Master Thesis

Master of Science in Urban Ecosystem Sciences

Increasing urban biodiversity by transforming lawns to meadows

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Eidesstattliche Erklärung

Hiermit erkläre ich, dass ich die vorliegende Arbeit selbstständig und eigenhändig sowie ohne unerlaubte fremde Hilfe und ausschließlich unter Verwendung der aufgeführten Quellen und Hilfsmittel angefertigt habe.

Berlin, den ....

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Contents

1 | Introduction

For some time there has been an alarming decline in diversity of insects worldwide (Foottit and Adler, 2017; Potts et al., 2010). Evaluating IUCN (International Union for Conservation of Nature) data, Dirzo et al. (2014) develop a global index of all invertebrate populations which shows an overall decline of 45 % over the last 40 years. Another study investigating insect populations in 63 nature protection areas in Germany finds that the biomass of flying insects decreased by about 76 % over 27 years (Hallmann et al., 2017). Reviewing more than 70 studies dealing with the decline of insects, Sánchez-Bayo and Wyckhuys (2019) reveal a potentially impending extinction of 40 % of the global insect species over the next few decades. Especially the decline of many native wild pollinating insects such as species of wild bees, bumblebees or butterflies is alarming (Potts et al., 2010). In Germany more than half of the 561 wild bee species are endangered (Westrich et al., 2011). Domesticated honey bees, albeit for different reasons, are also affected: Since 1961, a global decrease of domesticated honey bee hives of 45 % could be recorded (Aizen and Harder, 2009).

Insects are key components of ecological networks and perform important functions within ecosystems. One important function of both wild and domesticated insects is the pollination which affects wild and agricultural plants (Foottit and Adler, 2017; Ollerton et al., 2011). About 80 % to 85 % of wild plants worldwide require pollination trough insects to set seed (Grimaldi et al., 2005; Hallmann et al., 2017). The decline of pollinating insects is particularly threatening because it brings drastic consequences for many ecosystems, food-chains and therefore also human populations (Foottit and Adler, 2017; Gillespie et al., 2018).

Even if there is no definite cause for the decline and reasons vary among different groups of insects, some threats for insect biodiversity can be clearly identified. One major driver is the loss, degradation and fragmentation of habitats and the resulting loss of nesting or overwintering sites as well as food sources. The decrease of flower-rich habitats and native plants, that insects depend on, is especially problematic. Other factors are the intensification of agriculture, global climate change or pests and pathogens (Foottit and Adler, 2017; Living With Environmental Change (LWEC), 2014; Potts et al., 2010; Sánchez-Bayo and Wyckhuys, 2019).

In times of increasing urbanization, cities and their green infrastructure play a crucial role in the conservation of biodiversity in general and pollinating insects in particular. As a result, there is a significant effort to counter the decline of biodiversity and insects also in urban areas. The key question is what are the most effective strategies and measures to this end.

A large portion of green spaces in cities is covered by lawn-type vegetation, for example in parks, playgrounds and gardens. The vegetation of these areas is typically homogeneous and characterised by few dominant grass species and introduced species (Chollet et al., 2018). Because of their homogeneity, reduced vegetation structures and the absence of flowering plants urban grasslands often show a low diversity of insects and other fauna (Norton et al., 2019; Southon et al., 2017). Therefore, these contribute only little to urban biodiversity and the regional species pool. Due to their primarily representative and recreational use, urban grasslands are often characterised by intensive management and human intervention and utilization (Chollet et al., 2018; Fischer et al., 2013b; Ignatieva and Hedblom, 2018).

Because of their abundance, these areas have significant potential to be developed for the sake of biodiversity. One promising approach is the transformation of species-poor lawn-type areas into natural, species-rich grassland. There are different methods for grassland restoration in urban areas. One involves the reduction of the mowing schedule, so that the existing vegetation has the chance to prosper (Garbuzow et al., 2015; Lerman et al., 2018). Another way is the deliberate seeding of selected species to create a wildflower meadow (Norton et al., 2019). These measures can help to enhance general biodiversity by increasing plant diversity, including native species, and providing habitats and food sources for (pollinating) insects and other animal species (Chollet et al., 2018; Fischer et al., 2016; Klaus, 2013; Lerman et al., 2018).

So far, there are only few studies concerning this topic and even less considering practical examples. Only few pilot projects exist, e.g. the initiatives „Bunte Wiese" in Tübingen or „Blumiger Landkreis Osnabrück", implementing the approach (Umweltschutz und Lebenshilfe gUg, 2018; Unterweger et al., 2013). Therefore, there are still research gaps, particularly with regard to the practical implementation (Klaus, 2013).

Because the targeted areas are deeply embedded into urban neighbourhoods, the acceptance of local residents is of utmost importance. The proposed measures change the properties of the green spaces which may impact the perceived value of the areas. If measures are not well understood and accepted, risk of interference and vandalism may increase. On the other hand, the transformation of lawns into species-rich grasslands can provide aesthetic benefits (Ahern et al., 1992). The rising number of citizens' initiatives and referendums dealing with the decline of pollinating insects indicates increasing awareness of the importance of such measures. For example, in 2019 1.8 million Bavarians voted in favour of the referendum „Rettet die Bienen!" aiming for protection of biodiversity and strengthening the use of organic farming (Bund Naturschutz in Bayern, 2019). In order for measures to be successful, the interrelation between nature conservation measures and acceptance has to be taken into account.

The question is: How should the transformation of urban grasslands be implemented in order to maximize the increase of biodiversity and the acceptance of local residents? The present work addresses this question by investigating a practical project „Blühflächen im Gemeindepark Lankwitz“ that aims to enhance urban biodiversity in Berlin Steglitz Zehlendorf. The project is initiated by the voluntary initiative „Your Little Planet!“ and is realizing the transformation of two communal grassland areas to species-rich flower meadows as food source and habitat for pollinating insects and other local fauna by seeding a custom-made seed mixture. Furthermore the project pursues a neighbourly collaboration approach in order to involve local residents. This work investigates selected aspects of the project with regard to the transformation of lawns to flower meadows, addressing the following research questions:

1. Does the custom-made seed mixture benefit urban biodiversity by increasing plant species richness and promoting pollinating insects under the given conditions on site?

2. How well do local residents and visitors of the community park accept the transformation of the area?

2 Materials and methods

2.1 Study area

The present work investigates an urban grassland area which was transformed into a flower meadow as part of the project „Blühflächen im Gemeindepark Lankwitz“. The study area is located in front of the community hall „Maria-Rimkus Haus“ in the community park Lankwitz in Berlin Steglitz-Zehlendorf (see Figure 1). It was formerly used as a hayfield and was rarely frequented by visitors. In autumn 2018, the area was prepared by mowing, sod removal and ploughing. Afterwards, a custom-made wildflower seed mixture was sown on 1000 m^2. The seed was mixed with sand and hand-sown at a rate of $1.6\,g\,m^{-2}$ by the initiators of the project with the help of friends and neighbours. Additionally, various types of shrub (e.g. *Ribes* spec., *Cornus mas*) were planted at the edge of the area in order to serve as food for pollinators and humans alike. In addition to promoting urban biodiversity, the project also aims to strengthen neighbourly collaboration through direct interaction of residents with their local environment. Environmental education in terms of sustainable development is also an explicit project objective (Bramke and Bramke, 2018).

FIGURE 1: The study area in April 2019.

The present work systematically investigates different aspects of the project on three levels (see Figure 2). To answer the first research question of whether the seed mixture is benefiting urban biodiversity under the given conditions on site, methods from the field of vegetation ecology are used. First, the success of the seed-mixture is examined by mapping of the vegetation on site one year after sowing and comparing the results with the species in the seed-mixture. Second, the increase in plant diversity is quantified by comparing the results of the mapping of the sown area with the mapping of an unmodified control area. To also assess the germination potential, the soil seed banks of both, the sown area and the control area are examined. Regarding the second research question, the public acceptance towards the transformation of the area is investigated using methods from empirical social research. For this purpose, a survey of the visiting public is conducted using a custom questionnaire.

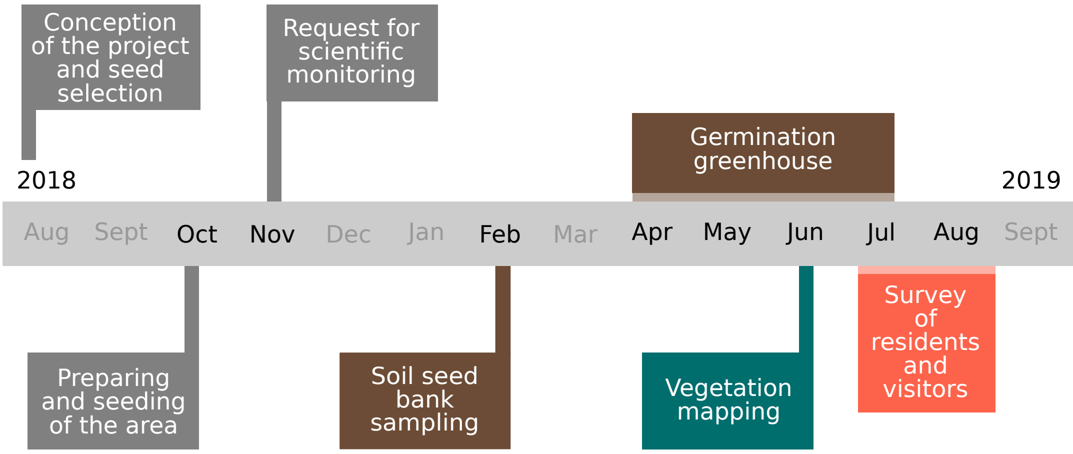


FIGURE 2: Timeline of the project and present work. Items related to the project are coloured grey, the investigation of the soil seed bank brown, the vegetation mapping green and the survey of local residents and visitors orange.

