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Actionable information and climate change awareness drive consumer selection of environmentally beneficial garden plants

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HIGHLIGHTS

- Information on favourable plant traits changed participants' plant selection.
- Climate change concern promotes pro-environmental plant choices.
- Plant recommendations and climate change knowledge impacted garden plant selection.

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ABSTRACT

Domestic gardens worldwide cover approximately 15–30 % of residential urban space and with the appropriate plant composition, have potential to help manage urban water flows, regulate temperatures and air-pollution. However, the provision of these regulating ecosystem services depends upon the preferences and willingness of private garden owners to adopt environmentally beneficial planting, with associated traits that confer these benefits. This study tested whether the way information on beneficial plant traits is presented influences taxa choices. In an experimental online survey, participants were divided into two groups: one received only 'system information' (basic facts about environmental problems: climate change, urban flooding, and poor air quality, n = 208), while the other also received 'action-related information' (how to potentially address environmental problems by choosing plants with certain traits, n = 211). Receiving 'action-related information' significantly influenced plant taxa selection; fewer choices were made for ornamental plants without traits that are beneficial for flood or pollution mitigation. Additionally, participants concerned about climate change were more willing to choose environmentally beneficial taxa, regardless of information group. These findings indicate that pro environmental planting choices in domestic gardens can be encouraged by providing actionable information and linking to existing climate change concerns.

1. Introduction

Due to their close proximity to the home, gardens allow people to engage with nature on a frequent basis (Chalmin-Pui et al., 2021a). Gardens also provide environmental benefits (ecosystem services), particularly if they have a higher proportion of greenery (Cameron, 2023; Royal Horticultural Society, 2021). The composition and magnitude of service provision depend on the type and density of plants used (Heim et al., 2023; O'Carroll et al., 2023), with certain garden plants linked to enhanced potential for flood mitigation (Blanuša & Hadley, 2019; Nur Hannah Ismail et al., 2023), air pollutant capture (del Carmen Redondo-Bermúdez et al., 2021; Shao et al., 2019; Wang et al., 2024), temperature regulation (Cameron & Blanuša, 2016; Egerer et al., 2024), and human health (Chalmin-Pui *et al.,* 2021a).

Domestic gardens or yards (referred to as gardens throughout this paper) are defined as "a piece of land next to and belonging to a house, where flowers and other plants are grown, and often containing an area of grass" (Cambridge Dictionary, 2025). These spaces make up a

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substantial part of urban and suburban land area across many parts of the globe, accounting for approximately 30 % of this land area in the UK, and in Europe the number of residential properties with outside garden space ranges from 56 % in Spain to 90 % in some areas of the Netherlands (Cameron, 2023; Chalmin-Pui *et al.,* 2021a). Depending on location > 15 % of residential land in South America, India, Africa, and China can be occupied by home gardens (Cilliers et al. 2012; Huai et al., 2011; Jaganmohan et al., 2012; Baudry & Yu, 1999). In the USA, garden (yard) area represents 3 % of urban and 25 % of suburban total land area (Lerman et al., 2023). In Latin America, the average domestic garden is between 0.1 and 0.25 ha, although some can be as large as 2.5 ha (Pulido Silva, 2008).

As privately owned spaces, management of gardens is at the discretion of the owner. Over time the vegetation cover of domestic gardens has decreased, often to be replaced by impervious surfaces (Stobbelaar et al., 2021; Warhurst et al., 2014) or dominated by grass lawn monocultures (Ignatieva et al., 2015). There is potential, however, to improve the environmental credentials of domestic gardens. Due to the areas involved, such improvements could help policy makers/city authorities address, at the city level, several climate change impacts, including flooding and heat island mitigation (Tomatis et al., 2023).

Climate change in NW Europe is predicted to result in less frequent but heavier individual rainfall events, potentially leading to more frequent and severe flooding (IPCC, 2021; Kendon et al., 2023; Webster et al., 2017), particularly in urban areas due to increased impervious surfaces (e.g. Warhurst et al., 2014). Vegetation can help reduce rainfall runoff by capturing rainfall in plant canopies, removing some of the excess water via evapotranspiration while increasing soil's capacity to store subsequent rainfall (Blanuša & Hadley, 2019). Fine leaf structures can facilitate droplet retention in the canopy followed by droplet evaporation (Beidokhti & Moore, 2021; Nur Hannah Nur Hannah Ismail et al., 2023), and a higher evapotranspiration rate removes greater volumes of water from the soil (Chu & Farrell, 2022; Kemp et al., 2019). Plants with many fine-narrow leaves, pitted leaf micro-surfaces and hairy leaves have the added advantage of also trapping more air pollution particulate matter (PM) than smooth leaves, thus helping to remove PM from the atmosphere (Blanuša et al., 2020; Shao et al., 2019).

Preferences for garden layouts and the plant taxa used in them is determined by diverse factors including aesthetics, household income, cultural backgrounds, garden use, time available to do gardening and pedoclimatic conditions such as soil type or annual rainfall (Kendal et al., 2012; Peterson et al., 2012).

