Urban residents value multi-functional urban greenspaces

Roberts, Michaela; Glenk, Klaus; McVittie, Alistair

Published in:
Urban Forestry and Urban Greening

DOI:
10.1016/j.ufug.2022.127681

Print publication: 01/08/2022

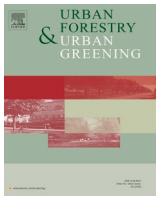
Document Version
Publisher's PDF, also known as Version of record

Urban Forestry & Urban Greening 74 (2022) 127681

Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

journal homepage: www.elsevier.com/locate/ufug



Original article

Urban residents value multi-functional urban greenspaces

Michaela Roberts [a,*], Klaus Glenk [b], Alistair McVittie [b]

[a] James Hutton Institute, Social, Economic and Geographical Sciences Group, Craigiebuckler, Aberdeen AB15 8QH, Scotland, UK
[b] Department of Rural Economy, Environment & Society, Scotland's Rural College (SRUC), Peter Wilson Building, Kings Buildings, West Mains Road, Edinburgh EH9 3JG, Scotland, UK

ARTICLE INFO

Handling Editor: Wendy Chen

Keywords:
Choice experiment
Stated preferences
Parks
Natural areas
Spatial heterogeneity

ABSTRACT

Urban greenspaces are multifunctional spaces, providing services to people and biodiversity. With space in urban areas being limited creation and maintenance of urban greenspaces relies on understanding the preferences of urban residents for their characteristics. Such preferences are expected to vary with current availability, and the availability of alternatives to greenspaces such as gardens or gyms. We carried out a nationwide discrete choice experiment with Scottish urban residents to estimate values associated with greenspace attributes of: recreational features; plants and natural features; trees; accessibility; time to walk from home and size, to test the hypotheses that: (i) people are willing to pay to maintain greenspace, (ii) people have willingness to pay for greenspaces with multiple functions, including features for direct use (e.g. play equipment) and biodiversity (e.g. wildflowers), (iii) willingness to pay for individual greenspace will vary according to socioeconomic characteristics and (iv) vary with the amount of greenspace or substitute facilities available. We find a positive willingness to pay to maintain greenspace in general, and higher willingness to pay for larger greenspaces closer to home, which are multi-functional and contain both direct use features (e.g. children's play park) and biodiversity features. Although we find significant heterogeneity in willingness to pay for maintaining greenspace, this is not well explained by either socioeconomic characteristics or the availability of substitute facilities. Our results have relevance for urban natural capital accounting, and demonstrate to urban planners the importance of the design and maintenance of multi-functional greenspaces for urban populations and would benefit from future research that further explores heterogeneity, including perceptions of greenspace access and substitutes, and greenspace quality.

1. Introduction

The multiple benefits of urban greenspace are widely documented, including benefits to both environment and people (Mäntymaa et al., 2021). Urban greenspaces can provide refugia for species whose habitats have otherwise been destroyed (Beninde et al., 2015; Theodorou et al., 2020; Knapp et al., 2021), as well as contributing to the liveability of cities with rapidly growing urban populations. Urban greenspaces provide space for recreation and relaxation, improve air quality (Haase et al., 2017; Fischer et al., 2018), and allow contact with nature, which has restorative effects (Hoyle et al., 2017; Fischer et al., 2018). The multifunctionality of urban greenspaces, however, can lead to competing interests within the space, as well as competing for land with other urban land uses, such as schools, health centres and housing (Smith et al., 2012; Mäntymaa et al., 2021). In the UK, funding for urban greenspaces in general has been in long-term decline (Heritage Lottery Fund, 2016), with real terms expenditure on parks falling by 18 % between 1979 and 2000, and likely exacerbated by UK fiscal austerity policies since 2010. As pressures on public funding increase this decline in funding, and associated greenspace quality, has become of national interest (Taylor, 2018). Understanding the value and preferences urban residents have for urban greenspace attributes can therefore contribute to planning decisions in urban landscapes to benefit both people and environment. Linking these values to spatial data, such as current urban greenspace provision, leads to further understanding of urban settlements current natural capital provision, and provides information on residents' values and preferences to link to urban and greenspace planning.

Connection to nature, such as that provided by urban greenspaces, has direct positive impacts on human wellbeing (Grilli et al., 2020), and an absence of nature within urban areas reduces access to these services (Apfelbeck et al., 2020). Urban residents also value experiences of

* Corresponding author.
E-mail address: Michaela.roberts@hutton.ac.uk (M. Roberts).

https://doi.org/10.1016/j.ufug.2022.127681
Received 4 March 2022; Received in revised form 11 July 2022; Accepted 12 July 2022
Available online 14 July 2022

nature provided by urban greenspaces for a variety of reasons, including opportunities for social or cultural connections for individuals (Ives and Kendal, 2014). Although the full range of urban greenspace services (e.g. space for relaxation) cannot be valued in monetary terms, preference can be revealed through the market via, for example, bird seed sales (Clucas et al., 2015) or higher house prices near to urban greenspaces (Brander and Koetse, 2011; Tu et al., 2016). Non-market values can also be estimated through stated preference modelling (Brander and Koetse, 2011; Clucas et al., 2015; Mäntymaa et al., 2021). In Scotland, urban greenspaces represent the most frequently visited areas for outdoor recreation, and account for 41 % of time spent outdoors (Office for National Statistics, 2021). Recreation spending in urban greenspaces (including visits to villages) was estimated at £190 million per year (or £0.73 per visit), the highest of any outdoor recreation destination in Scotland (Office for National Statistics, 2021). Given that most visits to urban greenspaces do not involve any spending, and that the value of £190 million is a lower bound of people's maximum willingness to pay to enjoy urban greenspace. This signifies the high importance of urban greenspaces across Scotland. The Covid 19 pandemic has further highlighted the importance of urban greenspace for health and wellbeing (Poortinga et al., 2021).

Although an important aspect of urban greenspace, biodiversity is not always the most favoured attribute by users (Qiu et al., 2013; Fischer et al., 2018) and in fact may be negatively perceived if higher levels of biodiversity lead to more 'untidy' areas (Hoyle et al., 2017; Lampinen et al., 2021), reduced ability to engage in recreation (Lampinen et al., 2021), or go against 'urban norms' (Lampinen et al., 2021). Urban greenspaces are required to be multifunctional. Hence, attributes such as cleanliness and maintenance (Bertram et al., 2017), visitor facilities such a cafés or toilets (De Valck et al., 2017; Grilli et al., 2020); and attributes to facilitate access, such as signed trails (De Valck et al., 2017), may be of equal or higher importance to natural features, including biodiversity (Bertram et al., 2017; De Valck et al., 2017; Grilli et al., 2020). Therefore, finding synergies between needs of people and the environment, and understanding heterogeneity in these needs, is important for allocating funds to urban greenspace planning and maintenance (Knapp et al., 2021). Although the use of urban greenspaces is increasing (Office for National Statistics, 2021), and recent Scottish legislation requires the creation of open space plans by local councils (Planning (Scotland) Act, 2019), there remain pressures due to declining public funding (Heritage Lottery Fund, 2016; APSE, 2021), and many urban greenspaces have been taken over completely or in part by private or community groups (van der Jagt et al., 2016; Mattijssen et al., 2017). With disparate groups responsible for management and development (Mattijssen et al., 2017), collective understanding of the preferences of citizens for urban greenspace attributes can be important to ensure that the multifunctionality of urban greenspaces persists, particularly as some types of citizen involvement do not always promote sustainable outcomes (Wamsler et al., 2020).

Stated preference methods, and specifically discrete choice experiments, are increasingly used in economics to elicit preferences for goods and their characteristics or attributes (Hanley and Czajkowski, 2019). In discrete choice experiment studies, respondents are provided with information relevant to making choices among hypothetical alternatives that describe alternative courses of action or states of the world (Mariel et al., 2021). These values can be impacted by an individual's socioeconomic or demographic characteristics, as well as spatial heterogeneity, such as the availability of alternative goods, in the environment. Heterogeneity in preferences elicited through stated preference methods is often thought to stem from these socioeconomic, demographic or spatial variations, but can frequently be poorly captured (De Valck et al., 2017; Năstase et al., 2019; Glenk et al., 2020).

Stated preference studies have been widely used to value urban greenspaces, and a number of meta-analyses of urban greenspace stated preference studies have been carried out over the last 10 years (Brander and Koetse, 2011; Perino et al., 2014; Bockarjova et al., 2020; Diluiso et al., 2021). Across studies, a positive preference for urban greenspace has been identified, with value varying with GDP per capita (Bockarjova, Botzen and Koetse, 2020), and population density (Brander and Koetse, 2011; Bockarjova et al., 2020). These meta-analyses focus on land uses (Brander and Koetse, 2011; Perino et al., 2014; Bockarjova et al., 2020) and ecosystem services (Bockarjova et al., 2020), with extensions to include calculated urban greenspace availability (Diluiso et al., 2021). Studies have predominantly been carried out at the city or region scale (Bockarjova et al., 2020; Diluiso et al., 2021).