2.2 Biodiversity patterns

2.2.1 Seed mixture

A mixture of 42 native plant species, hereinafter referred to as *target species*, was sown (see Table 2). The selection of individual species for the mixture was not part of this work, but was independently conducted by the project „Blühflächen im Gemeindepark Lankwitz“. The custom-made mixture was financed by subsidies within the framework of the support programme „Freiwilliges Engagement In Nachbarschaften“ of the city of Berlin and produced by the company „Rieger-Hofmann GmbH“. Species selection focused on the enhancement of a broad spectrum of groups of wild pollinators. The different species were furthermore selected according to the following criteria: drought-resistance, conservation status and regional provenance (Bramke and Bramke, 2018). The mixture contains annual and perennial herbaceous plants, but no grasses, in order to minimize the pressure of competition as the grasses are expected to establish themselves from the soil seed bank. In addition to promoting urban biodiversity, the seed mixture also considers aesthetic aspects for humans by including a variety of flowering plants. To systematically assess both the aesthetic aspects as well as the benefits for pollinating insects, we review corresponding literature and gather key aspects like height, flowering season and colour and beneficiary pollinator groups for all species in a neat and appealing illustration (see Figure 16).

2.2.2 Soil seed bank sampling

To investigate the potential of the collective seed bank, consisting of the seeds already present and the ones added as part of the seed mixture, soil samples are taken and the contained seeds are germinated. Samples are taken at six evenly distributed locations within the sown flower meadow. Additionally, we choose six points with original lawn vegetation as control samples. Three of them are close to the meadow, the other three are located further north across a pathway (see Figure 3).

Overall twelve 1-L soil samples are taken using a post hole digger. After sifting and washing to remove coarse stones and vegetable fragments, the soil samples are evenly distributed on diaspore-free soil. The germination in planting trays in a greenhouse takes place under standardised conditions for four months, starting in April 2019 (see Figure 4). Two blank samples of diaspore-free soil are also set up to detect potential seed bank contaminants either from the soil or wind blown seeds. The soil samples from each sampling point are split into two planting trays, resulting in a total of 26 samples being examined. The planting trays are rearranged and hand-watered with tap water regularly. The seedlings from germinated seeds are identified, counted, recorded and discarded on a regular basis. The abundance of each species is classified into one of two categories; low for less than ten individuals and high for more than ten individuals. Specimen that can not be determined at the seedling stage are potted and cultivated until identification is possible.

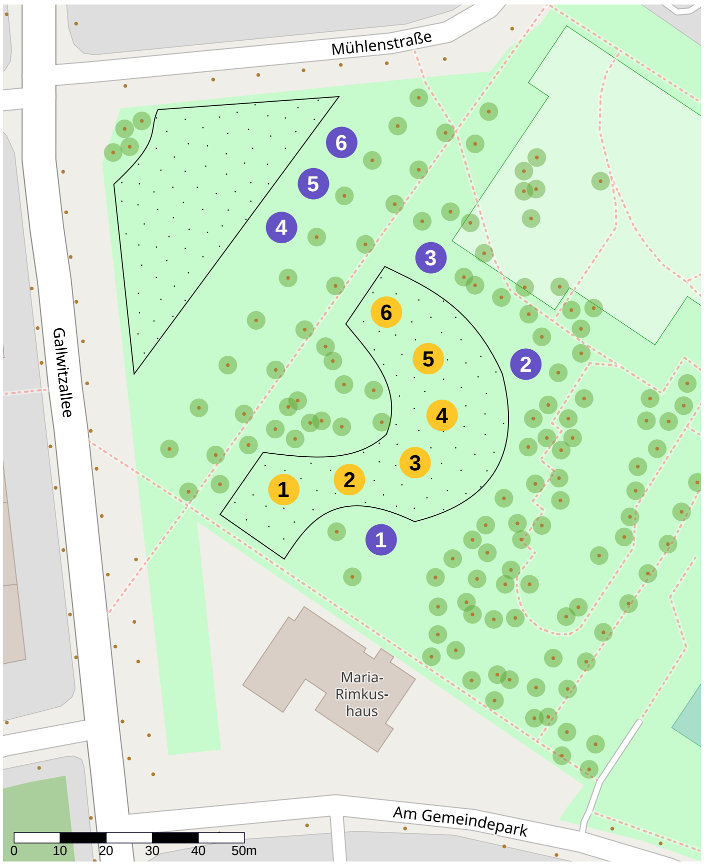


FIGURE 3: Map with points for soil sampling and vegetation mapping. The sampling points in the flower meadow are coloured yellow and the sampling points in the control area are coloured blue. Own illustration based on OpenStreetMapContributors (2019) and Senatsverwaltung für Stadtentwicklung und Wohnen (2019).

FIGURE 4: Investigation of the soil seed bank: seeds of the soil seed bank samples are germinated in a greenhouse.

FIGURE 5: Vegetation mapping: target and non-target species within square frames around the sampling points are identified on site.

2.2.3 Vegetation mapping

To investigate the germination potential and growing characteristics of individual species under the given environmental conditions on site, a mapping of the vegetation is carried out with respect to the species in the seed mixture, the original species present in the area's soil as well as spontaneous vegetation. On two dates in June 2019 the vegetation at 12 plots in both the flower meadow and the control area is mapped (see Figure 3). We map all target and non-target plant species within a north-aligned 1 x 1 m quadrant centred around the original soil sampling points (see Figure 5). The occurrence of each species in every sampling point is classified into one of two categories; low for less than ten individuals and high for more than ten individuals. The non-target species are categorised into ruderal and grassland species based on the biotope types according to Klotz et al. (2002) and Köstler et al. (2005).

2.3 Survey of local residents and visitors

To investigate the acceptance of the project among local residents and visitors of the community park Lankwitz, a survey is carried out using a custom-designed questionnaire (see Figure 17), inspired by Fischer et al. (2018). For inquiring into the perception of different levels of biodiversity and flowering aspects, photographic material is used (see Figure 6). The upper picture shows the target area in the community park Lankwitz in its current condition in order to provide spatial context. Below, three images representing different types of grassland with different levels of biodiversity are shown. The image on the left (number 1) shows a regularly mown lawn with no identifiable flowers (low biodiversity), hereinafter referred to as lawn. The picture in the middle (number 2) represents a flower meadow with a diverse palette of flowering plants (high biodiversity), hereinafter referred to as flower meadow. This is the target state of the investigated area. The image on the right (number 3) shows a lawn that has not been mowed for an extended period of time and exhibits only one kind of flowering plant (medium biodiversity), hereinafter referred to as mixed type.

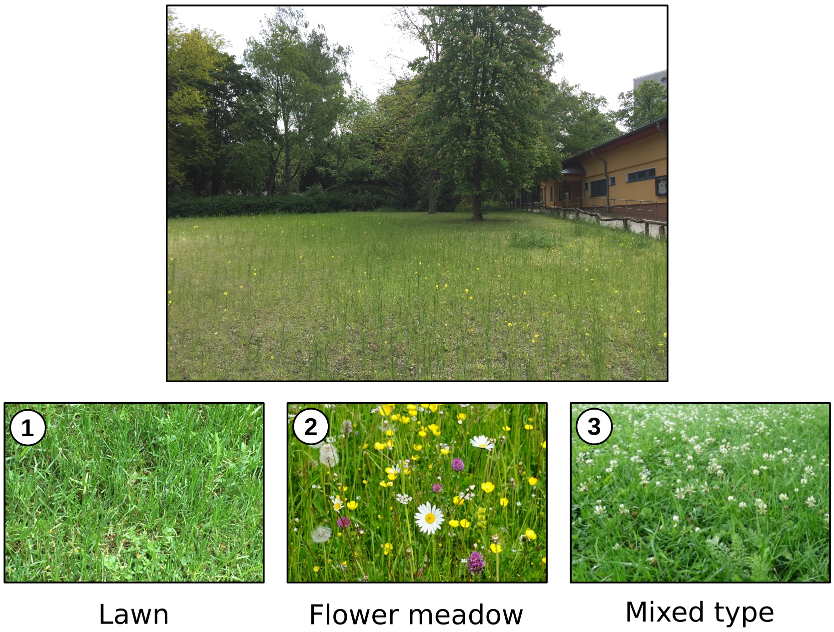


FIGURE 6: Photographic material for the survey.

The questionnaire is divided into two sections. The first section assesses the valuation of the three aforementioned types of grassland vegetation. Respondents are first asked to carry out a personal valuation *(Q1: Liking)* by asking „How do you like each of these three variations of an area in the community park Lankwitz?“. The response may be largely determined by aesthetic preferences and personal needs regarding grassland vegetation. Next, the respondents are asked about the estimated benefits of the three grassland types for urban plants and insects by asking „Do you think these areas are good for many different plants/insects in a city?“. These questions are hereinafter referred as *question* *about promoting urban plants (Q2: Plants)* and *question about promoting urban insects (Q3: Insects)*. The response to these questions should be largely independent of their individual needs and preferences. All three questions are evaluated by using a five-point Likert scale from 1 ([like] not at all) to 5 ([like] to a very great extent), following established methodology (Bryman, 2016).

The second section of the questionnaire queries more detailed information about the respondents which may be related to their response to the three main questions. This includes questions regarding the frequency of their visits, place of residence and personal gardening activity. Additionally, the respondents are asked about their familiarity with the project and how they got to know about it. Socio-demographic information like age, gender and companionship is recorded visually by the interviewer. These data are hereinafter referred to as explanatory variables.

The survey is conducted by means of personal interviews on site. On four dates in July and August 2019 the respondents are interviewed at various locations in the community park Lankwitz nearby the flower meadow. The survey is conducted on weekdays, weekends and at different times of the day to ensure that the range of people surveyed is as broad as possible. All respondents are approached while they are walking. 23 of the 76 asked do not want to participate, corresponding to a rejection rate of 30.26 %. The sample consists of the remaining 53 respondents. After agreeing to participate, respondents complete the questionnaire individually. 64.15 % of the respondents are categorized as female and 35.85 % as male. 37.74 % of the respondents are between 18 and 35 years old, 35.85 % are between 36 and 60 years old and 26.42 % are older than 60 years. 37.74 % of all respondents are accompanied by a child and 16.99 % by a dog. Statistics of the demographic profile and explanatory variables are shown in Table 3.

