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# Supporting biodiversity: Structures of participatory actions in urban green spaces

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Biodiversity loss is an important topic considering climate change, global warming, and even the reasoning of current and future animal-related diseases, such as the COVID-19 pandemic. Urban biodiversity is also important because of the ecosystem services they provide, restorative benefits for well-being, and physical health of the people who live in urban areas. Each city has its own strategies to cope with this issue, and these strategies do not function without the contribution of habitants of the cities. We developed an index (BBS) of the existing possibilities to support urban biodiversity in Berlin to measure the awareness and willingness of the Berliners to participate and support urban biodiversity. A survey was conducted in a face-to-face situation in four districts of Berlin with 431 urban residents, measuring preference for three different levels of biodiversity, connectedness to residential greenspace, neighborhood and city, nature relatedness, and willingness in participatory actions around greenspace. The results show that the high biodiversity condition in a photo scenario was preferred by most residents, indicating the appreciation for urban biodiversity. The connectedness to the residential greenspace was high (and higher than the connectedness to neighborhood and city), showing large potential for quality of life. While the overall willingness to participate in actions to support urban greenspace was rather high, our index shows substantial differences in activities, which are perceived more or less. This is a key result for urban park management to increase urban biodiversity participation processes.

## KEYWORDS

biodiversity, participation, urban greenspace, nature relatedness, connectedness, preference

## Introduction

Urban green spaces (UGS) are considered as ecosystem units that offer a natural habitat to the plants, animals, fungi, and microorganisms in urban areas (Jose et al., 2018), which makes them vital for urban biodiversity. Biodiversity loss is a global issue considering climate change and global warming (Habibullah et al., 2022) and even the reasoning of current/future animal-related diseases, such as the COVID-19 pandemic (invasion of the natural habitats) (Smith et al., 2014; Lawler et al., 2021). On the contrary, urban biodiversity is important in means of ecosystem services (Haines-Young and Potschin, 2010; Potschin and Haines-Young, 2011) such as restorative benefits for

well-being (Marselle, 2019; Zhang et al., 2020) and physical health of the people who live in urban areas (W.H.O., 1998; Browning et al., 2022). Therefore, UGS are crucial areas for both urban biodiversity and its beneficial effects to the urban life. This study thus addresses first the meaning of biodiversity for preference of urban residents, second the meaning of individual relatedness of urban residents to the living environment and nature, and third the awareness and willingness to participate in the design and maintenance of UGS to analyze how UGS can be supported to meet the needs for biodiversity and quality of life.

## The role of greenspace and biodiversity

The positive impact of greenspace for restoration and well-being has been shown in various studies (Ulrich et al., 1991; Roe et al., 2016), showing a direct effect and an indirect effect by, for example, providing affordances for a healthy lifestyle (e.g., Hartig et al., 1997; Marselle, 2019). UGS are used regularly by people for various reasons such as physical activities, social activities, and restoration (Porcherie et al., 2019). According to recent studies, the usage of these areas has increased during the COVID-19 pandemic (Geng et al., 2020; Fischer and Gopal, 2021). It can be related to the measures that governments have taken to prevent the spread of the virus. Thus, UGS can serve as a resource for health promotion, especially in times of crises such as a pandemic by providing space for social interactions under secure conditions. The impact of biodiversity for health has not been shown as clearly (Marselle et al., 2019), and it might serve as a moderator (Marselle et al., 2021). However, an important aspect is the preference for specific UGS, since the probability to visit UGS—and thus enable the positive health impact—increases when residents have access and prefer the type of UGS and actually enjoy being there (Takano et al., 2003). Thus, this study explores the preference of biodiversity by urban residents.

## The role of relatedness of urban residents to the living environment and nature

Locations which are preferred by residents enable a specific bond to their users. Users develop a connectedness to these locations. They feel comfortable and safe and remain longer in areas they have a bond to (Hernández et al., 2007). Place attachment appears on different levels, such as the neighborhood and the city (Hidalgo and Hernández, 2001). If there is a special bond to the nearby UGS, it can substantially support the health-related effects of UGS, because the usage frequency is likely to be increased.

In addition, nature relatedness (NR) can be a driver in conservation of urban biodiversity. The term was described as an understanding of human interconnectedness with all other living things. It is not simply a love for nature, or enjoyment

of only the superficially pleasing facets of nature (e.g., sunsets and snowflakes), but rather an awareness and understanding of all aspects of the natural world, even those that are not always aesthetically appealing or useful to humans (e.g., insects and rodents), as part of healthy ecosystems. Nature relatedness is a relatively stable individual difference characteristic, similar to a personality trait or aspect of the self-concept (Nisbet and Zelenski, 2014). Still, the level of NR can be promoted. Nature relatedness is associated with more concern and pro-environmental attitudes as well as sustainable behavior. Since the strategies to preserve and conserve biodiversity are in need of different approaches to succeed, NR of the citizens can play a key role in their willingness to participate in biodiversity strategies, which will be taken into consideration in this study.

