Cryptopipiza, Heringia, Pipiza***

- **Main Assessors**: Ante Vujić (Co-Chair, Red List Authority Coordinator, IUCN SSC Hoverfly Specialist Group; University of Novi Sad, Serbia), Gunilla Ståhls (University of Helsinki, Finland)
- **Contributors**: Marija Miličić (University of Novi Sad, Serbia), Marina Janković (University of Novi Sad, Serbia), Laura Likov (University of Novi Sad, Serbia), Tamara Tot (University of Novi Sad, Serbia), Anja Šebić (University of Novi Sad, Serbia), Dubravka Milić (University of Novi Sad, Serbia)

Group 3: ***Eumerus, Paragus, Pipizella***

- **Main Assessor:** Ana Grković (University of Novi Sad, Serbia)
- **Contributors:** Tamara Tot (University of Novi Sad, Serbia), Marija Miličić (University of Novi Sad, Serbia)

Group 4: ***Anasimyia, Ceriana, Copestylum, Eristalinus, Eristalis, Eurimyia, Ferdinandea, Helophilus, Ischiodon, Mesembrius, Myathropa, Myolepta, Neocnemodon, Parhelophilus, Platynochaetus, Primocerioides, Pseudodoros, Psilota, Sphiximorpha, Tropidia, Volucella***

- **Main Assessors:** Santos Rojo (University of Alicante, Spain), Celeste Pérez Banon (University of Alicante, Spain)
- **Contributor:** Andrea Aracil (University of Alicante, Spain)

Group 5: ***Arctosyrphus, Blera, Brachypalpoides, Brachypalpus, Caliprobola, Callicera, Chalcosyrphus, Lejops, Lejota, Mallota, Milesia, Palumbia, Pelecocera, Pseudopelecocera, Sericomyia, Spilomyia, Syritta, Temnostoma, Xylota***

- **Main Assessor:** Gerard Pennards (Independent consultant, The Netherlands)

Group 6: ***Baccha, Chrysosyrphus, Chrysotoxum, Dasysyrphus, Didea, Doros, Epistrophe, Epistrophella, Episyrphus, Eriozona, Eupeodes, Leucozona, Melangyna, Melanostoma, Meliscaeva, Parasyrphus, Pocota, Scaeva, Sphecomyia, Syrphus, Xanthandrus, Xanthogramma***

- **Main Assessors:** Antonio Ricarte (CIBIO Research Institute, University of Alicante, Spain), Libor Mazánek (Palacký University Olomouc, Czech Republic), Zorica Nedeljković (University of Novi Sad, Serbia)

Group 7: ***Microdon, Platycheirus, Pyrophaena, Sphaerophoria***

- **Main Assessors:** Axel Ssymank (Wachtberg, Germany), Rita Földesi (Universität Bonn, Germany)

Group 8: ***Brachyopa, Chrysogaster, Criorhina, Hammerschmidtia, Ischyroptera, Lejogaster, Melanogaster, Neoascia, Orthonevra, Portevinia, Psarus, Rhingia, Riponnensia, Rohdendorfia, Spazigaster, Sphegina, Syrphocheilosia, Trichopsomyia, Triglyphus***

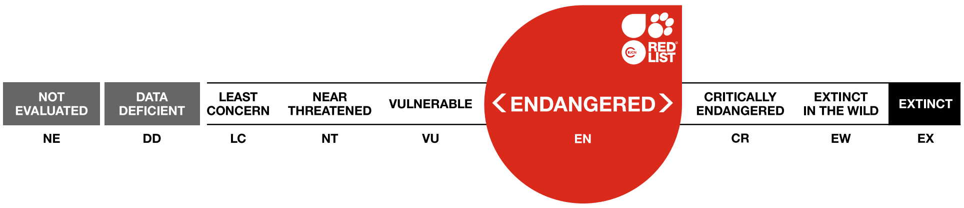
- **Main Assessors:** Jeroen van Steenis (Syrphidae Foundation, The Netherlands), Wouter van Steenis (Vereniging Natuurmonumenten, The Netherlands), Leendert-Jan van der Ent (Red List Authority Coordinator, IUCN SSC Hoverfly Specialist Group, The Netherlands)

Appendix 3. Example of species summary and distribution map

The IUCN Red List of Threatened Species™
ISSN 2307-8235 (online)
IUCN 2021: T149115163A149115165
Scope(s): Global, Europe
Language: English

Merodon adriaticus

Assessment by: Radenković, S. & Milić, D.