2.4 Statistical analysis

Statistical analysis is performed in Python using *pandas* (McKinney, 2010) and *SciPy* (Jones et al., 2001) libraries. Regarding the vegetation data, we investigate the number of target species and non-target species in the sampling points of the flower meadow and the control area. We calculate statistics of intersections and differences between species found in the flower meadow and control area with respect to both, the soil seed bank and results of the mapping.

Regarding the results of the survey we calculate the histograms and mean values of the answers to the main questions. A Spearman's rank-order correlation test is conducted to test the relation between the rating of the same picture across different questions. The demographic and explanatory variables are grouped into summarizing categories. A Kruskal-Wallis test is conducted to reveal relationships between explanatory variables and answers to the main questions. For the variables with more than two possible answers, a post-hoc test is conducted in order to identify the groups with significant differences.

3 Results

3.1 Biodiversity patterns

The investigation of the soil seed bank and the above-ground vegetation shows a larger number of species, and therefore higher plant diversity, in all flower meadow samples than in the samples from the control area. We count 64 species in the flower meadow and 48 species in the control area (see Figure 7). Of these, 31 species occur in both areas.

Comparing the soil seed bank in the planting trays with soil of the flower meadow, 9.66 species per tray are found on average, while in the soil samples of the control area only 5.66 species per tray germinated. Also, the vegetation mapping on site, shows that the plant species richness is higher in the examined flower meadow points than in the control area. In the flower meadow, we find an average of 32 species per sampling point, while in the control area, we find an average of only 18.5 species per sampling point.

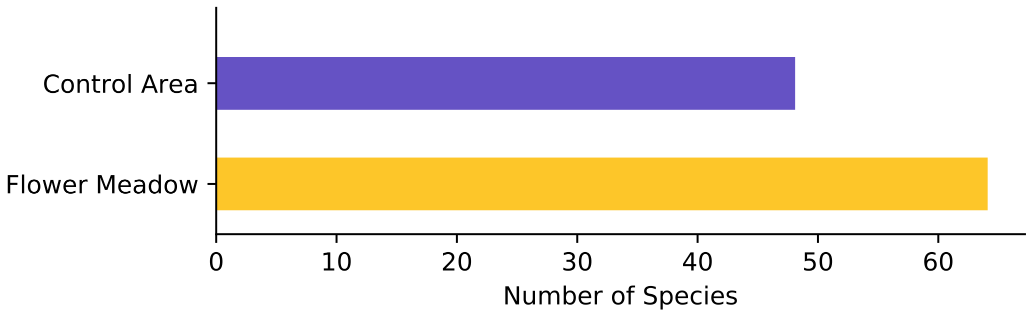


Figure 7: The number of species found in the flower meadow (64) exceeds the number of species found in the control area (48). 81 species are found in total, 31 of which occur in both areas.

3.1.1 Target species

Flower meadow vs. control area. 20 out of the 42 target species can be found in the flower meadow. We identify four target species that occur in the flower meadow as well as in the control area (see Figure 8). 22 species of the seed-mixture can neither be found in the flower meadow nor in the control area (see Table 2).

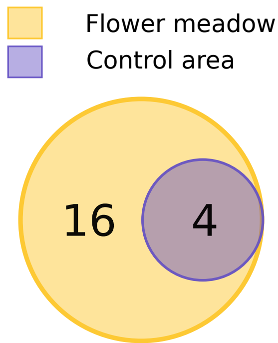
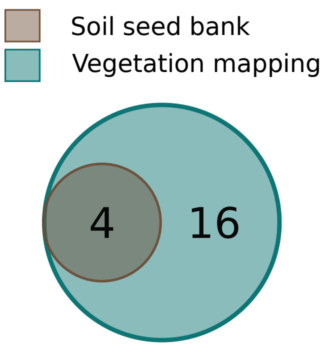


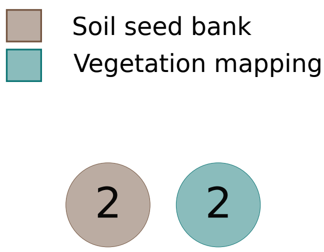
FIGURE 8: In total, 20 out of 42 target species are found in the flower meadow and the control area.

Flower meadow: soil seed bank vs. mapping. Looking more closely at the 20 target species occurring in the flower meadow, we find that 16 of them are found only by mapping. Four species are found both by vegetation mapping and investigation of the soil seed bank (see Figure 9a), namely *Crepis capillaris*, *Hypericum perforatum*, *Lotus corniculatus* and *Silene latifolia* subsp. *alba*. In all, this means that almost half of the sown species could establish themselves successfully within the first year. For example, all sown species from the classes *Centaurea* (four species), *Silene* (two species) and *Trifolium* (two species) germinated.

Control area: soil seed bank vs. mapping. In the control area four target species can be identified in total and all of them also occur in the flower meadow. Two species are identified by vegetation mapping (*Achillea millefolium*, *Crepis capillaris*) and two species by investigation of the soil seed bank (*Hypericum perforatum*, *Trifolium arvense*) (see Figure 9b).



(a) In total, 20 out of 42 target species are found in the **flower meadow**.



(b) In total, 4 out of 42 target species are found in the **control area**.

FIGURE 9: Target species found in the soil seed bank and in the vegetation mapping.

List of target species. The list of target species in Figure 16 shows that the selection of species for the seed mixture ensures different height gradations as well as a long period with varying flowering effects. Particularly, there are flowering times from May to November in a variety of colours. Most of the species provide nectar and thus support many pollinator groups, especially bees, wasps and flies. The illustration also shows which of the target species can become established in the first year on site.

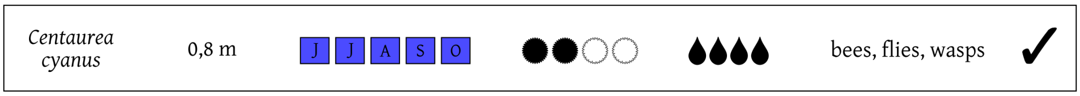


FIGURE 10: Example for a successful target species from the complete list in Figure 16. *Centaurea cyanus* blossoms in blue from June to October, producing a moderate amount of pollen (level 2/4) and a large amount of nectar (level 4/4) making it attractive for bees, flies and wasps.

3.1.2 Non-target species

Flower meadow vs. control area. Apart from the target species, a total of 61 other species are found in the examined points. Most of them belong to the groups of grassland or ruderal species. We find 44 species in the flower meadow and 44 species in the control area. 27 species occur in both areas (see Figure 11). 17 species only occur in the control area which represents the original lawn vegetation. 31.82 % of these are grasses. 17 non-target species are found only in the flower meadow and not in the control area, 18.18 % of which are grasses.

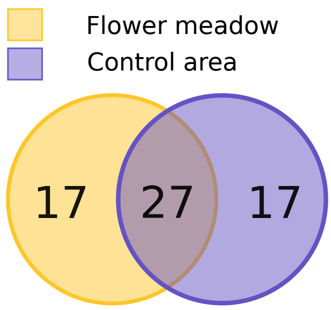
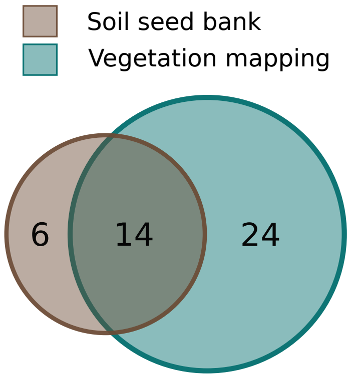
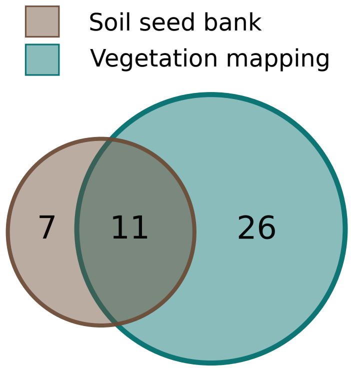


FIGURE 11: In total, 61 non-target species are found in the flower meadow and the control area.

Flower meadow and control area: soil seed bank vs. mapping. Figure 12a and 12b illustrate how many of the non-target species are found by mapping of the vegetation and how many are found by investigating the soil seed bank. The majority of non-target species in the flower meadow as well as in the control area are identified during the mapping of the vegetation. By investigation of the soil seed bank we find no seedlings in the two blank samples, indicating that no additional seeds were introduced by wind or other means.



(a) In total, 44 out of 61 non-target species are found in the **flower meadow**.



(b) In total, 44 out of 61 non-target species are found in the **control area**.

Figure 12: Non-target species found in the soil seed bank and in the vegetation mapping.

3.2 Survey of local residents and visitors

To determine the acceptance of local residents and visitors of the park, a survey of the visiting public is part of this work.

3.2.1 Main questions

The results of the survey of local residents and visitors of the park provide insights into their acceptance and their opinion on the target state of the area after the transformation (see Table 6, 7 and 8).

Q1: Liking. The results reveal that, regarding the question about the liking, the picture of the flower meadow is rated highest by most respondents (mean value on the Likert scale: 4.89). The mixed type is still rated higher (mean value on the Likert scale: 3.96) than the lawn (mean value on the Likert scale: 3.33). The distribution of the answers shows that the majority of respondents rates the flower meadow very similarly, while the response to the other two vegetation pictures, especially to the lawn, is more broadly distributed (see Figure 13).

Q2: Plants. Considering the question of how the areas contribute to the promotion of urban plants, the flower meadow is also rated highest (mean value on the Likert scale: 4.73). Similar to the first question, the lawn is rated lowest (mean value on the Likert scale: 3.30) and the mixed type is rated in between (mean value on the Likert scale: 4.13). The preference of the interviewees for the flower meadow is unambiguous, while the responses to the other grassland types are more widely spread. The response to the lawn picture ranges across the entire Likert scale, while the response to the mixed type is slightly less widely distributed (see Figure 13).