## The role of awareness and willingness to participate in the design and maintenance of UGS

As biodiversity conservation is a global challenge, the need for international and local strategies and policies is steadily increasing (Bonebrake et al., 2019), especially because the proportion of the population living in cities will continue to increase both worldwide and in Germany (Statista, 2022). When we look at the local scale, as part of a wider nature restoration plan, more focus will go to cities, and many cities around the world have their own strategies and activities to support and conserve their own urban biodiversity (Nilon et al., 2017; Hermoso et al., 2022). The city of Berlin provides a rather large amount of greenspace compared with other European cities, and most residents appreciate the benefits from UGS (GALK (Deutsche Gartenamtsleiterkonferenz e.V.), 2013). However, continuous urban growth pressure is still a threat on UGS and urban biodiversity (Kirmeyer, 1978; Vierikko et al., 2017; McDonald et al., 2019; Onaindia and Fisher, 2021), and the positive impact of UGS on aspects of quality of life could decrease if it is not planned carefully including the results from research. Being aware of this, several programs and strategies to promote biodiversity have been started in Berlin (e.g., BBSR (Bundesinstitut für Bau-, Stadt- und Raumforschung), 2017) including, for example, watering trees, taking over sponsorship for greenspace, or planning greenspaces to name just a few. These programs usually include the activity of the residents, a strategy not only to promote participation in UGS planning but also to avoid cost-intensive maintenance in a financial difficult situation of the districts and the city itself. These programs and strategies, however, have not been focused in research, and the acceptance in public has not been looked at in detail. However, participation of the residents in these strategies and participatory activities (PA) should not be underestimated. Ignoring people's lack of support for specific

measures of greenspace management strategies can considerably undermine the effectiveness of policies aiming to promote urban biodiversity (Stoll-Kleemann, 2001). Convincing people to participate in these kinds of activities might be a difficult task for authorities. One aim of this study is to understand the awareness and willingness of the population to increase their participation in conservation strategies. The awareness and willingness of the population to participate may be related to habitants' age and gender (Sang et al., 2016), urban center-edge gradients (Chen et al., 2022), and nature relatedness (Nisbet and Zelenski, 2013; Dean et al., 2018). Another important aspect influencing the awareness of biodiversity strategy is the sociocultural background (Fischer et al., 2018). Berlin is a city with various sociocultural backgrounds. Still, most of the research done has been carried out in either German or English (Botzat et al., 2016). Only one study integrated other languages, for example, Turkish (Piniak et al., 2008), underrepresenting specific user groups due to language barriers. In this study, these language barriers shall be conquered by a research design carried out in different languages—German, Turkish, and Russian as the most spoken languages (Statista, 2022)—to reach a broader variety of residents in Berlin and extend the scope of the results.

Including people's opinions in the design and management of biodiverse friendly greenspaces is critical for successful biodiversity conservation in cities. This study aims at a better understanding of people's awareness and willingness to participate and support the activities about conservation of urban biodiversity of different language groups, which is essential for the success of conservational strategies offered by the authorities. Aiming to show how to use resources to improve urban biodiversity, we address the following research questions in the city of Berlin: (1) What level of biodiversity do urban residents prefer? (2a) How is the connectedness to the place of residency pronounced in urban residents? (2b) What role does their nature relatedness play? (3a) What is the willingness to participate on a general level? and (3b) What is the willingness to participate in a specific activity?

Considering these factors affecting the involvement of the habitants in biodiversity conservation activities can be a key approach to increase participation in urban biodiversity activities which leads us to develop more sustainable cities.

## Methods

### Questionnaire design and measures

To gather the perspective of urban residents, a questionnaire has been developed. It was conducted in German, Turkish, and Russian depending on the language skills of the participants to reach different target groups that have so far been strongly underrepresented in nature-related surveys.

### Preference of biodiversity level

Since people show a very limited ability to accurately perceive the biodiversity that surrounds them (Pett et al., 2016), we avoided mentioning the term biodiversity or species richness, but used a procedure strictly based on the perception of given pictures. To measure respondents' preferences for different types of urban green spaces, we followed the collage methodology offered by the Green Surge Project team (Fischer et al., 2018). The method is based on photo collages showing a standard situation within an UGS type, for example, a meadow in a park. The collages consist of a photographic frame showing a locally typical and recognizable UGS type in the center and a neutral sky on the background that remains constant across all collages. In this case, we used the park "Tempelhofer Feld" in Berlin, because it provides a well-known area for all residents and still did not represent any of the survey areas. Using Adobe Photoshop™, we replaced the foreground vegetation of the UGS-type frames with three images ("fillings") showing local vegetation at three biodiversity levels (low, medium, and high). All fillings stemmed from sites that were similar in vegetation structure but differed in plant species richness (see Figure 1).

### Connectedness to the place of residence

Connectedness was measured on three levels: connectedness to Berlin, to the neighborhood, and to the green spaces in the neighborhood. It was rated on a four-point Likert scale (from 1 = very weak connection to 4 = very strong connection). In addition, respondent's time living in Berlin (from 1 = <2 years, to 5 = >10 years) was asked for. We also asked for the usage frequency of UGS before and during the COVID-19 pandemic using a scale ranging from 0 = not at all to 5 = daily.

Nature relatedness of the participants was rated on a four-point Likert scale (from 0 = strongly disagree to 3 = strongly agree) by using the Nature Relatedness 6 (NR6) Scale (Nisbet and Zelenski, 2013).

### Willingness to participate on a general level

One question addressed the general willingness to be involved in participatory actions (PA) in UGS, giving the answering categories "yes" and "no." In addition, we asked how much time they wanted to invest in these activities monthly from "no time at all" to more than eight h (0, 1–2, 3–4, 5–6, 7–8, and >8).

### Willingness to participate in a specific activity in the city of Berlin

Specific activities in the city of Berlin were given by the "Senatsverwaltung für Umwelt, Mobilität, Verbraucher- und Klimaschutz" (Senate Department for the Environment, Urban Mobility, Consumer Protection and Climate Action).



FIGURE 1

Stimuli material for Berlin (from the left: low, medium, and high biodiversity). Instruction: In which of these places would you feel most comfortable? Please take your time and have a look at all three pictures and then point to the chosen one.