We use discrete choice experiments to understand the willingness of Scottish urban residents to pay to maintain urban greenspaces, extending the existing understanding by accounting for spatial variation in urban greenspace availability at the individual level, and incorporating availability of partial substitutes for urban greenspace. Although these substitutes do not provide the full range of services provided by public urban greenspaces, areas such as private gardens, which provide some biodiversity and recreation opportunities (Hanson et al., 2021; Lehberger et al., 2021), and gyms or sports clubs, which provide dedicated spaces for physical exercise, may reduce the added value of urban greenspace for some users. We hypothesised that: (i) people are willing to contribute financially to maintenance of urban greenspace, (ii) people have a higher willingness to pay (WTP) for urban greenspaces which are multifunctional and contain features for direct use (e.g. play equipment) and biodiversity (e.g. wildflowers) than for those without, (iii) WTP for individual urban greenspace varies according to socioeconomic characteristics and (iv) the amount of urban greenspace or substitute facilities available. The results will have implications for urban land use planning and greenspace management, most notably through the linking of valuation data to spatial variation in urban greenspace (and potential or partial substitute) availability. As recent legislation in Scotland mandates that towns must have open space plans (Planning (Scotland) Act, 2019), the data provided can make a tangible contribution to urban areas spatial planning through the linking of values to asset registers based on GIS and spatial data. This could inform understanding of urban greenspace assets by local authorities including data requirements on greenspace features. Urban greenspace assets registers can in turn contribute to local level natural capital accounting. A wider contribution of understanding of heterogeneity in stated values could improve prioritisation of greenspace policy.

2. Methods

2.1. Survey design and implementation

A survey on urban greenspace by Scottish urban residents was piloted in January 2020, and the full survey was carried out between January and March 2020,[1] via an online survey panel with quota set for settlement size of either Category 1 (towns and cities with over 125,000 inhabitants) or 2 (towns with 10,000 to 125,000 inhabitants) in Scottish Urban-Rural classification (Scottish Government, 2018), gender and social grade. In addition to the discrete choice experiment, the full survey included questions of use of urban greenspace, capabilities for accessing urban greenspace and socioeconomic and demographic variables. The survey also collected full postcode data, allowing for estimation of urban greenspace availability by amount of urban greenspace and distance to nearest urban greenspace for respondents. For the full survey please see Supplementary materials.

The discrete choice experiment valuation scenario detailed the costs involved in maintaining urban greenspaces and described that one of two greenspaces presented on choice cards would continue to be maintained for an increase in council tax,[2] while the other would

[1] Preceding Covid-19 restrictions on movement in Scotland.

[2] Council tax is an annual local tax levied by local government in the UK, paid by households and broadly based on property values.

become unsafe for use (Fig. 1). The third alternative was a "neither" option (aka "status quo option"), which indicated that both greenspaces offered in the choice card would go without maintenance, and therefore become unsafe for use. This status quo description was chosen as there is a need for a common comparison while being unable to objectively ascertain the actual status quo conditions (i.e. the current allocation of urban greenspace) faced by many spatially dispersed respondents. Recent research (APSE, 2021) and national reporting (Taylor, 2018) shows a decline in urban greenspace to be a realistic outcome under current funding regimes, with which the public will be familiar. Each participant responded to eight choice cards (Fig. 1). The urban greenspaces varied across a number of different attributes relating to their multifunctional use, with an experimental design optimised for D-efficiency based in a multinomial logit (MNL) model with priors informed by the pilot study.[3] The attributes included: main greenspace features, natural features, tree presence, accessibility, size, time to walk from home (as a proxy for distance) and increase in council tax (Table 1).

2.2. Spatial data

We collected data on survey respondent's postcodes to enable derivation of a number of spatial indicators. In relation to spatial socio-economic indicators, we identified whether respondents lived in urban areas of over 50,000 inhabitants, and the deprivation level of the area according to the Scottish Index of Multiple Deprivation (Scottish Government, 2020b).

To understand the level of 'greenness' of a respondents home location, we derived two 'green' metrics. We first calculated proximity to the nearest urban greenspace. We derived walking distance using the ArcGIS 'calculate nearest' tool. 'Walking time' was used as the travel mode parameter with the centroid of the respondents post code as the starting point and the OS greenspace (Ordnance Survey, 2020) access points for 'General use' (as defined in the OS open greenspace map) greenspaces used as the destinations. The shortest time location was then selected by the tool by simulating walking routes.

Data on the area of urban greenspace within a 2 km radius of peoples' place of residents was derived by adding a 2 km buffer to the postcode centroids and using 'Pairwise intersect' with the OS greenspace polygons (Ordnance Survey, 2020) to calculate areas of urban greenspace within the 2 km radius. Greenspace types were grouped to match discrete choice experiment categories.

2.3. Data analysis

The choice data was modelled using a WTP space specification (Train and Weeks, 2005). To account for preference heterogeneity, we fit a mixed logit model, in which preferences are allowed to vary following a pre-defined statistical (random) distribution. We assume that an alternative specific constant (ASC, capturing the welfare change associated with a move away from the situation in the "neither" or 'opt-out' option) follows a normal distribution. The parameters of non-monetary attribute levels, which are all dummy coded (where a value of one indicates that an attribute level is present in a greenspace alternative), follow symmetrical triangular distributions.[4] Sensitivity to changes in tax amounts for greenspace alternatives are specified to follow a log-normal distribution. The estimation was performed using the *Apollo* package in R (Hess and Palma, 2019) using 5000 Sobol draws.

The relevant welfare measure of is compensating surplus, estimated following (Hanemann, 1984), adapted for the WTP space specification, as:

$$CS = \left[ln \sum \exp V^1 - ln \sum \exp V^0 \right] \quad (1)$$

where CS is the compensating surplus welfare measure, and V^0 and V^1 represent the value of the indirect utility functions before and after the change under consideration, ignoring the cost coefficient for V^1 because of the estimation in WTP space.

In our study, V^0 is described only by the ASC. We estimated WTP as well as 95% confidence intervals using the Delta method (Greene, 2008) for the full factorial of greenspaces that can be valued using this study, based on all possible combinations of attributes and thus greenspace features and characteristics, and demonstrate these values through selected greenspaces. We performed sensitivity analyses both with respect to distance bands used (300 m, 1 km, 2 km (reported here), and 4 km) and with respect to composition of elements included in total greenspace area within a distance band (general use, total area, specific use e.g. sports).

To investigate preference (WTP) heterogeneity, conditional WTP estimates for changes in urban greenspace attributes are derived for each sampled respondent based on individual conditional distributions derived from the mixed logit (random parameter) model. The expected value of marginal WTP for individual n can be approximated by simulation making use of Bayes' theorem (Train, 2003).

The estimation of the conditional WTP estimates is also derived using post-estimation options in the *Apollo* package in R (Hess and Palma, 2019). The conditional WTP estimates subsequently serve as dependent variables in ordinary least square (OLS) regressions, with respondent specific characteristics being explanatory variables.

3. Results

3.1. Descriptive statistics

The final survey was completed by 1021 respondents. Once those who did not provide postcode information, whose postcode information did not lie within urban areas, or those with suspected protest motives had been excluded, 866 responses remained for the WTP analysis. We classified respondents to have "protest" motives if they questioned the need for the collection and use of additional funds for urban greenspaces, and if respondents specifically stated that they "do not think the funding for urban green spaces should come from council tax", and/or that they "do not believe an increase in council tax will be used to maintain urban green spaces". The above motives indicate that respondents were not revealing their preferences for urban greenspace attributes but were rather making a statement of preferences or trust in the payment method. There was a slight trend for having no information on postcodes from younger respondents and female respondents, while no clear trends could be observed for income and education. The final sample was representative in terms of age, gender, settlement size, and ethnicity. Fewer respondents had children than the Scottish urban population, and a higher proportion stated they had no religion, were in good health, or held a degree level education (Table 2).

3.2. Willingness to pay estimates

The mean of the ASC is negative and significant. It shows that respondents exhibit a tendency to opt for maintaining urban greenspace that is not explained through the attribute information per se; they are willing to pay to maintain urban greenspaces in general. When comparing attributes, members of the public are willing to pay, on

[3] The experimental design was produced using NGENE (ChoiceMetrics, 2018).