Q3: Insects. The answers to the question about promoting urban insects show that the respondents consider the flower meadow to be most beneficial in terms of enhancing urban insects (mean value on the Likert scale: 4.91), while the mixed type is rated worse (mean value on the Likert scale: 4.25) and the lawn is rated worst (mean value on the Likert scale: 3.00). The distribution shows that the response to the lawn ranges across the entire Likert scale, while the mixed type is rated slightly better overall. Regarding the flower meadow, there is a clear trend in the answers (see Figure 13). As for the previous questions, the answers for the flower meadow are sparsely distributed.

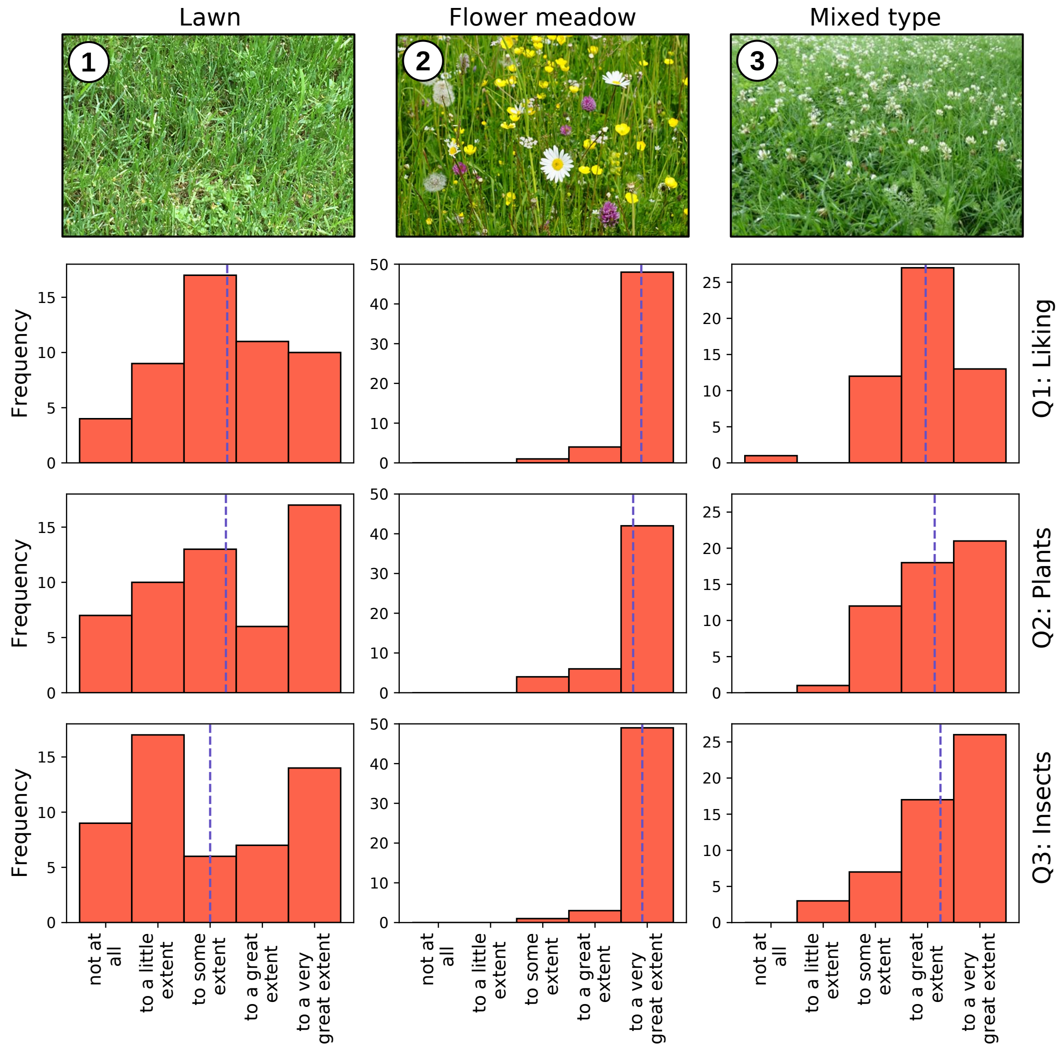
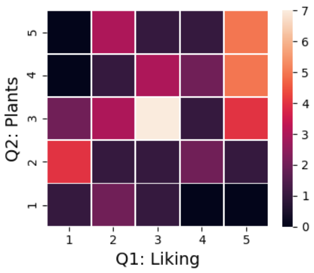


FIGURE 13: Histograms of the responses to the main questions (Q1, Q2, Q3) regarding the three grassland vegetation pictures. The blue line marks the mean value on the Likert scale. 53 participants in total.

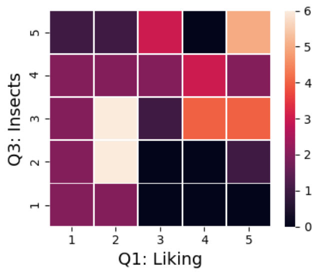
By calculating the Spearman's rank-order correlation coefficient we explore the relation between the evaluation of every single vegetation picture across the three main questions. The resulting coefficient ρ and the error probability p for all pictures and combinations of questions are shown in Table 1. We show the heatmaps for the five cases for which we observe a significant correlation in Figure 14a, 14b, 14c, 14d and 14e. Respondents who rate the lawn higher or lower in one question are likely to do so in any other question (see Figure 14a, 14b and 14c). With regard to the flower meadow there is a correlation between the answers to the questions about promoting urban plants and about promoting urban insects (see Figure 14d). The same applies to the mixed type (see Figure 14e), which also exhibits a significant correlation between the answers of the question regarding the promotion of urban plants and the question regarding the promotion of urban insects.

Picture	Questions	ρ	p
Lawn	Q1: Liking vs Q2: Plants	**0.45**	**0.00**
	Q1: Liking vs Q3: Insects	**0.43**	**0.00**
	Q2: Plants vs Q3: Insects	**0.58**	**0.00**
Flower meadow	Q1: Liking vs Q2: Plants	0.15	0.27
	Q1: Liking vs Q3: Insects	-0.09	0.51
	Q2: Plants vs Q3: Insects	**0.47**	**0.00**
Mixed type	Q1: Liking vs Q2: Plants	0.22	0.12
	Q1: Liking vs Q3: Insects	0.18	0.18
	Q2: Plants vs Q3: Insects	**0.49**	**0.00**

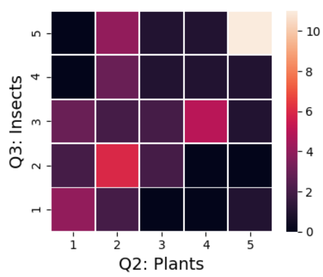
Table 1: Resulting correlation coefficient ρ and error probability p of the Spearman's rank-order correlation test between answers to different questions with respect to the same picture. The numbers of the five cases with significant correlation are highlighted.



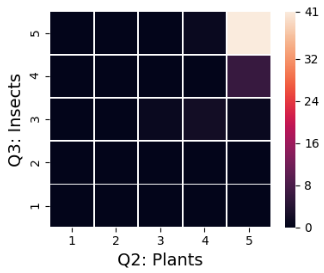
(a) Lawn



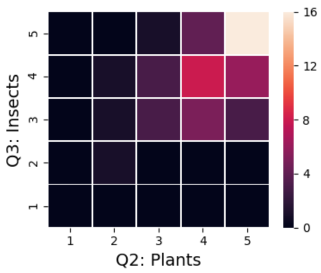
(b) Lawn



(c) Lawn



(d) Flower meadow



(e) Mixed type

Figure 14: The heatmaps show how often any particular combination of answers is given to two different questions for the five cases with significant correlation. They visualize the correlation of answers to different questions with respect to the same picture. The brighter the colour, the more frequent the combination of answers is observed.

3.2.2 Explanatory variables

Besides the main questions, additional information about the respondents is requested in the second section of the questionnaire (see Table 3). Being asked about the frequency of their visits, 66.04 % of the respondents state that they visit the park often, i.e. several times or at least once a week, while 32.08 % of those surveyed rarely spend time there. 75.47 % of the respondents state to be residents (within walking distance) and 22.64 % state to be only visitors of the park. One of the respondents does not make a statement about frequency of visit or residence. 67.92 % of the 53 interviewees indicate that they are gardeners themselves. 71.7 % of the respondents have not yet heard of the project „Blühwiesen im Gemeindepark Lankwitz". Most people who know the project say that they got to know it from the signposts around the flower meadow. Table 4 shows how the individual interviewees got to know the project in detail.

In most cases, the result of the Kruskal-Wallis test reveals no significant difference in the response to the main questions between the groups of the explanatory variables (see Table 5). We only find a significant difference in one case: The liking of the mixed type differs with respect to the gardening activity of the respondents ($\chi^2 = 3.89$, $p = 0.05$, df $= 1$). The group of respondents who state to be active gardeners rates the picture lower on average (mean value on the Likert scale: 3.86) than the group who does not garden (mean value on the Likert scale: 4.18) (see Figure 15).

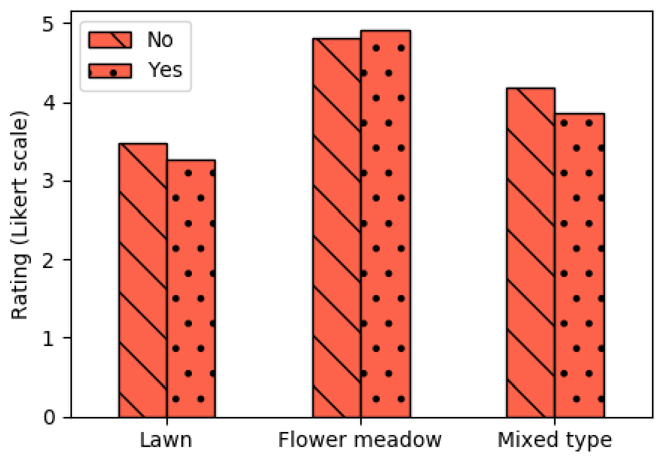


FIGURE 15: Mean Likert scale results for the question about the liking (Q1) regarding the explanatory variable gardening activity.