They comprised twelve specific PA, which already existed in the context of Berlin, offered by authorities and associations. These twelve specific PA were surveyed by asking in each case whether the respondents were aware of the PA, were already participating in it, or would like to participate in it. A score was derived from these answers, enabling us to report mean values of the willingness to participate for each activity. We then developed the “Berlin Urban Green Space Participation Index” (“Beteiligungsindex Berliner Stadtgrün” BBS) to understand the peoples’ willingness to participate in activities.

Sociodemographic data, such as gender, age, migration background, education, and membership of an environmental organization, were gathered. The density of the district—city center with high density or outskirts with lower density—was assessed by the location of the field survey.

## Field survey

The research areas were chosen to represent different districts of Berlin, including two dense areas with low amounts of UGS in the city center and two less dense areas with higher amounts of UGS in the outskirts. Districts from the former East and West of Berlin were represented evenly. The field survey was thus conducted in the districts of Neukölln, Mitte, Marzahn-Hellersdorf, and Spandau.

To reach people who do not or only rarely spend time in the UGS, we conducted surveys at two study sites: in a park (Volkspark Humboldthain, Volkspark Hasenheide, Spekte Park, and Bürgerpark Marzahn) and on a market (Leopoldplatz, Maybachufer, Rathaus Spandau, and Marzahner Promenade). In each district, the park and market situations corresponded to the same neighborhood to reach the same residents.

The survey was prepared using the QuestionPro™ software in three languages (German, Turkish, and Russian). The interviewers spoke one or more of these language fluently. They

conducted the surveys in the field *via* tablets in a face-to-face interview, meeting the pandemic requirements (e.g., face masks and fumigation). In addition, a paper-pencil version of the survey was provided when asked for. Ten interviewers, all trained in a half-day workshop, guided the surveys within three shifts (10:00–13:00, 13:00–16:00, and 16:00–19:00 weekdays and weekends) to reach people who visit mentioned areas in different times of the day and thus reaching a broad selection of using habits. To prevent the influence of the interviewers, random respondent method was used to choose the respondents. According to this method, interviewers asked every fourth person in sight whether she/he wants to participate in the questionnaire.

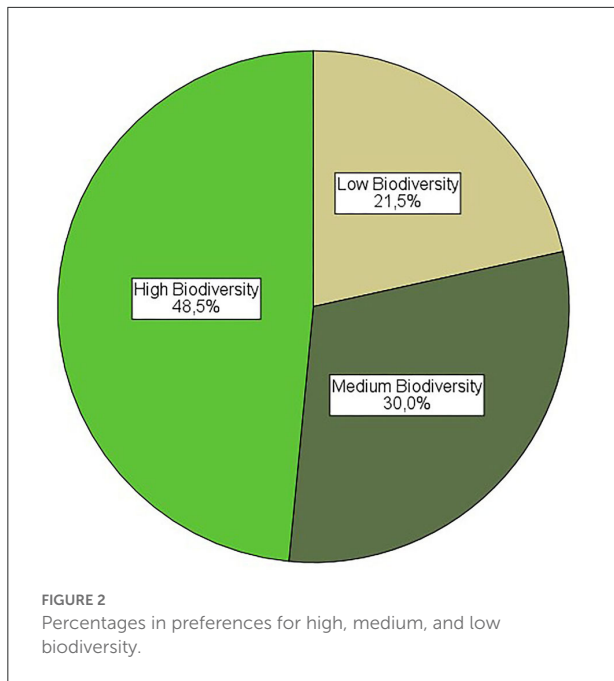
The survey took place from 3 May to 26 June 2021. A total of 431 people were interviewed, with a minimum of 50 persons in each survey situation (market/park) in each district.

## Statistical analyses

As a first step, variables of interest of the dataset were tested for their normality. The results of Kolmogorov–Smirnov test, histograms, and Q–Q plots showed that variables of interest were not distributed normally. Thus, non-parametric tests (Mann–Whitney *U*, Kruskal–Wallis *H*, and *post-hoc*/Games–Howell) were applied to make further analysis to understand the relations between explanatory and dependent variables. We interpreted data with descriptive and inferential statistics.

Non-parametric tests were performed to understand the relation between general willingness to be involved in PA and different variables such as demographic data.

We performed an explanatory factor analysis (FA) on our sample to see whether there is a significant relation in between the twelve specific PA, using a principal component analysis and varimax rotation. The minimum factor loading criteria were set to 0.40. The communalities of the scale, indicating the amount of variance in each dimension, were above 0.40, thus



ensuring acceptable levels of explanation. The FA revealed four factors distinguishing participation activities (“Commitment,” “Greening,” “Gardening,” and “Targeted Species Conservation”), which will be explained further in the results section.

We used nonparametric tests (Mann–Whitney  $U$ , Kruskal–Wallis  $H$ , and *post-hoc*/Games–Howell) to explain the relation between these four factors and different variables. All statistical analyses were carried out using IBM SPSS Statistics v.28.0.0.0 (190).

## Results

When we looked at the results for the UGS preference, respondents showed a notable preference for high biodiversity level. While 48.5 % of the respondents voted for UGS with high biodiversity level, 30 % of them preferred UGS with middle biodiversity level. Only 21.5 % of the people preferred UGS with low biodiversity level (see Figure 2).

Connectedness of the respondents to the city Berlin, their neighborhood, and the UGS in their neighborhood varies. The highest connectedness level (respondents who answered “I have a very strong connection”) was measured for “UGS in their neighborhood” with the rate of 50.2%. When we look at the results for “the city Berlin” and “the neighborhood,” the rates are 40.5 and 36.6%, respectively. About 34.7 % of the respondents reported a strong connection to “UGS in their neighborhood,” 44.6 % to “the neighborhood,” and 42.6 % to “the city Berlin” (see Figure 3).