[4] We also estimated a model with normal distributions for non-monetary attribute levels. The model using normal distributions outperformed the model using triangular distributions (gain of 9 points in the value of the log-likelihood function). Mean values are highly similar. We chose the model using triangular distributions as the preferred one, because we consider a defined preference range implied by a triangular distribution to be advantageous over potential long tails in normal distributions for the use of conditional WTP estimates to investigate preference heterogeneity

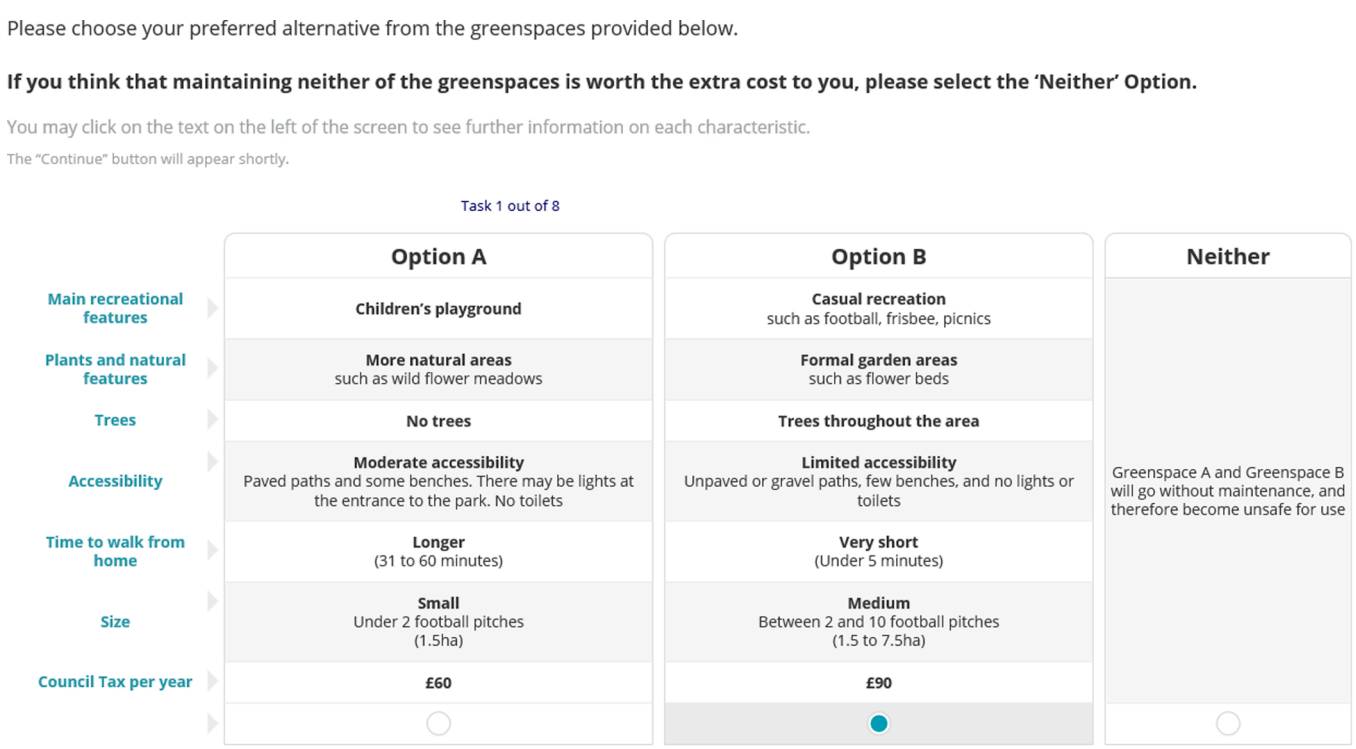


Fig. 1. Choice card example.

Table 1
Attribute levels presented in the discrete choice experiment. Each respondent received 8 choice cards. Text in brackets shows abbreviation for level used throughout other tables.

Attribute	Label	Level 1	Level 2	Level 3	Level 4
Main recreational features	REF	Children's playground (play)	Casual recreation such as football, frisbee, picnics (casual)	Designated sports area such as football pitches, tennis courts (sport)	*Limited suitability for recreation other than walking*
Plants and natural features	PNF	Formal garden areas such as flower beds (garden)	More natural areas such as wildflower meadows (natural)	*Grass only*	
Trees	TRE	Trees throughout the area (area)	Trees around the edges (edge)	*No trees*	
Accessibility	ACC	High accessibility (high) Paths are wide and paved, with many benches. There is lighting along the main paths and toilets.	Moderate accessibility (moderate) Has paved paths and some benches. There may be lights at the entrance to the park. No toilets.	*Limited accessibility Has unpaved or gravel paths, few benches, and no lights or toilets*	
Time to walk from home	TIM	Very short (Under 5 min)	Short (6–15 min)	Moderate (16–30 min)	*Longer (31–60 min)*
Size	SIZ	Small Under 2 football pitches (1.5 ha)	Medium Between 2 and 10 football pitches (1.5–7.5 ha)	*Large More than 10 football pitches (7.5 ha)*	
Council Tax per year	CT	£10; £30; £60; £90; £120; £180			

Note: omitted categories for dummy variables in models shown in italics.

average, considerable amounts to maintain urban greenspaces if they (i) are more accessible; (ii) have trees throughout and around the edges rather than no trees; (iii) have extra features such as formal garden areas or 'wild' areas. Respondents are also, on average, willing to pay extra if urban greenspaces can be used for dedicated activities other than walking such as casual recreation, and include children's play areas. These results indicate a preference for multifunctional spaces. Larger urban greenspaces are preferred to smaller ones. However, the marginal value per hectare of urban greenspace decreases with increasing size of the urban greenspace, indicating diminishing marginal benefits of urban greenspaces as they increase in size. Furthermore, closer urban greenspaces are preferred to those further away; here, WTP appears to first decrease slowly as walking time increases, but the decrease becomes increasingly steep as walking distance to the urban greenspace becomes greater than 30 min. There is also considerable spread around the mean for the majority of attribute levels, indicating high preference heterogeneity (Table 3 and Table 4).

3.3. Preference heterogeneity

3.3.1. Socioeconomic and respondent specific characteristics

We selected four attribute bundles reflecting typical and common urban greenspace types in Scotland to analyse heterogeneity in WTP (Table 5). The respondent characteristics used in the heterogeneity analysis are described in Table 6. Our assumptions about the relationships between the spatial characteristics of the respondents' neighbourhoods are summarised in Table 7. WTP related to the ASC, reflecting the value of saving any urban greenspace from discontinued

Table 2
Descriptive statistics for the 866 respondents used in the main analysis.

	Percentage	Median	Scottish estimates	Chi^2 p value
Countryside visit in past 12 months	73%			
Garden access	83%			
Over 65	21%		16%	0.47
Dependent children	24%		41%	0.02
Gender: female	49%		52%	0.78
Settlement size: large	51%		46%	0.57
Urban greenspace area		1.5 km^2		
No religion	52%		37%	0.046
Ethnicity: White	95%		95%	1
Good health	94%		82%	0.02
Income		£ 30–35k	27k*	
Degree education	47%		26%	0.003

Scottish urban population estimates shown where available. * Poverty and Income inequality Scotland. All others Scotland's Census 2011.

maintenance, is rather high in magnitude in relation to marginal WTP for attributes. As a result, variation in WTP values for urban greenspace may be dominated by the ASC component if it is included. Therefore, we analyse heterogeneity in WTP for attribute bundles without inclusion of the ASC, because variation in ASC does not reflect preferences for attributes, which are of interest in this section. Because of the potential relevance for aggregation of value estimates, however, we also report results of regressions with WTP for urban greenspaces based on both attribute bundles and the ASC as the dependent variable.

With respect to age, gender, income and whether a child lives in the household, the clearest association with WTP for urban greenspace is found for age (Table 8). Relative to under 30 s, older respondents tend to have a lower WTP for the continued maintenance of selected urban greenspaces GS1–GS4. WTP drops consistently with age. Having children is positively but not significantly associated with WTP (Table 8).

As may be expected, having used urban greenspaces in the past 12 months has a positive association with WTP. Finally, being a member of an environmental organisation or a member of a sports club or gym is also positively associated with WTP (Table 9). Compared to those in the least deprived quintile areas those living in more deprived areas (MD_1 is the most deprived quintile) tend to have higher WTP, though there is no impact of settlement size (Table 10).

3.3.2. Urban greenspace availability

Neither of the spatial indicators of distance and substitute availability (quantity within distance) were found to have an effect on WTP (Table 11). However, having access to private and shared gardens is positively associated with WTP (Table 9) suggesting these are not substitutes for urban greenspace. We ran additional models including greenspaces from 300 m to 4 km away and found little change in relationship than reported here.

4. Discussion

Overall, respondents had a positive WTP to maintain access to urban greenspaces, with higher demand for larger urban greenspaces closer to home, although with diminishing marginal utility when considering walking time from home and size of greenspace, in line with similar studies (Brander and Koetse, 2011; Grilli et al., 2020). Although there is no empirically driven 'rule' to define market extent (distance decay); it seems equally unreasonable to assume that value would not decrease with distance and thus aggregate benefit estimates without limits, especially since survey respondents expressed a clear preferences for parks closer from home. An approach that can be easily implemented with our data is to apply a cut off of 30 min based on Natural England recommendation that all people have greenspace access within 2 km of their home (Handley et al., 2003). If data on the use frequency-distance relationship was available, it could be used to define a distance where greenspace use likely falls to a zero, or a low background level. An alternative option is to draw on existing literature regarding distance decay for greenspace values as, for example, reported for the meta-analysis conducted by Perino et al. (2014).

Respondents preferred urban greenspaces with higher accessibility and with 'direct use' features and natural features, demonstrating a preference for multifunctional spaces. Preferences for natural features are seen in previous studies, including wildflower meadows (Southon et al., 2017) and forests (Smith et al., 2012). The value of multifunctionality of natural features alongside recreational features is being

Table 3
Results of mixed logit model of urban greenspace discrete choice experiment data. For multinomial logit see Appendix A.

