1 **Title:** *The origin of urban communities: from the regional species pool to*
2 *community assemblages in city*

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4 **Running title:** *The assembly of urban communities*

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16 **Abstract:**

17 **Aim:** Cities worldwide are characterized by unique human stressors that filter species based
18 on their traits, potentially leading to biodiversity loss. The knowledge of which species are
19 filtered and at which scale is important to gain a more mechanistic understanding of urban
20 community assembly and to develop strategies to manage human impact on urban
21 ecosystems. We investigate the ecological mechanisms shaping urban community assembly,
22 taking into account changes across scales, taxa, and urban green space types.

23 **Location:** City of Zurich, Switzerland

24 **Taxon:** Carabid beetles and wild bees

Methods: We use a large species occurrence and trait dataset with a high spatial resolution to assess the filtering effect of a medium-sized city on a regional pool of potential colonists. We then assess the filtering from the urban pool to five widely distributed types of urban green spaces.

Results: We found that our model city selects for functionally similar but taxonomically diverse bee and carabid beetle species from the regional species pool. Within the city, community assembly processes vary among green space types and taxa resulting in important changes in community taxonomic and functional composition.

Main conclusions: Our findings suggest that urban community assembly is a multi-scale process dominated by the strong environmental filtering from a regional to an urban species pool. This leads to the selection of species pre-adapted to urban conditions. Spatial habitat heterogeneity within and among UGS types can maintain an important taxonomic diversity within cities. However, increasing urban functional diversity would require stronger management efforts that consider regional ecological processes.

Keywords: community assembly, environmental heterogeneity, functional diversity, functional traits, ground beetles, niche breadth, species composition, urbanization, wild bees

1 INTRODUCTION

Land-use change is a major cause of biodiversity loss worldwide (Sala *et al.* 2000) and the expansion of urban areas is among the most frequent forms of such changes, as an increasing proportion of the global human population is living in cities and towns (Foley *et al.* 2005). Urban biodiversity provides important ecosystem services for human well-being such as, for example, climate and water regulation, noise reduction, air filtration, and recreational and aesthetic value (Bolund & Hunhammar, 1999; Tzoulas *et al.* 2007; Elmquist *et al.* 2015). And,

cities can host species with high conservation value (Sattler *et al.* 2011; Ives *et al.* 2016; Hall *et al.* 2017). However, the effect of urbanization on biodiversity remains unclear with studies showing inconsistent patterns across taxa, spatial and temporal scales, and Urban Green Space (UGS) types (McDonnell & Hahs 2008; McKinney 2008; Magura, Lövei & Tóthmérész 2010; Baldock *et al.* 2015; Knop 2016). A more mechanistic understanding of urban community assembly is needed to assess and predict the effect of urbanization on biodiversity (Shochat *et al.* 2006; Concepción *et al.* 2015; Aronson *et al.* 2016).

Urban ecosystems feature a unique environmental template (Pickett *et al.* 2001) leading to the assembly of novel ecological communities (Turner 1990). Cities worldwide are characterized by large proportions of impervious area, which cause habitat loss and fragmentation while leading to several degrees warmer and dryer climates, decades ahead of the global average (Youngsteadt *et al.* 2015). These environmental features filter (i.e. selection for/against species through ecological processes such as competition or niche-environment interactions as opposed to evolutionary ones such as the evolution of individual traits by adaptation) the morphological, physiological, phenological, or behavioral properties of organisms (hereafter functional traits), thereby shaping the composition of urban communities (e.g. Williams *et al.* 2009; Aronson *et al.* 2016). For instance, habitat loss and fragmentation select for mobile species (Concepción *et al.* 2015; Cheptou *et al.* 2017), while urban warming selects for hot- and drought-tolerant species and hampers the successful recovery of hygrophilous species (Menke *et al.* 2011). For example, Magura *et al.* (2013) found fewer hygrophilous rove beetle species in urban habitats as compared to rural ones. A similar result was obtained by Tajthi *et al.* (2017) for spiders in riparian areas. Hence, it is expected that cities select for a few functionally similar species, resulting in impoverished but well-adapted urban communities, and ultimately in a worldwide homogenization of urban biodiversity (Grimm *et al.* 2008).

75 However, cities harbor large amounts of urban green spaces, including a wide range of
76 natural, semi-natural and artificial habitats such as urban forests, wastelands, gardens, yards
77 and green roofs (Figure 1) (Aronson *et al.* 2017). This environmental heterogeneity, referred to
78 as a close-knit mosaic of habitats, provides habitat to important portions of global biodiversity,
79 including rare, endemic, and threatened species (Sattler *et al.* 2011; Aronson *et al.* 2014; Ives
80 *et al.* 2016; Hall *et al.* 2017), while supporting urban ecosystem processes and services (e.g.
81 Tresch *et al.* 2019). It is also an important driver of urban community assembly, and evidence
82 shows that urban communities are spatially more structured than communities in more
83 homogenous environments, as most diversity in urban ecosystems is found between (high beta
84 diversity) rather than within (low alpha diversity) local communities (McDonnell & Hahs
85 2013). For instance, Tonteri & Haila (1990) observed higher plant beta diversity among UGS
86 types in Helsinki than among semi-natural forest sites outside of the city. Therefore, taxonomic
87 (TD) and functional (FD) diversities might be underestimated by looking at single UGS types,
88 spatial scales, and biodiversity measures such as alpha diversities (e.g. Gaston *et al.* 2005).

89 Empirical studies in urban ecosystems have largely ignored larger scale biogeographic
90 processes such as the connection, via dispersal, of species between the city and the surrounding
91 ecosystems despite theoretical and empirical evidence of the importance of these processes for
92 local community dynamics (Leibold *et al.* 2004; Economo 2011). Ecologists have often
93 compared cities with rural or pristine ecosystems (e.g. McDonnell & Pickett 1990; McDonnell
94 & Hahs 2008) suggesting that high degrees of urbanization promote the loss of native species
95 and the establishment of non-native species (McKinney 2006) leading to biotic homogenization
96 (e.g. McKinney & Lockwood 1999; Deguines *et al.* 2016; Knop 2016). Another approach
97 focuses on community patterns and mechanisms within cities highlighting the importance of
98 area (Beninde, Veith & Hochkirch 2015), connectivity (Braaker *et al.* 2014; Beninde, Veith &
99 Hochkirch 2015), and heterogeneity within and among UGS (Tonteri & Haila 1990; Lepczyk

et al. 2017) for urban biodiversity. However, these studies are sensitive to the size and composition of the pool of species available to colonize a focal site (Lessard *et al.* 2012; Cornell & Harrison 2014), that is the regional species pool. For example, two UGS with similar environmental conditions but located in different regions will harbor communities with different composition and diversity levels depending on species diversity in their respective regional pools. Not considering the regional pool when studying local urban community assembly can lead to bias estimation of the filtering effect of cities and difficulties to compare assembly processes among regions and studies (de Bello *et al.* 2012). For example, one might interpret species-poor local urban communities as resulting from strong environmental filtering whereas they actually reflect the low diversity of the region surrounding the city (species pool composed by few species). The contrary is also possible in a species-rich region (i.e. underestimation of the filtering effect because local communities are relatively diverse, but they do not reflect the diversity of the regional pool).

Here, we focus on two series of filters at different spatial scales. The first series determines which species can colonize the city from the regional pool. The second series occurs within the city among the different types of UGS and determine the changes in species composition among UGS and thus the beta diversity within the city. Studying these hierarchical filters simultaneously in cities is new and integrates urban-regional interactions thus providing complementary information about the changes in community assembly processes across scales (Shochat *et al.* 2006; Aronson *et al.* 2016).

We pioneer the use of this hierarchical approach to investigate urban community assembly of carabid beetles and bees. These groups are ubiquitous, diverse and abundant in cities (e.g. McIntyre 2000; Hernandez, Frankie & Thorp 2009; Niemelä & Kotze 2009; Magura, Lövei & Tóthmérész 2010). They play a key ecological role (e.g., as predators and pollinators respectively) in urban ecosystems (Sattler *et al.* 2011; Baldock *et al.* 2015; Hall *et al.* 2017).

They differ in their habitat and food preferences and mobility with carabid beetles having overall lower mobility than bees which are good flyers and actively forage for resources at relatively large spatial scales (Magura, Lövei & Tóthmérész 2010; Braaker *et al.* 2014; Nagy *et al.* 2018). At the community level, these differences are likely to result in distinct scale-dependencies with carabid beetle communities being more likely to vary among UGS than bee communities (Braaker *et al.* 2014; Braaker *et al.* 2017).

The goal of our study is to understand species assembly in cities across multiple spatial scales, UGS types, and across two functional guilds with distinct diet and mobility. We investigate the filtering effect of the largest Swiss city, Zurich, and its distinct UGS types on bee and carabid beetle species and functional traits. First, we define the pool of species present in the city, the urban pool, and the pool of species that can potentially colonize the city, the regional pool. We then investigate the filtering of functional diversity from the regional pool to the urban pool. We expect our model city to select for drought-tolerant species with broad ecological niches, broad diet, and good dispersal ability that are active early and for long periods during the season (McIntyre 2000, Piano *et al.* 2017). We then assess the filtering from the urban pool to each UGS type and the contribution of each UGS type to the changes of species and traits within the city (urban beta diversity). Because of their lower mobility, we expect a higher variability in species composition (beta TD) and trait composition (beta FD) in carabid beetle communities than in bee communities.

2 METHODS

2.1 Regional species pool

The regional pool is defined using a co-occurrence-based approach where a species that co-occurs with a species present in the city is likely to be able to colonize the city itself (Srivastava 1999; Lessard *et al.* 2012). To do so, we use species occurrence data from the Swiss Biological

Records Centre (<http://www.cscf.ch>, data accessed on the 12th of April 2017) projected on a 1 km x 1 km grid (about 41,200 grid cells) covering all of Switzerland and spanning from 2000 to present (12.04.2017). We first select all grid cells where any of the species present in the urban pool are observed and include all the species present in these cells in the regional species pool (Figure 1A). The regional pool includes ~56,000 bee and 28,000 carabid beetle occurrences and 15,714 grid cells (38% of all 1 km² grid cells in Switzerland). This approach allows excluding the species with very low chances of colonizing the city from the analyses, thus avoiding the overestimation of the filtering effect of cities. Also, it can be applied to any taxa, at any scales, and it does not require specific assumptions about the drivers of community assembly.

2.2 Urban species pool

2.2.1 Study location

This study was carried out in Zurich, Switzerland (Figure 1B). The city has a temperate climate with an annual mean temperature of 9.3 °C and annual mean precipitation of 1,134 mm over the past 30 years. Zurich has approx. 400,000 inhabitants, placing it in the most common city-size class globally (United Nations 2014). It is the center of the largest Swiss metropolitan agglomeration, which comprises about 1.3 million inhabitants (Federal Statistical Office, 2017). Home gardens cover approx. 11% of settlement area and 25% of urban green space, while the 5,500 allotments cover about 3% of settlement area and 7% of urban green space (Grün Stadt Zürich 2010). Green roofs cover about one-third (189 ha) of all flat roofs (Grün Stadt Zürich 2013).

2.2.2 Urban green space types

We consider five UGS types widely distributed in cities worldwide: Gardens, Allotment, Parks, Brownfields, and Green roofs (Figure 1C) (Aronson *et al.* 2017). Gardens predominantly consist of lawn, flower borders and woody vegetation (Tresch *et al.* 2018) and are adjacent to a single-occupancy house. Allotments encompass gardens on public land, managed by associations and leased to gardeners in lots of 100-200 m². Allotments are dominated by annual vegetation such as vegetables and characterized by high amounts of bare soil (Tresch *et al.* 2018). They also include many white flowering shrubs and fruit trees. Parks are defined as large lawns and meadows with sparse tree vegetation (Sattler *et al.* 2010). Ruderal surfaces, hereafter “Brownfields”, include brownfields, wastelands and vacant lots as well as extensively managed dry meadows (Braaker *et al.* 2014). Green roofs are vegetated rooftops spanning a gradient from *Sedum*-dominated plant communities to communities dominated by species typical of dry meadows (Braaker *et al.* 2014).

2.2.3 Arthropod sampling

To define the urban species pool, we pool arthropod data collected by Braaker *et al.* (2014), Sattler *et al.* (2010), and Frey *et al.* (2016). In total, 199 plots were sampled across five UGS types (Gardens: N = 43, Allotments: N = 42, Parks: N = 36, Brownfields: N = 38, and Green roofs: N = 40). Each UGS covers an area of a minimum of about 20 m² and were distant on average of about ~4000 m (minimum distance = 100 m; maximum distance = 11,000 m). Carabid beetles were sampled using pitfall traps. In all UGS types, one set of three pitfall traps (72 mm in diameter, covered with transparent roofs 10 cm above) were placed at the edges of isosceles triangles with a side length of 1 m. Bees were sampled using pan traps. In Parks, Brownfields, and Green roofs, traps consisted in a window interception device and a yellow pan (50 cm diameter pan with Plexiglas-window). In allotment and home gardens, three one-liter bowl traps, with each bowl sprayed with either UV-bright blue, white or yellow paint were

used (20 cm diameter each without Plexiglas-window). Both trap types were placed on wooden poles approx. 1.5 m above ground and were filled with a 0.2% Rocima solution (a bactericide and fungicide from Acima, Buchs, Switzerland). All traps were emptied weekly for 7 (Sattler *et al.* 2010), 13 (Frey *et al.* 2016) and 11 (Braaker *et al.* 2014) weeks between mid-May and the end of August in 2006, 2015, and 2010, respectively.

2.3 Trait data and community indices

For each plot, we measure the community-weighted mean value of each trait (CWM_{trait}), and alpha, beta and gamma TD and FD using presence-absence data. Functional traits are gathered from Klaiber *et al.* (2017) for carabid beetles, and from the European trait database (compiler: Stuart Roberts; pollinator loss module of the EU- FP6 ALARM-project) for bees, and are selected because they are expected to respond to urban filters (Moretti *et al.* 2017) (Table 1). Niche breadth is estimated from the species co-occurrence data using the approach by Fridley *et al.* (2007) modified according to Zeleny (2009). This approach assesses habitat generalists and specialists from co-occurrence data and is based on the idea that generalists should co-occur with many species, whereas specialists should co-occur with relatively few species.