About 69.4 % of the respondents answered “yes” for the question “Would you like to participate in the activities for Urban Green Spaces?” (General willingness for PA). Younger people ( $H = 31.937$ ,  $p < 0.001$ ,  $df = 3$ ), residents who lived in dense districts ( $U = 19,783.000$ ,  $p = 0.006$ ), people with a migrant background ( $U = 18,528.000$ ,  $p = 0.041$ ), environmental organization members ( $U = 7,602.500$ ,  $p < 0.001$ ), and people who started to live recently (<2 years) in Berlin ( $H = 13.355$ ,  $p = 0.010$ ,  $df = 4$ ) show higher general willingness rates compared to the others (see Table 1).

The time people were willing to invest in UGS activities was given in a free answering format, ranging from 0 h to over 8 h in a month (see Figure 4).

“Planting balconies and windowsills” is by far the most popular participation opportunity, followed by “Gardening in your own garden” and “Watering city trees” (see Figure 5). Less popular are “care assignments supervised by professionals” and “taking on sponsorships for certain green spaces.”

After performing a factor analysis, the empirical data reveal four BBS factors that can be distinguished in participation.

An important step involved weighing the overall significance of the correlation matrix through Bartlett’s Test of Sphericity, which provides a measure of the statistical probability that the correlation matrix has significant correlations among some of its components. The results were significant, chi-square ( $n = 336$ ) = 611.848 ( $p < 0.001$ ), which indicates its suitability for factor analysis. The Kaiser–Meyer–Olkin measure of sampling adequacy (KMO), which indicates the appropriateness of the data for factor analysis, was 0.766. In this regard, data with KMO values between 0.700 and 0.800 are considered good for factor analysis (Field, 2013). Finally, the factor solution derived from this analysis yielded four factors for the scale, which accounted for 56.7% of the variation in the data.

In the FA, items load on four dimensions significantly, and four factors were identified (Table 2). Based on the FA, we defined the factors as follows:

Factor 1 “Commitment” can be summarized as activities which require undertaking a responsibility and investing time/money on UGS. It includes the items “taking part in UGS planning,” “taking over sponsorship for UGS,” and “care assignments supervised by professionals.”

Factor 2 “Greening” can be explained as the activities in which habitants of the city can make their surrounding environment greener by participating in them. It includes the items “greening backyards,” “planting unused areas,” “watering city trees,” and “planting balconies and windowsills.”

Factor 3 “Gardening” includes the activities which support urban biodiversity by activities that people can do in different types of gardens in their cities. It includes the items “gardening in your own garden,” “gardening in allotment garden,” and “gardening in the community garden.”

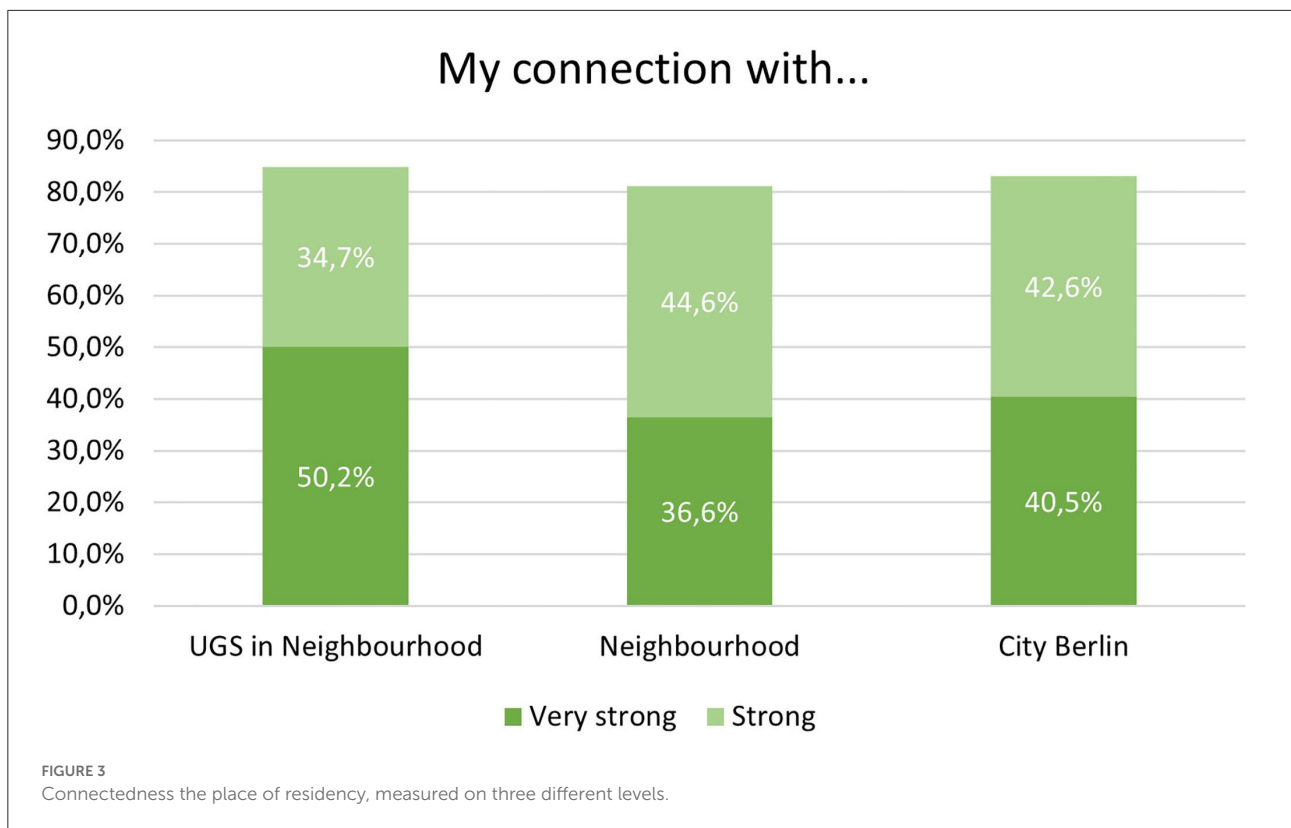


TABLE 1 Mann–Whitney *U*-test results for the participation willingness per sample.