View on www.iucnredlist.org

Citation: Radenković, S. & Milić, D. 2021. *Merodon adriaticus*. *The IUCN Red List of Threatened Species* 2021: e.T149115163A149115165. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T149115163A149115165.en

Taxonomy

Kingdom	Phylum	Class	Order	Family
Animalia	Arthropoda	Insecta	Diptera	Syrphidae

Scientific Name: *Merodon adriaticus* Veselić, Vujić & Radenković, 2017

Taxonomic Source(s):

SANJA VESELIĆ, ANTE VUJIĆ & SNEŽANA RADENKOVIĆ. 2017. Three new Eastern-Mediterranean endemic species of the Merodon aureus group (Diptera: Syrphidae). *Zootaxa* 4254 (4): 401–434.

Identification Information:

This species belongs to Merodon aureus group (small-sized, short rounded abdomen, a distinct spike on the hind trochanter in males, and a characteristic structure of the male genitalia: posterior surstyle lobe with parallel margins and rounded apex and a narrow, elongated, sickle-shaped hypandrium without lateral sclerite of aedeagus), M. bessarabicus subgroup (species with predominantly yellow to orange tibiae and dark brown to black tergites). It can be recognized by the following diagnostic features: species with bluish reflection of mesonotum and green reflection of abdomen; mesonotum predominantly covered with black pile and tergites completely covered with pale pile in male. Similar to M. rufipes, from which it differs by larger area of black pile on eyes (mostly pale pile in M. rufipes); mesoscutum almost completely with black pilosity (in M. rufipes black pile present only in posterior half); pilosity on scutellum partly black (completely pale in M. rufipes) (Veselić et al., 2017).

Assessment Information

Red List Category & Criteria: Endangered B1ab(iii)+2ab(iii) ver 3.1

Year Published: 2021

Date Assessed: November 8, 2019

Justification:

Global and European regional assessment: Endangered (EN)
EU 27 regional assessment: Endangered (EN)

The Adriatic coast in Croatia and Montenegro is the only known area of *Merodon adriaticus*. It is a Mediterranean species and its habitats are increasingly destructed by tourism. Only five specimens in three localities have been recorded, although in Montenegro the species is considered Possibly Extinct since it has not been recorded there since 1997). It is considered to be likely that this species is endemic to this area. Based on the small geographic range of the species (the area of occupancy is 8-12 km^2, the extent of occurrence is 45-1,127 km^2) with only two (possibly three) locations based on the continuing decline of the habitat quality because of the intensive tourism, it is assessed as Endangered in Europe and the EU27.

We propose the monitoring of its population, as well as the monitoring of the habitat trend. Further research on life history and ecology of this species is needed.

Geographic Range

Range Description:

This species is endemic to Europe, with records from the Adriatic coast of Croatia and Montenegro (Veselić *et al.* 2017). Until now, it has been recorded only from three point localities (Veselić *et al.* 2017, Speight 2020). In Montenegro, the species has not been recorded since 1997, although surveys have been carried out systematically. Therefore, it can be considered as possibly extinct there. In Croatia, it was last recorded in 2017.

