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Participatory perception mapping, informal public green space and ecological health in Southmead, Bristol

PARTICIPATORY PERCEPTION MAPPING, INFORMAL PUBLIC GREEN SPACE AND ECOLOGICAL HEALTH IN SOUTHMEAD, BRISTOL

THEODORA YOUNG

Image Credit: Southmead Development Trust, 2021.

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ABSTRACT

This project employs a novel, critical PPGIS methodology to map local participant's perceptions of the spatiality and quality of informal green spaces in Southmead, one of Bristol's most relatively deprived wards. It does so in the face of the ecological crisis, which has impacts on human health and well-being that are unevenly embodied across lines of socioeconomic inequality in urban populations. It turns the technocentric and power-laden logic of GIS towards legitimising community value judgements about informal green spaces and their associated ecologies by facilitating the production of qualitative, localised spatial knowledge. This knowledge demonstrates a fundamental understanding of how the public understand their own well-being as bound up with ecological health, motivating action and custodianship. The project aims to address procedural and participatory injustice by bringing a more equal knowledge politics to planning in Bristol's green spaces. It draws on a critical cartographic and political ecology theoretical framework to simultaneously address the continued abstraction of urban human communities from urban non-human nature by piloting an alternative to the expert-led GIS-based data collection methods used to analyse ecological value in urban landscapes.

AUTHOR'S DECLARATION

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's *Regulations and Code of Practice for Research Degree Programmes* and that it has not been submitted for any other academic award. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

SIGNED: THEODORA HELEN YOUNG DATE: 22/02/2023

1. INTRODUCTION

Over the last decade, urban planning has become increasingly preoccupied with both the quality and the quantity of urban green spaces (Haaland and van Den Bosch, 2015). Conservation ecologists have developed mapping language to describe how they directly and indirectly provide 'ecosystem services'[1] to the human population (Sczlavecz et al., 2011), including air purification, urban heat island mitigation, stress reduction, and provision of recreational space, to name a few (Bowler et al., 2010). Consequently, widespread concern about their declining quality and condition has been tied up with the growing recognition of green spaces as fundamental assets for the wellbeing and health of residents. Their decline has been, historically, due in part to their low priority in the political agenda at both national and local levels (Swanwick et al., 2003:94). More recently, their development, management and maintenance has been compromised by the growing need for intensive development in urban areas (Haase et al., 2014), to meet the demands of growing urban populations. Meanwhile, the past few years have seen declarations of ecological crisis by national and city councils, prompted by an elevated awareness insect and other invertebrate abundance, diversity, and biomass being reduced across the biosphere. This has been attributed to anthropogenic stressors, including the fragmentation and loss of wildlife habitat, pollution, influence of invasive species, of climate change and overharvesting. These stressors depreciate food webs and ecosystem service provision, as well as human health and wellbeing, and economies (Dirzo et al., 2014).

Bristol's Mayor Marvin Rees (Labour) declared an ecological emergency in Bristol in February of 2020. Subsequently, that September, Bristol's One City Environmental Board developed an ecological emergency strategy for the city. This was its first co-ordinated effort to confront the decline of nature in the city, and support a nature recovery by 2030 (Bristol City Council, 2020). One of the four key goals of the strategy was to manage 30% of land in Bristol for the benefit of wildlife by 2030 (*ibid*). Urban centres have been proven potentially more regenerative for pollinator populations compared to the rural and suburban landscapes that surround them due to their varied landscape of forage and nesting sites[2] (Hall et al, 2017:26). The spatial commitment of Bristol's One City Environmental Board to protect urban green space could therefore be pivotal for restoring urban invertebrate and populations, and biodiversity in general. However, such commitments to protecting green space in Bristol are pitted against the rising demand for affordable housing, which makes Bristol the critical locus of this study. Marvin Rees recently declared that accelerating the building of affordable housing across Bristol would be one of the key strategies for facing the housing crisis (Rees, for Bristol City Council, 2022). Whilst the Council have reallocated development proposals for new homes where ecological reports have found sites to be of conservation value, such as on South Bristol's Western Slopes (Avon Wildlife Trust, 2021) in order to protect important green spaces, the future delivery of affordable housing still depends on building more densely on sites deemed less valuable elsewhere in the city.