	Mean ((log)normal distribution) **Lower bound** (triangular distribution[a])		**Standard deviation** ((log)normal distribution) **Spread/2** (triangular distribution)		**Derived mean and spread**[a] (triangular distribution)	
	Coefficient	t-ratio	Coefficient	t-ratio	Mean	Spread
ASC[b]	**-1.13**	-13.46	**1.39**	18.45	–	–
REF – play	**-0.31**	-2.59	**0.44**	3.69	**0.11**	**-0.63;0.85**
REF – casual	**0.63**	6.28	**-0.59**	-5.74	**0.12**	**-0.31;0.56**
REF – sports	**-0.63**	-5.76	**0.74**	7.14	0.04	**-0.55;0.63**
PNF – garden	-0.14	-1.47	**0.45**	4.91	**0.16**	-0.01;**0.33**
PNF – natural	-0.01	-0.05	0.17	1.02	**0.30**	-0.14;**0.75**
TRE – area	**0.86**	8.43	**-0.49**	-4.68	**0.29**	**-0.15;0.74**
TRE – edges	**-0.16**	-1.76	**0.45**	5.05	**0.37**	-0.12;**0.86**
ACC – high	0.14	0.6	0.09	0.37	**0.45**	**-0.33;1.22**
ACC – moderate	**1.22**	14.71	**-0.77**	-8.88	**0.23**	0.14;0.32
TIM – 30 min	**0.53**	4.32	**-0.33**	-2.64	**0.21**	-0.12;**0.53**
TIM – 15 min	0.05	0.3	0.2	1.1	**0.25**	0.05;**0.45**
TIM – 5 min	**0.66**	4.65	**-0.35**	-2.43	**0.31**	-0.04;**0.66**
SIZ – small	**-0.36**	-2.73	**0.26**	1.97	**-0.21**	**-0.36**;− 0.05
SIZ – medium	**-0.37**	-1.95	0.16	0.86	**-0.10**	**-0.37**;0.15
CT[c]	**0.90**	16.07	**0.64**	7.93	–	–

Note: Value of the Log-Likelihood function at convergence: − 6703.22; McFadden's Rho squared: 0.22; Estimates that are significantly different from zero at the 10 % level are shown in bold; [a] Given an estimate for lower bound or minimum value (lb) and an estimate of spread/2 (s_2), the derived mean is $lb+s_2$; the upper bound or maximum value is $lb + 2^* s_2$; [b] Alternative specific constant associated with "neither" option; [c] Values reported are the mean m and standard deviation sd associated with a log-normally transformed (negative of the) Council Tax attribute, and therefore the corresponding mean of the lognormal distribution is $\exp(m + sd^2/2)$; The CT (Council Tax) attribute was rescaled by 1/100, which means that the ASC and non-monetary attribute coefficients need to be multiplied by 100 to derive WTP estimates.

Table 4
WTP estimates and 95 % confidence interval based on urban greenspace discrete choice experiment data. Values in GBP per household and year.

	Mean	95 % confidence interval	
		Lower bound	Upper bound
ASC[a]	**113.14**	96.67	129.62
REF – play	**11.03**	6.07	15.99
REF – casual	**12.33**	7.83	16.83
REF – sports	3.84	-0.96	8.65
PNF – garden	**15.91**	11.74	20.07
PNF – natural	**30.41**	26.30	34.51
TRE – area	**29.19**	25.26	33.12
TRE – edges	**36.97**	32.5	41.44
ACC – high	**44.53**	39.64	49.41
ACC – moderate	**22.86**	18.65	27.08
TIM – 30 min	**20.85**	16.34	25.36
TIM – 15 min	**24.95**	20.27	29.62
TIM – 5 min	**30.99**	25.66	36.31
SIZ – small	**-20.82**	-24.61	-17.02
SIZ – medium	**-10.38**	-14.12	-6.63

Note: Confidence bounds derived via the Delta method (Greene, 2008); Estimates that are significantly different from zero at the 10 % level are shown in bold; [a] This describes the welfare change associated with a move away from the situation in the "neither" option (loss of safe access to urban greenspaces shown in choice tasks)

increasingly recognised. In Finland the improvement of greenspace to serve ecological, cultural and services was estimated to lead to an increase in value of 66 %, compared to 14–21 % for each service alone (Mäntymaa et al., 2021). Preferences for elements of multifunctionality may also be influenced by the ways in which people use greenspaces (De Valck et al., 2017). Given the people's use of greenspace is also not static, future research may look at multifunctionality of the selection of greenspace available to individuals around their home and work environment to meet multiple needs. It is also to ensure that multifunctional developments do not lead to the overshadowing of one function, such as commercial vs ecological needs (Mäntymaa et al., 2021).

The payment method was set as council tax, a tax based roughly on property prices paid by most households in Scotland. Although council tax varies by property price, mean council tax in the period of the survey was £ 1308/household/year (Scottish Government, 2020a). For the common urban greenspaces presented we therefore estimate a WTP an increase in council tax of 13–16 % for the average household for the typical and common greenspaces used elsewhere in analysis, or as much as 21 % for a greenspace with the 'best' level of each attribute. Given the level of reporting of funding it is not possible to determine exactly the amount of council tax which is used to maintain urban greenspace in Scottish councils. However, Edinburgh council reports approximately 5 % (~ £70/year) of council tax for a Band D (average) household on environment, including maintenance of urban greenspace but also waste collection (City of Edinburgh Council, 2021). Despite the uncertainty surrounding exact urban greenspace spending, it is clear that urban residents would support a significant increase in funding of urban greenspaces.

The ASC (opt-out, both greenspaces become unsafe for use) and associated implicit price are considerably larger than the values for the attribute levels. We suggest that this arises from a strong preference for any type of urban greenspace relative to the features within that greenspace. This may also stem from the difficulties in defining the status quo levels for the attributes. The existing levels of our attributes were both unobservable, and will vary for each respondent, consequently we needed a common status quo or counterfactual. Our choice of the greenspace becoming unsafe to use is arguably less extreme than complete loss (much urban greenspace is legally protected from development so full or partial loss is unlikely). However, a problem remains that the meaning and understanding of 'unsafe' is likely to vary across respondents both in terms of respondent and greenspace characteristics.

Although we find a positive WTP there is significant preference heterogeneity, which is partly explained by our socioeconomic or urban greenspace availability variables. The clearest indicator of WTP was associated with age, with those over age of 30 having a lower WTP than those under 30, and WTP dropping consistently with age. That those aged over 65 have the lowest WTP is in line with previous studies, which find less use of urban greenspace by older people (Boyd et al., 2018), though this finding is not universal and may depend on the way in which people engage with the space (Ode Sang et al., 2016; Fischer et al., 2018). Our data indicate that a smaller proportion of older respondents use greenspace daily, and a larger proportion less than monthly, but between those (several times a week but less than daily or less than weekly but more than monthly) the proportions are similar across all age groups. Further, older respondents spend longer in greenspace when they visit. It is somewhat surprising that income, gender and dependent children did not impact WTP as these are recognised in previous studies as predicting increased use (Boyd et al., 2018), which is typically, and indeed in this study, correlated to WTP.

We do find a higher WTP for urban greenspace (small park with a children's play area) in those who live in the most deprived areas compared to those who live in the least deprived areas. Access to urban greenspace varies with deprivation, with higher deprivation predicting reduced access to parks (Ferguson et al., 2018) and often reporting lower urban greenspace use (Boyd et al., 2018). Higher deprivation is also associated with higher population densities, which is often positively associated with WTP for urban greenspace (Brander and Koetse, 2011). These studies therefore suggest that those in higher deprivation areas have reduced access to urban greenspaces suitable for use, such as parks, and those urban greenspaces that they do have are likely to be overcrowded due to higher population densities. Although the total urban greenspace area may therefore not differ, access to higher quality urban

Table 5
Urban greenspace types for WTP heterogeneity analysis.

Greenspace	Description	Attributes (see Table 1)						Mean WTP (£/hh/year) *
		Main re-creational features (REF)	Plants and natural features (PNF)	Trees (TRE)	Accessibility (ACC)	Size (SIZ)	Time to walk from home (TIM)	
GS1	Small park with children play area	Children's playground	Grass only	No trees	High	Small	Short (6–15 min)	173.94
GS2	City park with flower beds	Casual recreation such as football, frisbee, picnics	Formal garden areas such as flower beds	Trees around the edges	Moderate	Small	Short (6–15 min)	206.24
GS3	Public golf course	Designated sports area	Grass only	Trees throughout the area	Low	Large	Short (6–15 min)	172.37
GS4	'Green' lawn with 'semi-natural' features	Limited suitability for recreation other than walking	More natural areas such as wildflower meadows	No trees	Moderate	Medium	Short (6–15 min)	182.15

* Including ASC.

Table 6
Variables used in WTP heterogeneity analysis.

