



## Prime Hoverfly (Insecta: Diptera: Syrphidae) Areas (PHA) as a conservation tool in Serbia



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### ABSTRACT

Hoverflies are a valuable group of species in need of conservation and monitoring, due to their large contribution to pollination, biological control, and role as indicators of ecosystem change. Though hoverflies are a well-known group of insects, there has been little documentation of their current conservation status. Using long-term hoverfly monitoring data, this study reports on their prevalence in Serbia and presents priority areas for their conservation. An expert-generated, criteria-driven approach was used to identify core areas for conservation of hoverflies, named Prime Hoverfly Areas (PHA); 34% of the identified area lies outside of a national protection area (NPA) network. A systematic conservation approach (gap and irreplaceability analysis) was then applied to evaluate: 1) sufficiency of the NPA for hoverfly conservation, and 2) degree of improvement in hoverfly conservation conferred by the expert-generated PHA network. The networks were evaluated for the achievement of predefined representation targets for each of the 155 hoverfly species identified as important for conservation. We found that the NPA network is insufficient, as it does not cover the ranges of 18% of considered species. The area of the proposed PHA outside of the NPA is small (1.36% of the national territory), but its protection would greatly improve hoverfly conservation by increasing the inclusion of hoverfly habitats for previously unprotected species and by including hoverfly biodiversity hot spots. The suggested PHA network was then compared to a similarly designed habitat network aimed to conserve butterflies. There was partial overlap between the two networks, highlighting the importance of considering multiple groups in planning comprehensive conservation strategies for pollinators.

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## 1. Introduction

Establishing protected areas (PAs) is one of the oldest and most common biodiversity conservation strategies (Groom et al., 2006; Primack, 2008; Soulé, 1991). Over the last few decades, global efforts to increase the amount of land under legal protection have met with some success (Cabeza, 2013; Zimmerer et al., 2004). However, the contribution of PAs to the conservation of biodiversity has been questioned for several reasons. First, biodiversity is decreasing (Butchart et al., 2010) while management of protected areas remains highly variable (Naughton-Treves et al., 2005). Second, the habitats of various species do not always overlap with protected areas, especially for lesser known (or less charismatic) organisms, such as various groups of invertebrates (e.g. Bosso et al., 2012; Cardoso et al., 2011; D'Amen et al., 2013; Hernández-Manrique et al., 2012; Verovnik et al., 2011). This problem is compounded by the fact that biodiversity conservation aims within nature conservation policy initiatives are often focused on

a very small number of species, with insufficient coverage of taxonomic and functional species groups. For example, in legal instruments such as the species protection Annexes of the EU Habitats Directive, major pollinator groups (bees and hoverflies) are absent. Finally, many protected areas were created for anthropocentric reasons (e.g. aesthetic, cultural, religious) rather than for improved biodiversity conservation (Oldfield et al., 2004).

To strengthen the conservation of underrepresented organisms and to encourage better designation of protected area networks, detailed inventory programmes have been initiated throughout the world that reveal new spaces in need of protection, including key biodiversity areas (Eken et al., 2004). Identification of important habitat areas has been completed for various species groups, using many different approaches and criteria for site choice. Generally, these methods for protected area identification can be labelled either 'scoring-based approaches' or 'complementarity approaches' (Zeydanli et al., 2012). The most commonly applied protected area selection methodology is based on the concept of Important Bird Areas (IBA), where the selection of sites is criteria-driven, using a scoring-based approach. This approach has since been extended to other taxa, identifying important areas for species

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conservation, including Important Plant Areas (IPA) (Anderson, 2002) and Prime Butterfly Areas (PBA) in Europe (van Swaay and Warren, 2003, 2006). However, to date, the majority of protected area identification and establishment efforts have focused on well-researched charismatic species, while many other groups remain underrepresented. In order to increase representation of previously unconsidered but ecologically important species within established PA methodology, in the present study we use long-term monitoring data to propose priority areas for hoverfly conservation in Serbia.

Hoverflies are an important pollinator group (Inouye et al., 2015; Larson et al., 2001; Rader et al., 2015; Szymank et al., 2009, 2008) and excellent ecosystem indicators, with a high number of different functional groups due to diverse larval ecology (Schweiger et al., 2007). In fact, hoverflies are one of the better studied groups of insects, especially in Europe where national faunas have been published for several countries (Bartsch et al., 2009a, 2009b; Haarto and Kerppola, 2007; Reemer et al., 2009; Stubbs and Falk, 2002; Torp, 1984), along with national and regional red lists (Cederberg et al., 2010; Doczkal et al., 1999; Farkač et al., 2005; Jentsch, 1998; Szymank and Doczkal, 1998; Szymank et al., 2011; Stuke et al., 1998).

In Europe, hoverflies have been recognised as a threatened group (Biesmeijer et al., 2006; Speight, 2000, 1989; Speight et al., 2013) due to the pressing problem of pollinator decline. The European Union (EU) Project on Status and Trends of European Pollinators (STEP, <http://www.step-project.net>) (2010–2015) has initiated action for developing the European Red List of hoverfly species, which should be used in combination with data for butterflies and bees in developing a Red List of European pollinators (STEP, <http://step-project.net>). As a result of the 6th International Symposium on Syrphidae (2011) in Glasgow (UK), Martin Speight (2011, unpublished) prepared a list of 60 threatened European Syrphid hoverfly species from the 886 European hoverfly species in the Syrph the Net (StN) database (Speight, 2011) and suggested that they should be proposed for Annex II of the Habitats Directive (92/43/EEC), the EU directive aiming to ensure survival of Europe's most endangered and vulnerable species. Species listed in Annex II must have core areas of their habitat protected and managed in accordance with species ecological requirements ([http://ec.europa.eu/environment/nature/conservation/species/habitats\\_dir\\_en.htm](http://ec.europa.eu/environment/nature/conservation/species/habitats_dir_en.htm)). There is, however, indirect protection of characteristic or typical species of Annex I habitats, which does cover some hoverflies. For Germany, these species are listed in the German Habitats Interpretation Manual (Szymank et al., 1998), which is currently under revision for a new edition with extended information on characteristic species.