Utilising garden plants with specific or enhanced traits associated with ecosystem service delivery could improve gardens' environmental benefits (Cameron & Blanuša, 2016; Cameron, 2023). However, whilst the recent UK surveys (Royal Horticultural Society, 2021; Webster et al., 2017) show there is a good awareness of climate change among the general public, less than 20 % of respondents realised that plants could help mitigate localised flooding, and only 2 % felt they were prepared for gardening within a changed climate. Globally too, while people have good awareness of climate change, they tend to underestimate the level of public support for climate change mitigation and be reluctant to act themselves (Andre et al., 2024). Thus, raising the awareness about the value of plants, and what taxa provide specific benefits, might result in more environmentally-sensitive garden design, e.g. creating domestic gardens better able to mitigate flooding (Royal Horticultural Society, 2021). Yet garden owners either lack the knowledge or confidence to choose environmentally appropriate planting, or aesthetics can still take precedent when selecting plants (Royal Horticultural Society, 2021, Cameron, 2023, Gush et al., 2024). It is likely that information on the beneficial species needs to be more widespread and better understood by gardening public, with the role for the organisations in this sphere to encourage, enthuse and help gardeners adopt behavioural changes that promote more environmentally beneficial plantings.

The Theory of Planned Behaviour (Ajzen, 1991) states that decision-making is influenced by individual intent. Factors influencing whether a person will undertake behavioural change include what the individual perceives as 'normal' or regular behaviour, their attitude towards the behaviour (positive/negative), and the degree the individual feels they can/feel capable of undertaking that changed behaviour (Ajzen, 1991; de Leeuw et al., 2015). Social influences or the quality of information messaging surrounding behaviour can also have a positive or negative effect on the outcome (Birau & Faure, 2018; Cialdini, 2003; Stobbelaar et al., 2021). Consequently, framing environmental problems as easy to overcome leads to greater adoption of new, favourable, practices (Ajzen, 1991; Birau & Faure, 2018; Neubig et al., 2020; Stobbelaar et al., 2021). Applied to the adoption of pro-environmental behaviours, specifically plant selection for ecosystem service delivery, this means that willingness to adopt beneficial planting is more likely when a person has a positive attitude towards this action and believes that this change is manageable and can be undertaken easily.

Educational processes are a key component of encouraging behavioural change with respect to environmental issues. Previous research on encouraging environmental behavioural change indicates that there are three ways in which information can be presented to increase people's knowledge about the issues and help effect behavioural change (Frick et al., 2004; Neubig et al., 2020). These include using i. 'system information' (outlining the basic principles of the environmental problem), ii. 'action-related information' (presenting potential solutions to the environmental problem through behavioural change), and iii. 'effective information' (highlighting the resulting environmental benefits of behavioural change) (Neubig et al., 2020). Could these approaches be used to encourage changes in planting choices for domestic gardens? Environmental gardening (e.g. reduced chemical, water or energy input in garden maintenance and providing habitats for wildlife) is more likely to be adopted when education on sustainable landscape and biodiversity management is provided or when resultant outcomes are perceived as aesthetically appealing (Fernández-Cañero et al., 2011; Hostetler, 2021; van den Berg & Winsum-Westra, 2010).

Building on the approach of Neubig et al. (2020), who found that participants reduced their food waste when they were exposed to both 'system' and 'action-related information', this is one of the first studies applying this method to influencing peoples' planting behaviours with the intention to positively impact urban planting communities. We set out to investigate, through an experimental survey, how information about plant taxa and their beneficial environmental traits affected gardeners' plant preferences. The study also explored how participants' aesthetic preferences and views on climate change influenced their plant choices. The objectives were to answer four key questions:

- What prior knowledge did participants have about garden plant benefits and the traits required to deliver ecosystem services?
- To what extent did the type of information ('system' or 'action-related') affect participants' understanding of how garden plants can mitigate flood risk and air pollution?
- Would recommendations based on plant traits influence plant selection?
- How did participants' knowledge of climate change affect their choices?

The overarching aim of our work was to understand effective ways to encourage gardeners to consider and implement planting with environmentally beneficial traits within their gardens that could help alleviate garden flooding, presenting an opportunity to engage people with environmental and climate-ready action at a local scale.

2. Methodology

2.1. Description of the study context

We created a web-based survey using Qualtrics XM software (Qualtrics, Provo, UT), to investigate people's plant preferences when provided with information relating to potential ecosystem services that plants deliver (full survey in supplementary Appendix).

Participants (500 +) were recruited by sharing the survey link widely within the authors' work and personal networks. Participants were randomly assigned into two groups, a 'system information' group and 'action-related information' group. Both groups were asked the same questions but were provided different information about plant selection and localised flooding in the middle of the survey to determine their effects on participants' plant preferences.