4 Discussion

The present work shows that, overall, the practical implementation of transforming an urban lawn area into a flower meadow in the context of the project „Blühflächen im Gemeindepark Lankwitz“ has been successful. Sowing flowering species increases plant diversity as well as the potential benefit for pollinating insects by providing richer food sources and habitat structures. Furthermore the results of the survey indicate that among the one third of respondents who knew about the project, it is well perceived. These findings are mostly consistent with the results from corresponding literature.

4.1 Biodiversity patterns

After sowing the target species, plant species richness in the flower meadow exceeded that of the control area. Plant species richness can benefit the faunal diversity and also the total biodiversity (Scherber et al., 2010). Thus, by increasing plant species richness and by introducing target species that are especially beneficial for pollinating insects, the project has a positive effect on urban biodiversity.

4.1.1 Target species

Table 2 lists all target species and whether they are found during mapping or soil seed bank examination. Since almost half of the target species are found growing in the flower meadow after just one year, the seeding of the mixture can be described as a success. Four target species can be identified both during mapping and during investigation of the soil seed bank, which means they have germinated both, in the greenhouse and outside in the meadow. Besides *Hypericum perforatum* and *Lotus corniculatus*, the mapping revealed particular abundance of the species *Crepis capillaris* and *Silene latifolia* subsp. *alba*. These species have well established, widely spread populations in Berlin (Seitz et al., 2012). This also applies to two of the three classes of which all target species were successful, namely *Silene* and *Trifolium*. This raises the question whether the inclusion of these species in the seed mixture brings about benefits at this particular location. In contrast, the four species from the third successful class, *Centaurea*, are less widely distributed in Berlin and particularly in Steglitz-Zehlendorf, where the flower meadow is located (Seitz et al., 2012). Thus, it was useful to add these species to the seed mixture and their success is especially important. Our results are in accordance with the findings from a similar study, examining the success of a grassland restoration treatment by sowing species in Berlin. The study also lists the species *Centaurea jacea* subsp. *jacea*, *Centaurea scabiosa* and *Silene vulgaris* as successful target species (Fischer et al., 2013a).

The fact that 22 of the target species have not yet germinated in either the greenhouse or the flower meadow is not unusual. On the one hand, the extreme weather conditions (heat and drought) in the year after sowing may have affected the germination rate in the flower meadow. On the other hand, the majority of these species are perennial species which may take several years to establish themselves after sowing (National Biodiversity Data Center, 2017). In general, studies show that plant species richness increases over time after the restoration. For example, in the study of Fischer et al. (2013b) the number of species is found to increase between the second and the third year. Landesbund für Vogelschutz in Bayern e.V. (LBV) (2002) also state that the final success of the establishment of a flower meadow can only be judged after two to four years. Reviewing 38 studies on grassland restoration Hedberg and Kotowski (2010) even show that satisfying results can only be achieved in a period of five to fifteen years. Besides the number of species, especially the dominance of target species increases over time (Conrad and Tischew, 2011; Nordbakken et al., 2010). In summary, it can be expected that the target species will gradually establish themselves so that a meadow community with a high number of species develops over the course of multiple years.

Interestingly, the following four target species from the seed mixture are found in the control area, too: *Achillea millefolium*, *Crepis capillaris*, *Hypericum perforatum* and *Trifolium arvense*. This has been observed in a similar study, where species occurring in the target and the control area are referred to as resident species (Fischer et al., 2013a). One possible explanation is that some seeds from the seed mixture could have entered the area by means of wind, humans or animals. However, the fact that the species *Hypericum perforatum* and *Trifolium arvense* are also found in the soil seed bank of the control area implies that they are part of the original vegetation. For the two other species *Achillea millefolium* and *Crepis capillaris* growing in the above-ground vegetation of the control area it cannot be determined wether they established themselves through immigration, activation of the soil seed bank or sowing of the seed mixture. In this context, one study concludes that species establish themselves more often by other means of entry than by the activation of the soil seed bank (Latzel et al., 2011). All of the four sown species and especially *Achillea millefolium* and *Hypericum perforatum* are among the most common species in Berlin (Seitz et al., 2012). It can therefore be assumed that they have established themselves on the area independently and would not have needed to be included in the seed mixture.

4.1.2 Non-target species

Notably, the control area, which represents the previous vegetation before the transformation, exhibit a significant plant diversity (44 species). Species characteristic for different grassland biotopes of Berlin could be identified. For example we find species that are typical for fresh meadows (*Arrhenaterum elatius*, *Galium mollugo*) and ruderal meadows (*Dactylis glomerata*, *Rumex thyrsiflorus*). Furthermore we find species that are typical for the biotope type wet meadow of nutrient-rich sites (*Ranunculus acris*, *Rumex acetosa*) (Köstler et al., 2005). The species *Rumex acetosa* is listed on the early warning list of the red list of Berlin (Seitz et al., 2018). The large proportion of grasses such as *Festuca rubra* can be explained by the former use of the area as a hayfield. On site inspections of the area in the year before the transformation showed only few flowering aspects which are only present during distinct time periods (Bramke and Bramke, 2018). Nevertheless, the question arises whether a more detailed mapping of the transformed area could have better revealed the present ecological value of the original state of the area. Transforming an area with already high plant diversity and important individual species offers less potential benefit and may even have adverse effects. On the other hand, there are obviously other factors that severely limit the freedom to select areas as candidates for transformation.

A large number of non-target species also occur in the flower meadow as remainder of the original vegetation. This is due to seeds of the pre-existing vegetation still being present in the flower meadow soil.

Interestingly, 17 non-target species are found in the flower meadow but not in the control area. For example, in one sampling point of the flower meadow, we find the rare species *Ranunculus bulbosus*, which is classified as endangered in the red list of Berlin and therefore valuable from a nature conservation perspective (Seitz et al., 2018). On the one hand these species can originate from seeds "sleeping" in the soil, which were activated by ploughing of the area (Naturschutzbund Stadtverband Köln, 2016). This is especially true for the species only occurring in the soil seed bank of the flower meadow (*Cirsium arvense*, *Veronica sublobata*). Studies show that grasslands often exhibit large, persistent seed banks, whose species do not necessarily reflect the species composition of the above-ground vegetation (Thompson and Grime, 1979; Nordbakken et al., 2010). However, these seed banks are often dominated by ruderal species (Bossuyt and Hermy, 2003). Especially grasslands with a long-term cutting regime exhibit only few target species even though these species are present in the above-ground vegetation (Bakker et al., 2002). Reviewing numerous seed bank composition studies, Bossuyt and Hermy (2003) conclude that the probability of a successful restoration of grasslands through germination of the seed bank is very limited. This is in accordance with studies by Valkó et al. (2011) or Nordbakken et al. (2010) which show limited success in the creation of grasslands only through activation of the seed bank. Thus, ploughing of the area alone is not sufficient for effective enhancement of plant species richness. On the other hand, the exposed soil after the transformation of the area allows spontaneous species to settle and grow. This is a particularly likely explanation for indigenous or well-established ruderal species such as *Chenopodium album*, *Medicago lupulina* and *Papaver rhoeas* which are widely spread over the city area of Berlin (Seitz et al., 2012). The same applies to the neophytes *Ailanthus altissima* and *Tripleurospermum inodorum*, which are reported to occur in the district Steglitz-Zehlendorf, too (Seitz et al., 2012).

In the examined points of the flower meadow numerous grasses could be identified though none were sown. Numerous studies have shown that grasses (originating from the soil seed bank) are very competitive and can supersede other herbaceous or forb species (Hitchmough et al., 2008; Pywell et al., 2008). The dominance of grasses and other invasive species can be counteracted with appropriate maintenance measures such as mowing or hand weeding (Ahern and Boughton, 1994; Aldrich, 2002; Naturschutzbund Stadtverband Köln, 2016).

4.1.3 Limitations of the investigation of the soil seed bank

We note that the germination rate during the investigation of the soil seed bank was relatively low. Only few species germinated and in some planting trays no seeds germinated at all. Perhaps, a germination period of more than four months would have been necessary for more seeds to germinate, especially for seeds from species with a longer dormancy. Additionally, some species require special light and temperature conditions for germination (Bewley, 1997). High temperatures in the greenhouse (> 30°C) may have also inhibited germination of some species. In summary, it can be assumed that not all species of the soil seed bank have been recorded during the examination. On the other hand, the low germination success may be an indication that a mere ploughing of the area without insertion of seeds would not have been sufficient to achieve the goal of increasing plant diversity.

4.2 Survey of local residents and visitors

4.2.1 Main questions

The results of the survey suggest a high acceptance of the transformation of the area to a flower meadow among the visiting public. Being asked about their personal preference, most of the interviewees rate the flower meadow highest among the three grassland types. It can be assumed that the high plant diversity and the flowering aspects of the flower meadow are aesthetically pleasing, resulting in a higher rating valuation than the monotonous, low diverse grasslands without or with less flowers.

Q1: Liking. The result that a large plant diversity of urban meadows is highly appreciated is in accordance with the findings from other studies (Lindemann-Matthies et al., 2010; Southon et al., 2017). For example, the work of Southon et al. (2017) also suggests that respondents prefer meadows over mown grassland. Another study among people with different sociocultural backgrounds shows that they prefer high plant diversity across a range of urban green spaces including urban grasslands (Fischer et al., 2018). The study assesses detailed information on respondents socio-cultural background, such as education, occupation, health status and migration background. Regarding the valuation of urban park meadows the respondents rate the high biodiversity better than the low biodiversity level, regardless of their socio-cultural background. In contrast to the results of the present work, Fischer et al. (2018) find slight differences between younger and older respondents.

Similar to our results, several studies show that participants particularly like colourful flowering aspects in green spaces (Akbar et al., 2003; Hoyle et al., 2017; Junge et al., 2015; Southon et al., 2017). The study of Hoyle et al. (2018) even finds that existing flowering aspects play a greater role than plant diversity in the public assessment of meadows. Interestingly, the study also points out that the diversity of coloured flowers plays an important role both in terms of public acceptance and the presence of pollinating insects.