We then measure the relative importance of alpha and beta TD and FD in urban plots using the Rao index with Jost correction and additive partitioning (Jost 2007; de Bello *et al.* 2010) where beta diversity measures the regional diversity excess as the difference in diversity between the entire dataset and an average sampling unit (Tuomisto 2010). To calculate TD, we use a maximal distance of 1 among each pair of species. In this case, the Rao index is equivalent to the Simpson index of diversity. In the case of FD, we use the Gower distance applied on trait data. We then assess the relative importance of taxonomic and functional turnover and nestedness among UGS using the beta diversity decomposition by Baselga (2010, 2012) and Villéger, Grenouillet & Brosse (2013). Changes in community composition among plots (beta

diversity) can result from different processes (Baselga 2010): (i) turnover refers to species (TD) or traits (FD) replacement along an environmental gradient, whereas (ii) nestedness refers to species loss. These metrics provide complementary information about community assembly that can prove useful to understand the ecological dynamics of urban ecosystems (Baselga 2010; Dapporto *et al.* 2014).

2.4. Data analyses

2.4.1 Regional pool to urban pool

We assess the filtering effect of the focal city on the regional species pool using null models. We pool the data from the 199 urban plots and calculated the observed values of CWM, TD, FD, and niche breadth for the focal city. We randomly sample 92 grid cells of 1 km x 1 km in the regional pool to have a similar area as the focal city (92 km²). We randomly attribute trait values from the species present in the selected grid cells to species in the urban pool and recalculate CWM, FD, and niche breadth. We repeat this procedure 10,000 times to obtain a random distribution for each community index and calculate p-values and standardized effect sizes (SES). This approach preserves species abundances and richness in each site and assumes that all species within the regional pool have equal probability to occur in the city. It, therefore, minimizes the effect of species richness per se on the target community metrics as well as potential biases related to irregular sampling intensity in the regional pool.

2.4.2 Urban pool to urban green spaces

We then test for the filtering effect of the different UGS on the urban pool. We calculate the average abundances of all species per UGS types and calculate the observed values of CWM, TD, FD, and niche breadth using these pooled data. We randomly attribute trait values from species in the urban pool to species in the different UGS types excluding the species present

only in the focal UGS to avoid potential bias. We use the same procedure as before to obtain p-values and SES for functional diversity and niche breadth.

2.4.3 Beta diversity within the urban pool

We finally assess the contribution of the different UGS types to the overall urban beta diversity using permutational multivariate analysis of variance (PERMANOVA, Adonis, vegan). The response matrix is the pairwise beta diversity (Rao index with Jost correction) among urban plots and the explanatory variable is a factor representing the five UGS types. To represent this analysis visually, we perform a nonmetric multidimensional scaling (NMDS) on the pairwise beta diversity among plots (metaMDS, vegan). NMDS is chosen because it provides a 2D, easily interpretable picture of the data. We also assess the changes in CWM among UGS types and their significance using ANOVA and Tukey's Honest Significant Difference tests. All statistical analyses have been performed on R version 3.5.1 (R Development Core Team 2018).

3 RESULTS

The regional species pool includes ~81% (447) of all carabid species known in Switzerland (552) and ~85% (535) of all bee species (632). The urban species pool includes ~19% (86) of all carabid beetle and ~31% (164) of all bee species in the regional pool (see Supplementary Tables S1 and S2). Furthermore, no bee and a single carabid beetle species (*Perigona nigriceps*) present in the city is considered as non-native species in Switzerland (Wittenberg 2006).

3.1 Regional pool to urban pool

We find our model city to select for large, social, and pollen generalist (i.e. polylectic + short tongues) bee species active longer and earlier in the season and that use existing cavities for nesting (i.e. renter) (Table 2A). These species are characterized by high values of niche

breadth. In carabid communities, our model city selects for winged, drought-tolerant species that preferentially occur in lowlands (Table 2B). These species have high values of niche breadth and broad feeding preferences (omnivore). We also observe a significant decrease in carabid FD. Finally, we observe opposite trends in body size in the two taxa with small bees and large carabid beetles filtered from the city.

3.2 Urban pool to urban green spaces

We find different patterns depending on the UGS type, taxonomic group, and community index considered. We find higher bee species richness and (Simpson) diversity in Gardens, Allotments, and Brownfields (Figure 2A). We find that all UGS selected for social bee species with high niche breadth that use existing cavities for nesting (Table 3A). And, all UGS filter out parasitic bee species. However, we also find different filtering effects among UGS types. For instance, Gardens and Allotments select for species with short tongue. And, Parks, Roofs, and Brownfields select for generalist (high niche breadth values) bee species active longer and sooner in the season; and filter out solitary bee species. No UGS selects for higher or lower FD than expected by chance.

In the case of carabids, we find that Brownfields has the highest species richness and Shannon diversity (Figure 2B). Allotments and Gardens filter herbivore species from the communities whereas Roofs select for omnivore species (Table 3B). Parks, Brownfields, and Roofs filter out species with mixed overwintering strategy (larvae/imago) and select for species overwintering as imago. Home gardens and Allotments select for brachypterous species whereas Brownfields selects for macropterous species that preferentially occur in lowlands (elevation optimum). Finally, Parks, Brownfields, and Roofs have significantly lower FD than expected by chance.

3.3 Beta diversity within the urban pool

In the case of bees, 65% of urban gamma TD and 4% of urban gamma FD is due to differences among plots (i.e. beta diversity). Within this, 81% of beta TD and 26% of beta FD are related to turnover among plots as opposed to nestedness. In agreement, the NMDS analyses show taxonomic and functional differentiation between gardens and allotments *versus* the three other UGS types (Figure 3A-B). These differences are clearer for TD than FD. The PERMANOVA analyses show that UGS type explains an important proportion of the taxonomic and functional differences of bee communities among urban plots (beta TD_{Bee}: $R^2 = 0.61$, $p = 0.001$; beta FD_{Bee}: $R^2 = 0.62$; $p = 0.001$).

In the case of carabid beetles, 86% of urban gamma TD and 6% of urban gamma FD are due to differences among plots. Within this, 78% of beta TD and 36% of beta FD are related to turnover among plots as opposed to nestedness. In agreement, the NMDS analyses show a clear differentiation among the five habitats for taxonomic differences but less so for functional differences (Figure 3C-D). In both cases, the variability within UGS is higher than that observed for bees. The PERMANOVA analyses show that UGS type explains a relatively low part of the taxonomic and functional beta diversity of carabid communities (beta TD_{Carabid}: $R^2 = 0.43$, $p = 0.001$; beta FD_{Carabid}: $R^2 = 0.27$; $p = 0.001$).

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4. DISCUSSION

Community assembly in cities is poorly understood making it difficult to predict possible effects of changes in urbanization dynamics on biodiversity. There is thus a need to understand the mechanisms underlying urban community assembly and how they change across scales and taxa. Our results suggest that our model city selects from the regional pool mainly mobile bee and carabid beetle species that are drought-tolerant, diet generalists, and active earlier and for

longer periods during the season. This results in species-rich communities with relatively low FD (Knapp *et al.* 2008; Nock *et al.* 2013). Within the city, our results reveal differences in assembly processes among UGS types, between bees and carabid beetles, and within each taxonomic group, at both taxonomic and functional level. Our study highlights the multi-scale nature of urban community assembly with regional processes filtering out species with poorly adapted traits and environmental heterogeneity within the city favoring the coexistence of multiple but functionally similar species. These multi-scale processes can have important consequences for the structure and functions of urban ecosystems. In particular, our results suggest that considering the species pool outside the city is key for successful management of biodiversity within cities.

4.1 Urban arthropod community assembly from the regional pool

Our results are consistent with previous studies on carabid beetles (e.g. Piano *et al.* 2017), bees (e.g. Deguines *et al.* 2016), birds (e.g. Sepp *et al.* 2018), and plants (e.g. Knapp *et al.* 2008) and overall suggest that local climatic conditions, and resource availability and distribution are the main drivers of the assembly of urban communities from the regional pool. For instance, in a meta-analysis, Merckx *et al.* (2018) find body size changes among several taxa, possibly driven by both the urban-heat-island effect and habitat fragmentation. Similarly, our model city may select for cavity-nesting bees because of the increasing availability of artificial cavities but also the corresponding lack of bare ground for ground nesting bees. Although studies investigating changes in the functional and/or taxonomic community composition along urbanization gradients usually interpret such effects as biotic homogenization and thus biodiversity loss (McKinney 2008; Knop 2016), here we argue that such effects may not be specific to urban ecosystems, but rather are a pervasive and general feature of strong environmental gradients and/or ecosystems. This is because, by definition, each ecosystem or habitat along an

environmental gradient is characterized by specific abiotic and biotic conditions, which should filter for a functionally more similar species composition when compared to the regional pool (e.g. de Bello et al. 2012). Nevertheless, the strength of such filtering may also depend on the area, environmental heterogeneity and biogeographic history spanned by the regional species pool. Overall, while urbanization can lead to the local extinction of some poorly adapted taxa (Fattorini et al. 2011a; Fattorini et al. 2011b), it can also trigger evolutionary adaptations to the changed environmental conditions of cities (Alberti 2015; Alberti et al. 2017; Johnson & Munshi-South 2017) which is likely to be the case with any anthropogenic or novel ecosystems.

4.2 Mechanisms shaping biodiversity within cities: the role of urban green spaces

Understanding how urbanization impacts species assembly and biodiversity at the regional scale is important but equally important is to understand the mechanisms driving community assembly within cities and the role played by different UGS types in structuring urban biodiversity. In agreement with other studies in different cities (Lososová *et al.* 2016; Martins, Gonzalez & Lechowicz 2017), we show that most of the total TD (i.e. gamma TD) in Zurich comes from changes in species composition among UGS types (i.e. beta TD) rather than from local diversity (i.e. alpha TD). These findings are consistent with Tonteri & Haila (1990), who found that plant communities' composition in Helsinki is more dissimilar among urban habitats than among semi-natural forest sites outside the city. In that sense, our results support the close knit-mosaic view of urban ecosystems and highlight the importance of environmental heterogeneity among UGS for urban biodiversity (Lepczyk *et al.* 2017) as well as its potential to help mitigate biotic homogenization. Studies showing that changes in species composition among plots outside cities are higher than within cities (e.g., McKinney 2008; Knop 2016) have considered a number of UGS and/or plots that does neither reflect the environmental

heterogeneity in the cities under investigation nor the local landscape composition and configuration (e.g. Sattler et al., 2010; Braaker et al., 2017).

Despite the relatively low overall functional beta diversity, our results point toward important traits for species distribution within the city. UGS had a different impact on bee phenology, feeding preferences, nesting mode, voltinism, and sociality, as well as carabid beetle feeding preferences, overwintering strategy, mobility, and abiotic preferences. These changes lead to differences among UGS types in mean community niche breadth for bees and in functional diversity for carabid beetles. Overall, these results support the idea that resource distribution within the city is key for functional beta diversity. Indeed, gardens and allotments harbored more specialized bee species most likely because of the presence of cultivated flowers that provide different resources to bees that are absent in other UGS. In the case of carabid beetles, the higher FD in Gardens and Allotments can tentatively be explained by the higher abundance of prey that allows species with lower mobility (brachypterous) to sustain their needs. Also, carnivorous species are more likely to find preys as they typically hunt on bare ground which is more abundant in these two UGS. And, there are overall fewer constraints on overwintering strategies in Gardens and Allotments potentially because of the higher abundance of winter preys, such as springtails (Jaskula & Soszyńska-Maj 2011). Taken together, these results show that less mobile taxa, such as non-flying species (as observed here) or species belonging to low trophic levels that do not actively move among habitats to find food resources (e.g. Nagy et al. 2018), are more likely to show important taxonomic and functional differences among UGS, thus highlighting the key role of species dispersal capacity and/or mobility for urban beta diversity (Braaker *et al.* 2014).

Finally, increasing beta functional diversity should be a key target of biodiversity management in urban ecosystems. Our results suggest that this can be achieved through specific management of the spatial distribution of food resources and nesting sites (in the case of bees) across the city

and within UGS. Also, specific management of key resources such as increasing the amount of available bare ground is likely to favor certain functional groups that are yet poorly represented in cities (e.g. strictly carnivorous ground beetles and ground nesting bees).

4.3 Beyond the biotic homogenization perspective of urbanization

While several studies suggest that urbanization leads to biotic homogenization (McKinney 2006; Groffman *et al.* 2014; Deguines *et al.* 2016), evidence that city harbors unique species assemblages also exists (Sattler *et al.* 2011; Swan, Johnson & Nowak 2017). Our results provide mixed evidence for this issue. For instance, our results provide some support to the idea of functional homogenization when the regional species pool was considered but contradict that of taxonomic and functional homogenization at the scale of the city for both taxa. Overall, our results rather point toward the multi-scale and complex nature of community assembly in cities. Thus, we argue that ecologists should adopt a more mechanistic approach to study biotic homogenization (McDonnell & Hahs 2013), for instance, by taking into account the marked environmental heterogeneity of cities (Lepczyk *et al.* 2017). We suggest that instead of looking for patterns of biotic homogenization *per se*, ecologists should focus on questions such as: *Which filters operate in cities? Which functional traits are filtered? At which spatial scales? In which habitats? How different taxa respond to these filters? Which of them result in taxonomic, functional, and/or genetic homogenization? What is the minimum amount and quality of habitat that must be restored to mitigate those negative effects? How can we use this knowledge to predict future changes in urban and UGS biodiversity (e.g. Houlahan et al. 2017)?* We argue that addressing these questions would increase our understanding of how urbanization shapes biodiversity, and ultimately how urban biodiversity supports ecosystem functioning and services in cities.

4.4 Strengths and limitations of the study

While our approach provides important results for our understanding of community assembly in cities, it also calls for more systematic and standardized sampling within and around cities. For instance, by pooling data from different studies and slightly different trapping methods for bees (but not for Carabid beetles), we introduced a potential bias in our results. However, this bias is likely to be minimal because some of the significant changes in traits or community metrics in bees cannot be explained by the differences in sampling (e.g. polylectic bees) and carabids show the same patterns (i.e. Garden and Allotment different from the others) for some traits or metrics (e.g. FD) which suggest that this is a real pattern and not an artifact due to sampling. Moreover, we use presence/absence instead of abundance to minimize the sampling bias that is likely to be more important for abundance.

Future studies should expand our approach to other UGS types and taxa across multiple cities in different biogeographical regions, especially in developing countries, where most of the current urban expansion takes place (e.g. United Nations 2014). However, care should be taken to use databases with strict control of observations quality (as done in the CSCF database that was used here). If this is not the case (e.g. GBIF), data have to be revised for inconsistencies (i.e., remove duplicated occurrences, homonyms and location errors).