This leads us to the spatial focus on the study, Bristol's informal green spaces. They are defined here using Rupprecht and Byrne's 2014 broad typology. This covers any publicly accessible urban green space that governing institutions and property owners do not formally recognise or specifically designate for gardening, recreation, farming, forestry, or ecological conservation. The vegetation within them is often spontaneous (weedy), and is not managed for any of these purposes

by an 'official owner' (Rupprecht and Byrne, 2014:598). Such spaces are a particularly undervalued and overlooked part of the urban landscape (*ibid*), despite much work that highlights their potential for mitigating deleterious effects of urban densification on biodiversity (Vega and Küffer, 2021; Van Rossum and Triest, 2014). They are more likely to be threatened by development pressures in burgeoning cities than formally designated public parks, which receive greater legislative protection (Kronenberg et al., 2020). The latter are often simpler in terms of vegetation structure and composition, host a limited suite of plant species, or are specifically designed for public amenity and safety. Given that funding for their management usually comes from the local authority's general revenue budget (which is financed by government transfers or local taxation), this is usually done for lowest cost of maintenance rather than biodiversity (Vega and Küffer, 2021). At the same time, informal green spaces have been proven as underestimated resources of greenery that provide ecosystem services like air cooling and purification, water storage and importantly, preserving biodiversity (Hermann et al., 2017; Anderson and Minor, 2019). Informal green spaces have a high spatial share in cities, and could therefore radically enhance the city's green network whilst at once reducing inequalities of access to green space, and the benefit they bring to urban citizens (Silva et al., 2018). They are recognised in terms of their potential contribution to green corridors - habitat areas connecting wildlife populations across an otherwise fragmented ecosystem within the urban landscape – in Bristol's Green Space Strategy. However, this policy document characterises them as small and often blighted by litter, having lacked significant investment to fulfil other significant functions such as wildlife-sensitive management (Bristol City Council 2008a:7; Bristol City Council, 2008b). This characterisation has had a stultifying impact on their planning and management for quality and availability. Not only has their ecological potential been overlooked, particularly in working-class areas where the population are already more likely to experience environmental deprivation (Bell, 2020), but they have not protected been from urbanisation and development.

As environmental justice scholars and activists have pointed out, working-class areas in England are at a higher risk of losing their green spaces to new urban developments than more affluent areas (Bell, 2008). Initially, environmental justice scholarship brought attention to issues of the inequitable distribution of waste and pollution. This focus on distributive justice remains a key focus of environmental justice research, however, a growing body of literature now attends to procedural and participatory justice issues. This highlights how the decisions that transform the lived environment are not usually made by people who bear their impacts (Schlosberg, 2013). The public have, historically, been marginalised by decision-making institutions at all scales from the local to the global which have the power change the environmental conditions of their lives (Bell and Carrick, 2017). Despite increased commitments to public engagement and participation, the ways these commitments manifest still have real and often unequal outcomes. Per environmental justice scholars like Bell and Carrick, inequalities of political authority and power persist in environmental decision-making in the UK (*ibid*).

Nonetheless, where commitments to meaningful public collaboration in these processes are centred and upheld by institutions, they can and do have transformative impacts on environmental conditions. For example, the aforementioned new ecological report on South Bristol's Western Slopes was instigated by residents who suggested that important wildlife inhabit the land at Novers Hill. In collaboration with Avon Wildlife Trust, local's expertise and situated, place-based knowledge played a key role in reframing the way that informal green space is perceived and valued, contributing productively to the strategic development of an ecologically sustainable Bristol.

However, structural inequalities persist which disadvantage these local voices in planning processes and often foreclose on meaningful public contributions to the protection, recovery, and enhancement of urban ecologies. Who's knowledge matters, and how it is integrated and used, informs outcomes for urban green space planning.