Variable	Description
CityLarge	= 1 if place of residence is in City > 50,000 inhabitants
MD_1	= 1 if Scottish index of multiple deprivation quintile is 1: most deprived
MD_2	= 1 if Scottish index of multiple deprivation quintile is 3
MD_3	= 1 if Scottish index of multiple deprivation quintile is 4
MD_4	= 1 if Scottish index of multiple deprivation quintile is 4
Dist_ParkL	Natural log of walking distance to closest public park or garden from place of residence
TGS_ha_2kmL	Natural log of total area of greenspace within 2 km radius around place of residence
GUse_ha_2kmL	Natural log of area of general use greenspace within 2 km radius around place of residence
age_30_44	= 1 if age = 30–44
age_45_64	= 1 if age = 45–64
age_65plus	= 1 if age > 65
female	= 1 if respondent is female
Inc2	= 1 if annual household income > £25k and < 40k
Inc3	= 1 if annual household income > £40k
incmiss	= 1 if income data is missing
YChild	= 1 is respondents states that children < age 18 stay in household
Envorg	= 1 if respondent is member of an environmental organisation
Gym	= 1 if respondent is member of sports club or gym
GardenPriv	= 1 if respondents has access to private garden
GardenShare	= 1 if respondents has access to shared garden
GSUser	= 1 if respondent states to have used greenspace in past 12 months

greenspaces may be lower. More deprived areas may also have fewer alternative options to provide the services that urban greenspace provide, such as gyms or social clubs, although we did not consider these in this study. This would indicate fewer substitute sites, and therefore predict a higher WTP for maintenance of a single urban greenspace. Although previous studies have found higher WTP for urban greenspace in deprived areas overall (Brander and Koetse, 2011), this is not universal across all urban greenspace attributes, with finch conservation (Clucas et al., 2015) and wildflower meadows (Southon et al., 2017) both being preferred less in more deprived areas. This may indicate a difference in values between the 'direct use' (e.g. children's play area) attributes and those that provide more indirect benefits.

We expected that the presence of alternative exposures to biodiversity (e.g. garden) or options for physical activity (e.g. sports club) would lead to reduced WTP for urban greenspaces, in line with recent studies, which find public urban greenspace of more importance to those without gardens (Poortinga et al., 2021). However, our survey shows the opposite effect; respondents with gardens or members of sports clubs have a higher WTP to maintain urban greenspace. This suggests that the services provided by gardens and sports clubs do not offer a substitute to those offered by public urban greenspaces, but a complement. In studies of the contributions of gardens to people, the services provided were identified as the activity of gardening, growing and consuming of edible plants, providing a space for privacy with nature, and an extra room for socialising during the summer months (Hanson et al., 2021; Lehberger et al., 2021), with gardens not being subject to the same disservices (e.g. litter) as public urban greenspaces (Lehberger et al., 2021). In previous studies, frequency of use of urban greenspace was unrelated to having a garden, though willingness to trade private urban greenspace for increased public urban greenspace was impacted by the quality of respondents local urban greenspace, suggesting that high quality urban greenspaces may be substitutable with private gardens (Schindler et al., 2018). Garden-owners have also been found to spend more time overall in urban greenspaces than non-garden owners (Lehberger et al., 2021), which may indicate a higher preference for urban greenspaces, though it may also reflect the easier access to gardens compared to public urban greenspaces. The habituation effect, whereby individuals value a good higher because they are already familiar with the value it holds (Abildtrup et al., 2013), may also lead to increased value of greenspace by garden owners. Our data do show that higher income households are

Table 7
Assumptions about impacts of neighbourhood characteristics on willingness to pay.

Spatial characteristics/ neighbourhood characteristics related to respondents' place of residence	Available information in dataset	Expected effect (s) on WTP in order of relevance (own judgement)	Rationale
Locality (Large City – Smaller Town)	• Population size/ Size of town of residence • 6-class urban rural classification for Scotland • Respondent self-reported town size	+, 0	• Greater demand for UGS in larger cities – UGS relatively scarce -> higher WTP • However, high quality public UGS provision is also not guaranteed for smaller cities (who e.g. may have less funds) -> no difference in WTP
Level of deprivation	• Scottish index of multiple deprivation (see Scottish Government, 2019)	-, 0, +	• Likely lower available income if in more deprived areas -> lower WTP • High deprivation likely implies other priorities (than UGS) -> lower WTP • Lower use of UGS in deprived areas (suggested by survey data and Scottish Household Survey) -> lower WTP • Lower satisfaction with existing UGS in deprived areas (Scottish Household Survey) -> higher WTP
Proximity to closest UGS	• By UGS type (cemetery, bowling green, golf course, play space, playing field, public park, allotments), in minutes walking time and kilometres	+ (on WTP for UGS) - (greater negative WTP for increased walking TIME)	• Closer distance may be linked to greater use; more likely to visit if within 5 min walk (Colley and Irvine 2018), thus -> higher WTP (although UGS valued in discrete choice experiment is not closest UGS) • Sorting behaviour & revealed preference – proximity to UGS may become criteria for housing choice, thus closer UGS, greater appreciation -> higher WTP

(*continued on next page*)

Table 7 (*continued*)

Spatial characteristics/ neighbourhood characteristics related to respondents' place of residence	Available information in dataset	Expected effect (s) on WTP in order of relevance (own judgement)	Rationale
			• General distance decay (Glenk et al., 2020), closer UGS -> higher WTP • Close distance (e.g. to preferred UGS type) may suggest being less tolerant of it being further away (impact on TIME)
Area of UGS in local area	• Area of various UGS types for 4 distance bands used – 300 m, 1 km, 2 km, 4 km • UGS types include e.g. total greenspace; casual recreation; allotment; general use; play space; sport (various)	- (for greater availability)	• Reflection of substitute availability – greater availability of substitute UGS sites should lower demand -> lower WTP (Glenk et al., 2020; Holland and Johnston, 2017; Granado-Díaz et al. 2020)

more likely to have access to private gardens than lower incomes households suggesting that WTP for urban greenspace is also a function of ability to pay.

Our final anticipated source of preference heterogeneity was the urban greenspace already available to respondents. Because respondents in greener areas have access to substitute urban greenspaces (either in number or size), we expect that they would have a lower WTP to protect any single urban greenspace. However, this was not reflected in our results, and neither distance to nearest urban greenspace nor area of urban greenspace in the surrounding area was a significant predictor of WTP. A similar non-effect of spatial variation was observed in the meta-analysis of contingent valuation of urban greenspaces (Diluiso et al., 2021). Our results may have arisen due to limitations in our measurement of urban greenspace. We considered only areas of publicly available urban greenspace, while views of other people's gardens, or the presence of street trees, may also impact utility. Although we accounted for urban greenspace area, we did not consider the type of urban greenspace. Spaces that are substitutable vary according to the activity undertaken, for example, dog walking typically has low requirements for specific features, and high requirement to be close to home, and therefore has more potential substitute sites than, for example, hiking (De Valck et al., 2017). We considered only urban greenspaces as substitutes, while some substitutability has been found between urban and natural outdoor areas in individuals with a preference for urban infrastructure (Năstase et al., 2019). For those who prefer natural environments distance was found to be of little importance when selecting recreation destinations (Năstase et al., 2019). We also did not probe the respondent's perceived endowments of urban greenspace types and characteristics, which they may have used to make comparisons with the discrete choice experiment options, i.e., we did not observe their perceived substitutes. Finally, the status quo alternative in this instance was that the greenspace would become unsafe for use due to reduced maintenance. However, this may not impact the natural elements of the space, such as trees and flowers. Respondents may therefore have considered more important the 'direct use' features of the space to protect.

Given the limited ability of our socioeconomic data or availability of substitutes to explain heterogeneity in WTP, future work should consider alternative explanations for differences, such as the quality of available urban greenspace substitutes. Such variation in quality may explain the higher WTP we find for respondents in more deprived areas, who often have reduced access to urban greenspace of good quality for use (Ferguson et al., 2018). In a similar vein, we considered the availability of urban greenspace as a uniform good; we did not differentiate between urban greenspace types. The consideration of substitutes is complicated by the variety of types, functions and uses of urban greenspace (Glenk et al., 2020). Our survey respondents ranked walking and cycling paths, general use greenspace and play areas as the urban greenspace features most important to them in their most frequently used greenspaces. The focus of our valuation scenario was a specific set of greenspace features, many of which are not observable in available greenspace spatial data. We took the approach of researcher-identified substitutes, rather than those identified by greenspace users. While this improved the practicality of assessing substitute availability, it may not have covered those spaces that respondents may consider substitutable (Glenk et al., 2020). Individuals may vary in their preference for urban greenspace types, and perceive a wider definition of urban greenspace than that available to be mapped (De Valck and Rolfe, 2018). The spatial configuration of different urban greenspace types is also important (Qiu et al., 2013), and is absent in our discrete choice experiment which considered only hypothetical urban greenspaces. Future work would benefit from focusing on the detailed spatial context of respondents' preferences to better inform urban planning. This would be better achieved in a study of specific greenspaces within a defined spatial context rather than a nationwide survey as applied here.