Would you like to involve in the participatory activities for UGS? *N* = 425

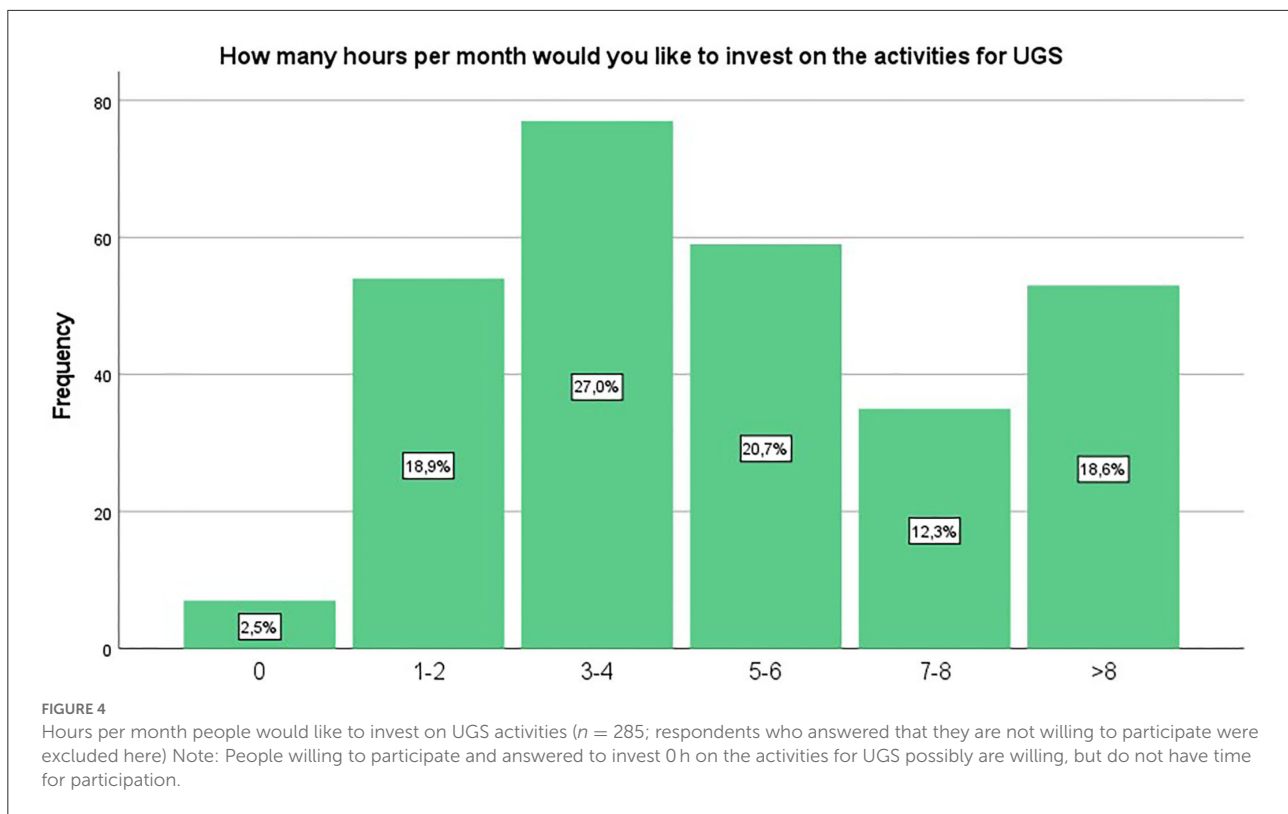
		<i>n</i>	Mean rank	Sum of ranks	<i>Z</i>	Mann-Whitney <i>U</i>	<i>P</i>
Density of living area	City center	213	226.12	48,164.00	−2,766	19,783	0.006
	Outskirts	212	199.82	42,361.00			
Migration background	With	148	226.31	33,494.00	−2,046	18,528	0.041
	Without	277	205.89	57,031.00			
Membership in an environmental organization	Member	58	262.62	14,969.50	−4,156	7,602.5	<0.001
	Non-member	367	204.72	75,130.50			

Finally, Factor 4 “Targeted Species Conservation” represents the activities to support the conservation of specific members of plant, animal, or mushroom groups. It includes the items “nest support” and “observe and count animals and plants”.

Our results demonstrate that different factors of BBS show significant relations with specific variables. Taking into consideration Factor 1 “Commitment,” our non-parametric tests reveal that people with a migrant background ( $U = 10,191.000$ ,  $p = 0.003$ ), the ones who answered “yes” to the general willingness for PA ( $U = 7,292.000$ ,  $p < 0.001$ ), and the ones who are a member of an environmental organization ( $U = 5,073.000$ ,  $p = 0.002$ ) are more aware of and willing to participate

in “Commitment” activities (see [Supplementary Table 1](#) and [Table 2](#)).