This study combines insight from environmental justice scholarship and political ecology. The latter field focuses on the political struggles mediating the relationships that characterise the social-ecological systems in which we live, as well as the spaces in which these power relations are made manifest. In everyday urban green spaces, the power to produce and apply environmental knowledge and actualise convivial futures – futures in which relationality and interdependence is between humans and non-humans is considered intrinsically valuable to the flourishing and resilience of urban communities (Adloff and Caille, 2020:14) - is being reclaimed by local actors. As Alex Loftus asserts, 'world-changing ideas emerge from everyday men and women, whose practical acts make the world as it is' (2012:xii). Across the city of Bristol, and specifically, in Southmead (one of Bristol's more economically deprived wards), the ecological crisis is being taken into hand by the public. Local activists are working together to create healthy socio-natural worlds at the scale of their communities by restoring and managing ecological niches in its informal green spaces. Along the Trym Valley and Hazel Brook, individuals and groups from within and beyond the ward labour hard to collaboratively to enhance the ecological value of their surroundings.

A hyper-local focus facilitates the critical stance of political ecologists, who are preoccupied with the marginal, mundane, and everyday spaces of urban nature as rich ground for public engagement and important loci for building convivial, multispecies futures (Yung et al., 2013). This lens also highlights how informal green spaces are highly curated social-ecological niches. It necessitates the recognition of a multiplicity of different types of being in the city, and the involvement of multiple species in thick relational webs that produce life within it. Given that human and non-human health, well-being, and survival are bound up in this way, the study focuses on the environmental justice issue of procedural and participatory justice. The project seeks to bring these theoretical frames together in a practical, methodologically focused way, and informal green spaces from the critical scale of analysis.

To uncover how these niches are perceived and produced by local actors, this study investigates the aesthetic, sensorial and physical factors that determine local actors' value judgements of the ecological health and benefit of their local informal green spaces (or lack thereof). This enables it to get to the root of *how* local environmental knowledge is generated. It was important to base this study in Southmead, where tensions surrounding informal green spaces are mounting as they become threatened by the developments demanded by Bristol's burgeoning population and attendant housing crisis. Proposals have recently made to build on Doncaster Road Park as part of the delivery of Southmead's Masterplan (Southmead Future Housing, 2021). The added ecological value engendered by local stewardship is not accounted for in planning fora, arguably, because its spatiality cannot be mapped by traditional techniques and models.

Herein lies a key systemic factor of procedural injustice in urban green space planning; GIS (Geographic Information Systems) mapping plays a central role in urban development as a planning tool for ascribing value across urban ecosystems. Using digital mapping technologies, this assessment mainly includes biophysical, empirical, statistical, and survey-based models (Haase et al.,

2014). Qualitative studies, whilst important for obtaining local values, are less widely applied due to being more time intensive and costly (*ibid*)*.* GIS mappings of local ecosystems have therefore perpetuated the omission of meaningful contributions from the public regarding ecological value. Ecological value mapping usually forms part of very technical analysis, carried out by select "experts," a priori of public engagement. Therefore, procedural exclusivity is afforded to those able to perform the calculations, compared to who may live with their political impacts. Locals are less able to speak on behalf of their immediate surroundings, contribute to data collection, and access evidence about its ecological value. This has contributed to the low conservation priority of informal, everyday green spaces compared to larger reserves and the ongoing, gradual shrinking of the urban ecological network, despite the ecological restoration goals touted by city planners. Communities in areas like Southmead require new methodological approaches to green space mapping to reveal embodied, local knowledge at the human-biodiversity interface. This project seeks to enable the public to help produce, access, and use rich qualitative datasets about local ecologies to achieve procedural and participatory environmental justice in the planning and management of informal green spaces in Bristol.

The investigation was developed in a number of stages. Firstly, an interwoven, cross-disciplinary theoretical frame of environmental justice, political ecology, and critical PPGIS (public participatory GIS) is developed. This frame is crucial in the moment of ecological crisis which contextualises the study. In re-making the mapping practises which condition how knowledge about informal green spaces is produced, and who participates in its production, it joins the wider project of re-making of environmental politics in a world woven from numerous entanglements of socio-natural relations (Loftus, 2012:ix). Respecting these entanglements demands dismantling the 'false boundaries out of which the social and natural are separated' (*ibid*). To do this, tenuous boundaries between academic spheres that delineate ways of knowing the world must be transgressed. This need is critically evident in mundane, everday spaces, such as informal green spaces, because here the distance between human and non-human lives collapses (*ibid*:x). The literature review, therefore, explores these different areas of study and thought to develop a suitably transgressive frame with which to develop a how a novel PPGIS mapping methodology might capture public perceptions of value in informal green spaces, and in so doing, transform normative green space mapping practise.