Individual characteristics beyond socioeconomic characteristics may also explain heterogeneity in preferences (Ives and Kendal, 2014; Fischer et al., 2018). 'Nature Orientated' people had higher preferences for urban greenspace sounds and aesthetics than non-nature orientated people in medium and higher biodiversity areas (Gunnarsson et al., 2017). Experience also shapes preferences, be that experience with greenspace in rural or urban settings at home (Rambonilaza and Dachary-Bernard, 2007) or through actively visiting urban greenspaces (Tu et al., 2016). Preferences can also be linked to social capital and social norms (Smith et al., 2012; Lampinen et al., 2021), self and family identity, cultural history and place attachment (Smith et al., 2012). Where planners and policy makers wish to target development to a specific group, such as infrequent urban greenspace users, understanding the individual relationships to urban greenspace preferences will be particularly important.

The transferability of these results must also be considered. Scotland has a relatively stable and mild climate, particularly in the urban areas focused on in this study. As such outdoor recreation is accessible throughout the year, and risks such as wildfires are low, which may not be the case in all locations, particularly in Northern continental Europe or the Mediterranean, leading to different relationships with urban greenspaces (Fischer et al., 2018). Although our sample is representative of the Scottish population, care must also be taken in transferring values to areas with higher ethnic diversity, which can elicit different preferences for urban greenspace attributes, as well as socioeconomic and geographic contexts (Fischer et al., 2018). Finally, it is important to note that our survey took place in February and March of 2020, and, therefore, narrowly preceded Covid 19 restrictions in Scotland. Use of urban greenspace during Covid restrictions changed (Day, 2020; Schio et al., 2021), and with it citizens assigned increased importance to urban greenspaces for recreation, although this importance was already high pre-Covid 19 restrictions (Schio et al., 2021). We do not yet know how movement and social contact may continue to be restricted as we learn to live with endemic Covid 19, but it is likely that the importance of

Table 8
WTP for urban greenspace in relation to selected socioeconomic indicators. Correlation matrix presented in Supplementary material.

	GS1 no ASC	GS2 no ASC	GS3 no ASC	GS4 no ASC	ASC	GS1 with ASC	GS2 with ASC	GS3 with ASC	GS4 with ASC
age_30_44	-2.62	**-1.96***	**-2.84***	-0.34	**-54.21*****	**-56.83*****	**-56.17*****	**-57.05*****	**-54.54*****
age_45_64	-2.83	**-2.54***	-1.79	-0.78	**-48.31*****	**-51.14*****	**-50.85*****	**-50.10*****	**-49.08*****
age_a65	2.99	-2.36	-0.35	-1.14	**-47.74*****	**-44.74*****	**-50.09*****	**-48.09*****	**-48.87*****
female	4.23	0.24	-0.42	-0.79	12.54	**16.77***	12.78	12.12	11.75
inclow	-1.27	-1.51	1.31	-0.62	**-26.58***	**-27.84****	**-28.09****	**-25.26****	**-27.20****
incmed	-2.78	-0.56	-0.78	-1.06	-13.91	-16.69	-14.47	-14.69	-14.97
incmiss	**10.94****	1.19	1.21	-1.92	-15.40	-4.46	-14.21	-14.18	-17.32
YChild	1.55	-0.14	0.26	-0.07	0.89	2.44	0.74	1.14	0.82
ENVORG	-4.00	1.05	1.36	0.95	**22.05***	18.05	**23.11***	**23.41***	**23.01***
GYM	-1.11	0.80	0.47	-0.10	3.90	2.79	4.70	4.37	3.79
GSUSER	2.61	1.40	0.76	0.24	**28.91***	**31.52****	**30.31****	**29.67****	**29.15****
GardenPriv	2.63	0.71	1.77	0.83	**40.35*****	**42.98*****	**41.06*****	**42.12*****	**41.18*****
GardenShare	4.29	-0.13	1.56	0.16	**38.48****	**42.77*****	**38.36****	**40.04*****	**38.64****
CityLarge	1.49	1.07	0.18	0.92	**17.87***	**19.36****	**18.95***	**18.05***	**18.79***
MD_1	**8.31*****	0.55	0.10	0.23	18.29	**26.59****	18.83	18.39	18.52
MD_2	3.44	-1.36	1.54	0.13	**33.02****	**36.46*****	**31.66****	**34.56*****	**33.15****
MD_3	**7.94*****	1.06	0.15	-0.52	16.16	24.09	17.22	16.31	15.64
MD_4	4.62	1.14	0.42	0.24	**26.87***	**31.49****	**28.01****	**27.28***	**27.11***
Dist_ParkL	0.45	-0.07	-0.30	**-0.54***	-3.40	-2.95	-3.47	-3.71	-3.94
GUse_GS_ha_2L	-2.44	-0.85	-0.40	0.08	-4.65	-7.09	-5.49	-5.05	-4.56
TotGS_ha_2L	0.16	0.91	0.41	-0.63	-2.39	-2.23	-1.48	-1.99	-3.02
Constant	58.65***	90.46***	55.21***	70.48***	**97.43****	**156.09*****	**187.89*****	**152.64*****	**167.91*****
Adj. R2	0.04	0.01	0.01	0.004	0.05	0.05	0.08	0.06	0.05
N	695	695	695	695	695	695	695	695	695
Reduced variables model									
age_30_44	-2.59	**-1.62*****	-0.96	-0.24	**-28.88*****	**-31.47****	**-30.5****	**-29.84****	**-29.12****
age_45_64	-3.15	**-2.81*****	-1.64	-0.51	**-33.07*****	**-36.22*****	**-35.88*****	**-34.71*****	**-33.58*****
age_65plus	2.21	-2.98	-0.47	-1	**-37.85*****	**-35.64*****	**-40.83*****	**-38.32*****	**-38.85*****
female	**3.21****	-0.43	-0.46	-0.48	12.52	**15.73***	12.09	12.06	12.04
Inc2	1.65	**-1.24***	1.39	-0.13	-6.80	-5.15	-8.05	-5.41	-6.93
Inc3	0.21	0.06	1.01	0.32	16.09*	16.30	16.15	**17.1***	**16.41***
incmiss	**10.35*****	2.05	-1.41	-1.1	-10.58	-0.23	-8.53	-11.99	-11.68
YChild	1.78	-0.28	-0.33	0.09	4.24	6.03	3.96	3.91	4.33
Constant	55.95***	94.9***	58.95***	68.44***	127.7***	183.65***	222.6***	186.64***	196.14***
Adj. R2	0.002	0.01	0.003	0.002	0.03	0.02	0.02	0.02	0.02
N	866	866	866	866	866	866	866	866	866

*,**,*** Significant at 10 % level; 5 % level; 1 % level; significant coefficients related to variables in bold.

Table 9
WTP for urban greenspace in relation to selected respondent-specific characteristics.

	GS1 no ASC	GS2 no ASC	GS3 no ASC	GS4 no ASC	ASC	GS1 with ASC	GS2 with ASC	GS3 with ASC	GS4 with ASC
Envorg	**-4.02****	0.77	1.67	0.64	16.70	12.68	**17.48***	**18.38***	**17.35***
Gym	0.01	**1.21****	0.77	0.4	**13.61***	13.62	**14.82****	**14.38***	**14.00***
GardenPriv	3.08	**1.7****	0.53	0.63	**32.74*****	**35.81*****	**34.44*****	**33.26*****	**33.37*****
GardenShare	2.53	0.66	1.29	-0.04	**40.22*****	**42.75*****	**40.88*****	**41.51*****	**40.19*****
GSUser	2.51	0.04	**2.23****	-0.35	**42.04*****	**44.55*****	**42.08*****	**44.27*****	**41.69*****
Constant	55.55***	89.52***	55.9***	67.16***	45.44***	100.99***	134.97***	101.34***	112.61***
Adj. R2	0.003	0.002	0.003	0.002	0.03	0.03	0.04	0.04	0.03
N	866	866	866	866	866	866	866	866	866

*,**,*** Significant at 10 % level; 5 % level; 1 % level; significant coefficients related to variables in bold.

Table 10
WTP for urban greenspace in relation to locality and index of deprivation.

	GS1 no ASC	GS2 no ASC	GS3 no ASC	GS4 no ASC	ASC	GS1 with ASC	GS2 with ASC	GS3 with ASC	GS4 with ASC
CityLarge	-0.48	0.27	-0.17	0.37	7.81	-2.22	-1.46	-1.90	-1.36
MD_1	**7.44*****	-0.19	0.53	-0.05	11.73	18.50	10.87	11.59	11.02
MD_2	1.76	-0.90	1.27	0.32	11.52	**29.89****	**27.23****	**29.4****	**28.45****
MD_3	3.38	0.13	1.62	-0.55	11.72	18.57	15.32	16.81	14.64
MD_4	3.49	1.23	0.68	-0.02	**12.37***	**25.61***	**23.35***	**22.8***	**22.09***
Constant	56.91***	91.8***	57.38***	67.7***	100.74***	157.65***	192.55***	158.13***	168.44***
Adj. R2	0.01	0.0003	0.0004	0.0002	0.0004	0.003	0.004	0.004	0.003
N	866	866	866	866	866	866	866	866	866

*,**,*** Significant at 10 % level; 5 % level; 1 % level; significant coefficients related to variables in bold

urban greenspaces will not decline. Our results, therefore, represent a lower bound of their valuation.