The 'system information' group received information on the impacts of climate change and the increased flooding risk when replacing plants in gardens with impervious surfaces. The 'action-related information' group received a condensed version of the system information (intending to keep the duration of the two survey types similar) and – additionally – recommendations on using plant taxa with specific traits to reduce localised flooding risk and air pollution in their gardens. Recommendations were in the form of simple planting suggestions based on trait-specific information. All survey participants also answered questions on their concern about climate change.

We collected demographic information and established participants

Fig. 1. Plant taxa and their associated traits used in the survey. Plant A – hairy leaves, *Pseudodictamnus mediterraneus*, Plant B – smooth leaves, *Verbena bonariensis*, Plant C – 'thirsty' plant with high transpiration rate, *Oenothera lindheimeri* 'Whirling Butterflies', Plant D – low transpiration rate, *Heuchera* 'Obsidian', Plant E – hairy leaves and 'thirsty' plant with high transpiration rate, *Stachys byzantina*, Plant F – smooth leaves and low transpiration rate, *Erysimum* 'Bowles's Mauve'.

interest in gardening and time spent gardening to understand and account for potential bias in our sample. The survey asked participants for their preference when given the option of six plants, their prior knowledge of plant traits, and their knowledge of the ability of plants to improve their local environment (ecosystem service delivery). This was used to establish the baseline knowledge of each participant and identify the impact that information and recommendations can have (Frick et al., 2004).

2.2. Knowledge of plant traits and ecosystem services

The survey focused on two plant traits – the presence of leaf hairs and the high transpiration rate (referred to in the survey as 'thirsty' plants to accommodate a non-scientific audience). Information on other plant traits were not conveyed to reduce 'information overload' and enable a quicker and easier survey. Participants were also asked about their awareness of flood mitigation and air pollution reduction services provided by plants both before and after survey information.

2.3. Plant selection

Six plant taxa were chosen for their contrasting traits, based on previous empirical research evidencing their ecosystem services (Kemp et al., 2019; McLaughlin, 2024; Weerakkody et al., 2017) – *Pseudodictamnus mediterraneus*, *Verbena bonariensis*, *Oenothera lindheimeri* 'Whirling Butterflies', *Heuchera* 'Obsidian', *Stachys byzantina*, *Erysimum* 'Bowles's Mauve' – referred to throughout this paper by their genus names. All the plant taxa options were shown to participants visually via photographs, online. Each taxon was displayed by three images showing plant, leaf and flower form and colour (Fig. 1). No taxa were named in this survey, but rather were referred to as Plant A, B, C, D, E, or F. Photographs were taken by the lead author or obtained from the Royal Horticultural Society. Previous research using photographs has indicated they elicit similar emotional responses as live plants (Berger et al., 2022; Zhang et al., 2024).

Participants were first asked to select the plant taxa they preferred. After receiving the 'system' or 'action-related' information they were asked to consider this when re-selecting their taxonomic preference. The two forms of information provided did not refer to any plant taxa or include taxonomic suggestions, only climate change information for the 'system group' or trait-based recommendations for the 'action group'. In the latter, it was communicated that certain plant types with leaf hairs could help catch rainwater and air pollutants or possess high transpiration rates, therefore, the plant selection most clearly linked to ecosystem service provision would thus be Plants A, C or E (Fig. 1).

2.4. Survey design and data collection

Questions were intentionally written to include the phrases 'can benefit', 'can improve', and 'can reduce' to ensure no definitive statements were included, as the benefits of traits are contingent on other factors including location, soil type, other green infrastructure in the area, etc. A five-point Likert scale was used to gauge participant's plant preferences and opinions on gardens, plants and the environment. No free-text questions were included. The survey format, questions, and ease of use were tested via eight testers in a pilot study before distribution, with an average completion time of 8 min. Feedback from testers was considered and survey design altered to improve flow and understanding. The survey, aimed at participants aged 18 and over, was assessed and approved by Ethics Committee. The survey was disseminated through several staff and student mailing lists at the University of Reading (providing a wide range of disciplinary backgrounds), authors' and colleagues' social media channels (X, LinkedIn, Instagram, Facebook), WhatsApp groups and personal contacts (with requests to share the link widely in addition to participating). Survey programming enabled participants to be randomly split into two equally sized survey groups. The survey was live for 28 days, between the 13th November and 11th December 2023.

2.5. Data analysis

Data analysis first sought to identify which demographic characteristics (e.g. age, gender) and which responses related to interest in gardening (e.g. hours spent gardening, horticultural qualifications) were associated with differences in awareness of the potential ecosystem services delivered by plants (e.g. flood mitigation, pollution reduction, wildlife) and the role of certain plant traits in that delivery (e.g. leaf hairs or high transpiration rate). To do this, ordinal regression models containing all explanatory variables (maximal models) were simplified through stepwise selection using AIC via the step function in R statistical software (Christensen, 2023; R Core Team, 2021). Brant tests (Brant, 1990) were used to assess whether the proportional odds assumption of ordinal regression was met in the maximal models. Correlations between explanatory variables (e.g. hours spent gardening and whether someone held a horticultural qualification) were tested with Pearson's Chi-Squared tests. Next, any change in knowledge of ecosystem services during the survey was assessed, and whether this change varied between the 'action-related' and 'system' information groups. To do this, ordinal regression models were used as above, but with survey information type as the explanatory variable. Changes in participant preferences for certain plant taxa were also examined, again focusing on whether changes in response varied between information groups. Finally, it was evaluated whether survey information type, experience of climate change, or concern about climate change influenced reported willingness to select these plants for gardens.