Secondly, the methodology section outlines the research design of this experimental PPGIS mapping and its rationale. 5 key research questions ground the investigation at the level of human perception of the environment. The methodology comprises an interactive, web-based 'Emotional mapping' platform developed to explore how locals perceive informal green spaces in physical and spatial terms, but also in qualitative terms of ecological health and benefit. A map-based survey attached to this platform uncovers the contextual factors that inform these value judgements.

The third stage of the investigation comprises a reflexive analysis of the data generated by this methodology. It is found that participants are very aware of the entangled nature of their own health and that of the green spaces around them, and that informal green spaces that serve multiple uses are perceived as healthier and more beneficial. Responses showed perceptions of increased ecological benefit of informal green spaces, attributed to the work of local activists. This indicates the central role of local custodianship within functioning, flourishing social-ecological systems. A key part of this analysis is also the investigation of whether this use of a novel PPGIS upheld its

commitments to enable participants to express situated knowledge about informal green spaces, and whether or not the knowledge produced offer a critical counterpoint to normative cartographic representations. Based on the literature, it is found that to achieve these aims, the maps had to be enhanced by data that highlights the collaborative custodial work and action through which local environmental knowledge is actualised in informal green spaces. Finally, multiple datasets are collated, and the findings situated within a holistic framework for a future, collaborative research project. This proposal also integrates Karen Bell's Checklist for Meaningful Inclusion in Environmental Decision-Making and her guidelines for Working-class Inclusion (2020:73), in order to guide future community-based environmental knowledge production projects that inform just planning and development strategies within Bristol.

1.1 Footnotes

[1.] Ecologists Reid *et al* conceptualised the healthy functioning of ecosystems at various scales, from global to local, as fundamental to the direct and indirect delivery of ecosystem services that contribute to human wellbeing (2005). Their 2005 Millennium Ecosystem Assessment identified four categories of ecosystem services, direct and indirect. Firstly, ecosystems regulate water supplies, the climate, and human diseases, by way of example. They directly produce goods, such as fibres and building materials, food, and fresh water. Indirect ecosystem services may be cultural— the less palpable benefits which society derived from ecosystems, like 'spiritual enrichment, recreation, and aesthetic experience, and aesthetic values' which are inextricable from human societies; or supporting, ensuring the 'flow' of other services (*ibid*).

[2.] Contrary to a more traditional viewpoint of cities, they have been identified as a refugia for insects that bring crucial ecosystems services to human society. Ecological studies evidence greater abundance and diversity of native bee populations in cities than nearby rural landscapes (Hall et al., 2017; Baldock et al. 2015; Verboven et al. 2014; Sirohi et al. 2015). As such, they must not be overlooked in ecological management and conservation. Urban areas foster greater species richness of bumblebees for example, than more natural, rural areas (Baldock et al. 2015; Gunnarsson and Federsel, 2014). This has apparent urban abundance has been attributed to the loss and homogenisation of countryside habitat, through systemic use of herbicides and pesticides (Goulson et al. 2015; Simon-Delso et al. 2014).

2. LITERATURE REVIEW

This section highlights the foundational literatures that guide the project, firstly from within and between environmental justice and political ecology, and then the critical cartography and public participatory GIS (PPGIS) scholarship which informs the study's methodological approach. This section explores why a PPGIS approach is necessary for gathering qualitative, place-based knowledge as spatial data. Whilst terms for participatory mapping seem to be used interchangeably in GIS scholarship, Brown and Kyttä (2014) differentiate PPGIS from PGIS. They state that the former is often employed by government planning agencies to boost public involvement in decision-making fora by combining qualitative and quantitative datasets in the mapping process. On the other hand, PGIS is usually funded by NGO's building social capital in developing countries, and it employs non-digital maps as a more accessible research methodology.