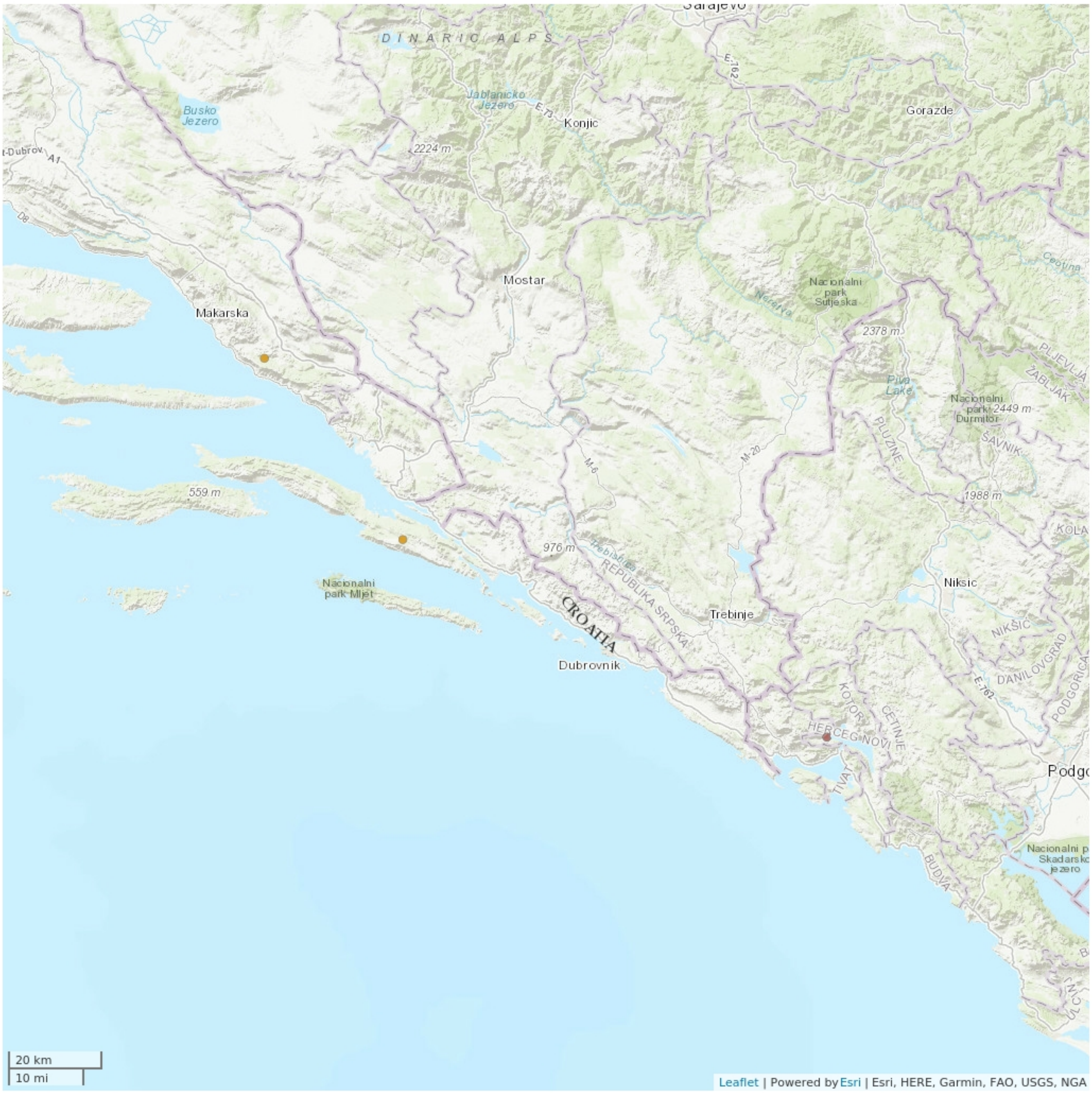
The extent of occurrence (EOO) is 45-1,127 km^2, which is estimated based on a rough calculation (the distance between points and a rough width - 1 km) because only two point localities are confirmed and in the third it is possibly extinct; the area of occupancy (AOO) is estimated to be 8-12 km^2 based on this rationale.

Country Occurrence:

Native, Extant (resident): Croatia

Native, Possibly Extinct: Montenegro

Distribution Map



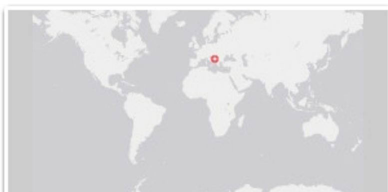
Legend

EXTANT (RESIDENT)

POSSIBLY EXTINCT

Compiled by:

IUCN European Red List 2019



The boundaries and names shown and the designations used on this map do not imply any official endorsement, acceptance or opinion by IUCN.