The pictures of the lawn and the mixed type are not rated as unambiguously as the one of the flower meadow, which could be due to their perceived similarity. In this context, it should be noted that lawns and meadows have very different uses. Lawns are valued for their recreational use and through their perceived tidiness they have a representative function. Otherwise a tall-growing grassland like a flower meadow is more associated with wilderness and nature than an area to be used directly by humans (Klaus, 2013; Lampinen and Tuomi, 2018). Thus, perceived value may be rated similarly, but for quite different reasons. Nevertheless, the lawn with no visible flowering plants and the lowest plant diversity was rated worst by the respondents on average.

Q2: Plants. In the present survey, the respondents estimate the benefit of the flower meadow for urban plants and insects highest. The answers to the question about promoting urban plants suggest that the respondents are able to visibly assess the diversity of plants. While one study, dealing with urban green spaces, shows that people can accurately assess plant species richness (Fuller et al., 2007), another study shows that people tend to overestimate or underestimate plant species richness (Lindemann-Matthies et al., 2010).

Q3: Insects. The significant correlation between the assessment of promoting urban plants and urban insects regarding the flower meadow and the mixed type suggests that respondents see a dependence between plant diversity and estimated benefit for insects. The results indicate public awareness of the benefits of flower meadows for plants and insects. However, the study of Hoyle et al. (2018) states that people have only limited knowledge and awareness of the real value of a meadow area for plant or insect diversity.

The correlation between the attractiveness and the perceived value of a planting area for insects is consistent with the results of Hoyle et al. (2017). On the one hand, this may be a result of the growing awareness of the value of flowering plants to counteract the decline in pollinating insects, that is evident from the increasing number of referenda and citizens' initiatives like the one in Bavaria 2019 (Bund Naturschutz in Bayern, 2019). On the other hand, although difficult to accurately assess for visitors, the dual benefit for humans as well as insects was a key factor for the selection of the target species (see Figure 16).

Projection of results. It should be noted that the pictures used in the survey are only of symbolic nature and do not show the actual condition of the respective area in the community park Lankwitz. Furthermore, flowering aspects may take multiple years to fully develop. However, the fact that respondents rate the flower meadow higher than than the other grassland types which represent the previous status of the area allows to predict general acceptance of the actual transformation in the long run.

4.2.2 Explanatory variables

Schenk et al. (2007) point out that, alongside communication and opportunities for participation, information is the most relevant factor for public acceptance of nature conservation measures. Another study shows that a large proportion of people would accept meadows even outside the flowering season if they were informed about their aesthetics and benefits for biodiversity (Southon et al., 2017).

Currently, the study area in the community park Lankwitz is still under development and does not yet resemble the target state. The results of the survey further show that only a minority of the interviewees (28.3 %) knew about the project and the flower meadow itself, although most of them are residents and visit the park frequently. This might be an explanation for some visitors crossing the flower meadow and forming trails through it. This sort of interference is not expected given the positive assessment of the flower meadow in the survey. Therefore, education and sensitization of the public is of great importance, especially in this early phase of the transformation (Egan et al., 2012). Public awareness of the value of a flower meadow can only be obtained by information about the benefits and threats for the success of the measure (Williams et al., 2015). Although the initiators heavily advertise the project, especially via internet (social media and website) and local press, in total only 13.33 % came to know about the project this way. Because most of the respondents who knew about the project were informed by signposts on site (40.0 %), additional and clearer signage may be the key to higher awareness and may ultimately prove more effective than other information channels. This is also supported by Williams et al. (2015), who highlight the importance of signage as a way of informing and educating the visiting public. The existing signposts around the flower meadow are relatively small and do not contain detailed information about the current and target state. If visitors of the park would also be informed about the benefits of the flower meadow, they may be more inclined to preserve it.

5 | Conclusions

By mapping of the vegetation and analysis of the soil seed bank, this work documents the success of the transformation of an urban lawn area into a flower meadow by seeding a custom-made seed mixture. The corresponding project, „Blühflächen im Gemeindepark Lankwitz“ achieved the goal of increasing plant diversity and creating additional food sources and habitat structures for pollinating insects in the centre of Berlin (Bramke and Bramke, 2018). A survey of the visiting public, conducted as part of this work, provides valuable insights into the appreciation of the measure among visitors of the park. Notably, the measure was initiated and conducted by a private initiative with the help of residents, rather than within the framework of a public project. The evidence gathered by this work allows to promote the project as a successful example for similar private initiatives in urban neighbourhoods. The work furthermore reveals several interesting aspects with regard to the seed mixture, the choice of the target area and the communication with visitors that may help to make future measures even more effective.

There are significant logistical and organisational challenges associated with a privately initiated and implemented project in a public area. These aspects should be further investigated, in order to identify key hurdles and to provide a guideline for the implementation of future projects. This work shows that the majority of target species germinated successfully within the first year after sowing. Further observation, like in the study of Fischer et al. (2013a) is needed in order to evaluate the final establishment of a stable community of meadow plants in the following years. While this work could demonstrate the potential of the flower meadow to benefit pollinating insects by increasing the number of plant species with particular value for insects, the actual, realized benefits for pollinating insects have not yet been evaluated. To this end, further scientific monitoring of the area in terms of floristic and faunistic studies is necessary.

Most previous work focuses either on the ecological benefits (Chollet et al., 2018; Lerman et al., 2018; Norton et al., 2019) or on the public acceptance (Lindemann-Matthies et al., 2010; Southon et al., 2017) of measures, like the one studied in this work. However, there is a lack of integrative research that considers the synergies of both aspects. For example, the study of Hoyle et al. (2018) examines the connection between the promotion of human beings and insects and which factors influence both positively. More studies of this kind are required to derive practical guidelines for a successful transformation of an area that benefits both biodiversity and humans.

6 Abstract

For some time there has been an alarming decline in diversity of pollinating insects worldwide. Considering the increasing urbanisation, the restoration of urban grassland areas is a promising approach to enhance biodiversity and to improve the conditions for pollinators. However, the practical implementation of such measures remains widely unexplored. This work studies the transformation of an urban lawn into a flower meadow within the framework of the project „Blühflächen im Gemeindepark Lankwitz“ by the private initiative „Your Little Planet!“. The project aims to enhance biodiversity and create additional benefits for pollinating insects and humans by seeding a seed mixture. Using this practical example, we investigate: 1) whether the custom-made seed mixture benefits urban biodiversity by increasing plant species richness and promoting pollinating insects under the given conditions on site; and 2) how well the transformation of the area is accepted among local residents and visitors of the park.

The success of the target species in the first year after establishment is examined by mapping of the vegetation. Additionally the potential of the soil seed bank is investigated by taking soil samples and germinating the included seeds. To evaluate the plant diversity before and after the transformation, the results for the flower meadow are compared with a control area, representing the previous vegetation. Furthermore, a photography-based survey of the visiting public is conducted in order to assess the acceptance of the project and its perceived benefits for urban biodiversity.

The results show that almost half of the target species germinated within the first year and that the plant diversity is significantly increased, indicating potential benefit for pollinating insects. The survey reveals general appreciation and awareness of the importance of the transformation of the area to a flower meadow.

In summary, the work finds that the transformation is a success. Especially considering the implementation of the project by a private initiative, it can be seen as an example for similar projects in the future. The approach of this work to explore, the synergies of nature conservation and public acceptance within a concrete project is a promising direction for the design of more effective measures for enhancing biodiversity in urban contexts.

7 | Zusammenfassung

Seit einiger Zeit ist global ein alarmierender Rückgang an bestäubenden Insektenarten zu verzeichnen. Mit Hinblick auf die zunehmende Urbanisierung stellt die Umwandlung von Rasen- in Wiesenflächen einen vielversprechenden Ansatz zur Förderung urbaner Biodiversität und bestäubender Insekten dar. Die praktische Umsetzung solcher Maßnahmen ist jedoch weitgehend unerforscht. Die vorliegende Arbeit untersucht die Umwandlung einer öffentlichen Rasenfläche in eine artenreiche Blühwiese am Beispiel des Projektes "Blühflächen im Gemeindepark Lankwitz" der privaten Bildungsintiative "Your Little Planet!". Durch Aussaat einer Saatgutmischung sollen Nahrungspflanzen für bestäubende Insekten bereitgestellt werden, um dadurch eine Erhöhung der urbanen Biodiversität zu bewirken. Zusätzlich soll das Projekt das nachbarschaftliche Miteinander und die Lebensqualität der Menschen fördern. Die Arbeit untersucht verschiedene Aspekte des Projektes, um die folgenden Fragen zu beantworten: 1) Kommt die maßgeschneiderte Saatgutmischung der urbanen Biodiversität durch Förderung von Pflanzenvielfalt und bestäubenden Insekten unter den Bedingungen vor Ort zugute? und 2) Wie wird die Umwandlung der Fläche von AnwohnerInnen und BesucherInnen des Parks angenommen?

Mithilfe einer Vegetationskartierung wird der Erfolg der Zielarten ein Jahr nach der Umwandlung untersucht. Zusätzlich wird das Potenzial der Diasporenbank durch die Entnahme von Bodenproben und der Aufzucht der enthaltenen Samen ermittelt. Um die Pflanzendiversität vor und nach der Umwandlung zu untersuchen, werden die Ergebnisse der Blühwiese mit denen einer Kontrollfläche verglichen, welche die ursprüngliche Vegetation aufweist. Mithilfe eines Fragebogens und fotografischen Materials wird eine Befragung von BesucherInnen und AnwohnerInnen durchgeführt, um die Akzeptanz der Umwandlung der Fläche und den wahrgenommenen Nutzen für die urbane Biodiversität zu bewerten.