3. Results

A total of 419 complete responses were received and used for analysis (208 allocated to the 'system information' group and 211 in the 'action-related information' group). There was a greater proportion of responses from females or people with a university degree than in the general population of England and Wales (Office for National Statistics, 2023a & 2023b). Comprehensive demographic information is summarised in supplementary material Appendix.

Seventy percent of respondents considered themselves gardeners or enjoyed gardening; 41 % had a qualification in horticulture, gardening, or the environmental sciences. Most participants (29 %) gardened between 1–3 h a week, followed by less than 1 h a week (22.9 %), 3–7 h a week (20.8 %), more than 7 h a week (14.6 %), and the least number of people never gardened (12.6 %). Most of each information group lived in a property with a garden (87 % in the 'system group' and 85.8 % in the 'action-related group').

3.1. Prior knowledge of plant benefits

3.1.1. Awareness of the concept of plant ecosystem services

No gender differences were found regarding participants' knowledge of plant ecosystem services (ability to support wildlife, reduce flood risks, mitigate air pollution and noise, and provide urban cooling) and plant traits (benefits of leaf hairs or higher transpiration rate for ecosystem service provision). A Pearson's Chi-squared test showed there was statistically significant evidence of an association between hours spent gardening, a horticultural qualification, and whether someone considered themselves a gardener ($p < 0.001$) (hours spent gardening and gardener $\chi^2 = 101.44$, hours spent gardening and a horticultural qualification $\chi^2 = 11.974$, horticultural qualification and gardener $\chi^2 = 12.434$). Participants who considered themselves gardeners or enjoyed gardening were more aware that garden plants helped wildlife, flood avoidance, noise mitigation and urban cooling than those who did not consider themselves gardeners (wildlife $p = 0.044$, others $p < 0.001$). A higher education level and a horticultural or equivalent qualification were associated with improved awareness of plants ability to reduce flooding risk, temperature and noise levels ($p < 0.001$). A significant association between education and having a horticultural qualification ($p < 0.001$) makes it difficult to separate the influence of either. Age also significantly impacted knowledge of all ecosystem services (pollution $p = 0.039$, others $p \leq 0.006$), and the majority of all age groups agreed to some capacity that plants could provide a range of ecosystem services. Participants aged 45–54 were more knowledgeable of these benefits than other age categories, but no one in any age group suggested that they *strongly* agreed that plants could reduce localised flooding.

3.1.2. Awareness of the function of leaf hairs

Most participants were ambivalent about leaf hairs, with 34.4 % selecting 'neither agree nor disagree' about their aesthetic preference for the feature, and 57 % selecting 'neither agree nor disagree' regarding their opinion on the potential environmental benefits provided by leaf hairs. Demographic characteristics, including gender, age, and education, showed no significant association with knowledge around the value/benefits of leaf hairs. Holding a horticultural or equivalent qualification, enjoyment of gardening, and the number of hours a week spent gardening, however, were associated with participant's awareness of the environmental benefits of leaf hairs (horticultural qualification (0.04). enjoyment of gardening $p = 0.015$, and hours gardening $p = 0.15$).

3.1.3. Awareness of the function of transpiration rate

Participants' prior engagement with gardening was not associated with appreciation of the benefits of a higher transpiration rate. Although age and education were found in the best-fit model, only the 65 and over age category was a significant factor ($p = 0.029$) in understanding the benefits associated with greater transpiration.

3.2. Change in ecosystem service knowledge following survey information

3.2.1. Awareness of flood mitigation ecosystem service delivery

Participants were asked whether plants could reduce the risk of localised flooding both before and after additional information was provided. 'Action-related' information resulted in more people valuing plants for their flood mitigation potential, changing their answers to a more significant degree than those that just received 'system' information only ($p = 0.035$).

3.2.2. Awareness of pollution reduction ecosystem service delivery

In contrast to flooding, there was no significant difference in answers regarding pollution awareness between the two survey groups before and after survey information, indicating the type of information did not impact responses ($p = 0.451$).

3.3. Plant selection

3.1.1 Initial plant preferences

Participants were asked prior to being given additional information (pre-information phase) to select the plant taxa they liked the most. The majority of respondents selected *Erysimum* (131 votes), followed by *Oenothera* (111 votes), and *Verbena* (101 votes) (Fig. 2).

3.1.2 Plant preference changes post-information

After being given additional information on the ecosystem services of the different plant taxa (post-information phase), participants were asked again to select the preferred taxon. Here 23 % of participants selected more than one taxon but for our analyses we only used those with one selection. This left us with 325 responses analysed for this question, with 180 allocated to the 'system' group and 145 to the 'action-related information' group.