For Factor 2 “Greening,” tests demonstrate that female respondents ( $U = 11,648.000$ ,  $p = 0.037$ ), people who live in the city center ( $U = 9,744.500$ ,  $p < 0.001$ ), who are ready to invest in PA more than 8 h/week ( $H = 20.390$ ,  $p = 0.001$ ,  $df = 5$ ), and/or who are a member of an environmental organization ( $U = 5,686.500$ ,  $p = 0.034$ ) are more aware of and willing to participate in “Greening” activities. People who live <5 min from the specific parks have less awareness and willingness compared to the ones who live far from the parks ( $H = 11.931$ ,  $p = 0.018$ ,  $df = 4$ ).



When we look at the relations between Factor 3 “Gardening,” we observe that people who live in the city center ( $U = 10,663.500$ ,  $p < 0.001$ ) and who answered “yes” to the general willingness for PA ( $U = 6,280.500$ ,  $p < 0.001$ ) are more aware of and willing to participate in “Gardening” activities. Respondents who are over 64 years old ( $H = 30.835$ ,  $p < 0.001$ ,  $df = 3$ ) have less awareness and willingness than younger ones.

Lastly, when we look at the significant relations between Factor 4 “Targeted species conservation,” our results indicate that people who answered “yes” to the general willingness for PA ( $U = 8,561.500$ ,  $p = 0.003$ ) and the ones who are a member of an environmental organization ( $U = 4,910.000$ ,  $p = 0.001$ ) are more aware of and willing to participate in “Targeted Species Conservation” activities.

Another noteworthy result that we assessed is the effect of NR6 scores of respondents on other variables. The results on four factors of BBS and different variables reveal that “general willingness for PA” and “membership to an environmental organization” shows significant relations, four out of four and three out of four factors, respectively. When we look at the relation between NR6 scores and these two variables, we see that those who answered “yes” to the general willingness for PA ( $U = 15,212.500$ ,  $p < 0.001$ ) and who are a member of an environmental organization ( $U = 8,011.500$ ,  $p < 0.001$ ) have higher NR6 scores. According to the Pearson correlation

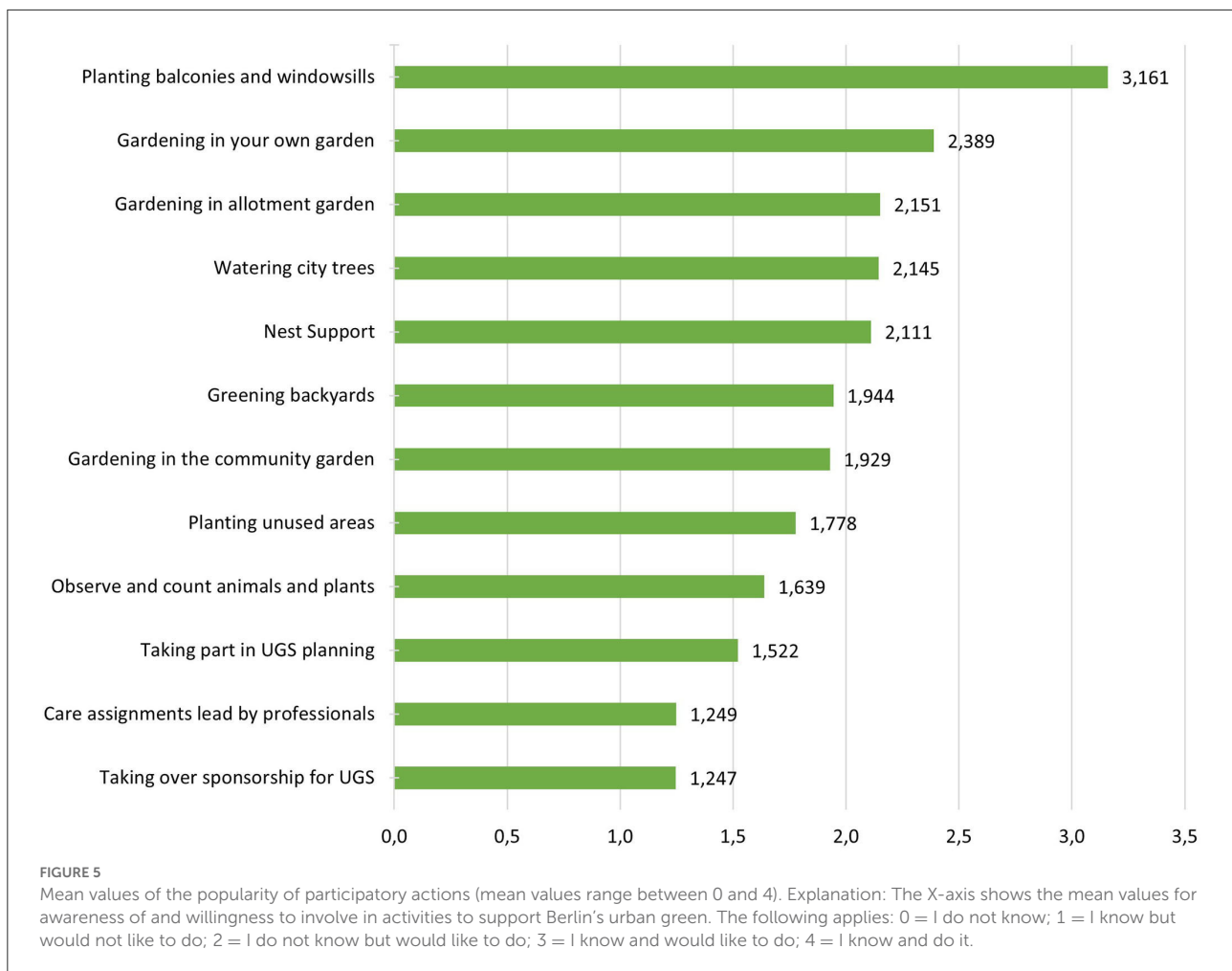
test, NR6 score of the respondents also correlates with three of the factors, which are “Commitment” ( $p = 0.199$ ), “Greening” ( $p = 0.253$ ), and “Targeted species conservation” ( $p = 0.199$ ) (Table 3).