The data we present here is valuable for urban planners and managers of urban greenspaces, particularly for identifying synergies between the needs of biodiversity and people (Apfelbeck et al., 2020). With declines in public funding for urban greenspaces (Heritage Lottery

Table 11
WTP for urban greenspace in relation to proximity to urban greenspace, "green-ness" and density of urban greenspace within 2 km distance.

	GS1 no ASC	GS2 no ASC	GS3 no ASC	GS4 no ASC	ASC	GS1 with ASC	GS2 with ASC	GS3 with ASC	GS4 with ASC
Dist_ParkL	0.8	0.02	-0.23	-0.5	-1.72	-0.92	-1.7	-1.96	-2.22
TGS_ha_2kmL	-1.17	-0.51	-0.26	0.25	-0.90	-2.07	-1.41	-1.16	-0.65
GUse_ha_2kmL	-0.28	0.86	0.24	-0.61	-4.15	-4.43	-3.29	-3.91	-4.76
Constant	66.84***	89.62***	57.45***	69.41***	133.77***	200.61***	223.39***	191.23***	203.18***
Adj. R2	0.02	0.01	0.003	0.004	0.02	0.02	0.02	0.02	0.02
N	695	695	695	695	695	695	695	695	695

*,**,*** Significant at 10 % level; 5 % level; 1 % level; significant coefficients related to variables in bold.

Fund, 2016; APSE, 2021), increasing pressure on councils to create open space plans (Planning (Scotland) Act, 2019), and competition of urban greenspace with other urban land uses (Smith et al., 2012; Mäntymaa et al., 2021), understanding the most valuable attributes of urban greenspace and how these competing needs for direct use and biodiversity can be combined into single spaces, will be central to maintaining urban greenspaces into the future. Our results demonstrate that even small changes to urban greenspaces, such as the planting of wildflowers, can increase their value, and that this is true across urban greenspaces of varied use types and urban greenspace sizes. Currently small children's play parks are the most abundant urban greenspace type. The addition of wildflowers to such spaces could therefore increase the value of urban greenspace across an urban settlement, while maintaining the multifunctional use of the urban greenspace, and requiring no additional land. Given the requirement for the production of open space plans by Scottish Government (Planning (Scotland) Act, 2019), and the increasing interest in local urban natural capital accounting, the valuation presented here has direct applicability to the management of urban greenspaces across Scotland. The WTP values derived through the discrete choice experiment represent value of a marginal change in urban greenspace, and can therefore be applied to similar marginal changes (e.g. planting trees in a single greenspace, or greening of a brownfield site), but cannot be used to value non-marginal changes, such as large housing development or a national drive to increase greenspace area. Values should also not be aggregated over urban greenspaces (i.e. they cannot simply be multiplied to estimate the value of greenspace across Scotland), but can be aggregated to estimate values of marginal changes, such as promotion of wildflower meadows.

5. Conclusions

This study shows that urban residents have a preference for maintaining urban greenspaces in general, and value larger, closer urban greenspaces with direct use features. Additionally, they value natural aspects of urban greenspaces, preferring urban greenspaces with trees and wildflower meadows. The value of marginal changes to urban greenspaces is important for urban and greenspace planning, particularly when these must balance the needs of growing urban populations with the drive to improve the ecological values of our urban areas. Although on average willingness to pay was positive and of considerable magnitude, there was also significant preference heterogeneity. Future work should look to directly incorporate details on local spatial context and consider a broader range of individual characteristics of respondents to better understand variation in urban greenspace value. This will help improve urban and greenspace planning to achieve the socially most desirable outcomes.

CRediT authorship contribution statement

Michaela Roberts: Conceptualization, Formal analysis, Methodology, Writing – original draft. **Klaus Glenk:** Conceptualization, Formal analysis, Methodology, Writing – original draft. **Alistair McVittie:** Conceptualization, Formal analysis, Methodology, Writing – original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This work was funded by the Scottish Government Rural & Environment Science & Analytical Services Division, Strategic Research Programme 2016–21 (Theme 1 Natural Assets). We also thank L MacLean for reviewing an early version of the manuscript and D Wardell-Johnson for contribution to GIS.

Appendix A. Results of multinomial logit model of urban greenspace discrete choice experiment data

	Coefficient	s.e.	t-ratio
ASC	-1.01	0.06	-15.92
REF – play	0.12	0.04	2.75
REF – casual	0.12	0.04	2.83
REF – sports	-0.02	0.04	-0.45
PNF – garden	0.07	0.04	1.68
PNF – natural	0.25	0.04	6.16
TRE – area	0.39	0.04	10.73
TRE – edges	0.29	0.05	6.26
ACC – high	0.36	0.05	7.56
ACC – moderate	0.12	0.04	2.93
TIM – 30 min	0.21	0.04	4.64
TIM – 15 min	0.21	0.05	4.46
TIM – 5 min	0.21	0.05	4.11
SIZ – small	-0.27	0.04	-7.33
SIZ – medium	-0.07	0.04	-1.83
CT	-0.01	0.00	-19.90

Note: Value of the Log-Likelihood function at convergence: – 7805.66; McFadden's Rho squared: 0.08.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ufug.2022.127681.

References

Abildtrup, J., et al., 2013. Spatial preference heterogeneity in forest recreation. Ecol. Econ. 92, 67–77. https://doi.org/10.1016/j.ecolecon.2013.01.001.

Apfelbeck, B., et al., 2020. Designing wildlife-inclusive cities that support human-animal co-existence. Landsc. Urban Plan. 200, 103817 https://doi.org/10.1016/j.landurbplan.2020.103817.

APSE, 2021. State of teh Markey Survey 2021. Local Authority Parks and Green Space Services.

Beninde, J., Veith, M., Hochkirch, A., 2015. Biodiversity in cities needs space: a meta-analysis of factors determining intra-urban biodiversity variation. In: Haddad, N. (Ed.), Ecology Letters, 18, pp. 581–592. https://doi.org/10.1111/ele.12427.

Bertram, C., et al., 2017. Differences in the recreational value of urban parks between weekdays and weekends: a discrete choice analysis. Landsc. Urban Plan. 159, 5–14. https://doi.org/10.1016/j.landurbplan.2016.10.006.

Bockarjova, M., Botzen, W.J.W., Koetse, M.J., 2020. Economic valuation of green and blue nature in cities: a meta-analysis. Ecol. Econ. 169, 106480 https://doi.org/10.1016/j.ecolecon.2019.106480.

Boyd, F., et al., 2018. Who doesn't visit natural environments for recreation and why: a population representative analysis of spatial, individual and temporal factors among adults in England. Landsc. Urban Plan. 175, 102–113. https://doi.org/10.1016/j.landurbplan.2018.03.016.

Brander, L.M., Koetse, M.J., 2011. The value of urban open space: meta-analyses of contingent valuation and hedonic pricing results. J. Environ. Manag. 92 (10), 2763–2773. https://doi.org/10.1016/j.jenvman.2011.06.019.

City of Edinburgh Council, 2021. City of Edinburgh Council Key Facts and Figures. Available at: ⟨https://www.edinburgh.gov.uk/downloads/file/29876/2021-2022⟩.

ChoiceMetrics, 2018, Ngene 1.2 User Manual and Reference Guide.Scottish Government, 2019, Scottish Index of Multiple Deprivation, Accessed From: https://simd.scot/#/simd2020/BTTTFTT/9/-4.0000/55.9000/.

Clucas, B., Rabotyagov, S., Marzluff, J.M., 2015. How much is that birdie in my backyard? A cross-continental economic valuation of native urban songbirds. Urban Ecosyst. 18 (1), 251–266. https://doi.org/10.1007/s11252-014-0392-x.

Day, B.H., 2020. The value of greenspace under pandemic lockdown. Environ. Resour. Econ. 76 (4), 1161–1185. https://doi.org/10.1007/s10640-020-00489-y.

De Valck, J., et al., 2017. Outdoor recreation in various landscapes: which site characteristics really matter. Land Use Policy 65, 186–197. https://doi.org/10.1016/j.landusepol.2017.04.009.

De Valck, J., Rolfe, J., 2018. Spatial heterogeneity in stated preference valuation: status, challenges and road ahead. Int. Rev. Environ. Resour. Econ. 11 (4), 355–422. https://doi.org/10.1561/101.00000097.

Diluiso, F., Guastella, G., Pareglio, S., 2021. Changes in urban green spaces' value perception: a meta-analytic benefit transfer function for European cities. Land Use Policy 101, 105116. https://doi.org/10.1016/j.landusepol.2020.105116.

Ferguson, M., et al., 2018. Contrasting distributions of urban green infrastructure across social and ethno-racial groups. Landsc. Urban Plan. 175, 136–148. https://doi.org/10.1016/j.landurbplan.2018.03.020.

Fischer, L.K., et al., 2018. Recreational ecosystem services in European cities: sociocultural and geographical contexts matter for park use. Ecosyst. Serv. 31, 455–467. https://doi.org/10.1016/j.ecoser.2018.01.015.