The preference for plant taxa changed with the provision of additional information, with *Stachys* increasing in popularity and *Verbena* and *Erysimum* decreasing in popularity. The type of information provided was important too, with a significantly stronger loss of popularity

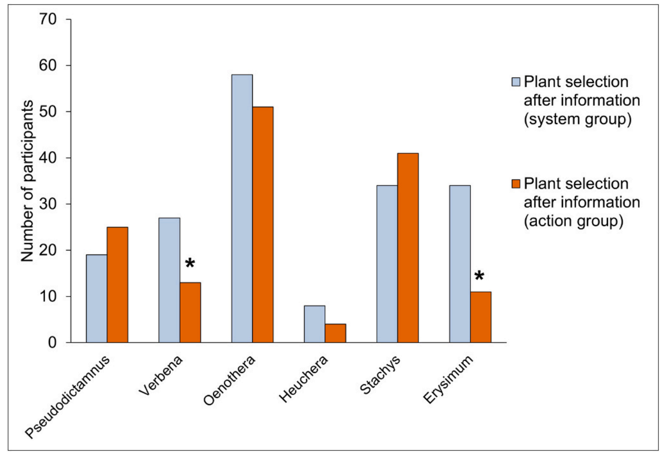

Fig. 2. Plant selection after receiving survey information. The asterisks indicate a significant change in plant preference after information when comparing the 'system' and 'action-related' groups.

in *Verbena* ($p = 0.02$) and *Erysimum* ($p < 0.001$) with the more informed 'action-related' group compared to the 'system' group after information (Fig. 2). *Pseudodictamnus* selection was also significantly different between groups ($p = 0.048$), with the 'action-related' group increasing their selection while the 'system' group decreased their selection. Both groups had otherwise broadly similar selection patterns, e.g. *Oenothera* (Plant C) – popular before and after the information, while *Heuchera* (Plant D) was relatively unpopular, both before and after the additional information.

3.4. Drivers of plant preference change

The majority of participants in the 'action-related information' group (58.3 %) changed their taxa preference after receiving planting recommendations, and the majority in the 'system information' group (63.9 %) did not change ($p < 0.001$). Participants were asked about drivers for this preference change. The taxonomic traits linked to enhanced environmental benefits significantly influenced preference change in the 'action-related' group compared to the 'system' group ($p = 0.011$) (Fig. 3). Plant aesthetics (more attractive) was not a driver for preference change and was not significantly different between groups ($p = 0.666$), with the majority of both groups selecting 'neither agree nor disagree'. Options relating to taxa better fitting the participant's garden, and/or the information provided with the survey were not associated

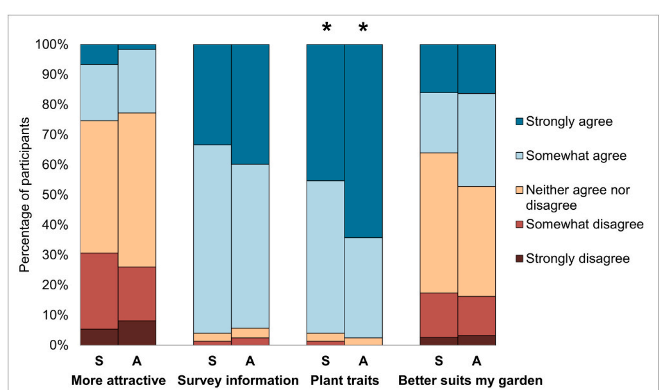

Fig. 3. Percentage allocation of reasons participants gave for changing their plant preference for the system information group (labelled S) (n = 75) and the action-related information group (A) (n = 123). The asterisks indicate a significant difference using ordinal regression models between the 'system' and 'action-related' groups.

with changes in selection in either group. However, most of both groups cited the survey information (facts about climate change in the UK e.g. heat waves and recent flash flooding) as a driver for preference change (Fig. 3).

3.5. The effect of climate change concerns and the experience of climate change on taxonomic selection and environmental intent

To investigate pro-environmental behaviours and intentions, participants were asked whether they would be willing to select plant taxa in the future, because of their environmental benefits. Responses were measured against the levels of concern participants expressed relating to climate change, or the extent to which they felt impacted by it. The majority of each group affirmed they were concerned about climate change (94.7 % in the system group and 96.2 % in the action group) and had experienced some direct effects of climate change (69.7 % in the 'system' group and 69.2 % in the 'action' group). Those who were concerned or impacted by climate change were significantly more willing to select plants in the future because of their environmental benefits ($p < 0.001$), with over 70 % agreeing or strongly agreeing (Fig. 4). The information group the respondents were allocated to, did not influence these outcomes ($p = 0.168$).