Die Ergebnisse zeigen, dass fast die Hälfte der Zielarten innerhalb des ersten Jahres gekeimt sind und die Pflanzendiversität deutlich erhöht wurde, was einen potenziellen Nutzen der Blühwiese für bestäubende Insekten birgt. Die Befragung von BesucherInnen und AnwohnerInnen ergibt, dass eine allgemeine Wertschätzung gegenüber der Blühwiese sowie ein Bewusstsein für deren Bedeutung für die urbane Biodiversität existiert.

Zusammenfassend zeigt die Arbeit den Erfolg der Umwandlung der Fläche in eine Blühwiese. Besonders in Anbetracht der Umsetzung durch eine private Initiative kann das Projekt als Beispiel für ähnliche zukünftige Maßnahmen angesehen werden. Der in der vorliegenden Arbeit verfolgte Ansatz, Synergien von Naturschutz und öffentlicher Akzeptanz innerhalb eines konkreten Projektes zu erforschen, ist vielversprechend für die Entwicklung effektiver Maßnahmen zur Verbesserung der urbanen Biodiversität.

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A | Appendix

A.1 List of target species

Name	Height	Flowering	Pollen	Nectar	Pollinators	1. year
Achillea millefolium	0,6 m	J J A S O	○○○○	●●●○	bees, flies, wasps	✓
Agrimonia eupatoria	1,0 m	J J A S	●●●●	●○○○	bees, flies, beetles	
Anchusa officinalis	1,0 m	M J J A	○○○○	●●●○	bees, wasps	✓
Artemisia campestris	0,4 m	A S O	○○○○	●○○○	bees, flies, beetles	
Campanula patula	0,7 m	M J J	●●○○	●●○○	bees	
Campanula rotundifolia	0,6 m	J J A S O	●●○○	●●○○	bees	
Carduus nutans	1,2 m	J J A	○○○○	●●●○	bees, flies, wasps	
Centaurea cyanus	0,8 m	J J A S O	●●○○	●●●●	bees, flies, wasps	✓
Centaurea jacea	0,8 m	J J A S O N	○○○○	●●●○	bees, flies, wasps	✓
Centaurea scabiosa	1,2 m	J A	○○○○	●●●○	bees, flies, wasps	✓
Centaurea stoebe	1,2 m	J A S	○○○○	●●●○	bees, flies, wasps	✓
Cichorium intybus	1,2 m	J A S O	●●●○	●●●○	bees, flies, wasps	
Crepis capillaris	0,9 m	J J A S O	○○○○	●●●○	bees, flies, wasps	✓
Daucus carota	1,0 m	J J A	○○○○	●●●○	bees, flies, wasps, beetles	✓
Echium vulgare	0,8 m	M J J	○○○○	●●●●	bees, wasps	
Heracleum sphondylium	1,5 m	J J A S	○○○○	●●●○	bees, flies, wasps, beetles	
Hypericum perforatum	0,7 m	J A	●●●●	●○○○	bees, flies, beetles	✓
Hypochaeris radicata	0,6 m	J J A S	○○○○	●●●○	bees, flies, wasps	✓
Jasione montana	0,5 m	J J A	○○○○	●●●○	bees, flies, wasps	✓
Knautia arvensis	1,0 m	J A	○○○○	●●●○	bees, flies, wasps	
Leontodon hispidus ssp. hispidus	0,5 m	J J A S O	○○○○	●●●○	bees, flies, wasps	

Name	Height	Flowering	Pollen	Nectar	Pollinators	1. year
Leucanthemum ircutianum	0,8 m	J J A S O (no fill)	○○○○	●●●○	bees, flies, wasps	
Leucanthemum vulgare agg.	1,0 m	J J A S O (no fill)	○○○○	●●●○	bees, flies, wasps	✓
Linaria vulgaris	0,8 m	J J A S O (yellow)	●●○○	●●●○	bees, wasps	
Lotus corniculatus	0,4 m	J J A (yellow)	●●●○	●●●○	bees	✓
Malva alcea	1,0 m	J J A S O (pink)	○○○○	●●●○	bees, flies, wasps	
Papaver rhoeas	0,7 m	M J J (red)	●●●●	●○○○	bees, flies, beetles	✓
Pimpinella major	0,9 m	J J A S (no fill)	○○○○	●●●○	bees, flies, wasps, beetles	
Prunella vulgaris	0,2 m	J J A S (purple)	○○○○	●●●○	bees, wasps	
Saponaria officinalis	0,7 m	J J A S (pink)	○○○○	●●●○	bees, butterflies, moths	
Scabiosa columbaria	0,8 m	J A S O N (purple)	N/A	N/A	bees, flies, wasps	
Scorzoneroides autumnalis	0,5 m	J A S (yellow)	○○○○	●●●○	bees, flies, wasps	
Sedum acre	0,1 m	J J A (yellow)	●●●○	●●●○	bees, flies, wasps	
Sedum sexangulare	0,1 m	J J A (yellow)	●●●○	●●●○	bees, flies, wasps	
Silene latifolia ssp. alba	0,7 m	J J A S (no fill)	○○○○	●●●○	butterflies, moths	✓
Silene vulgaris	0,7 m	M J J A S (no fill)	○○○○	●●●○	bees, butterflies, moths	✓
Sinapis arvensis	0,8 m	J J A S O (yellow)	○○○○	●●●○	bees, flies, wasps, beetles	✓
Solidago virgaurea	1,2 m	J A S O (yellow)	○○○○	●●●○	bees, flies, wasps	
Thymus pulegioides	0,2 m	J J A S O (pink)	○○○○	●●●○	bees, flies, wasps	✓
Tragopogon pratensis	0,7 m	M J J (yellow)	○○○○	●●●○	bees, flies, wasps	
Trifolium arvense	0,4 m	J J A S (no fill)	●●●●	●●●○	bees, wasps	✓
Trifolium campestre	0,3 m	J J A S (yellow)	●●●●	●●●○	bees, wasps	✓

FIGURE 16: List of target species with aesthetical and pollinator aspects. Own illustration based on Bramke and Bramke (2018); Bundesministerium für Ernährung und Landwirtschaft (BMEL) (2019); Driant (2019); Klotz et al. (2002); Lauber and Wagner (2018).

A.2 Investigation of the soil seed bank and vegetation mapping

Species name	Seed mixture	Soil seed bank		Mapping	
		Meadow	Control	Meadow	Control
Number of species	42	24	20	58	40
Acer platanoides				l	l
Achillea millefolium	X			h	h
Agrimonia eupatoria	X				
Agrostis capillaris		l	l	l	h
Agrostis gigantea				l	
Ailanthus altissima				l	
Alliaria petiolata					l
Anchusa officinalis	X			l	
Arabidopsis arenosa		l	l	h	l
Arabidopsis thaliana		l		l	
Arenaria serpyllifolia		l	l	h	l
Arrhenatherum elatius				l	l
Artemisia campestris	X				
Bellis perennis		l	l	l	l
Berteroa incana				l	l
Betula spec.		l	l		
Bromus hordeaceus				l	l
Campanula patula	X				
Campanula rotundifolia	X				
Capsella bursa-pastoris		h		h	l
Cardamine hirsuta		l	l		
Carduus nutans	X				
Carex hirta					l
Carex spicata					l
Centaurea cyanus	X			h	
Centaurea jacea	X			l	
Centaurea scabiosa	X			l	

Centaurea stoebe	X			l	
Cerastium arvense					l
Cerastium holosteoides		l	l	h	h
Cerastium semidecandrum				l	l
Chenopodium album				l	
Cichorium intybus	X				
Cirsium arvense		l			
Conyza canadensis			l		
Crepis capillaris	X	l		h	l
Dactylis glomerata				l	l
Daucus carota	X			h	
Echium vulgare	X				
Elymus repens					l
Festuca rubra					h
Galium mollugo					l
Geranium molle				l	l
Geranium pusillum				l	l
Heracleum sphondylium	X				
Holcus lanatus				l	
Hypericum perforatum	X	l	l	l	
Hypochaeris radicata	X			l	
Jasione montana	X			l	
Juncus effusus			l		
Knautia arvensis	X				
Lamium purpureum			l		
Leontodon autumnalis				l	
Leontodon hispidus subsp. *hispidus*	X				
Leucanthemum ircutianum	X				
Leucanthemum vulgare agg.	X			h	
Linaria vulgaris	X				
Lolium perenne			l	h	h
Lotus corniculatus	X	l		l	

Luzula campestris					l
Malva alcea	X				
Medicago lupulina				l	
Papaver dubium				l	
Papaver rhoeas	X			l	
Pimpinella major	X				
Plantago lanceolata		l	l	h	h
Poa spec.			l		
Poa trivialis		l	l		l
Polygonum arviculare				l	l
Potentilla argentea		l		l	
Prunella vulgaris	X				
Ranunculus acris					l
Ranunculus bulbosus				l	
Rumex acetosa				l	l
Rumex thyrsiflorus				l	l
Sagina procumbens		l		l	
Saponaria officinalis	X				
Scabiosa columbaria	X				
Scorzoneroides autumnalis	X				
Sedum acre	X				
Sedum sexangulare	X				
Silene latifolia subsp. *alba*	X	l		h	
Silene vulgaris	X			h	
Sinapis arvensis	X			l	
Solidago virgaurea	X				
Stellaria media		l	l	l	
Taraxacum officinale					l
Thymus pulegioides	X			l	
Tilia spec.				l	
Torilis nodosa		l		l	
Tragopogon pratensis	X				
Trifolium arvense	X		l	h	

Trifolium campestre	X			h	
Trifolium dubium					l
Trifolium pratense					l
Trifolium repens		l	l	l	l
Trifolium spec.				l	
Tripleurospermum inodorum				l	
Trisetum flavescens					l
Veronica arvensis				h	h
Veronica chamaedrys		l	l		l
Veronica serpyllifolia		l	l	l	l
Veronica sublobata		h			

TABLE 2: List of all species found in the meadow and control area during investigation of the soil seed bank and mapping of the vegetation. The abundance of the species is listed as low (l) or high (h) and the species of the seed mixture are marked with an X.