Moreover, other insect taxa, such as Orthopterans and Lepidopterans, are likely to have fewer suitable habitats in cities and thus might show a more negative response to urbanization (Ramírez-Restrepo & MacGregor-Fors 2017). Including urban forests, aquatic habitats, and grey habitats in our approach could add to the observed heterogeneity within the city. Also, some taxa tend to be introduced frequently from distant regions via trade, traffic, and transport (e.g. Cadotte *et al.* 2017). Such human-assisted long-distance dispersal events can impact local community composition (Colunga-Garcia, Haack & Adelaja 2009), but are likely to have an overall low impact in our case as suggested by the fact that we did not find non-native species

in the urban species pool. As such, future studies should extend the definition of the pool of potential colonists beyond the political borders of a country and integrate trait-based approaches into species assembly models. In addition, more mechanistic approaches can be used to define the regional pool (e.g. process-based species pools, e.g. Lessard *et al.* 2016) which would allow testing specific hypotheses about the colonization of cities. This will improve our ability to predict novel community assembly that might arise from species introduction and climate change.

Finally, differences among UGS types explain an important part of beta diversity within cities which further validates our approach. However, our approach does not allow to directly assess which features of the urban environment drive community assembly. A more continuous approach of the urban environment relating measured environmental variables to community structure would provide further mechanistic insights into the assembly of urban communities. Finally, our results highlight the different contribution of UGS types to biodiversity. For example, Parks have a relatively low contribution to taxonomic and functional diversities, and Brownfields have a relatively high contribution to taxonomic diversity in both taxa. Our results also highlight that some UGS might have different contributions to biodiversity depending on the taxonomic group considered. For example, Gardens harbor a relatively high bee species diversity but a relatively low carabid beetle species diversity. Urban land-use management plans should take these differences into consideration as they have the potential to improve urban biodiversity.

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DATA ACCESSIBILITY

All traits and species occurrence data are available from the Dryad Digital Repository: [doi to be added upon acceptance].

BIOSKETCH

Bertrand Fournier is interested in investigating community assembly in anthropogenic ecosystems across spatial and temporal scales, from the level of single species to whole communities. **David Frey** is a conservation biologist with a specific interest in plant-animal interactions in novel and anthropogenic ecosystems. **Marco Moretti** has broad interests in biodiversity, community ecology, and functional ecology with a particular focus on natural disturbances and urban ecosystems. All authors collaborate on questions of urban ecology and, more specifically, on the assembly of urban communities.

Author contributions: BF, MM, and DF conceived the ideas; BF, MM, and DF gathered the data; BF analyzed the data; and BF led the writing and MM and DF contributed substantially to the manuscript.

753 **TABLES**754 Table 1. List of ecological traits used in community assembly analysis for (A) bees and (B)
755 carabid beetles.

(A)			
Category	Trait	Values	Definition
Activity time	Phenology start	1-8	First month of activity at the beginning of the season
	Phenology duration	1-12	Number of months of activity during the season
Feeding	Feeding preferences (Lecty)	monolectic / oligolectic / polylectic / no lectic status	Flower specialization categories (monolectic = pollen collecting at a single species; oligolectic = pollen collecting restricted to plants within the same plant family; polylectic = pollen collecting on a number of species from different plant families; no lectic status = having no pollen collecting requirements, i.e. cleptoparasites).
	Tongue length	long / short	Categorical classification of species based on tongue length (long = > 5 mm; short = ≤ 5; genus <i>Bombus</i> : long = > 9 mm; short = ≤ 9)
Body size	Inter-tegula distance	mm (0.05 to 6.72)	Female mean inter-tegula distances (distance between the two insertion points of the wings)
Nesting	Nesting mode	carder / carpenter / excavator / mason / miner / cleptoparasite / renter	Categorical classification of species based on nesting strategy (carder = nest of plant wool; carpenter = nest in existing cavities of wood; excavator = nest dogged in the ground or wood; mason = nest of clay, sand, mud; miner = nest in existing underground cavities; cleptoparasite = nest in bee nests and larvae feed on the host bee pollen; renter = nest in existing above ground cavities or in snail shell)
Sociality	Social status	solitary / parasitic / polymorphic / social	Categorical classification of species based on sociality level
Voltinism	Type of voltinism	univoltine / polymorph / bivoltine /	Categorical classification of species based on the number of generations per year
(B)			
Category	Trait	Values	Definition
Activity time	Phenology start	1-10	First month of activity at the beginning of the season
	Phenology duration	1-12	Number of months of activity during the season
Feeding	Feeding preferences	carnivore / herbivore / omnivore	Categorical classification of species into three diet categories
Body size	Mean	mm (1.5 to 37)	Species mean body size
	Variation	%	Difference between maximum and minimum body size
Overwintering	Overwinter stage	imago / larvae / both	Categorical classification of species based on overwintering stage
Mobility	Dispersal mode (Wing form)	apter / brachypter / dimorphic / macropter	Categorical classification of species based on the morphology of the wings (apter = without wings; brachypter = short wings; dimorphic = short and long wings; macropter = long wings)
Abiotic tolerance	Elevation optimum	1-5	Preferred elevation layer in Switzerland (1 = low land; ... 5 = alpine)
	Elevation range	1-5	Range of elevation layers occupied in Switzerland (CSCF): 1 = elevation specialist; 4 = elevation generalist
	Drought tolerance	1-5	Ability to withstand dry conditions: 1 = low tolerance; 5 = high tolerance

Table 2. Trait filtering from the regional pool to the city (Zurich, Switzerland). The table shows p-values and standardized effect sizes (SES) obtained from null model analysis for (A) bees and (B) carabid beetles. Negative SES means lower values than expected under random assembly from the pool (filtering, competitive exclusion). Positive SES means higher values than expected under random assembly from the pool (niche partitioning). FD = functional diversity; NB = co-occurrence-based niche breadth. Bolded characters highlight significant differences from random assembly (i.e. P-value <0.025 or >0.975).

(A)				(B)			
Trait	Values	SES	P-value	Trait	Values	SES	P-value
Activity time	Phenology start	-2.960	0.004	Activity time	Phenology start	-0.744	0.224
	Phenology duration	5.604	1.000		Phenology duration	-0.409	0.355
Body size	Inter-tegula distance	1.481	0.917	Body size	Body size mean	-0.627	0.287
Feeding preferences	Monolectic	-0.397	0.278		Body size variation	2.004	0.965
	Oligolectic	-1.834	0.029	Feeding preferences	Carnivore	-1.263	0.108
	Polylectic	4.279	1.000		Herbivore	-0.577	0.361
Tongue length	Long	0.001	-3.612		Omnivore	3.216	0.997
	Short	1	3.612	Over-wintering	Imago	1.345	0.942
Nesting mode	Carder	2.312	0.972		Larva	-0.727	0.274
	Carpenter	-0.774	0.311		Larva/imago	-0.987	0.112
	Excavator	-0.331	0.351	Mobility	Apter	-0.142	0.443
	Mason	-1.201	0.004		Brachypter	-0.750	0.257
	Miner	-0.439	0.337		Dimorph	-0.946	0.182
	Parasite	-2.820	0.002		Macropter	1.359	0.906
	Renter	3.574	1.000	Abiotic tolerance	Drought tolerance	1.186	0.878
Voltinism	Bivoltine	0.282	0.641		Elevation range	1.158	0.881
	Polymorph	3.645	0.998		Elevation optimum	-1.855	0.007
	Univoltine	-0.215	0.386				
Social status	Parasitic	-2.820	0.002	Functional diversity	FD	-2.491	0.004
	Polymorphic	1.959	0.956	Niche breath	NB	0.174	0.613
	Social	5.747	1.000				
	Solitary	-1.501	0.066				
Functional diversity	FD	-0.500	0.299				
Niche breath	NB	2.713	0.998				

Table 3. Trait filtering from the urban pool to urban green habitats. The table shows p-values and standardized effect sizes (SES) obtained from null model analysis for (A) bees and (B) carabid beetles. Negative SES means lower values than expected under random assembly from the pool (filtering, competitive exclusion). Positive SES means higher values than expected under random assembly from the pool (niche partitioning). NAs are obtained when no or a single species with the corresponding trait value is present in a given UGS. FD = functional diversity; niche breadth = co-occurrence-based niche breadth. Bolded characters highlight significant differences from random assembly (i.e. P-value <0.025 or >0.975).

(A)

		Home gardens		Allotments		Parks		Brownfields		Roofs	
		SES	P-value	SES	P-value	SES	P-value	SES	P-value	SES	P-value
Activity time	Phenology start	0.492	0.700	0.186	0.566	-1.867	0.032	-3.935	0.001	-3.836	0.001
	Phenology duration	0.664	0.742	1.394	0.920	4.216	1.000	5.440	1.000	5.764	1.000
Body size	ITD Mean female	0.988	0.854	0.594	0.733	1.329	0.913	1.531	0.935	2.416	0.989
Feeding preferences	Monolectic	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Oligolectic	-0.539	0.299	-0.316	0.396	-0.858	0.215	-2.170	0.012	-1.845	0.020
	Polylectic	2.053	0.983	1.684	0.963	2.426	0.993	4.613	1.000	3.492	1.000
Tongue length	long	-2.061	0.02	-2.519	0.006	-0.979	0.176	-1.353	0.081	-0.756	0.246
	short	2.061	0.981	2.519	0.995	0.979	0.825	1.353	0.920	0.756	0.755
Nesting mode	Carder	0.339	0.675	0.166	0.594	2.101	0.956	1.432	0.899	1.403	0.901
	Carpenter	-0.571	0.449	-0.840	0.275	-0.762	0.176	-0.984	0.100	-0.733	0.205
	Excavator	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Mason	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Miner	-0.250	0.417	-1.034	0.159	-1.063	0.157	0.305	0.633	-0.834	0.197
	Parasite	-1.885	0.027	-1.650	0.044	-2.012	0.009	-3.331	0.001	-2.415	0.001
	Renter	1.942	0.964	2.772	0.995	2.444	0.993	2.433	0.990	2.655	0.990
Voltinism	Bivoltine	-0.514	0.334	-0.689	0.267	-0.392	0.404	0.573	0.720	0.596	0.742
	Polymorph	1.969	0.958	1.956	0.957	2.405	0.979	2.287	0.976	2.066	0.968
	Univoltine	-0.582	0.271	-0.424	0.334	-0.954	0.171	-1.440	0.086	-1.437	0.085
	Parasitic	-1.885	0.027	-1.650	0.044	-2.012	0.009	-3.331	0.001	-2.415	0.001
	Polymorphic	1.655	0.940	0.566	0.734	0.981	0.838	0.494	0.696	0.281	0.659
	Social	1.954	0.971	2.057	0.966	6.395	1.000	6.737	1.000	7.033	1.000
	Solitary	-0.262	0.379	-0.091	0.466	-3.206	0.003	-2.521	0.008	-3.321	0.001
Community structure	Functional diversity	-0.539	0.295	-0.735	0.231	0.055	0.528	-0.697	0.243	-0.250	0.397
	Niche breadth	1.479	0.929	1.090	0.865	3.984	1.000	3.643	1.000	3.576	1.000

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(B)

		Home gardens		Allotments		Parks		Brownfields		Roofs	
		SES	P-value	SES	P-value	SES	P-value	SES	P-value	SES	P-value
Activity time	Phenology start	-0.353	0.455	-0.018	0.535	-0.085	0.446	-0.246	0.455	-0.029	0.441
	Phenology duration	0.421	0.693	-0.161	0.455	-0.835	0.228	-0.776	0.238	-1.206	0.114
Body size	Body size mean	0.087	0.594	1.562	0.921	-0.715	0.218	-0.408	0.406	-1.007	0.149
	Body size variation	1.967	0.931	1.381	0.921	-0.060	0.535	0.459	0.752	0.424	0.663
Feeding preferences	Carnivore	-0.012	0.594	1.062	0.812	-0.533	0.351	-0.134	0.535	-1.036	0.173
	Herbivore	-0.767	0.010	-1.042	0.069	0.223	0.624	-0.307	0.460	-0.629	0.277
	Omnivore	0.961	0.673	0.064	0.614	0.593	0.693	0.346	0.673	2.118	0.990
Overwintering	Imago	0.524	0.713	0.649	0.723	1.171	0.921	1.146	0.980	1.280	0.911
	Larva	-0.411	0.386	-0.593	0.386	-0.187	0.525	-0.378	0.436	0.227	0.673
	Larva/imago	-0.268	0.515	-0.308	0.525	-1.473	0.020	-1.050	0.010	-1.557	0.035
Mobility	Apter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Brachypter	2.867	0.990	5.013	1.000	-0.752	0.203	-0.823	0.025	-0.991	0.094
	Dimorph	-0.713	0.168	-0.686	0.297	-1.093	0.144	-1.052	0.069	-0.829	0.213
	Macropter	-0.067	0.228	-1.237	0.139	1.321	0.921	1.283	0.975	1.223	0.876
Abiotic tolerance	Drought tolerance	-0.784	0.248	-0.515	0.307	0.566	0.752	0.251	0.653	0.451	0.718
	Elevation range	-1.162	0.178	0.711	0.752	1.078	0.866	1.040	0.847	0.247	0.574
	Elevation optimum	0.644	0.931	1.996	0.970	-1.032	0.099	-0.813	0.010	-1.244	0.040
Community structure	Functional diversity	-0.443	0.366	-0.036	0.574	-3.281	0.010	-2.780	0.010	-2.742	0.010
	Niche breadth	0.677	0.911	1.548	0.931	-1.180	0.109	-0.864	0.139	-1.333	0.079

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FIGURES

Figure 1. Illustration of the different scales and processes considered. (A) Map of Switzerland showing the sites selected in the regional pool. (B) Aerial view of the city of Zurich showing the extent of the urban pool and the location of example plots in the five Urban Green Space types. (C) Typical examples of plots in the five Urban Green Space types. (D) Scheme of the investigated multiscale assembly process.

Figure 2. Boxplots showing the within-city differences among urban green spaces (UGS) in community functional diversity and composition for (A) bees and (B) carabid beetles. The selected community indices are species richness, taxonomic diversity (Rao quadratic entropy, equivalent to Simpson index of diversity), functional diversity (Rao quadratic entropy), community-weighted mean niche breadth, body size (inter-tegula distance for bees), community-weighted mean phenology duration, diet breadth (percentage of polylectic species for bees, and percentage of strictly carnivorous species for carabids), and a taxa-specific community-weighted mean trait (bees = percentage of species nesting in existing cavities, carabids = community-weighted mean drought tolerance). Letters show differences among UGS (Tukey's Honest Significant Difference tests).

Figure 3. Non-metric multidimensional scaling (NMDS) of pairwise differences in community species and trait composition showing the importance of urban green spaces (UGS) for urban beta diversity. (A) Bee taxonomic beta diversity; (B) bee functional beta diversity; (C) carabid taxonomic beta diversity; (D) carabid functional beta diversity.

809 **Supplementary material**

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811 Table S1. List of bee species present in the regional and/or in the urban pool.