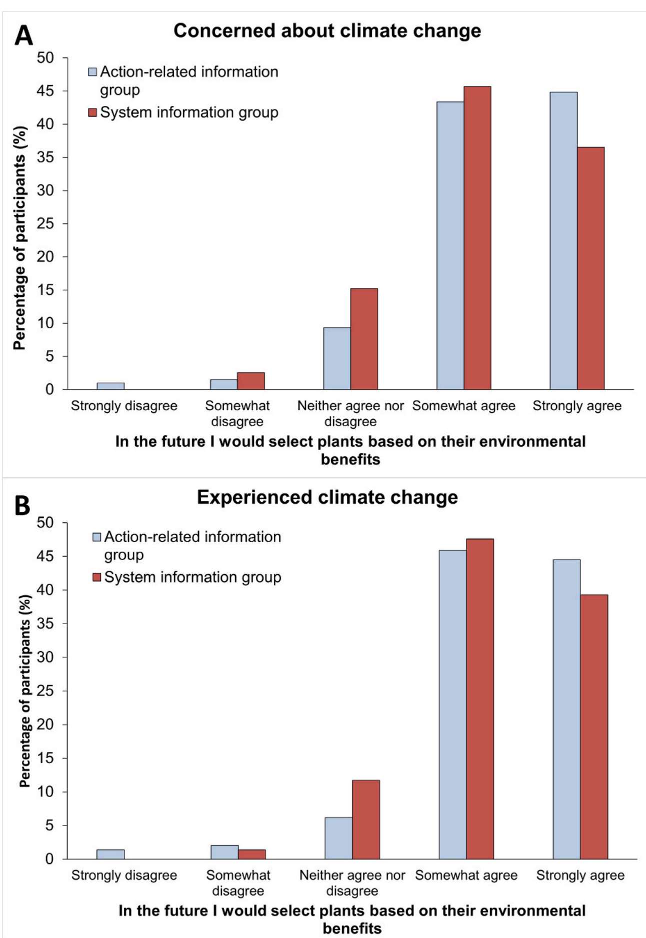

Fig. 4. Number of participants A) concerned about climate change and B) have experienced climate change who would select plants for their environmental benefits in the future. Results are divided by information groups ('system information' group participants – red bars, 'action-related information' group – blue bars). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

4. Discussion

An overarching goal within this project was to investigate to what extent we can influence garden owners' planting choices – to steer them away from considering purely plants' ornamental appeal, instead considering traits linked to better provision of some regulating ecosystem services. To explore this, we created surveys containing either 'system information' (basic facts about environmental problems) or 'action-related information' (how to potentially address environmental problems by choosing plants with certain traits). The introduction of 'action-related' knowledge was linked to a significant change in plant preference compared to 'system' knowledge alone, supporting theoretical framework introduced by Ajzen (1991), as well as other studies (Frick et al., 2004; Neubig et al., 2020), and indicating that they type of information and how it is delivered is important for changing behavioural outcomes. Prior knowledge of plants and gardening also linked to a greater understanding of ecosystem services but did not necessarily translate to an awareness of the benefits of a higher transpiration rate for localised flood mitigation. Importantly too, the concern participants felt about climate change was a driver for both groups to select environmentally beneficial plants, regardless of the information they received. Aesthetics, which is typically considered a major driver for plant selection in domestic gardens, did not significantly influence choices in this survey.

4.1. Does prior knowledge of plant benefits impact initial survey responses?

Respondents who considered themselves gardeners or had a horticultural qualification or equivalent were generally aware of all ecosystem service concepts listed in the survey. The number of hours per week spent gardening was also correlated with significantly improved awareness of the benefits of leaf hairs for capturing particulate matter air pollution and aiding localised flood mitigation. An 'interest in gardening' and knowledge of plants, both via formal education and hands-on experience, in this case led to a greater comprehension of the benefits plants can provide. An interest in gardening, however, was not linked with an awareness of the environmental benefits of plants with higher transpiration rates. Climate change communications frequently centre on messages around increased water scarcity (IPCC, 2021; Webster et al., 2017). A key component of ensuring plant survival is to sufficiently water plants; gardeners have been encouraged to minimise watering as a climate change adaption strategy (Egerer *et al.,* 2019). Plants with higher inherent transpiration rates are perceived to require more water however this trait does not always link with drought intolerance (Szota et al., 2017). Perennials *Oenothera* and *Stachys*, and woody plants *Cotinus* and *Lavandula* have higher transpiration rates when increased water is available (Cameron et al., 2006; Kemp et al., 2019; McLaughlin, 2024) but are also considered drought tolerant in gardening literature (Beth Chatto's Plants & Gardens, 2022; Wallington, 2022). This indicates that gardeners should not view taxa within the dichotomy of low or high transpiration rates and therefore drought-tolerant or drought-intolerant. In addition, emphasis on decreased water availability is only part of the climate change picture; the anticipated increase in heavier rainfall and flash flooding means garden plant taxa will need to tolerate periods of drought as well as inundation (Kendon et al., 2023; Webster et al., 2017). This and other studies (Cameron, 2023; Royal Horticultural Society, 2021; Webster et al., 2017) suggest that more work is needed to understand how to garden in a changing climate.

4.2. Does 'action-related' information impact or change plant preference?

The provision of the 'action-related' information, which provided specific information on plant traits and how they link to environmental benefits, significantly altered which taxa were preferentially selected.