A.3 Custom-designed questionnaire

Umfrage im Gemeindepark Lankwitz

Im Rahmen meiner Masterarbeit an der TU Berlin würde ich Ihnen gerne einige Fragen zu einer Fläche im Gemeindepark Lankwitz stellen. Die Ergebnisse sollen dazu beitragen, städtische Grünflächen nach den Bedürfnissen der Bevölkerung weiter zu entwickeln.

Beachten Sie beim Antworten bitte Folgendes:

- Die Teilnahme und Beantwortung einzelner Fragen sind freiwillig und alle Antworten werden vertraulich behandelt.
- Es gibt keine richtigen oder falschen Antworten, sondern es geht um Ihre ganz persönliche Meinung. Antworten Sie daher so, wie es für Sie persönlich zutrifft. Ausgewertet werden nur die Durchschnittswerte aus den Antworten vieler Personen.
- Bitte beantworten Sie möglichst alle Fragen, auch wenn Ihnen die Antwortmöglichkeiten nicht immer ganz passend erscheinen und antworten Sie ohne lange zu überlegen.

Ich werde Ihnen im Folgenden mehrere Bilder zu einer Fläche im Gemeindepark Lankwitz zeigen. Beantworten Sie im Anschluss die folgenden Fragen, indem Sie die Antwort ankreuzen, die am besten für Sie persönlich zutrifft.

1. Wie gefallen Ihnen diese drei Varianten einer Fläche im Gemeindepark Lankwitz?

	gefällt mir überhaupt nicht	gefällt mir kaum	gefällt mir einigermaßen	gefällt mir ziemlich	gefällt mir sehr	ich weiß nicht
Bild 1	☐	☐	☐	☐	☐	☐
Bild 2	☐	☐	☐	☐	☐	☐
Bild 3	☐	☐	☐	☐	☐	☐

2. Denken Sie, dass diese Flächen gut für viele unterschiedliche Pflanzen in der Stadt sind?

	überhaupt nicht	kaum	teils-teils	ziemlich	sehr	ich weiß nicht
Bild 1	☐	☐	☐	☐	☐	☐
Bild 2	☐	☐	☐	☐	☐	☐
Bild 3	☐	☐	☐	☐	☐	☐

3. Denken Sie, dass diese Flächen gut für viele unterschiedliche Insekten in der Stadt sind?

	überhaupt nicht	kaum	teils-teils	ziemlich	sehr	ich weiß nicht
Bild 1	☐	☐	☐	☐	☐	☐
Bild 2	☐	☐	☐	☐	☐	☐
Bild 3	☐	☐	☐	☐	☐	☐

4. Haben Sie schon einmal etwas von dem Projekt „Blühflächen im Gemeindepark Lankwitz“ von Your Little Planet gehört?
Wenn ja, wie haben Sie von dem Projekt erfahren?

- ☐ Ja
  - ☐ Internet (z.B. Homepage, soziale Medien)
  - ☐ Presse (z.B. Zeitung)
  - ☐ Schilder vor Ort
  - ☐ Hinweis von Bekannten oder FreundInnen
  - ☐ Sonstiges: ____________________
- ☐ Nein
- ☐ Ich weiß nicht/Keine Angabe

5. Wie häufig haben Sie ungefähr in den vergangenen vier Wochen den Gemeindepark Lankwitz besucht?

- ☐ Mehrmals pro Woche
- ☐ Einmal pro Woche
- ☐ Seltener als einmal pro Woche
- ☐ Nie
- ☐ Ich weiß nicht/Keine Angabe

6. Wohnen Sie in der Nähe des Gemeindeparks Lankwitz?

- ☐ AnwohnerIn ($<$ 10 Minuten zu Fuß)
- ☐ AnwohnerIn ($>$ 10 Minuten zu Fuß)
- ☐ BesucherIn
- ☐ Sonstiges: ____________________
- ☐ Ich weiß nicht/Keine Angabe

7. Gärtnern Sie (z.B. im eigenen Garten, auf dem eigenen Balkon oder in einem Gemeinschaftsgarten)?

- ☐ Ja
- ☐ Nein
- ☐ Ich weiß nicht/Keine Angabe

8. Möchten Sie über die Ergebnisse dieser Studie informiert werden?

- ☐ Nein
- ☐ Ja, meine E-Mail-Adresse ist: ______________________________

Vielen Dank für Ihre Teilnahme!

3

FIGURE 17: Custom-designed questionnaire.

A.4 Survey results

Explanatory variable	Group	Number (%)
Age	18-35 36-60 years > 60	20 (37.74 %) 19 (35.85 %) 14 (26.42 %)
Gender	male female	19 (35.85 %) 34 (64.15 %)
Frequency (missing value = 1 respondent)	often rare	35 (66.04 %) 17 (32.08 %)
Residence (missing value = 1 respondent)	resident visitor	40 (75.47 %) 12 (22.64 %)
Gardening	no yes	17 (32.08 %) 36 (67.92 %)
Familiarity	no yes	38 (71.70 %) 15 (28.30 %)
Companionship	- child dog child and dog	23 (43.40 %) 20 (37.74 %) 9 (16.98 %) 1 (1.89 %)

TABLE 3: Demographic profile of all 53 survey participants and explanatory variables.

Source of information	Number
Signs	6
Signs + Hints	2
Signs + Personal contact	1
Signs + Internet + Press	1
Hints	1
Personal contact	1
Internet	1
Internet + Press	1
Press	1

TABLE 4: Statistics of how respondents got to know about the project.

Variable	Picture	Question 1		Question 2		Question 3	
		χ^2	p	χ^2	p	χ^2	p
Age	Lawn	1.61	0.45	0.73	0.69	1.42	0.49
	Flower meadow	0.14	0.93	0.27	0.87	5.28	0.07
	Mixed type	5.25	0.07	0.58	0.75	0.28	0.87
Gender	Lawn	0.40	0.53	0.61	0.43	2.40	0.12
	Flower meadow	1.46	0.23	0.13	0.72	0.42	0.52
	Mixed type	2.68	0.10	0.05	0.83	0.77	0.38
Frequency	Lawn	9.42	0.40	10.06	0.35	7.69	0.57
	Flower meadow	0.31	0.58	1.94	0.16	0.13	0.72
	Mixed type	0.36	0.55	0.21	0.65	1.53	0.22
Residence	Lawn	0.23	0.63	1.04	0.31	0.38	0.54
	Flower meadow	0.01	0.93	2.63	0.10	0.00	0.94
	Mixed type	0.37	0.54	0.08	0.78	2.41	0.12
Gardening	Lawn	2.51	0.47	1.09	0.78	0.60	0.90
	Flower meadow	1.78	0.18	1.64	0.20	0.06	0.80
	Mixed type	**3.89**	**0.05**	1.69	0.19	2.19	0.14
Familiarity	Lawn	0.84	0.36	2.71	0.10	1.87	0.17
	Flower meadow	10.25	0.33	7.22	0.61	1.67	1.00
	Mixed type	7.38	0.60	11.67	0.23	9.78	0.37
Companionship	Lawn	0.52	0.47	0.25	0.61	0.00	0.96
	Flower meadow	1.80	0.61	0.94	0.81	0.77	0.86
	Mixed type	3.08	0.38	2.63	0.45	3.09	0.38

TABLE 5: Results of Kruskal-Wallis test: χ^2 and p values for the explanatory variables regarding the main questions. Significant values are in bold.

Variable	Group	Lawn	Flower meadow	Mixed type
All		3.33	4.89	3.96
Age	18-35	3.25	4.90	4.25
	36-60	3.56	4.84	3.63
	> 60	3.14	4.93	4.00
Gender	m	3.53	4.79	4.21
	f	3.21	4.94	3.82
Frequency	often	3.21	4.89	3.89
	rare	3.65	4.88	4.06
Residence	resident	3.23	4.90	3.90
	visitor	3.75	4.83	4.08
Gardening	no	3.47	4.82	4.18
	yes	3.26	4.92	3.86
Familiarity	no	3.37	4.89	3.97
	yes	3.21	4.87	3.93
Companionship	-	3.17	4.91	4.09
	child	3.55	4.80	3.90
	dog	3.00	5.00	3.67
	child and dog	5.00	5.00	5.00

TABLE 6: Question about the liking (Q1): mean values of the answers with respect to each explanatory variable.

Variable	Group	Lawn	Flower meadow	Mixed type
All		3.30	4.73	4.13
Age	18-35	3.15	4.74	4.05
	36-60	3.26	4.79	4.21
	> 60	3.57	4.64	4.14
Gender	m	3.11	4.78	4.11
	f	3.41	4.71	4.15
Frequency	often	3.29	4.80	4.14
	rare	3.47	4.56	4.06
Residence	resident	3.17	4.80	4.10
	visitor	3.92	4.45	4.18
Gardening	no	3.00	4.59	3.88
	yes	3.44	4.80	4.26
Familiarity	no	3.16	4.65	4.08
	yes	3.67	4.93	4.27
Companionship	-	3.35	4.77	4.05
	child	3.25	4.65	4.25
	dog	3.44	4.78	4.22
	child and dog	2.00	5.00	3.00

TABLE 7: Question about promoting urban plants (Q2): mean values of the answers with respect to each explanatory variable.

Variable	Group	Lawn	Flower meadow	Mixed type
All		3.00	4.91	4.25
Age	18-35	2.65	5.00	4.35
	36-60	3.21	4.89	4.21
	> 60	3.21	4.79	4.14
Gender	m	3.37	4.84	4.37
	f	2.79	4.94	4.18
Frequency	often	2.94	4.89	4.11
	rare	3.00	4.94	4.47
Residence	resident	2.80	4.90	4.12
	visitor	3.50	4.92	4.58
Gardening	no	3.18	4.88	4.47
	yes	2.92	4.92	4.14
Familiarity	no	2.97	4.87	4.16
	yes	3.07	5.00	4.47
Companionship	-	3.00	4.96	4.35
	child	2.85	4.85	4.25
	dog	3.33	4.89	3.89
	child and dog	3.00	5.00	5.00

TABLE 8: Question about promoting urban insects (Q3): mean values of the answers with respect to each explanatory variable.

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