<i>Species</i>	Regional pool	Urban pool	Gardens	Allotments	Parks	Brownfields	Roofs
<i>Andrena aeneiventris</i>	1	0	0	0	0	0	0
<i>Andrena afrensis</i>	1	0	0	0	0	0	0
<i>Andrena agilissima</i>	1	0	0	0	0	0	0
<i>Andrena alfenella</i>	1	1	0	0	0	1	0
<i>Andrena anthrisci</i>	1	0	0	0	0	0	0
<i>Andrena apicata</i>	1	0	0	0	0	0	0
<i>Andrena argentata</i>	1	0	0	0	0	0	0
<i>Andrena barbareae</i>	1	1	0	0	0	0	1
<i>Andrena barbilabris</i>	1	1	0	0	0	1	0
<i>Andrena bicolor</i>	1	1	1	1	1	1	1
<i>Andrena bimaculata</i>	1	0	0	0	0	0	0
<i>Andrena bucephala</i>	1	1	1	1	1	1	0
<i>Andrena carantonica</i>	1	1	1	1	1	1	1
<i>Andrena chrysopus</i>	1	0	0	0	0	0	0
<i>Andrena chrysosceles</i>	1	1	1	1	1	1	0
<i>Andrena cineraria</i>	1	1	1	1	0	1	1
<i>Andrena clarkella</i>	1	0	0	0	0	0	0
<i>Andrena coitana</i>	1	0	0	0	0	0	0
<i>Andrena combinata</i>	1	1	0	0	0	1	1
<i>Andrena confinis</i>	1	0	0	0	0	0	0
<i>Andrena curvungula</i>	1	0	0	0	0	0	0
<i>Andrena denticulata</i>	1	0	0	0	0	0	0
<i>Andrena distinguenda</i>	1	0	0	0	0	0	0
<i>Andrena falsifica</i>	1	0	0	0	0	0	0
<i>Andrena ferox</i>	1	0	0	0	0	0	0
<i>Andrena flavipes</i>	1	1	0	0	1	1	0
<i>Andrena florea</i>	1	0	0	0	0	0	0
<i>Andrena floricola</i>	1	0	0	0	0	0	0
<i>Andrena florivaga</i>	1	0	0	0	0	0	0
<i>Andrena freygessneri</i>	1	0	0	0	0	0	0
<i>Andrena fucata</i>	1	1	0	0	0	1	0
<i>Andrena fulva</i>	1	1	0	0	0	0	1
<i>Andrena fulvago</i>	1	1	0	0	1	0	0
<i>Andrena fulvata</i>	1	1	1	1	0	0	0
<i>Andrena fulvicornis</i>	1	1	0	0	0	1	1
<i>Andrena fulvida</i>	1	0	0	0	0	0	0
<i>Andrena fuscipes</i>	1	0	0	0	0	0	0
<i>Andrena gelriae</i>	1	1	0	0	1	0	0
<i>Andrena gravida</i>	1	1	1	1	1	1	1
<i>Andrena haemorrhhoa</i>	1	1	1	1	0	1	1
<i>Andrena hattorfiana</i>	1	0	0	0	0	0	0
<i>Andrena helvola</i>	1	1	1	1	0	0	0

<i>Andrena hesperia</i>	1	0	0	0	0	0	0
<i>Andrena humilis</i>	1	1	1	1	0	1	1
<i>Andrena intermedia</i>	1	0	0	0	0	0	0
<i>Andrena labialis</i>	1	0	0	0	0	0	0
<i>Andrena labiata</i>	1	0	0	0	0	0	0
<i>Andrena lagopus</i>	1	1	1	1	0	0	0
<i>Andrena lapponica</i>	1	0	0	0	0	0	0
<i>Andrena lathyri</i>	1	0	0	0	0	0	0
<i>Andrena limata</i>	1	0	0	0	0	0	0
<i>Andrena marginata</i>	1	0	0	0	0	0	0
<i>Andrena minutula</i>	1	1	1	1	1	1	0
<i>Andrena minutuloides</i>	1	1	0	0	0	1	0
<i>Andrena mitis</i>	1	0	0	0	0	0	0
<i>Andrena nana</i>	1	0	0	0	0	0	0
<i>Andrena nanula</i>	1	0	0	0	0	0	0
<i>Andrena nigroaenaea</i>	1	0	0	0	0	0	0
<i>Andrena nigroolivacea</i>	1	0	0	0	0	0	0
<i>Andrena nitida</i>	1	1	1	1	0	1	1
<i>Andrena nitidiuscula</i>	1	1	0	0	1	0	0
<i>Andrena niveata</i>	1	0	0	0	0	0	0
<i>Andrena nuptialis</i>	1	0	0	0	0	0	0
<i>Andrena ovatula</i>	1	1	1	1	1	1	1
<i>Andrena pandellei</i>	1	1	0	0	1	1	0
<i>Andrena parviceps</i>	1	0	0	0	0	0	0
<i>Andrena pilipes</i>	1	0	0	0	0	0	0
<i>Andrena polita</i>	1	0	0	0	0	0	0
<i>Andrena potentillae</i>	1	0	0	0	0	0	0
<i>Andrena praecox</i>	1	1	0	0	0	1	0
<i>Andrena probata</i>	1	0	0	0	0	0	0
<i>Andrena propinqua</i>	1	1	1	1	0	1	0
<i>Andrena proxima</i>	1	0	0	0	0	0	0
<i>Andrena pusilla</i>	0	1	1	0	0	0	0
<i>Andrena ranunculorum</i>	1	0	0	0	0	0	0
<i>Andrena rhenana</i>	1	0	0	0	0	0	0
<i>Andrena rogenhoferi</i>	1	0	0	0	0	0	0
<i>Andrena ruficrus</i>	1	0	0	0	0	0	0
<i>Andrena rufizona</i>	1	0	0	0	0	0	0
<i>Andrena rufula</i>	1	1	0	0	0	1	0
<i>Andrena rugulosa</i>	1	0	0	0	0	0	0
<i>Andrena saxonica</i>	1	0	0	0	0	0	0
<i>Andrena schencki</i>	1	0	0	0	0	0	0
<i>Andrena semilaevis</i>	1	0	0	0	0	0	0
<i>Andrena similis</i>	1	1	0	0	0	1	1
<i>Andrena simillima</i>	1	0	0	0	0	0	0
<i>Andrena simontornyella</i>	1	0	0	0	0	0	0
<i>Andrena stragulata</i>	1	1	0	0	0	1	0
<i>Andrena strohmei</i>	1	0	0	0	0	0	0
<i>Andrena subopaca</i>	1	1	0	0	0	1	1

<i>Andrena taraxaci</i>	1	0	0	0	0	0	0
<i>Andrena tarsata</i>	1	0	0	0	0	0	0
<i>Andrena thoracica</i>	1	0	0	0	0	0	0
<i>Andrena tibialis</i>	1	1	1	1	0	1	1
<i>Andrena trimmerana</i>	1	1	1	1	0	0	0
<i>Andrena vaga</i>	1	1	0	0	0	1	0
<i>Andrena varians</i>	1	0	0	0	0	0	0
<i>Andrena ventralis</i>	1	1	0	0	0	1	0
<i>Andrena viridescens</i>	1	1	0	0	0	1	0
<i>Andrena vulpecula</i>	1	0	0	0	0	0	0
<i>Andrena wilkella</i>	1	1	0	0	0	1	1
<i>Anthidium byssinum</i>	1	0	0	0	0	0	0
<i>Anthidium caturigense</i>	1	0	0	0	0	0	0
<i>Anthidium cingulatum</i>	1	0	0	0	0	0	0
<i>Anthidium florentinum</i>	1	0	0	0	0	0	0
<i>Anthidium interruptum</i>	1	0	0	0	0	0	0
<i>Anthidium laterale</i>	1	0	0	0	0	0	0
<i>Anthidium loti</i>	1	0	0	0	0	0	0
<i>Anthidium manicatum</i>	1	1	1	1	1	1	1
<i>Anthidium montanum</i>	1	0	0	0	0	0	0
<i>Anthidium oblongatum</i>	1	1	1	0	0	0	1
<i>Anthidium punctatum</i>	1	1	0	0	0	1	1
<i>Anthidium scapulare</i>	1	0	0	0	0	0	0
<i>Anthidium septemdentatum</i>	1	0	0	0	0	0	0
<i>Anthidium septemspinatum</i>	1	0	0	0	0	0	0
<i>Anthophora aestivalis</i>	1	0	0	0	0	0	0
<i>Anthophora albigena</i>	1	0	0	0	0	0	0
<i>Anthophora balnearum</i>	1	0	0	0	0	0	0
<i>Anthophora bimaculata</i>	1	0	0	0	0	0	0
<i>Anthophora crassipes</i>	1	0	0	0	0	0	0
<i>Anthophora crinipes</i>	1	0	0	0	0	0	0
<i>Anthophora dispar</i>	1	0	0	0	0	0	0
<i>Anthophora furcata</i>	1	1	1	0	0	0	0
<i>Anthophora garrula</i>	1	0	0	0	0	0	0
<i>Anthophora mucida</i>	1	0	0	0	0	0	0
<i>Anthophora plagiata</i>	1	0	0	0	0	0	0
<i>Anthophora plumipes</i>	1	1	0	0	0	1	0
<i>Anthophora pubescens</i>	1	0	0	0	0	0	0
<i>Anthophora quadrimaculata</i>	1	1	1	1	0	0	0
<i>Anthophora retusa</i>	1	0	0	0	0	0	0
<i>Apis mellifera</i>	1	1	1	1	0	1	1
<i>Blastes emarginatus</i>	1	0	0	0	0	0	0
<i>Blastes truncatus</i>	1	0	0	0	0	0	0
<i>Bombus alpinus</i>	1	0	0	0	0	0	0
<i>Bombus argillaceus</i>	1	0	0	0	0	0	0
<i>Bombus barbutellus</i>	1	1	1	1	1	1	1
<i>Bombus bohemicus</i>	1	1	1	1	0	1	0
<i>Bombus campestris</i>	1	1	1	1	1	0	1

<i>Bombus confusus</i>	1	0	0	0	0	0	0
<i>Bombus cryptarum</i>	1	0	0	0	0	0	0
<i>Bombus flavidus</i>	1	0	0	0	0	0	0
<i>Bombus gerstaeckeri</i>	1	0	0	0	0	0	0
<i>Bombus hortorum</i>	1	1	1	1	1	1	1
<i>Bombus humilis</i>	1	1	1	1	1	1	1
<i>Bombus hypnorum</i>	1	1	1	1	1	1	1
<i>Bombus inexpectatus</i>	1	0	0	0	0	0	0
<i>Bombus jonellus</i>	1	0	0	0	0	0	0
<i>Bombus lapidarius</i>	1	1	1	1	1	1	1
<i>Bombus lucorum</i>	1	1	1	1	1	1	1
<i>Bombus mendax</i>	1	0	0	0	0	0	0
<i>Bombus mesomelas</i>	1	0	0	0	0	0	0
<i>Bombus monticola</i>	1	0	0	0	0	0	0
<i>Bombus mucidus</i>	1	0	0	0	0	0	0
<i>Bombus muscorum</i>	1	0	0	0	0	0	0
<i>Bombus norvegicus</i>	1	1	0	0	1	0	0
<i>Bombus pascuorum</i>	1	1	1	1	1	1	1
<i>Bombus pratorum</i>	1	1	1	1	1	1	1
<i>Bombus pyrenaicus</i>	1	0	0	0	0	0	0
<i>Bombus quadricolor</i>	1	0	0	0	0	0	0
<i>Bombus ruderarius</i>	1	1	0	0	1	0	0
<i>Bombus ruderatus</i>	1	0	0	0	0	0	0
<i>Bombus rupestris</i>	1	1	1	0	1	1	1
<i>Bombus sichelii</i>	1	0	0	0	0	0	0
<i>Bombus soroeensis</i>	1	0	0	0	0	0	0
<i>Bombus subterraneus</i>	1	0	0	0	0	0	0
<i>Bombus sylvorum</i>	1	1	0	0	0	1	0
<i>Bombus sylvestris</i>	1	1	1	1	0	1	0
<i>Bombus terrestris</i>	1	1	1	1	1	1	1
<i>Bombus vestalis</i>	1	1	1	1	1	0	0
<i>Bombus veteranus</i>	1	1	0	0	1	0	0
<i>Bombus wurflenii</i>	1	0	0	0	0	0	0
<i>Ceratina chalybea</i>	1	0	0	0	0	0	0
<i>Ceratina cucurbitina</i>	1	0	0	0	0	0	0
<i>Ceratina cyanea</i>	1	1	1	1	0	0	0
<i>Chelostoma campanularum</i>	1	1	1	1	1	1	0
<i>Chelostoma distinctum</i>	1	1	0	0	1	0	0
<i>Chelostoma emarginatum</i>	1	0	0	0	0	0	0
<i>Chelostoma florisomne</i>	1	1	1	1	0	1	1
<i>Chelostoma foveolatum</i>	1	0	0	0	0	0	0
<i>Chelostoma grande</i>	1	0	0	0	0	0	0
<i>Chelostoma rapunculi</i>	1	1	1	1	1	1	1
<i>Coelioxys afra</i>	1	0	0	0	0	0	0
<i>Coelioxys alata</i>	1	0	0	0	0	0	0
<i>Coelioxys aurolimbata</i>	1	0	0	0	0	0	0
<i>Coelioxys conica</i>	1	0	0	0	0	0	0
<i>Coelioxys conoidea</i>	1	0	0	0	0	0	0