The aims of this study correlate with the former, however, unlike most PPGIS studies (*ibid*), data quality is not of primary importance here. What is being tested is the utility of a novel PPGIS methodology for recognising how local knowledge is produced at the human-biodiversity interface of urban socio-ecological niches. This project spans linked disciplines, such that the reflexive insights generated may guide future projects that aim to produce accessible, situated environmental knowledge in a collaborative fashion. It provides empirical examples of how these modes of thinking intersect where urban green space planning processes and outcomes are perceived and embodied in unequal ways by urban communities, finding the points where these spheres of study touch by pushing against their expanding edges. The environmental justice scholarship that focuses on participatory and procedural justice is explored first, as it underpins the need for more inclusive environmental knowledge production processes in urban landscapes.

Assertions of environmental justice arose in UK and US academic literature in the 1980s and 90s amidst a growing awareness that environmental risks were unequally distributed socio-spatially along lines of income inequality and race (Schlosberg, 2013). Campaigns by low-income Black, Asian and Minority Ethnic (BAME) communities brought attention to the disproportionate health impacts they were suffering as a result of the location of hazardous industries in their neighbourhoods, due to pollution and toxic chemical exposure. Today, the most deprived urban communities in the United Kingdom tend to be populated by BAME communities (CABE 2010a), and these continue to experience the poorest air quality (Mitchell, 2019), which contributes to excess mortality in these neighbourhoods. During the COVID-19 pandemic, it was identified by the Ramber's society and YouGov that 'British people with an annual household income lower than £15,000 were less likely to live within a 5-min walk of green spaces,' to live within a green urban setting, and report that good walking routes surround their homes compared to those with annual incomes of £35,000 or higher (Ramblers, 2020). Further, CABE's 2010a study showed working-class census wards in England to have had an average of one fifth of the green space available to affluent wards. It also showed that in areas mostly populated by BAME groups, the available green space was poorer in quality. Distributive injustices in accessibility to green space are also significant; a second study by CABE (2010b) identified the quality, access, and use of urban green space was a significant predictor for general health in BAME communities.

These distributive injustices lay the foundation for this study's focus on the more recently explored participatory and procedural elements of environmental justice scholarship. As we have seen, access to urban green space brings health benefits to urban residents. These benefits are 'equigenic' (Mitchell et al., 2015); they are most strongly felt amongst more strongly socioeconomically disenfranchised groups, including minority ethnic groups. The provision and maintenance of publicly accessible green space in urban areas may therefore help reduce health inequalities by providing ecosystem services (Bowler et al., 2010). Fairer processes are therefore necessary to include marginalised social groups in green space planning, for their benefit to be accessible and embodied at a local level.

Investigating the perception of green spaces is a critical starting point to identify how their benefit is embodied by different community groups, in order to enhance this. Sreetheran and van den Bosch (2014) have showed how ethnic minority groups who live in low-income urban neighbourhoods experience feelings of insecurity and vulnerability in local green spaces. Respondents to their study were afraid to visit parks and playgrounds because they had previously been directly or indirectly victimised within them. Further, for a white British population, a positive association was identified between the levels of urban greenness during pregnancy and babies' birth weight. The same was not present for mothers and babies in Pakistani families (Dadvand et al., 2014). This indicates the different sensorial and perceptive experience of green spaces that exist within urban communities, which determine how their benefits are embodied are the individual level.

Though understanding green space perceptions should be a crucial aim for research that informs urban green space management, qualitative engagement with perceptions of green space is less prevalent in spatial planning literature, existing policy documents and green space strategies. Nonetheless, environmental justice scholarship is committed to what Laura Pulido called the 'environmentalism of everyday life;' the ways that environmental injustices are reproduced at an everyday, bodily level, through the perpetuation of structural inequalities (1996:30). With this commitment at its core, research in the vein of procedural and participatory environmental justice engages with the substantial, persistent inadequacies regarding the inclusion of disadvantaged groups in environmental knowledge production, decision-making, and fair processes, when their lives are directly impacted by policy and planning outcomes (Bell, 2014; Schlosberg, 2013). What is missing, then, is a spatial study that commits to demonstrating the spatiality and nature of perception of public green space, whilst upholding a commitment to procedural and participatory justice.