IUCN Red List of Threatened Species™ – European Regional Assessment Reports

- ***The Status and Distribution of European Mammals.*** Temple and Terry (compilers), 2007. https://portals.iucn.org/library/node/9047
- ***European Red List of Reptiles.*** Cox and Temple (compilers), 2009. https://doi.org/10.2779/74504
- ***European Red List of Amphibians.*** Temple and Cox (compilers), 2009. https://doi.org/10.2779/73661
- ***European Red List of Dragonflies.*** Kalkman et al. (compilers), 2010. https://doi.org/10.2779/84650
- ***European Red List of Saproxylic Beetles.*** Nieto and Alexander (compilers), 2010. https://doi.org/10.2779/84561
- ***European Red List of Butterflies.*** van Swaay et al. (compilers), 2010. https://doi.org/10.2779/83897
- ***European Red List of Non-marine Molluscs.*** Cuttelod et al., 2011. https://doi.org/10.2779/84538
- ***European Red List of Freshwater Fishes.*** Freyhof and Brooks, 2011. https://doi.org/10.2779/85903
- ***European Red List of Vascular Plants.*** Bilz et al., 2011. https://doi.org/10.2779/8515
- ***European Red List of Medicinal Plants.*** Allen et al., 2014. https://doi.org/10.2779/907382
- ***European Red List of Bees.*** Nieto et al., 2014. https://doi.org/10.2779/51181
- ***European Red List of Birds.*** BirdLife International, 2015. https://doi.org/10.2779/975810
- ***European Red List of Marine Fishes.*** Nieto et al., 2015. https://doi.org/10.2779/082723
- ***European Red List of Grasshoppers, Crickets and Bush-Crickets.*** Hochkirch et al., 2016. https://doi.org/10.2779/60944
- ***European Red List of Lycopods and Ferns.*** García Criado et al., 2017. https://doi.org/10.2305/IUCN.CH.2017.ERL.1.en
- ***European Red List of Saproxylic Beetles.*** Cálix et al., 2018. Update to Nieto and Alexander, 2010. https://portals.iucn.org/library/node/47296
- ***A miniature world in decline: European Red List of Mosses, Liverworts and Hornworts.*** Hodgetts et al., 2019. https://doi.org/10.2305/IUCN.CH.2019.ERL.2.en
- ***European Red List of Trees.*** Rivers et al., 2019. https://doi.org/10.2305/IUCN.CH.2019.ERL.1.en
- ***European Red List of Terrestrial Molluscs: Snails, slugs and semi-slugs.*** Neubert et al., 2019. Update to Cuttelod et al., 2011. https://portals.iucn.org/library/node/48439
- ***European Red List of Selected Endemic Shrubs.*** Wilson et al., 2019. https://portals.iucn.org/library/node/48438
- ***European Red List of Mosses, Liverworts and Hornworts.*** Hodgetts et al., 2019. https://portals.iucn.org/library/sites/library/files/documents/RL-4-027-En.pdf

The European Red List is a review of the status of European species according to IUCN regional Red Listing guidelines. It identifies those species that are threatened with extinction at the regional level – in order that appropriate conservation action can be taken to improve their status.

This publication summarises results for all hoverfly species native to or naturalised in Europe (892 species). Overall, 37.2% (314 species) of the European hoverfly species assessed in this study were considered threatened with extinction at the European level mainly due to impacts of intensive agriculture, commercial/productive forestry, residential and commercial development and natural system modifications.

This European Red List of Hoverflies is an output of the Hoverfly Specialist Group of the IUCN Species Survival Commission, funded by the European Commission Service Contract 'Status assessment of European Hoverflies (Syrphidae) – European Red List of Hoverflies (EU and pan-Europe)' (No. 07.0202/2018/792937/SER/ENV.D.2).

It is available online at
http://ec.europa.eu/environment/nature/conservation/species/redlist
and
https://www.iucnredlist.org/regions/europe