<i>Coelioxys echinata</i>	1	0	0	0	0	0	0
<i>Coelioxys elongata</i>	1	1	1	1	0	1	0
<i>Coelioxys inermis</i>	1	1	0	0	0	1	0
<i>Coelioxys lanceolata</i>	1	0	0	0	0	0	0
<i>Coelioxys mandibularis</i>	1	0	0	0	0	0	0
<i>Coelioxys rufescens</i>	1	0	0	0	0	0	0
<i>Colletes cunicularius</i>	1	1	0	0	0	0	1
<i>Colletes daviesanus</i>	1	1	1	1	0	0	1
<i>Colletes floralis</i>	1	0	0	0	0	0	0
<i>Colletes fodiens</i>	1	0	0	0	0	0	0
<i>Colletes hederæ</i>	1	1	0	0	0	1	0
<i>Colletes impunctatus</i>	1	0	0	0	0	0	0
<i>Colletes marginatus</i>	1	0	0	0	0	0	0
<i>Colletes mlokoszewiczi</i>	1	0	0	0	0	0	0
<i>Colletes nigricans</i>	1	0	0	0	0	0	0
<i>Colletes sierrensis</i>	1	0	0	0	0	0	0
<i>Colletes similis</i>	1	1	1	1	1	1	1
<i>Colletes succinctus</i>	1	1	1	0	0	0	0
<i>Dasypoda argentata</i>	1	0	0	0	0	0	0
<i>Dasypoda hirtipes</i>	1	0	0	0	0	0	0
<i>Dioxys cincta</i>	1	0	0	0	0	0	0
<i>Dioxys tridentata</i>	1	0	0	0	0	0	0
<i>Dufourea alpina</i>	1	0	0	0	0	0	0
<i>Dufourea dentiventris</i>	1	0	0	0	0	0	0
<i>Dufourea halictula</i>	1	0	0	0	0	0	0
<i>Dufourea inermis</i>	1	0	0	0	0	0	0
<i>Dufourea minuta</i>	1	0	0	0	0	0	0
<i>Dufourea paradoxa</i>	1	0	0	0	0	0	0
<i>Epeoloides coecutiens</i>	1	0	0	0	0	0	0
<i>Epeolus alpinus</i>	1	0	0	0	0	0	0
<i>Epeolus cruciger</i>	1	0	0	0	0	0	0
<i>Epeolus productulus</i>	1	0	0	0	0	0	0
<i>Epeolus variegatus</i>	1	0	0	0	0	0	0
<i>Eucera interrupta</i>	1	0	0	0	0	0	0
<i>Eucera longicornis</i>	1	0	0	0	0	0	0
<i>Eucera nigrescens</i>	1	1	1	1	1	1	1
<i>Halictus carinthiacus</i>	1	0	0	0	0	0	0
<i>Halictus confusus</i>	1	1	1	1	1	0	0
<i>Halictus eurygnathus</i>	1	0	0	0	0	0	0
<i>Halictus langobardicus</i>	1	1	0	0	1	0	0
<i>Halictus leucaheneus</i>	1	0	0	0	0	0	0
<i>Halictus maculatus</i>	1	0	0	0	0	0	0
<i>Halictus quadricinctus</i>	1	0	0	0	0	0	0
<i>Halictus rubicundus</i>	1	1	1	1	0	0	0
<i>Halictus scabiosae</i>	1	1	1	1	1	1	1
<i>Halictus seladonius</i>	1	0	0	0	0	0	0
<i>Halictus sexcinctus</i>	1	0	0	0	0	0	0
<i>Halictus simplex</i>	1	1	1	1	1	1	1

<i>Halictus smaragdulus</i>	1	0	0	0	0	0	0
<i>Halictus subauratus</i>	1	1	0	0	0	1	0
<i>Halictus tumulorum</i>	1	1	1	1	1	1	1
<i>Heriades crenulatus</i>	1	1	0	0	1	0	1
<i>Heriades truncorum</i>	1	1	1	1	1	1	1
<i>Hylaeus alpinus</i>	1	0	0	0	0	0	0
<i>Hylaeus angustatus</i>	1	1	0	0	0	1	0
<i>Hylaeus annulatus</i>	1	0	0	0	0	0	0
<i>Hylaeus brevicornis</i>	1	1	1	1	0	0	0
<i>Hylaeus clypearis</i>	1	1	0	0	0	1	0
<i>Hylaeus communis</i>	1	1	1	1	1	1	1
<i>Hylaeus confusus</i>	1	1	1	1	1	1	0
<i>Hylaeus cornutus</i>	1	0	0	0	0	0	0
<i>Hylaeus crassanus</i>	1	0	0	0	0	0	0
<i>Hylaeus difformis</i>	1	1	1	1	1	0	0
<i>Hylaeus dilatatus</i>	1	0	0	0	0	0	0
<i>Hylaeus duckei</i>	1	0	0	0	0	0	0
<i>Hylaeus gibbus</i>	1	0	0	0	0	0	0
<i>Hylaeus glacialis</i>	1	0	0	0	0	0	0
<i>Hylaeus gredleri</i>	1	1	1	1	1	1	1
<i>Hylaeus hyalinatus</i>	1	1	1	1	1	1	1
<i>Hylaeus incongruus</i>	1	0	0	0	0	0	0
<i>Hylaeus kahri</i>	1	0	0	0	0	0	0
<i>Hylaeus leptocephalus</i>	1	1	1	1	1	1	1
<i>Hylaeus moricei</i>	1	0	0	0	0	0	0
<i>Hylaeus nigritus</i>	1	1	1	1	1	1	1
<i>Hylaeus nivalis</i>	1	0	0	0	0	0	0
<i>Hylaeus paulus</i>	1	1	1	1	0	1	0
<i>Hylaeus pectoralis</i>	1	0	0	0	0	0	0
<i>Hylaeus pfankuchi</i>	1	0	0	0	0	0	0
<i>Hylaeus pictipes</i>	1	1	1	1	1	1	1
<i>Hylaeus pilosulus</i>	1	0	0	0	0	0	0
<i>Hylaeus punctatus</i>	1	1	1	1	1	1	1
<i>Hylaeus punctulatissimus</i>	1	1	1	1	1	0	0
<i>Hylaeus rinki</i>	1	1	1	0	0	0	0
<i>Hylaeus signatus</i>	1	1	1	1	1	1	1
<i>Hylaeus sinuatus</i>	1	1	1	1	1	1	1
<i>Hylaeus styriacus</i>	1	1	1	1	0	0	0
<i>Hylaeus taeniolatus</i>	1	0	0	0	0	0	0
<i>Hylaeus tyrolensis</i>	1	0	0	0	0	0	0
<i>Hylaeus variegatus</i>	1	0	0	0	0	0	0
<i>Lasioglossum aeratum</i>	1	0	0	0	0	0	0
<i>Lasioglossum albipes</i>	1	1	1	1	0	1	0
<i>Lasioglossum albocinctum</i>	1	0	0	0	0	0	0
<i>Lasioglossum alpigenum</i>	1	0	0	0	0	0	0
<i>Lasioglossum bluethgeni</i>	1	0	0	0	0	0	0
<i>Lasioglossum brevicorne</i>	1	0	0	0	0	0	0
<i>Lasioglossum breviventre</i>	1	0	0	0	0	0	0

<i>Lasioglossum buccale</i>	1	0	0	0	0	0	0
<i>Lasioglossum calceatum</i>	1	1	1	1	1	1	1
<i>Lasioglossum chypeare</i>	1	0	0	0	0	0	0
<i>Lasioglossum convexiusculum</i>	1	0	0	0	0	0	0
<i>Lasioglossum costulatum</i>	1	1	0	0	0	1	0
<i>Lasioglossum cupromicans</i>	1	0	0	0	0	0	0
<i>Lasioglossum discum</i>	1	0	0	0	0	0	0
<i>Lasioglossum elegans</i>	1	0	0	0	0	0	0
<i>Lasioglossum euboeensis</i>	1	0	0	0	0	0	0
<i>Lasioglossum fratellum</i>	1	0	0	0	0	0	0
<i>Lasioglossum fulvicorne</i>	1	1	0	0	1	1	0
<i>Lasioglossum glabriusculum</i>	1	1	1	1	0	1	1
<i>Lasioglossum griseolum</i>	1	0	0	0	0	0	0
<i>Lasioglossum intermedium</i>	1	0	0	0	0	0	0
<i>Lasioglossum interruptum</i>	1	0	0	0	0	0	0
<i>Lasioglossum laeve</i>	1	0	0	0	0	0	0
<i>Lasioglossum laevidorsum</i>	1	0	0	0	0	0	0
<i>Lasioglossum laevigatum</i>	1	0	0	0	0	0	0
<i>Lasioglossum laterale</i>	1	0	0	0	0	0	0
<i>Lasioglossum laticeps</i>	1	1	1	1	1	1	1
<i>Lasioglossum lativentre</i>	1	1	1	1	1	1	1
<i>Lasioglossum leucopus</i>	1	0	0	0	0	0	0
<i>Lasioglossum leucozonium</i>	1	1	1	1	1	1	1
<i>Lasioglossum limbellum</i>	1	0	0	0	0	0	0
<i>Lasioglossum lineare</i>	1	0	0	0	0	0	0
<i>Lasioglossum lissonotum</i>	1	0	0	0	0	0	0
<i>Lasioglossum lucidulum</i>	1	1	0	0	0	1	1
<i>Lasioglossum majus</i>	1	0	0	0	0	0	0
<i>Lasioglossum malachurum</i>	1	1	1	1	1	1	1
<i>Lasioglossum marginatum</i>	1	0	0	0	0	0	0
<i>Lasioglossum marginellum</i>	1	0	0	0	0	0	0
<i>Lasioglossum minutissimum</i>	1	1	0	0	0	1	0
<i>Lasioglossum minutulum</i>	1	0	0	0	0	0	0
<i>Lasioglossum morio</i>	1	1	1	1	1	1	1
<i>Lasioglossum nigripes</i>	1	1	1	1	0	0	0
<i>Lasioglossum nitidiusculum</i>	1	0	0	0	0	0	0
<i>Lasioglossum nitidulum</i>	1	1	1	1	1	1	1
<i>Lasioglossum pallens</i>	1	0	0	0	0	0	0
<i>Lasioglossum parvulum</i>	1	0	0	0	0	0	0
<i>Lasioglossum pauxillum</i>	1	1	1	1	1	1	1
<i>Lasioglossum pleurospeculum</i>	1	0	0	0	0	0	0
<i>Lasioglossum podolicum</i>	1	0	0	0	0	0	0
<i>Lasioglossum politum</i>	1	1	0	0	1	1	1
<i>Lasioglossum punctatissimum</i>	1	1	0	0	0	1	0
<i>Lasioglossum puncticolle</i>	1	0	0	0	0	0	0
<i>Lasioglossum pygmaeum</i>	1	0	0	0	0	0	0
<i>Lasioglossum quadrinotatum</i>	1	0	0	0	0	0	0
<i>Lasioglossum quadrinotatum</i>	0	1	0	0	0	1	0

<i>Lasioglossum quadrisignatum</i>	1	0	0	0	0	0	0
<i>Lasioglossum rufitarse</i>	1	0	0	0	0	0	0
<i>Lasioglossum sabulosum</i>	1	1	0	0	0	1	0
<i>Lasioglossum semilucens</i>	1	0	0	0	0	0	0
<i>Lasioglossum setulosum</i>	1	0	0	0	0	0	0
<i>Lasioglossum sexnotatum</i>	1	0	0	0	0	0	0
<i>Lasioglossum sexstrigatum</i>	1	0	0	0	0	0	0
<i>Lasioglossum subfasciatum</i>	1	0	0	0	0	0	0
<i>Lasioglossum subfulvicorne</i>	1	1	0	0	0	1	0
<i>Lasioglossum tarsatum</i>	1	0	0	0	0	0	0
<i>Lasioglossum tricinctum</i>	1	0	0	0	0	0	0
<i>Lasioglossum villosulum</i>	1	1	1	1	1	1	1
<i>Lasioglossum xanthopus</i>	1	0	0	0	0	0	0
<i>Lasioglossum zonulum</i>	1	1	1	1	0	1	0
<i>Lithurgus chrysurus</i>	1	0	0	0	0	0	0
<i>Macropis europaea</i>	1	1	1	0	0	0	0
<i>Macropis fulvipes</i>	1	1	1	0	0	1	0
<i>Megachile alpicola</i>	1	1	1	1	0	0	0
<i>Megachile analis</i>	1	0	0	0	0	0	0
<i>Megachile centuncularis</i>	1	1	1	1	1	1	1
<i>Megachile circumcincta</i>	1	1	1	1	0	1	1
<i>Megachile ericetorum</i>	1	1	1	1	1	1	1
<i>Megachile flabellipes</i>	1	0	0	0	0	0	0
<i>Megachile genalis</i>	1	0	0	0	0	0	0
<i>Megachile lagopoda</i>	1	0	0	0	0	0	0
<i>Megachile lapponica</i>	1	0	0	0	0	0	0
<i>Megachile leachella</i>	1	0	0	0	0	0	0
<i>Megachile ligniseca</i>	1	0	0	0	0	0	0
<i>Megachile maritima</i>	1	0	0	0	0	0	0
<i>Megachile melanopyga</i>	1	0	0	0	0	0	0
<i>Megachile nigriventris</i>	1	1	1	1	1	1	1
<i>Megachile parietina</i>	1	0	0	0	0	0	0
<i>Megachile pilicrus</i>	1	0	0	0	0	0	0
<i>Megachile pilidens</i>	1	0	0	0	0	0	0
<i>Megachile pyrenaea</i>	1	0	0	0	0	0	0
<i>Megachile pyrenaica</i>	1	0	0	0	0	0	0
<i>Megachile rotundata</i>	1	1	1	0	0	1	0
<i>Megachile sculpturalis</i>	1	0	0	0	0	0	0
<i>Megachile versicolor</i>	1	0	0	0	0	0	0
<i>Megachile willughbiella</i>	1	1	1	0	1	1	1
<i>Melecta albifrons</i>	1	0	0	0	0	0	0
<i>Melecta festiva</i>	1	0	0	0	0	0	0
<i>Melecta luctuosa</i>	1	0	0	0	0	0	0
<i>Melitta dimidiata</i>	1	0	0	0	0	0	0
<i>Melitta haemorrhoidalis</i>	1	0	0	0	0	0	0
<i>Melitta leporina</i>	1	0	0	0	0	0	0
<i>Melitta nigricans</i>	1	0	0	0	0	0	0
<i>Melitta tricincta</i>	1	0	0	0	0	0	0