## Discussion

The empirical study addressing biodiversity in an urban context shows some insights into the perception and participation of urban greenspace (UGS) by urban residents, which we will discuss along with the research questions.

### What level of biodiversity do urban residents prefer?

In our study, aesthetic preference was used as an indicator for the appreciation for biodiversity, by using the photo manipulation method offered by Fischer et al. (2018). Preference was assessed by photo scenarios representing different levels of biodiversity. Since biodiversity was not mentioned as a concept, we assume that respondents were able to rate their preference just by perceiving the pictures, without biases, by different biodiversity definitions or knowledge. The results show a clear preference for the park with high biodiversity condition



over medium or low biodiversity conditions. This is consistent with earlier studies focusing on neighborhood green spaces for specific user groups (Fischer and Kowarik, 2020) and should be considered in urban planning processes. Biodiversity, here measured by plant species richness, seems to be a need for urban habitants. We need to take this into account for the management of the current parks and the planning of new ones. Parks in an urban context, or at least some intended areas in parks, should be designed providing high species richness to meet the aesthetical needs of urban residents. Besides the preference of residents, this could also affect the quality of species richness on other levels. Urban biodiversity strategies function as preserving remnant natural habitats by planning, designing, and implementing green-infrastructure networks which provide a diversity of natural, restored, and constructed habitats that serve to improve conditions of biodiversity in urban areas (Beninde et al., 2015). For example, private or allotment gardens or urban parks create some vital microhabitats that serve a large diversity of flora, fauna, and fungi that residents can directly experience (Smith et al., 2006; Loram et al., 2008).

Although urban areas often contain far fewer species than rural areas, they retain the ability to hold endemic and sometimes diverse wildlife populations (Nilon et al., 2017) and urban areas can contain more species than rural areas in some cases (e.g., plant richness peaks at intermediate levels of urbanization; McKinney, 2008). Thus, UGS are more frequently being seen as important stepping stones for wider biodiversity conservation goals (Dearborn, 2010; Goddard et al., 2010), and as our results show, this diversity can also contribute to the positive experience of park users.

## How is the connectedness to the place of residency pronounced in urban residents?

### What role does the connectedness to nearby greenspace play?

When facing the connectedness to the nearby greenspace, the neighborhood, and the city—all indicators for the living



TABLE 2 FA results.

Items	Commitment	Greening	Gardening	Targeted species conservation
Taking part in UGS planning	0.700			
Taking over sponsorship for UGS	0.695			
Care assignments supervised by professionals	0.688			
Greening backyards		0.779		
Planting unused areas		0.711		
Watering city trees		0.577		
Planting balconies and windowsills		0.463		
Gardening in your own garden			0.769	
Gardening in allotment garden			0.732	
Gardening in the community garden			0.473	
Nest support (bird nest, bug hotel, etc.)				0.797
Observe and count animals and plants				0.598

Extraction method: principal component analysis. Rotation method: varimax with Kaiser normalization.  
a. Rotation converged in five iterations.

TABLE 3 NR6 and involvement of the habitants.

	NR6	Commitment	Greening	Gardening	Targeted species conservation	General willingness (PA)	Membership to an environ. org.
NR6	–						
Commitment	<b>0.199**</b>	–					
Greening	<b>0.253**</b>	<b>0.347**</b>	–				
Gardening	0.0058	<b>0.286**</b>	<b>0.268**</b>	–			
Targeted species conservation	<b>0.285**</b>	<b>0.350**</b>	<b>0.277**</b>	<b>0.139*</b>	–		
General willingness (PA)	<b>0.175**</b>	<b>0.225**</b>	<b>0.269**</b>	<b>0.318**</b>	<b>0.155**</b>	–	
Membership in an environ. org.	<b>0.114*</b>	<b>0.157**</b>	<b>0.117*</b>	–0.001	<b>0.181**</b>	<b>0.202**</b>	–

\*\* Correlation is significant at the 0.01 level (two-tailed).

\* Correlation is significant at the 0.05 level (two-tailed).

Bold values indicate significant correlations.

environment—residents showed strong connections (84.9, 81.2, and 83.1 %, respectively). This is consistent with earlier results showing people's strong attachment to their neighborhood on different levels (Hidalgo and Hernández, 2001). However, our empirical data of 431 persons show a higher connectedness to the UGS than to the neighborhood or the city of Berlin. This result indicates the importance of natural environments for identification. Urban planning needs to focus on this and use the potential for planning processes to keep or increase the quality of life for urban dwellers. The involvement of residents in planning processes by participation could here be a key factor to further support identification with the neighborhood and thus increase the quality of life.