Information provided on plant hairs increased the popularity of *Stachys* and *Pseudodictamnus* (at the expense of *Verbena* and *Erysimum*), presumably due to their better capacity to contribute to a garden's flood resilience. After receiving the information, most of the 'action-related' group changed their plant preference, while the majority of the 'system information' group did not. These results were supported based on previous literature in other contexts (e.g. on litter management – Hartley et al., 2015) that 'action-related' information providing detail on actions that participants can implement relatively easily facilitates pro-environmental behaviour change (Frick et al., 2004; Gimenez et al., 2023; Hartley et al., 2015; Neubig et al., 2020).

4.3. How does aesthetic preference impact plant selection?

Aesthetics has been highlighted as a significant driver for plant selection (Berger et al., 2022; Hanson et al., 2021; Hoyle et al., 2017; Kaufman & Lohr, 2004; Kendal et al., 2012; Zhang et al., 2023). Initial preferences (before additional information) were for the colourful or visibly flowering *Verbena, Oenothera* and *Erysimum,* but unexpectedly plant aesthetics (whether participants found the taxa attractive) was not a significant reason for selection by either group. *Oenothera* was popular both before and after information was provided, perhaps reflecting its high intrinsic popularity, with its attractive flowers and capacity for high transpiration (and thus its potential to provide a 'service' of drying out wet soils). It could be possible that participants did not want to admit to being motivated by plant appearance as this can be deemed trivial when discussing global issues like climate change. Plant aesthetics, however, should not be overlooked as an early driver for plant selection, especially as aesthetics can support people adopting environmental practices and valuing a plant's ecosystem service potential (Frantzeskaki, 2019; Gush et al., 2024; Hanson et al., 2021; van den Berg & Winsum-Westra, 2010).

4.4. Does 'system' or 'action-related' information increase people's willingness to make pro-environmental taxa selections?

Only the minority of participants in the 'system information' group changed their plant choices, but those that did stated the survey information as the reason. Although they were not provided with specific recommendations of plant traits linked to environmental benefits, the 'system knowledge' informed participants about climate change's environmental problems and impacts. This information was also framed in a local context, linking it to individual's own gardens (i.e. a tangible factor people can readily relate to) (Pidgeon, 2012; Scannel & Gifford, 2013; Spence et al., 2011; Wiest et al., 2015). In this survey the 'system information' group were unsure of which taxa to choose. 'System information' without recommendations can have a positive impact on preferences and environmental behaviour (Adu-Gyamfi et al., 2022; Frick et al., 2004; Liu et al., 2020; Samus et al., 2023). Within a garden design context, 'system information' (environmental education) in other studies changed people's landscaping preferences (van Heezik et al., 2012), reducing energy intensive or manicured garden styles (Hostetler, 2021) and adoption of water-saving designs (Fernández-Cañero et al., 2011). Environmental knowledge has a significant positive effect on attitude, which in turn positively affects pro-environmental behaviour (Liu et al., 2020). Thus, how people feel towards an environmental action is also important for changing behaviours (de Leeuw et al., 2015; Liu et al., 2020).

4.5. How does climate change impact pro-environmental taxonomic choice?

Regardless of the survey group, the data showed that the participants' perceptions and previous experience of climate change were significant drivers for selecting more appropriate plant taxa (i.e. with beneficial traits) in the future. In this instance the type of information provided ('system' or 'action-related') did not impact the participants' choice. Those most concerned about climate change were those most willing to change their choice of taxa. Previous surveys have also found that people who have experienced climate change extremes care more about this issue and approve adaptations, and climate change could be a driver for environmental attitude change (Andre et al., 2024; Spence et al., 2011; Wong-Parodi & Rubin, 2022). Other awareness about the environment, including feeling connected to nature (Otto & Pensini, 2017; Samus et al., 2023) and caring about or experiencing concern for the environment (de Leeuw et al., 2015; Lange et al., 2022; Otto & Pensini, 2017; Samus et al., 2023) results in people being more likely to undertake pro-environmental behaviours or incorporate climate suitable planting (Hoyle et al., 2017). Most Royal Horticultural Society survey participants reported they cared about environmental issues (Royal Horticultural Society, 2021) and were optimistic they could adapt their garden planting to suit climate change conditions better (Webster et al., 2017). The same care and willingness to adapt was also seen in this survey.