<i>Melitturga clavicornis</i>	1	0	0	0	0	0	0
<i>Nomada alboguttata</i>	1	0	0	0	0	0	0
<i>Nomada argentata</i>	1	0	0	0	0	0	0
<i>Nomada armata</i>	1	0	0	0	0	0	0
<i>Nomada atroscutellaris</i>	1	0	0	0	0	0	0
<i>Nomada bifasciata</i>	1	1	1	0	0	0	0
<i>Nomada blepharipes</i>	1	0	0	0	0	0	0
<i>Nomada braunsiana</i>	1	0	0	0	0	0	0
<i>Nomada castellana</i>	1	0	0	0	0	0	0
<i>Nomada conjungens</i>	1	0	0	0	0	0	0
<i>Nomada discrepans</i>	1	0	0	0	0	0	0
<i>Nomada distinguenda</i>	1	0	0	0	0	0	0
<i>Nomada emarginata</i>	1	0	0	0	0	0	0
<i>Nomada errans</i>	1	0	0	0	0	0	0
<i>Nomada fabriciana</i>	1	1	1	0	1	0	1
<i>Nomada facilis</i>	1	0	0	0	0	0	0
<i>Nomada femoralis</i>	1	0	0	0	0	0	0
<i>Nomada ferruginata</i>	1	0	0	0	0	0	0
<i>Nomada flava</i>	1	0	0	0	0	0	0
<i>Nomada flavoguttata</i>	1	1	0	1	0	0	0
<i>Nomada flavopicta</i>	1	1	0	1	0	0	0
<i>Nomada fucata</i>	1	0	0	0	0	0	0
<i>Nomada fulvicornis</i>	1	0	0	0	0	0	0
<i>Nomada furva</i>	1	0	0	0	0	0	0
<i>Nomada fuscicornis</i>	1	1	0	0	0	1	0
<i>Nomada goodeniana</i>	1	1	0	0	0	1	0
<i>Nomada gransassoi</i>	1	0	0	0	0	0	0
<i>Nomada guttulata</i>	1	0	0	0	0	0	0
<i>Nomada hirtipes</i>	1	0	0	0	0	0	0
<i>Nomada integra</i>	1	0	0	0	0	0	0
<i>Nomada kohli</i>	1	0	0	0	0	0	0
<i>Nomada lathburiana</i>	1	0	0	0	0	0	0
<i>Nomada leucophthalma</i>	1	0	0	0	0	0	0
<i>Nomada marshalli</i>	1	0	0	0	0	0	0
<i>Nomada melathoracica</i>	1	0	0	0	0	0	0
<i>Nomada moeschleri</i>	1	0	0	0	0	0	0
<i>Nomada mutabilis</i>	1	0	0	0	0	0	0
<i>Nomada mutica</i>	1	0	0	0	0	0	0
<i>Nomada nobilis</i>	1	0	0	0	0	0	0
<i>Nomada obscura</i>	1	0	0	0	0	0	0
<i>Nomada obtusifrons</i>	1	0	0	0	0	0	0
<i>Nomada panzeri</i>	1	0	0	0	0	0	0
<i>Nomada piccioliana</i>	1	0	0	0	0	0	0
<i>Nomada pleurosticta</i>	1	0	0	0	0	0	0
<i>Nomada posthuma</i>	1	0	0	0	0	0	0
<i>Nomada roberjeotiana</i>	1	0	0	0	0	0	0
<i>Nomada ruficornis</i>	1	0	0	0	0	0	0
<i>Nomada rufipes</i>	1	0	0	0	0	0	0

<i>Nomada sexfasciata</i>	1	1	0	0	0	1	0
<i>Nomada sheppardana</i>	1	0	0	0	0	0	0
<i>Nomada signata</i>	1	0	0	0	0	0	0
<i>Nomada similis</i>	1	0	0	0	0	0	0
<i>Nomada stigma</i>	1	0	0	0	0	0	0
<i>Nomada striata</i>	1	1	0	0	0	1	1
<i>Nomada succincta</i>	1	0	0	0	0	0	0
<i>Nomada villosa</i>	1	0	0	0	0	0	0
<i>Nomada zonata</i>	1	0	0	0	0	0	0
<i>Nomia diversipes</i>	1	0	0	0	0	0	0
<i>Osmia acuticornis</i>	1	0	0	0	0	0	0
<i>Osmia adunca</i>	1	0	0	0	0	0	0
<i>Osmia alticola</i>	1	0	0	0	0	0	0
<i>Osmia anceyi</i>	1	0	0	0	0	0	0
<i>Osmia andrenoides</i>	1	0	0	0	0	0	0
<i>Osmia anthocopoides</i>	1	0	0	0	0	0	0
<i>Osmia aurulenta</i>	1	1	0	0	0	1	0
<i>Osmia bicolor</i>	1	1	0	1	0	0	0
<i>Osmia bicornis</i>	1	0	0	0	0	0	0
<i>Osmia brevicornis</i>	1	1	0	1	0	0	0
<i>Osmia caerulea</i>	1	1	0	1	1	1	1
<i>Osmia claviventris</i>	1	0	0	0	0	0	0
<i>Osmia cornuta</i>	1	0	0	0	0	0	0
<i>Osmia dalmatica</i>	1	0	0	0	0	0	0
<i>Osmia gallarum</i>	1	0	0	0	0	0	0
<i>Osmia inermis</i>	1	0	0	0	0	0	0
<i>Osmia labialis</i>	1	0	0	0	0	0	0
<i>Osmia latreillei</i>	1	0	0	0	0	0	0
<i>Osmia leaiana</i>	1	1	1	0	1	1	0
<i>Osmia lepeletieri</i>	1	0	0	0	0	0	0
<i>Osmia leucomelana</i>	1	0	0	0	0	0	0
<i>Osmia loti</i>	1	0	0	0	0	0	0
<i>Osmia minutula</i>	1	0	0	0	0	0	0
<i>Osmia mitis</i>	1	0	0	0	0	0	0
<i>Osmia mustelina</i>	1	0	0	0	0	0	0
<i>Osmia nigriventris</i>	1	0	0	0	0	0	0
<i>Osmia niveata</i>	1	0	0	0	0	0	0
<i>Osmia parietina</i>	1	0	0	0	0	0	0
<i>Osmia pilicornis</i>	1	0	0	0	0	0	0
<i>Osmia praestans</i>	1	0	0	0	0	0	0
<i>Osmia ravouxi</i>	1	0	0	0	0	0	0
<i>Osmia robusta</i>	1	0	0	0	0	0	0
<i>Osmia rufohirta</i>	1	0	0	0	0	0	0
<i>Osmia scutellaris</i>	1	0	0	0	0	0	0
<i>Osmia spinulosa</i>	1	0	0	0	0	0	0
<i>Osmia steinmanni</i>	1	0	0	0	0	0	0
<i>Osmia submicans</i>	1	0	0	0	0	0	0
<i>Osmia tergestensis</i>	1	0	0	0	0	0	0

<i>Osmia tridentata</i>	1	0	0	0	0	0	0
<i>Osmia tuberculata</i>	1	0	0	0	0	0	0
<i>Osmia uncinata</i>	1	0	0	0	0	0	0
<i>Osmia villosa</i>	1	0	0	0	0	0	0
<i>Osmia viridana</i>	1	0	0	0	0	0	0
<i>Osmia xanthomelana</i>	1	0	0	0	0	0	0
<i>Panurginus herzi</i>	1	0	0	0	0	0	0
<i>Panurginus montanus</i>	1	0	0	0	0	0	0
<i>Panurgus banksianus</i>	1	0	0	0	0	0	0
<i>Panurgus calcaratus</i>	1	0	0	0	0	0	0
<i>Panurgus dentipes</i>	1	0	0	0	0	0	0
<i>Pasites maculatus</i>	1	0	0	0	0	0	0
<i>Rhophitoides canus</i>	1	0	0	0	0	0	0
<i>Rophites algeris</i>	1	0	0	0	0	0	0
<i>Rophites quinquespinosus</i>	1	0	0	0	0	0	0
<i>Sphecodes albilabris</i>	1	1	0	1	0	0	0
<i>Sphecodes alternatus</i>	1	0	0	0	0	0	0
<i>Sphecodes crassus</i>	1	1	0	1	1	1	0
<i>Sphecodes cristatus</i>	1	0	0	0	0	0	0
<i>Sphecodes croaticus</i>	1	0	0	0	0	0	0
<i>Sphecodes ephippius</i>	1	1	0	1	0	1	1
<i>Sphecodes ferruginatus</i>	1	1	0	1	1	1	1
<i>Sphecodes geoffrellus</i>	1	1	0	0	0	0	1
<i>Sphecodes gibbus</i>	1	1	0	1	0	0	0
<i>Sphecodes hyalinatus</i>	1	1	0	0	1	0	1
<i>Sphecodes longulus</i>	1	1	0	0	0	0	1
<i>Sphecodes majalis</i>	1	0	0	0	0	0	0
<i>Sphecodes marginatus</i>	1	0	0	0	0	0	0
<i>Sphecodes miniatus</i>	1	0	0	0	0	0	0
<i>Sphecodes monilicornis</i>	1	1	0	0	1	0	0
<i>Sphecodes niger</i>	1	1	1	0	1	1	1
<i>Sphecodes pellucidus</i>	1	0	0	0	0	0	0
<i>Sphecodes pseudofasciatus</i>	1	0	0	0	0	0	0
<i>Sphecodes puncticeps</i>	1	0	0	0	0	0	0
<i>Sphecodes reticulatus</i>	1	0	0	0	0	0	0
<i>Sphecodes rubicundus</i>	1	0	0	0	0	0	0
<i>Sphecodes rufiventris</i>	1	0	0	0	0	0	0
<i>Sphecodes scabricollis</i>	1	0	0	0	0	0	0
<i>Sphecodes schenckii</i>	1	0	0	0	0	0	0
<i>Sphecodes spinulosus</i>	1	0	0	0	0	0	0
<i>Sphecodes zangherii</i>	1	0	0	0	0	0	0
<i>Stelis breviscula</i>	1	1	1	0	1	0	0
<i>Stelis franconica</i>	1	0	0	0	0	0	0
<i>Stelis minima</i>	0	1	0	1	0	0	0
<i>Stelis minuta</i>	1	0	0	0	0	0	0
<i>Stelis nasuta</i>	1	0	0	0	0	0	0
<i>Stelis odontopyga</i>	1	0	0	0	0	0	0
<i>Stelis ornatula</i>	1	1	0	0	0	1	0

<i>Stelis phaeoptera</i>	1	0	0	0	0	0	0
<i>Stelis punctulatissima</i>	1	1	0	1	1	1	0
<i>Stelis signata</i>	1	0	0	0	0	0	0
<i>Stelis simillima</i>	1	0	0	0	0	0	0
<i>Systropha curvicornis</i>	1	0	0	0	0	0	0
<i>Tetralonia alticincta</i>	1	0	0	0	0	0	0
<i>Tetralonia dentata</i>	1	0	0	0	0	0	0
<i>Tetralonia fulvescens</i>	1	0	0	0	0	0	0
<i>Tetralonia salicariae</i>	1	0	0	0	0	0	0
<i>Thyreus hirtus</i>	1	0	0	0	0	0	0
<i>Thyreus histrionicus</i>	1	0	0	0	0	0	0
<i>Thyreus orbatus</i>	1	0	0	0	0	0	0
<i>Thyreus ramosus</i>	1	0	0	0	0	0	0
<i>Xylocopa iris</i>	1	0	0	0	0	0	0
<i>Xylocopa valga</i>	1	0	0	0	0	0	0
<i>Xylocopa violacea</i>	1	1	0	1	0	0	0

Total number of species	535	164	95	93	77	114	77
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Table S2. List of carabid species present in the regional and/or in the urban pool.

Species	Regional pool	Urban pool	Gardens	Allotments	Parks	Brownfields	Roofs
<i>Abax continuus</i>	1	0	0	0	0	0	0
<i>Abax exaratus</i>	1	0	0	0	0	0	0
<i>Abax fiorii</i>	1	0	0	0	0	0	0
<i>Abax oblongus</i>	1	0	0	0	0	0	0
<i>Abax ovalis</i>	1	0	0	0	0	0	0
<i>Abax parallelepipedus</i>	1	1	1	1	0	0	0
<i>Abax parallelus</i>	1	0	0	0	0	0	0
<i>Acupalpus dubius</i>	1	1	0	0	1	0	0
<i>Acupalpus exiguus</i>	1	0	0	0	0	0	0
<i>Acupalpus flavicollis</i>	1	1	1	1	0	1	1
<i>Acupalpus maculatus</i>	1	1	0	0	0	1	0
<i>Acupalpus meridianus</i>	1	1	1	1	0	1	1
<i>Acupalpus parvulus</i>	1	0	0	0	0	0	0
<i>Agonum afrum</i>	1	0	0	0	0	0	0
<i>Agonum antennarium</i>	1	0	0	0	0	0	0
<i>Agonum carbonarium</i>	1	0	0	0	0	0	0
<i>Agonum ericeti</i>	1	0	0	0	0	0	0
<i>Agonum fuliginosum</i>	1	0	0	0	0	0	0
<i>Agonum gracile</i>	1	0	0	0	0	0	0
<i>Agonum hypocrita</i>	1	0	0	0	0	0	0
<i>Agonum lugens</i>	1	0	0	0	0	0	0
<i>Agonum marginatum</i>	1	0	0	0	0	0	0
<i>Agonum micans</i>	1	0	0	0	0	0	0
<i>Agonum muelleri</i>	1	1	1	1	1	1	1

<i>Agonum nigrum</i>	1	0	0	0	0	0	0
<i>Agonum piceum</i>	1	0	0	0	0	0	0
<i>Agonum scitulum</i>	1	0	0	0	0	0	0
<i>Agonum sexpunctatum</i>	1	1	0	0	0	1	1
<i>Agonum thoreyi</i>	1	0	0	0	0	0	0
<i>Agonum versutum</i>	1	0	0	0	0	0	0
<i>Agonum viduum</i>	1	0	0	0	0	0	0
<i>Agonum viridicupreum</i>	1	0	0	0	0	0	0
<i>Amara aenea</i>	1	1	1	1	1	1	1
<i>Amara anthobia</i>	1	0	0	0	0	0	0
<i>Amara apricaria</i>	1	0	0	0	0	0	0
<i>Amara aulica</i>	1	0	0	0	0	0	0
<i>Amara bifrons</i>	1	0	0	0	0	0	0
<i>Amara bischoffi</i>	1	0	0	0	0	0	0
<i>Amara communis</i>	1	1	1	1	1	0	0
<i>Amara consularis</i>	1	0	0	0	0	0	0
<i>Amara convexior</i>	1	1	0	0	0	1	1
<i>Amara cursitans</i>	1	0	0	0	0	0	0
<i>Amara curta</i>	1	0	0	0	0	0	0
<i>Amara equestris</i>	1	0	0	0	0	0	0
<i>Amara erratica</i>	1	0	0	0	0	0	0
<i>Amara eurynota</i>	1	0	0	0	0	0	0
<i>Amara familiaris</i>	1	1	1	1	1	1	1
<i>Amara fulva</i>	1	0	0	0	0	0	0
<i>Amara fulvipes</i>	1	1	0	0	0	0	1
<i>Amara fusca</i>	1	0	0	0	0	0	0
<i>Amara gebleri</i>	1	0	0	0	0	0	0
<i>Amara ingenua</i>	1	0	0	0	0	0	0
<i>Amara kulti</i>	1	0	0	0	0	0	0
<i>Amara littorea</i>	1	0	0	0	0	0	0
<i>Amara lucida</i>	1	1	0	0	0	1	1
<i>Amara lunicollis</i>	1	1	0	0	0	1	0
<i>Amara majuscula</i>	1	0	0	0	0	0	0
<i>Amara montivaga</i>	1	1	0	0	1	0	0
<i>Amara municipalis</i>	1	0	0	0	0	0	0
<i>Amara nigricornis</i>	1	0	0	0	0	0	0
<i>Amara nitida</i>	1	0	0	0	0	0	0
<i>Amara ovata</i>	1	1	1	1	1	1	1
<i>Amara plebeja</i>	1	1	0	0	0	0	1
<i>Amara praetermissa</i>	1	0	0	0	0	0	0
<i>Amara pulpani</i>	1	0	0	0	0	0	0
<i>Amara quenseli</i>	1	0	0	0	0	0	0
<i>Amara schimperi</i>	1	0	0	0	0	0	0
<i>Amara similata</i>	1	1	0	0	1	1	0
<i>Amara strenua</i>	1	0	0	0	0	0	0
<i>Amara tibialis</i>	1	0	0	0	0	0	0
<i>Amblystomus niger</i>	1	0	0	0	0	0	0
<i>Anchomenus cyaneus</i>	1	0	0	0	0	0	0