Glenk, K., et al., 2020. Spatial dimensions of stated preference valuation in environmental and resource economics: methods, trends and challenges. Environ. Resour. Econ. 75 (2), 215–242. https://doi.org/10.1007/s10640-018-00311-w.

Greene, W., 2008. Econometric Analysis, 6th edn. Pearson Education Inc, Upper Saddle River, NJ, USA.

Grilli, G., Mohan, G., Curtis, J., 2020. Public park attributes, park visits, and associated health status. Landsc. Urban Plan. 199, 103814 https://doi.org/10.1016/j.landurbplan.2020.103814.

Granado-Díaz, R., Gómez-Limón, J.A., Rodríguez-Entrena, M., Villanueva, A.J., 2020. Spatial analysis of demand for sparsely located ecosystem services using alternative index approaches. European Review of Agricultural Economics 47 (2), 752–784.

Gunnarsson, B., et al., 2017. Effects of biodiversity and environment-related attitude on perception of urban green space. Urban Ecosyst. 20 (1), 37–49. https://doi.org/10.1007/s11252-016-0581-x.

Holland, B.M., Johnston, R.J., 2017. Optimized quantity-within-distance models of spatial welfare heterogeneity. Journal of Environmental Economics and Management 85, 110–129.

Haase, D., et al., 2017. Greening cities – to be socially inclusive? About the alleged paradox of society and ecology in cities. Habitat Int. 64, 41–48. https://doi.org/10.1016/j.habitatint.2017.04.005.

Handley, J. , et al., 2003. Providing Accessible Natural Greenspace in Towns and Cities: A Practical Guide to Assessing the Resource and Implementing Local Standards for Provision. Report for English Nature.

Hanemann, W., 1984. Welfare evaluations in contingent valuation experiment with discrete responses. Am. J. Agric. Econ. 66, 332–341.

Hanley, N., Czajkowski, M., 2019. The role of stated preference valuation methods in understanding choices and informing policy. Rev. Environ. Econ. Policy 13 (2), 248–266. https://doi.org/10.1093/reep/rez005.

Hanson, H.I., et al., 2021. Gardens' contribution to people and urban green space. Urban For. Urban Green. 63, 127198 https://doi.org/10.1016/j.ufug.2021.127198.

Heritage Lottery Fund, 2016. State of UK Public Parks, p. 36.

Hess, S., Palma, D., 2019. Apollo: a flexible, powerful and customisable freeware package for choice model estimation and application. J. Choice Model. 32 (100170) https://doi.org/10.1016/j.jocm.2019.100170.

Hoyle, H., Hitchmough, J., Jorgensen, A., 2017. All about the "wow factor"? The relationships between aesthetics, restorative effect and perceived biodiversity in designed urban planting. Landsc. Urban Plan. 164, 109–123. https://doi.org/10.1016/j.landurbplan.2017.03.011.

Ives, C.D., Kendal, D., 2014. The role of social values in the management of ecological systems. J. Environ. Manag. 144, 67–72. https://doi.org/10.1016/j.jenvman.2014.05.013.

van der Jagt, A.P.N., et al., 2016. Participatory governance of urban green spaces: trends and practices in the EU. Nord. J. Archit. Res. 3, 35.

Knapp, S., et al., 2021. A research agenda for urban biodiversity in the global extinction crisis. BioScience 71 (3), 268–279. https://doi.org/10.1093/biosci/biaa141.

Lampinen, J., et al., 2021. Acceptance of near-natural greenspace management relates to ecological and socio-cultural assigned values among European urbanites. Basic Appl. Ecol. 50, 119–131. https://doi.org/10.1016/j.baae.2020.10.006.

Lehberger, M., Kleih, A.-K., Sparke, K., 2021. Self-reported well-being and the importance of green spaces – a comparison of garden owners and non-garden owners in times of COVID-19. Landsc. Urban Plan. 212, 104108 https://doi.org/10.1016/j.landurbplan.2021.104108.

Mäntymaa, E., et al., 2021. Providing ecological, cultural and commercial services in an urban park: a travel cost–contingent behavior application in Finland. Landsc. Urban Plan. 209, 104042 https://doi.org/10.1016/j.landurbplan.2021.104042.

Mariel, P., et al., 2021. Environmental valuation with discrete choice experiments: guidance on design, implementation and data analysis. Springer Nat. (SpringerBriefs Econ.) (Available at: ⟨https://doi.org/10.1007/978-3-030-62669-3⟩).

Mattijssen, T.J.M., et al., 2017. The long-term prospects of citizens managing urban green space: from place making to place-keeping? Urban For. Urban Green. 26, 78–84. https://doi.org/10.1016/j.ufug.2017.05.015.

Năstase, I.I., Pătru-Stupariu, I., Kienast, F., 2019. Landscape preferences and distance decay analysis for mapping the recreational potential of an urban area. Sustainability 11 (13), 3620. https://doi.org/10.3390/su11133620.

Ode Sang, Å., et al., 2016. The effects of naturalness, gender, and age on how urban green space is perceived and used. Urban For. Urban Green. 18, 268–276. https://doi.org/10.1016/j.ufug.2016.06.008.

Office for National Statistics, 2021. Scottish Natural Capital Accounts. UK Government.

Ordnance Survey, 2020. OS Open Greenspace.

Perino, G., et al., 2014. The value of urban green space in Britain: a methodological framework for spatially referenced benefit transfer. Environ. Resour. Econ. 57 (2), 251–272. https://doi.org/10.1007/s10640-013-9665-8.

Planning (Scotland) Act, 2019. asp 13.

Poortinga, W., et al., 2021. The role of perceived public and private green space in subjective health and wellbeing during and after the first peak of the COVID-19 outbreak. Landsc. Urban Plan. 211, 104092 https://doi.org/10.1016/j.landurbplan.2021.104092.

Qiu, L., Lindberg, S., Nielsen, A.B., 2013. Is biodiversity attractive?—on-site perception of recreational and biodiversity values in urban green space. Landsc. Urban Plan. 119, 136–146. https://doi.org/10.1016/j.landurbplan.2013.07.007.

Rambonilaza, M., Dachary-Bernard, J., 2007. 'Land-use planning and public preferences: what can we learn from choice experiment method. Landsc. Urban Plan. 83 (4), 318–326. https://doi.org/10.1016/j.landurbplan.2007.05.013.

Schindler, M., Le Texier, M., Caruso, G., 2018. Spatial sorting, attitudes and the use of green space in Brussels. Urban For. Urban Green. 31, 169–184. https://doi.org/10.1016/j.ufug.2018.02.009.

Schio, N. da, et al., 2021. The impact of the COVID-19 pandemic on the use of and attitudes towards urban forests and green spaces: exploring the instigators of change in Belgium. Urban For. Urban Green., 127305 https://doi.org/10.1016/j.ufug.2021.127305.

Scottish Government, 2018. Scottish Government Urban Rural Classification 2016.

Scottish Government, 2020a. Council Tax Datasets. Available at: ⟨https://www.gov.scot/publications/council-tax-datasets/⟩.

Scottish Government, 2020b. Scottish Index of Multiple Deprivation 2020. Available at: ⟨https://www.gov.scot/collections/scottish-index-of-multiple-deprivation-2020/?utm_source=redirect&utm_medium=shorturl&utm_campaign=simd⟩.

Smith, J.W., et al., 2012. The effects of place meanings and social capital on desired forest management outcomes: a stated preference experiment. Landsc. Urban Plan. 106 (2), 207–218. https://doi.org/10.1016/j.landurbplan.2012.03.009.

Southon, G.E., et al., 2017. Biodiverse perennial meadows have aesthetic value and increase residents' perceptions of site quality in urban green-space. Landsc. Urban Plan. 158, 105–118. https://doi.org/10.1016/j.landurbplan.2016.08.003.

Taylor, M., 2018. Time running out for UK parks, government told, The Gaurdian, 21 June. Available at: ⟨https://www.theguardian.com/environment/2018/jun/21/time-running-out-for-uk-parks-government-told⟩, (Accessed 11 February 2022).

Theodorou, P., et al., 2020. Urban areas as hotspots for bees and pollination but not a panacea for all insects. Nat. Commun. 11 (1), 576. https://doi.org/10.1038/s41467-020-14496-6.

Train, K., 2003. Discrete Choice Methods with Simulation. Cambridge University Press, Cambridge.

Train, K., Weeks, M., 2005. Discrete choice models in preference space and willingness-to-pay space. In: Applications of Simulation Methods in Environmental and Resource Economics. The Economics of Non-Market Goods and Resources. Springer, Dordrecht. https://doi.org/10.1007/1-4020-3684-1_1.

Tu, G., Abildtrup, J., Garcia, S., 2016. Preferences for urban green spaces and peri-urban forests: an analysis of stated residential choices. Landsc. Urban Plan. 148, 120–131. https://doi.org/10.1016/j.landurbplan.2015.12.013.

Wamsler, C., et al., 2020. Beyond participation: when citizen engagement leads to undesirable outcomes for nature-based solutions and climate change adaptation. Clim. Change 158 (2), 235–254. https://doi.org/10.1007/s10584-019-02557-9.