4.6. How can 'action-related' information be utilised to increase pro-environmental behaviours?

Understanding people's willingness to make environmental choices and linking this to actionable targets could improve the environmental impact of domestic gardens. Multiple studies indicate that people's perceptions and experiences of climate change could be key drivers to convert intent into actions (Derkzen et al., 2017; Hartley et al., 2015; Neubig et al., 2020; Phillips et al., 2023). The Royal Horticultural Society's 'Plants for Pollinators' scheme (Royal Horticultural Society, 2019) also works using a similar information premise to the Theory of Planned Behaviour theoretical framework (Ajzen, 1991) and educational information type outlined by Frick et al. (2004), informing consumers of plants that benefit pollinating insects. The scheme's online and printed information delivers 'system information' (Royal Horticultural Society, 2019), and the logo conveys an 'action-related' recommendation that enables people to make an environmentally informed planting choice. A 2016 survey found that 77.8 % of nationally representative UK residents were aware of the scheme and label meaning compared to other garden centre labelling (34.3 % and 31.6 % for the two other label comparisons), and only 13 % were not aware of any pollinator scheme (Bird et al., 2016). This indicates that clear plant labelling and easy-to-follow recommendations can facilitate beneficial change and enable consumers to make practical, environmentally friendly choices within their gardens. This scheme could be expanded to other ecosystem services. Garden design styles are copied, so environmental gardening could be replicated across neighbourhoods if it gains traction or becomes fashionable (Doll et al., 2023; Francis, 2018; Minor et al., 2016), particularly if people are concerned about climate change and willing to make changes, as seen in this survey regardless of information group.

4.7. Practice and Policy

There is increasing interest in using landscape and garden plants that both can survive a changing climate (e.g. Lewis et al., 2019) and help reduce, at a local level, the impacts of climate change (e.g. Gush et al., 2024). There are significant ecosystem services linked with the latter, with plants being able to help mitigate urban heat islands, improve air quality, hold and slow rainwater and re-charge the soil's capacity to hold water between consecutive storm events (Cameron & Hitchmough, 2016). There are some notable disservices with urban plants, however – for example, fuelling and propagating forest fires through suburban areas (Ondei et al., 2024). Policy makers acknowledge that green infrastructure typology affects these factors and that careful plant choice is vital to maximise any given service and minimise any disservice. This is one of the first studies to determine how providing more information about the services garden plants provide, can influence and potentially re-shape urban plant communities. Policy makers should take note that targeted dissemination of information may be one way to improve service delivery from privately owned landscapes, which is vital if they wish to tackle key environmental issues at the city scale, such as flooding and heat mitigation. Co-ordinated activities across policy makers, NGOs, the plant production/retail sectors and gardeners would allow for the evolution of gardens to become more sustainable but also more environmentally functional (Cameron, 2023; Egerer et al., 2024; Frost & Murtagh, 2024).

4.8. Limitations

Participants in this survey were predominantly female – a bias that is common in garden surveys (Samus et al., 2023), and gender did not have a significant impact on the results in either this survey or others (Chalmin-Pui et al., 2021b; de Leeuw et al., 2015; Mackay & Schmitt, 2019). The participants for this survey were approached via networks that the authors had access to, and the higher proportion of university-educated or holding a horticultural (or equivalent) qualification would also both have introduced bias. While participants were allocated randomly to the different information groups it is possible this sample may respond more positively to actionable information, and future work should aim for a wider reach and pool from participants that have varied levels of education and no gardening experience. However, previous studies representing different population samples (Frick et al., 2004; Gimenez et al., 2023; Hartley et al., 2015; Neubig et al., 2020) found similar results to this survey and although population bias is noted for this paper it may not negatively impact the generalisation of these results. Acquiescence bias or responses reflecting socially desirable attitudes may have influenced responses, although anonymous answers likely mitigated this slightly (de Leeuw et al., 2015; Toor, 2020), but could potentially explain why aesthetic preference was not a significant driver for plant selection in the survey. Previous studies have also indicated a discrepancy between self-reported answers and real-life intentions (de Leeuw et al., 2015; Samus et al., 2023). Some studies have found action-related information results in short-term change only, therefore, behavioural change may need to be supported beyond action-related information to ensure longer-term impact, such as labelling schemes (Royal Horticultural Society, 2019), or regular support and information (van Heezik et al., 2012). This support could come additionally from other parties, including both policy and stakeholders, and industries driving garden consumerism such as garden centres and growers (Frost & Murtagh, 2024). A combination of forces including action-related information, holistically working to contribute to gardening behavioural change and environmentally positive outcomes, could be the answer to supporting sustained changes (Cameron, 2023; Neubig et al., 2020).

5. Conclusions

'Action-related' knowledge significantly increased the likelihood of people changing their planting preferences in favour of taxa that could mitigate floods and reduce air pollution. The information provided in the survey, specifically the information on plant traits and how they benefit environmental outcomes, was linked to this change in preference. In addition, participants that were concerned about, or had experienced, the impacts of climate change were significantly more willing to select taxa that provided environmental benefits in the future. This effect was not influenced by 'system' or 'action-related' knowledge and could be harnessed to encourage pro-environmental plant selection in domestic gardens.

CRediT authorship contribution statement

Caitlin L. McLaughlin: Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Tijana Blanuša:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Ross Cameron:** Writing – review & editing, Supervision. **Martin Lukac:** Writing – review & editing, Supervision. **Simone Pfuderer:** Writing – review & editing, Formal analysis. **Jacob Bishop:** Writing – review & editing, Supervision, Methodology, Formal analysis, Conceptualization.

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.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.landurbplan.2025.105522.

Data availability

Data will be made available on request.

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