In Serbia, intensive and continuous studies of hoverfly fauna began in the 1950s (Glumac, 1955). Hoverflies have been a continual focus of Serbian research, which has improved our knowledge of their taxonomy, zoogeography, phylogeny and ecology, while also providing important insight into the complex history of the Serbian landscape. So far, more than 400 hoverfly species have been identified in Serbia (Glumac, 1972; Nedeljković, 2011; Radenković, 2008; Steenis et al., 2015; Vujić, 1997, 1999a; Vujić et al., 2013b; Vujić, unpublished), a large percentage of which are rare and endemic species (Claussen and Vujić, 1995, 1993; Nedeljković et al., 2013; Radenković et al., 2013; Smith and Vujić, 2007; Vujić, 1999a, 1999b, 1997, 1994a, 1994b, 1990; Vujić and Claussen, 2000, 1994a, 1994b; Vujić and Stuke, 1998; Vujić et al., 2013a, 2013b, 2008, 2004, 1999a, 1999b, 1995). This is in agreement with the complex geological history and diverse habitat present in the Balkan Peninsula, which creates favourable conditions for rich biodiversity.

Two important legal achievements have resulted from this extensive research and conservation efforts in Serbia:

1. Three areas were protected based on hoverfly fauna (Pil and Vujić, 2004); the first European example of site protection based solely on diversity and the importance of Diptera species.

2. 77 hoverfly species and their habitats were protected by a national legal act (33 protected and 44 strictly protected) (Code on declaration

and protection of strictly protected and protected wild species of plants, animals and fungi ("Official Gazette of RS", no. 5/2010)).

Despite these major achievements, it has come into question whether the current protection scheme in Serbia is sufficient to meet conservation goals for hoverflies. This is of particular importance with respect to the new Global Strategic Plan for Biodiversity (2011–2020), which emphasises areas where species groups lacking information on important habitat areas may have been previously ignored in conservation efforts.

To remedy this situation, an attempt was made via a national project (Conservation strategy for protected and strictly protected hoverflies (Insecta: Diptera: Syrphidae) in Serbia – Case study) to identify areas important for hoverfly conservation, called Prime Hoverfly Areas (PHA). The selection process was criteria-driven and relied on expert opinion. The success of implementing these results into practice will largely depend on the strength of expert arguments.

To supplement this PHA identification process, we took the complementary approach of systematic conservation planning, applying gap and irreplaceability analysis in order to evaluate the sufficiency of the current national protected area (NPA) network for hoverfly conservation, and the contribution of the expert-generated PHA to this aim.

As of 2012, only 6% of the territory of Serbia was under legal protection (Serbian Biodiversity Conservation Strategy 2011–2018, "Official Gazette of RS", 13/11). The plan for the future is to increase the coverage of protected areas to 10% by 2015, and to 12% by 2021 (Spatial Plan for the Republic of Serbia, "Official Gazette of RS", 88/10). Recently, additional protected areas were announced, increasing the total protected area to 7% ([http://www.zzps.rs/novo/index.php?jezik=sr&strana=zastita\\_prirode\\_osnovni\\_podaci](http://www.zzps.rs/novo/index.php?jezik=sr&strana=zastita_prirode_osnovni_podaci)). Efforts were also made to define important areas for the protection for various species of birds, plants, and butterflies (IBA, IPA and PBA respectively). These areas, together with the NPA, represent a national ecological network, the cornerstone of the future Natura 2000 Network (the EU wide Network of nature protection areas) in Serbia.

Excluding the NPA, the national ecological network is not yet formally protected, and needs further revision and specification of borders. At present it only represents inventories of areas of special importance for certain groups of species and plant communities, but is not based on systematic conservation planning or evaluation of its contribution to species conservation. Thus, it would be futile to assess these areas before it is known whether they sufficiently cover important areas for the species groups in question.

In the present study, we evaluate the adequacy of the NPA for hoverfly conservation, an important pollinator group. In addition we propose an approach for systematic inclusion of important conservation areas. The present study is the first to apply systematic spatial conservation planning to hoverflies with the goal of testing the efficiency of expert-based selection and delineation of PHA areas in Serbia. Finally, we analysed the degree of overlap between the PHA and a similarly designed habitat network aimed to conserve butterflies, since this is of interest in planning conservation strategies for pollinators.

## 2. Materials and methods

### 2.1. Data on hoverfly species distribution

Hoverfly species distribution throughout Serbia has been regularly recorded for the last 35 years. Although systematic grid-based mapping of hoverfly distribution has never been conducted in Serbia, a large amount of accurately and precisely geo-referenced data on species presence has been collected throughout the country, covering all geographical regions, biogeographical zones and all habitat types. Areas with important habitats for hoverfly species of interest have been explored more intensively in faunistic and taxonomic studies. During sampling, adult specimens were collected during the peak flight period of the species expected for the area. All presence records were geo-referenced

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