<i>Anchomenus dorsalis</i>	1	1	1	1	1	1	1
<i>Anisodactylus binotatus</i>	1	1	1	1	1	1	1
<i>Anisodactylus nemorivagus</i>	1	0	0	0	0	0	0
<i>Anisodactylus signatus</i>	1	1	1	1	0	1	1
<i>Apristus europaeus</i>	1	1	0	0	1	0	0
<i>Asaphidion austriacum</i>	1	1	1	1	0	0	0
<i>Asaphidion caraboides</i>	1	0	0	0	0	0	0
<i>Asaphidion curtum</i>	1	0	0	0	0	0	0
<i>Asaphidion flavipes</i>	1	1	0	0	0	0	1
<i>Asaphidion pallipes</i>	1	1	1	1	0	1	0
<i>Badister bullatus</i>	1	1	1	1	1	1	1
<i>Badister collaris</i>	1	0	0	0	0	0	0
<i>Badister dilatatus</i>	1	0	0	0	0	0	0
<i>Badister lacertosus</i>	1	0	0	0	0	0	0
<i>Badister meridionalis</i>	1	0	0	0	0	0	0
<i>Badister peltatus</i>	1	0	0	0	0	0	0
<i>Badister sodalis</i>	1	1	1	1	0	0	0
<i>Bembidion articulatum</i>	1	0	0	0	0	0	0
<i>Bembidion ascendens</i>	1	0	0	0	0	0	0
<i>Bembidion assimile</i>	1	0	0	0	0	0	0
<i>Bembidion atrocaeruleum</i>	1	0	0	0	0	0	0
<i>Bembidion azurescens</i>	1	0	0	0	0	0	0
<i>Bembidion biguttatum</i>	1	0	0	0	0	0	0
<i>Bembidion bipunctatum</i>	1	0	0	0	0	0	0
<i>Bembidion bruxellense</i>	1	0	0	0	0	0	0
<i>Bembidion bualei</i>	1	0	0	0	0	0	0
<i>Bembidion bugnioni</i>	1	0	0	0	0	0	0
<i>Bembidion coeruleum</i>	1	0	0	0	0	0	0
<i>Bembidion complanatum</i>	1	0	0	0	0	0	0
<i>Bembidion conforme</i>	1	0	0	0	0	0	0
<i>Bembidion decoratum</i>	1	0	0	0	0	0	0
<i>Bembidion decorum</i>	1	1	0	0	1	0	0
<i>Bembidion deletum</i>	1	1	0	0	0	1	0
<i>Bembidion dentellum</i>	1	0	0	0	0	0	0
<i>Bembidion distinguendum</i>	1	0	0	0	0	0	0
<i>Bembidion doderoi</i>	1	0	0	0	0	0	0
<i>Bembidion doris</i>	1	0	0	0	0	0	0
<i>Bembidion elongatum</i>	1	0	0	0	0	0	0
<i>Bembidion eques</i>	1	0	0	0	0	0	0
<i>Bembidion fasciolatum</i>	1	0	0	0	0	0	0
<i>Bembidion femoratum</i>	1	1	0	0	1	1	1
<i>Bembidion fluviatile</i>	1	0	0	0	0	0	0
<i>Bembidion foraminosum</i>	1	0	0	0	0	0	0
<i>Bembidion fulvipes</i>	1	0	0	0	0	0	0
<i>Bembidion fumigatum</i>	1	0	0	0	0	0	0
<i>Bembidion geniculatum</i>	1	0	0	0	0	0	0
<i>Bembidion glaciale</i>	1	0	0	0	0	0	0
<i>Bembidion guttula</i>	1	0	0	0	0	0	0

<i>Bembidion humerale</i>	1	0	0	0	0	0	0
<i>Bembidion illigeri</i>	1	0	0	0	0	0	0
<i>Bembidion incognitum</i>	1	0	0	0	0	0	0
<i>Bembidion inustum</i>	1	0	0	0	0	0	0
<i>Bembidion italicum</i>	1	0	0	0	0	0	0
<i>Bembidion jacqueti</i>	1	0	0	0	0	0	0
<i>Bembidion lampros</i>	1	1	1	1	0	1	0
<i>Bembidion latinum</i>	1	0	0	0	0	0	0
<i>Bembidion litorale</i>	1	0	0	0	0	0	0
<i>Bembidion longipes</i>	1	0	0	0	0	0	0
<i>Bembidion lunatum</i>	1	0	0	0	0	0	0
<i>Bembidion lunulatum</i>	1	1	1	1	1	1	1
<i>Bembidion mannerheimii</i>	1	0	0	0	0	0	0
<i>Bembidion milleri</i>	1	0	0	0	0	0	0
<i>Bembidion modestum</i>	1	0	0	0	0	0	0
<i>Bembidion monticola</i>	1	0	0	0	0	0	0
<i>Bembidion octomaculatum</i>	1	0	0	0	0	0	0
<i>Bembidion penninum</i>	1	0	0	0	0	0	0
<i>Bembidion prasinum</i>	1	0	0	0	0	0	0
<i>Bembidion properans</i>	1	1	1	1	1	1	1
<i>Bembidion pseudascendens</i>	1	0	0	0	0	0	0
<i>Bembidion punctulatum</i>	1	0	0	0	0	0	0
<i>Bembidion pygmaeum</i>	1	0	0	0	0	0	0
<i>Bembidion pyrenaeum</i>	1	0	0	0	0	0	0
<i>Bembidion quadrimaculatum</i>	1	1	1	1	1	1	1
<i>Bembidion ruficorne</i>	1	0	0	0	0	0	0
<i>Bembidion scapulare</i>	1	0	0	0	0	0	0
<i>Bembidion schueppelii</i>	1	0	0	0	0	0	0
<i>Bembidion semipunctatum</i>	1	0	0	0	0	0	0
<i>Bembidion stephensii</i>	1	0	0	0	0	0	0
<i>Bembidion stomoides</i>	1	0	0	0	0	0	0
<i>Bembidion terminale</i>	1	0	0	0	0	0	0
<i>Bembidion testaceum</i>	1	0	0	0	0	0	0
<i>Bembidion tetracolum</i>	1	0	0	0	0	0	0
<i>Bembidion tibiale</i>	1	0	0	0	0	0	0
<i>Bembidion varicolor</i>	1	0	0	0	0	0	0
<i>Binaghites subalpinus</i>	1	0	0	0	0	0	0
<i>Blemus discus</i>	1	0	0	0	0	0	0
<i>Brachinus crepitans</i>	1	0	0	0	0	0	0
<i>Brachinus elegans</i>	1	0	0	0	0	0	0
<i>Brachinus explodens</i>	1	1	1	1	1	1	0
<i>Brachinus sclopeta</i>	1	0	0	0	0	0	0
<i>Bradycellus caucasicus</i>	1	0	0	0	0	0	0
<i>Bradycellus csikii</i>	1	0	0	0	0	0	0
<i>Bradycellus harpalinus</i>	1	0	0	0	0	0	0
<i>Bradycellus verbasci</i>	1	1	0	0	0	1	1
<i>Broscus cephalotes</i>	1	0	0	0	0	0	0
<i>Calathus ambiguus</i>	1	0	0	0	0	0	0

<i>Calathus cinctus</i>	1	0	0	0	0	0	0
<i>Calathus erratus</i>	1	0	0	0	0	0	0
<i>Calathus fuscipes</i>	1	1	1	0	0	1	0
<i>Calathus melanocephalus</i>	1	1	1	1	0	0	0
<i>Calathus micropterus</i>	1	0	0	0	0	0	0
<i>Calathus rubripes</i>	1	0	0	0	0	0	0
<i>Callistus lunatus</i>	1	1	1	1	0	1	1
<i>Calodromius spilotus</i>	1	0	0	0	0	0	0
<i>Calosoma inquisitor</i>	1	0	0	0	0	0	0
<i>Calosoma maderae</i>	1	0	0	0	0	0	0
<i>Calosoma sycophanta</i>	1	0	0	0	0	0	0
<i>Carabus arvensis</i>	1	0	0	0	0	0	0
<i>Carabus auratus</i>	1	1	1	1	1	1	0
<i>Carabus auronitens</i>	1	0	0	0	0	0	0
<i>Carabus cancellatus</i>	1	0	0	0	0	0	0
<i>Carabus concolor</i>	1	0	0	0	0	0	0
<i>Carabus convexus</i>	1	0	0	0	0	0	0
<i>Carabus coriaceus</i>	1	1	1	1	0	0	0
<i>Carabus creutzeri</i>	1	0	0	0	0	0	0
<i>Carabus fabricii</i>	1	0	0	0	0	0	0
<i>Carabus germarii</i>	1	0	0	0	0	0	0
<i>Carabus glabratus</i>	1	0	0	0	0	0	0
<i>Carabus granulatus</i>	1	1	1	1	0	0	0
<i>Carabus hortensis</i>	1	0	0	0	0	0	0
<i>Carabus intricatus</i>	1	0	0	0	0	0	0
<i>Carabus irregularis</i>	1	0	0	0	0	0	0
<i>Carabus lucens</i>	1	0	0	0	0	0	0
<i>Carabus monilis</i>	1	0	0	0	0	0	0
<i>Carabus monticola</i>	1	0	0	0	0	0	0
<i>Carabus nemoralis</i>	1	0	0	0	0	0	0
<i>Carabus problematicus</i>	1	0	0	0	0	0	0
<i>Carabus purpurascens</i>	1	0	0	0	0	0	0
<i>Carabus violaceus</i>	1	0	0	0	0	0	0
<i>Carabus italicus</i>	1	0	0	0	0	0	0
<i>Chlaeniellus nigricornis</i>	1	0	0	0	0	0	0
<i>Chlaenius nitidulus</i>	1	0	0	0	0	0	0
<i>Chlaenius olivieri</i>	1	0	0	0	0	0	0
<i>Chlaenius tibialis</i>	1	1	0	0	0	1	0
<i>Chlaenius tristis</i>	1	0	0	0	0	0	0
<i>Chlaenius velutinus</i>	1	0	0	0	0	0	0
<i>Chlaenius vestitus</i>	1	1	0	0	0	1	0
<i>Cicindela campestris</i>	1	1	1	1	0	0	0
<i>Cicindela gallica</i>	1	0	0	0	0	0	0
<i>Cicindela hybrida</i>	1	0	0	0	0	0	0
<i>Cicindela sylvicola</i>	1	0	0	0	0	0	0
<i>Clivina collaris</i>	1	1	1	1	0	1	0
<i>Clivina fossor</i>	1	1	1	1	1	1	0
<i>Cychrus angustatus</i>	1	0	0	0	0	0	0

<i>Cychrus attenuatus</i>	1	0	0	0	0	0	0
<i>Cychrus caraboides</i>	1	0	0	0	0	0	0
<i>Cychrus italicus</i>	1	0	0	0	0	0	0
<i>Cylindera germanica</i>	1	0	0	0	0	0	0
<i>Cymindis axillaris</i>	1	0	0	0	0	0	0
<i>Cymindis humeralis</i>	1	0	0	0	0	0	0
<i>Cymindis vaporariorum</i>	1	0	0	0	0	0	0
<i>Demetrias atricapillus</i>	1	1	0	0	0	1	0
<i>Demetrias imperialis</i>	1	0	0	0	0	0	0
<i>Demetrias monostigma</i>	1	0	0	0	0	0	0
<i>Diachromus germanus</i>	1	1	1	1	1	1	1
<i>Dicheirotichus placidus</i>	1	0	0	0	0	0	0
<i>Dolichus halensis</i>	1	0	0	0	0	0	0
<i>Dromius agilis</i>	1	1	0	0	0	0	1
<i>Dromius angustus</i>	1	0	0	0	0	0	0
<i>Dromius fenestratus</i>	1	0	0	0	0	0	0
<i>Dromius linearis</i>	1	0	0	0	0	0	0
<i>Dromius quadraticollis</i>	1	0	0	0	0	0	0
<i>Dromius quadrimaculatus</i>	1	1	0	0	1	1	0
<i>Dromius schneideri</i>	1	0	0	0	0	0	0
<i>Drypta dentata</i>	1	0	0	0	0	0	0
<i>Duvalius longhii</i>	1	0	0	0	0	0	0
<i>Dyschirioides globosus</i>	1	0	0	0	0	0	0
<i>Dyschirius abditus</i>	1	0	0	0	0	0	0
<i>Dyschirius aeneus</i>	1	0	0	0	0	0	0
<i>Dyschirius agnatus</i>	1	0	0	0	0	0	0
<i>Dyschirius angustatus</i>	1	0	0	0	0	0	0
<i>Dyschirius intermedius</i>	1	0	0	0	0	0	0
<i>Dyschirius laeviusculus</i>	1	0	0	0	0	0	0
<i>Elaphropus parvulus</i>	1	0	0	0	0	0	0
<i>Elaphropus quadrisignatus</i>	1	0	0	0	0	0	0
<i>Elaphropus sexstriatus</i>	1	0	0	0	0	0	0
<i>Elaphrus cupreus</i>	1	0	0	0	0	0	0
<i>Elaphrus riparius</i>	1	0	0	0	0	0	0
<i>Elaphrus uliginosus</i>	1	0	0	0	0	0	0
<i>Harpalus affinis</i>	1	1	0	1	1	1	1
<i>Harpalus anxius</i>	1	0	0	0	0	0	0
<i>Harpalus atratus</i>	1	1	0	1	1	1	1
<i>Harpalus attenuatus</i>	1	0	0	0	0	0	0
<i>Harpalus autumnalis</i>	1	0	0	0	0	0	0
<i>Harpalus calceatus</i>	1	0	0	0	0	0	0
<i>Harpalus dimidiatus</i>	1	1	0	1	0	1	0
<i>Harpalus distinguendus</i>	1	1	0	1	0	1	1
<i>Harpalus froelichii</i>	1	0	0	0	0	0	0
<i>Harpalus fuscicornis</i>	1	0	0	0	0	0	0
<i>Harpalus griseus</i>	1	0	0	0	0	0	0
<i>Harpalus honestus</i>	1	0	0	0	0	0	0
<i>Harpalus laevipes</i>	1	0	0	0	0	0	0