### What role does residents' nature relatedness play?

“General willingness for participatory actions” (PA) and “membership to an environmental organization” are two

variables which have a crucial impact on the motivation to involve in PA, as these two variables show significant relations with four out of four factors and three out of four factors, respectively. Our results show that respondents who are members of an environmental organization and who are willing to be involved in PA have higher NR6 scores. NR6 scores are also in correlation with factors “Commitment,” “Greening,” and “Targeted species conservation.” We know that nature relatedness is a feature that affects sustainable behavior and therefore it should be promoted (Nisbet and Zelenski, 2014). This could be addressed by various activities as previous studies have been pointing out: early childhood experiences and past encounters in nature (Chawla, 1999), a regular nature contact, extended wilderness adventures (Kaplan and Frey Talbot, 1983), viewing photographs of nature (Weinstein and Brown, 2009), and even learning about natural history, biology, and geography seems to help people maintain a sense of nature relatedness and increased empathy for nature (Nisbet and Zelenski, 2014). If people have little exposure to nature or neglect opportunities

to immerse themselves in the natural environment, it may be difficult to feel protective or appreciative of nature. Conversely, if people enjoy their experiences in nature, it may motivate sustainable behavior (Hartig et al., 1997). Nature relatedness is linked with both well-being and concern about the environment. Acting sustainably may cause happiness and produce a positive feedback loop, thus promoting wellbeing (Brown and Kasser, 2005). With all these reasons, finding ways to promote nature relatedness is one of the important features of biodiversity conservation strategies.

### How is the willingness to participate on a general level?

Almost 70 % of the respondents would like to participate in UGS activities, revealing a high resource to support biodiversity in an urban context through participatory activities. Especially residents living in dense districts and people with a migrant background show high willingness to participate. Residents living in dense districts appear to have a high willingness possibly due to the lack of ability to shape their own environments (Martens and Frick, 2014). Residents with a migrant background, however, have not been much in focus in previous research yet. Thus, our results provide important information about not yet perceived resources to support urban greenspace.

Another group with significantly higher values in willingness to support UGS participatory activities is people who moved to Berlin recently. This might be due to the need for social interaction, which is enabled in natural environments better than in built environments (Verheij, 1996). Strategies to reach these people should be addressed to use the potential to support participation in UGS maintenance. This could be by information at the registration offices or flyers in the streets and *via* social media.

The high amount of people willing to participate in the design of UGS indicates that people can and should be integrated into planning and maintaining activities of UGS. This is especially the case for people who live in very dense districts since they have fewer possibilities for restoration in their daily life (Herbst, 2011) and people with a migrant background. Our results show that they provide a large potential on participatory activities to enhance urban biodiversity. However, participatory programs should address these groups, for example, by considering different languages in information material and events to include these groups. Another important aspect is the motivation, which does not necessarily need to be a desire to support biodiversity or nature protection, but could also arouse from social interactions, community building, and identification processes to reach different user groups.

### What is the willingness to participate in a specific activity?

While the willingness to participate is rather high on a general level, some specific actions are not as highly perceived. Listing a variation of twelve different participation activities shows that “planting balconies and windowsills” is by far the most popular participation opportunity, followed by “Gardening in your own garden” and “Watering city trees.” Less popular are “care assignments supervised by professionals” and “taking on sponsorships for certain green spaces.” This ranking could be due to the effort needed to take part in the specific action. Balconies and windowsills present a very low threshold to get active and participate in doing something, since the person can stay in their private surroundings and is able to harvest directly either flowers or vegetables. Other activities need some planning beforehand, such as searching an event and signing in on the internet. These processes need to be supported by the municipalities to lower the threshold for participation.

The factor analysis (FA) accounted with almost 60 % for a high percentage of the variance in the empirical data, thus providing a good indicator for the willingness to participate in specific activities (Döring et al., 2016). Four factors can be distinguished in participation, which were different in their perception and acceptance according to the willingness to participate. Factor 1 “Commitment” needs to be addressed in future to reach a higher participation level. Possibly, the threshold to take part in activities such as “taking part in UGS planning” and “taking over sponsorship for UGS” is rather high. Previous research showed that activities with a high amount of responsibility are linked to people with a high education background and language skills (Martens and Frick, 2014). Substantial efforts could be made to address people with lower education background or little language skills in German to lower this threshold.

Factor 2 “Greening” and factor 3 “gardening” provide higher values of participation in the given sample. These provide activities that are very practical. These activities seem to work well when communicating them to the public. These factors could be supported by specific activities to enhance biodiversity.

Factor 4 “Targeted Species Conservation” again needs some care if it is the aim of the city to support interactions with UGS.

### Limitations of the study

Our study shows results from a questionnaire answered by a very diverse group of 431 city residents. The willingness to participate was only assessed verbally; thus, we were not able to control for actual participatory actions. These might be lower than our results due to social desirability arousing when answering the questions and the gap between willingness and actual action. This needs to be addressed in further research.

Another limitation is identified by the non-parametric tests. The correlative character of our data analysis is rather explorative, and we cannot make causal statements about the relationship between different variables. Larger sample sizes could be the aim of further projects to use tests with the ability to make causal statements.

## Conclusion

The study shows the importance of UGS on a nearby local level for urban habitants. Urban planning processes should consider this, even under the condition of continuous urban growth pressure, to provide urban quality of life in the long term. Residents' participation can be a key task in this aim, showing a resource that has not yet been completely addressed.

While the management concepts in urban areas often have an insufficient budget for the maintenance of UGS, our results show that there is a high potential of residents from Berlin who actually want to be involved and are willing to get active. This implies that there is a need for participatory UGS activities, which can support the development of greenspace with high biodiversity. Activities with lower visible output (commitment and targeted species conservation) need to be addressed more closely to motivate participation.

An increasing number of people who live in urban areas and growing land coverage of cities are some of the factors which lead to biodiversity loss and climate change discursively. We can help conserve and preserve biodiversity by planning sustainable cities with determined and participatory urban biodiversity strategies. Participation of the residents in these strategies will both inform and motivate the people about the environment, which may lead us to a well informed and conscious as well as active community.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants

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provided their written informed consent to participate in this study.

## Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/frsc.2022.952790/full#supplementary-material>

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