<i>Harpalus latus</i>	1	1	0	0	0	1	1
<i>Harpalus luteicornis</i>	1	1	0	1	1	1	1
<i>Harpalus modestus</i>	1	0	0	0	0	0	0
<i>Harpalus neglectus</i>	1	0	0	0	0	0	0
<i>Harpalus progrediens</i>	1	0	0	0	0	0	0
<i>Harpalus pumilus</i>	1	0	0	0	0	0	0
<i>Harpalus rubripes</i>	1	1	0	1	1	1	1
<i>Harpalus rufipalpis</i>	1	0	0	0	0	0	0
<i>Harpalus rufipes</i>	1	0	0	0	0	0	0
<i>Harpalus serripes</i>	1	0	0	0	0	0	0
<i>Harpalus servus</i>	1	0	0	0	0	0	0
<i>Harpalus signaticornis</i>	1	1	0	1	0	1	1
<i>Harpalus smaragdinus</i>	1	0	0	0	0	0	0
<i>Harpalus solitaris</i>	1	0	0	0	0	0	0
<i>Harpalus subcylindricus</i>	1	1	0	1	0	0	0
<i>Harpalus sulphuripes</i>	1	0	0	0	0	0	0
<i>Harpalus tardus</i>	1	1	0	1	1	1	1
<i>Harpalus tenebrosus</i>	1	0	0	0	0	0	0
<i>Harpalus zabroides</i>	1	0	0	0	0	0	0
<i>Laemostenus janthinus</i>	1	0	0	0	0	0	0
<i>Laemostenus macropus</i>	1	0	0	0	0	0	0
<i>Lebia chlorocephala</i>	1	0	0	0	0	0	0
<i>Lebia cruxminor</i>	1	0	0	0	0	0	0
<i>Lebia cyanocephala</i>	1	0	0	0	0	0	0
<i>Lebia scapularis</i>	1	0	0	0	0	0	0
<i>Lebia trimaculata</i>	1	0	0	0	0	0	0
<i>Leistus ferrugineus</i>	1	0	0	0	0	0	0
<i>Leistus fulvibarbis</i>	1	0	0	0	0	0	0
<i>Leistus montanus</i>	1	0	0	0	0	0	0
<i>Leistus nitidus</i>	1	0	0	0	0	0	0
<i>Leistus piceus</i>	1	0	0	0	0	0	0
<i>Leistus rufomarginatus</i>	1	0	0	0	0	0	0
<i>Leistus spinibarbis</i>	1	0	0	0	0	0	0
<i>Leistus terminatus</i>	1	0	0	0	0	0	0
<i>Licinus cassideus</i>	1	0	0	0	0	0	0
<i>Licinus depressus</i>	1	0	0	0	0	0	0
<i>Licinus hoffmannseggii</i>	1	0	0	0	0	0	0
<i>Limodromus assimilis</i>	1	0	0	0	0	0	0
<i>Lionychus quadrillum</i>	1	1	0	0	1	1	0
<i>Loricera pilicornis</i>	1	1	0	1	1	1	0
<i>Microlestes maurus</i>	1	1	0	0	1	0	0
<i>Microlestes minutulus</i>	1	1	0	1	0	1	0
<i>Miscodera arctica</i>	1	0	0	0	0	0	0
<i>Molops elatus</i>	1	0	0	0	0	0	0
<i>Molops piceus</i>	1	0	0	0	0	0	0
<i>Nebria brevicollis</i>	1	1	0	1	0	1	0
<i>Nebria castanea</i>	1	0	0	0	0	0	0
<i>Nebria cordicollis</i>	1	0	0	0	0	0	0

<i>Nebria crenatostrata</i>	1	0	0	0	0	0	0
<i>Nebria fontinalis</i>	1	0	0	0	0	0	0
<i>Nebria germarii</i>	1	0	0	0	0	0	0
<i>Nebria gyllenhali</i>	1	0	0	0	0	0	0
<i>Nebria heeri</i>	1	0	0	0	0	0	0
<i>Nebria jockischii</i>	1	0	0	0	0	0	0
<i>Nebria laticollis</i>	1	0	0	0	0	0	0
<i>Nebria livida</i>	1	0	0	0	0	0	0
<i>Nebria picicornis</i>	1	0	0	0	0	0	0
<i>Nebria psammodes</i>	1	0	0	0	0	0	0
<i>Nebria salina</i>	1	0	0	0	0	0	0
<i>Notiophilus aestuans</i>	1	0	0	0	0	0	0
<i>Notiophilus aquaticus</i>	1	0	0	0	0	0	0
<i>Notiophilus biguttatus</i>	1	1	1	0	0	0	0
<i>Notiophilus germinyi</i>	1	0	0	0	0	0	0
<i>Notiophilus palustris</i>	1	0	0	0	0	0	0
<i>Notiophilus quadripunctatus</i>	1	0	0	0	0	0	0
<i>Notiophilus rufipes</i>	1	0	0	0	0	0	0
<i>Notiophilus substriatus</i>	1	0	0	0	0	0	0
<i>Ocys harpaloides</i>	1	0	0	0	0	0	0
<i>Ocys quinquestriatus</i>	1	0	0	0	0	0	0
<i>Ocys tachysoides</i>	1	0	0	0	0	0	0
<i>Odacantha melanura</i>	1	0	0	0	0	0	0
<i>Omophron limbatum</i>	1	0	0	0	0	0	0
<i>Oodes helopioides</i>	1	0	0	0	0	0	0
<i>Ophonus ardosiacus</i>	1	1	0	1	1	1	0
<i>Ophonus azureus</i>	1	1	0	1	1	1	1
<i>Ophonus diffinis</i>	1	0	0	0	0	0	0
<i>Ophonus nitidulus</i>	1	0	0	0	0	0	0
<i>Ophonus parallelus</i>	1	0	0	0	0	0	0
<i>Ophonus puncticeps</i>	1	1	0	0	1	1	1
<i>Ophonus puncticollis</i>	1	0	0	0	0	0	0
<i>Ophonus rufibarbis</i>	1	1	0	1	0	0	0
<i>Ophonus rupicola</i>	1	0	0	0	0	0	0
<i>Ophonus sabulicola</i>	1	0	0	0	0	0	0
<i>Ophonus schaubergerianus</i>	1	0	0	0	0	0	0
<i>Ophonus stictus</i>	1	0	0	0	0	0	0
<i>Oreonebria angustata</i>	1	0	0	0	0	0	0
<i>Oreonebria angusticollis</i>	1	0	0	0	0	0	0
<i>Oreonebria breinii</i>	1	0	0	0	0	0	0
<i>Oreonebria picea</i>	1	0	0	0	0	0	0
<i>Oxypselaphus obscurus</i>	1	0	0	0	0	0	0
<i>Panagaeus bipustulatus</i>	1	1	0	0	0	1	0
<i>Panagaeus cruxmajor</i>	1	0	0	0	0	0	0
<i>Paradromius longiceps</i>	1	0	0	0	0	0	0
<i>Paranchus albipes</i>	1	0	0	0	0	0	0
<i>Paratachys bistratus</i>	1	0	0	0	0	0	0
<i>Parophonon maculicornis</i>	1	1	0	1	1	1	1

<i>Patrobus atrorufus</i>	1	0	0	0	0	0	0
<i>Patrobus australis</i>	1	0	0	0	0	0	0
<i>Patrobus septentrionis</i>	1	0	0	0	0	0	0
<i>Pedius longicollis</i>	1	0	0	0	0	0	0
<i>Perigona nigriceps</i>	1	1	0	0	1	0	1
<i>Perileptus areolatus</i>	1	0	0	0	0	0	0
<i>Philorhizus melanocephalus</i>	1	0	0	0	0	0	0
<i>Philorhizus notatus</i>	1	0	0	0	0	0	0
<i>Philorhizus quadrisignatus</i>	1	0	0	0	0	0	0
<i>Phyla obtusa</i>	1	0	0	0	0	0	0
<i>Platyderus depressus</i>	1	0	0	0	0	0	0
<i>Platyderus rufus</i>	1	0	0	0	0	0	0
<i>Platynus complanatus</i>	1	0	0	0	0	0	0
<i>Platynus depressus</i>	1	0	0	0	0	0	0
<i>Platynus livens</i>	1	0	0	0	0	0	0
<i>Platynus longiventris</i>	1	0	0	0	0	0	0
<i>Poecilus cupreus</i>	1	1	0	1	1	1	1
<i>Poecilus kugelanni</i>	1	0	0	0	0	0	0
<i>Poecilus lepidus</i>	1	0	0	0	0	0	0
<i>Poecilus versicolor</i>	1	1	0	0	1	0	0
<i>Polistichus connexus</i>	1	0	0	0	0	0	0
<i>Pterostichus aethiops</i>	1	0	0	0	0	0	0
<i>Pterostichus anthracinus</i>	1	1	0	1	0	0	0
<i>Pterostichus apenninus</i>	1	0	0	0	0	0	0
<i>Pterostichus aterrimus</i>	1	0	0	0	0	0	0
<i>Pterostichus burmeisteri</i>	1	0	0	0	0	0	0
<i>Pterostichus cribratus</i>	1	0	0	0	0	0	0
<i>Pterostichus cristatus</i>	1	0	0	0	0	0	0
<i>Pterostichus diligens</i>	1	0	0	0	0	0	0
<i>Pterostichus fasciatopunctatus</i>	1	0	0	0	0	0	0
<i>Pterostichus gracilis</i>	1	0	0	0	0	0	0
<i>Pterostichus hagenbachii</i>	1	0	0	0	0	0	0
<i>Pterostichus honnoratii</i>	1	0	0	0	0	0	0
<i>Pterostichus jurinei</i>	1	0	0	0	0	0	0
<i>Pterostichus madidus</i>	1	1	0	1	0	0	0
<i>Pterostichus melanarius</i>	1	1	0	0	0	1	0
<i>Pterostichus melas</i>	1	0	0	0	0	0	0
<i>Pterostichus micans</i>	1	0	0	0	0	0	0
<i>Pterostichus minor</i>	1	0	0	0	0	0	0
<i>Pterostichus morio</i>	1	0	0	0	0	0	0
<i>Pterostichus multipunctatus</i>	1	0	0	0	0	0	0
<i>Pterostichus niger</i>	1	0	0	0	0	0	0
<i>Pterostichus nigrita</i>	1	0	0	0	0	0	0
<i>Pterostichus oblongopunctatus</i>	1	1	0	1	0	0	0
<i>Pterostichus oenotrius</i>	1	0	0	0	0	0	0
<i>Pterostichus ovoideus</i>	1	1	0	1	0	1	0
<i>Pterostichus panzeri</i>	1	0	0	0	0	0	0
<i>Pterostichus pumilio</i>	1	0	0	0	0	0	0

<i>Pterostichus quadriveolatus</i>	1	0	0	0	0	0	0
<i>Pterostichus rhaeticus</i>	1	0	0	0	0	0	0
<i>Pterostichus rutilans</i>	1	0	0	0	0	0	0
<i>Pterostichus selmanni</i>	1	0	0	0	0	0	0
<i>Pterostichus spinolae</i>	1	0	0	0	0	0	0
<i>Pterostichus strenuus</i>	1	0	0	0	0	0	0
<i>Pterostichus unctulatus</i>	1	0	0	0	0	0	0
<i>Pterostichus vernalis</i>	1	1	0	1	1	1	1
<i>Sericoda quadripunctata</i>	1	0	0	0	0	0	0
<i>Stenolophus marginatus</i>	1	0	0	0	0	0	0
<i>Stenolophus mixtus</i>	1	1	0	1	0	1	0
<i>Stenolophus teutonus</i>	1	1	0	1	1	1	1
<i>Stomis pumicatus</i>	1	0	0	0	0	0	0
<i>Syntomus foveatus</i>	1	0	0	0	0	0	0
<i>Syntomus obscuriguttatus</i>	1	0	0	0	0	0	0
<i>Syntomus truncatellus</i>	1	0	0	0	0	0	0
<i>Synuchus vivalis</i>	1	0	0	0	0	0	0
<i>Tachys bisulcatus</i>	1	0	0	0	0	0	0
<i>Tachys micros</i>	1	0	0	0	0	0	0
<i>Tachyta nana</i>	1	1	0	0	0	1	0
<i>Tachyura hoemorrhoidalis</i>	1	0	0	0	0	0	0
<i>Tanythrix edurus</i>	1	0	0	0	0	0	0
<i>Thalassophilus longicornis</i>	1	0	0	0	0	0	0
<i>Trechoblemus micros</i>	1	0	0	0	0	0	0
<i>Trechus fairmairei</i>	1	0	0	0	0	0	0
<i>Trechus glacialis</i>	1	0	0	0	0	0	0
<i>Trechus laevipes</i>	1	0	0	0	0	0	0
<i>Trechus obtusus</i>	1	0	0	0	0	0	0
<i>Trechus pertyi</i>	1	0	0	0	0	0	0
<i>Trechus quadristriatus</i>	1	1	1	0	1	1	1
<i>Trechus rubens</i>	1	0	0	0	0	0	0
<i>Trechus schaumii</i>	1	0	0	0	0	0	0
<i>Trechus schyberosiae</i>	1	0	0	0	0	0	0
<i>Trechus secalis</i>	1	0	0	0	0	0	0
<i>Trechus strasseri</i>	1	0	0	0	0	0	0
<i>Trichotichnus laevicollis</i>	1	0	0	0	0	0	0
<i>Trichotichnus nitens</i>	1	0	0	0	0	0	0
<i>Trichotichnus rimanus</i>	1	0	0	0	0	0	0
<i>Zabrus tenebrioides</i>	1	0	0	0	0	0	0
Total number of species	447	86	32	53	40	61	40

815

816

817

Figure S1. Apidae (A) and Carabidae (B) species accumulation curves in the regional and urban pool.

Grey polygons show the standard deviation from random permutations of the data. The ratio of the observed number of species over the extrapolated number of species from the species accumulation curves (using a non-parametric bootstrap approach; see Palmer 1990) is given in the top right corner of each plot. A value of 100% would suggest that all species were present in the survey. In all cases, our data includes more than 90% of the extrapolated number of species.

Figure S2. Apidae (A) and Carabidae (B) species accumulation curves in the different Urban Green Space (UGS) types. Grey polygons show the standard deviation from random permutations of the data. The ratio of the observed number of species over the extrapolated number of species from the species accumulation curves (using a non-parametric bootstrap approach; see Palmer 1990) is given in the top right corner of each plot. A value of 100% would suggest that all species were present in the survey. In all cases, our data includes more than 85% of the extrapolated number of species.