Combining a hyper-local spatial preoccupation with participatory and procedural justice focus enables this study to link the lived, embodied focus of environmental justice work to theoretical engagements with place. These engagements stem from human geography and the field of political ecology. Political ecologists assert that 'environmental politics grows from the conditions out of which environmental knowledge is produced' (Loftus, 2012:x). Given environmental policy in the UK's 'strong scientific framing of problems and solutions' (Haklay and Francis, 2017:300), the expert-led production of environmental knowledge has legitimised and perpetuated a 'singular story of the world.' This has determined environmental policy outcomes according to the 'broad thrust' of such expertise (Palmer, 2019:147). Within this normative scientific paradigm, communities intending to use environmental justice arguments to further fair policy outcomes must collect evidence to

support their claims. The need for publicly accessible and usable environmental evidence fosters the attendant need for increased public participation in the collection, production, and dissemination of environmental data. However, opportunities for the public to be the creators of such knowledge, design research projects and have ownership over the data produced are limited.

Public participation is increasingly posited as an important part of environmental policy-making processes, as it enables the public to influence its outcomes (Bell, 2014; Haklay and Francis, 2017). However, there has been increasing critique about how such processes work in practice (*ibid*:10). The term 'procedural injustice' captures how public participation processes in environmental planning may actually cause procedural injustices if they are insensitive to local voices or otherwise remain inaccessible. In the context of Bristol's housing crisis, the situation faced by residents of Cheswick Village in Lockleaze captures this concept. Despite statutory planning consultuation processes in place and a large number of consultation events and activities, as well as a regular Lockleaze Residents' Planning Group, the Council is overriding planning restrictions it previously put in place to protect the Stapleton and Frome Valley Conservation Area. This is to facilitate a 268-home development on the adjacent Romney House site (Coulter, 2020), demonstrating the danger of public engagement in planning that is not meaningful. More economically deprived communities like the Lockleaze ward are regularly situated as 'subordinate subjects' in environmental debates and action. They may be allowed only to agree upon a set of 'compensatory practices' in exchange for the permission to destroy their everyday environments (Kaika, 2017:96), and are seldom afforded the status of co-decision makers in a constructive capacity, such as when development goals are being set and resources allocated.

Participatory justice issues also persist in the UK. Learning from the public, making research relevant, enhancing impact and accountability are still cited as less important for environmental research than merely informing the public about environmental issues and attaining public agreement (as per the NERC – which is the UK's largest funder of independent environmental research) (Mitchell, 2019). The public's expertise and place-based knowledge[1] is not sufficiently brought to debates and actions in environmental planning and policy (Bell, 2020:12) to contextualise ecological issues, like urban biodiversity loss and blight. Addressing these issues requires participatory research that produces a grounded insights into how socio-political factors influence land use across complex urban landscapes, and the ways in which human and non-human species interact with each other within the dense, evolving socio-ecological network of the city.

2.1 Procedural and Participatory Injustice as Multi-Species Injustice

When it comes to reworking a politics of knowledge in environmental planning and policy, attention is increasingly paid to the question of multi-species justice (Celermajer et al., 2021). In an effort to encompass whole ecosystems as moral subjects, this scholarship 'seeks to understand the types of relationships humans ought to cultivate with more-than-human beings so as to produce just outcomes' (*ibid:120*). As we have seen, the capacity of urban communities to access, advocate for, manage and enhance the social-ecological systems which they co-form depends on procedural and participatory justice. Therefore, just approaches to urban development and the ecological crisis must commit to centring local voices in urban green space planning fora.

The ecological crisis demonstrates a multi-species environmental justice issue in that its impacts are lived and felt unfairly across human as well as non-human populations. Baldock et al's hotspot mapping of major cities across the UK England, Bristol included (2019), showed the positive association between pollinator abundance and floral diversity in residential gardens, and socioeconomic status. This aligns with previous studies that correlate socioeconomic status and plant diversity (Hope et al., 2008), reflecting the phenomenon ecologists term the 'Luxury Effect,' (Baldock et al., 2019). This is problematic because biodiversity has been shown to foster healthier neighbourhoods (Shanahan et al., 2015), encourage social activity (Sirakaya et al, 2018), reduce crime, help children's learning, and contribute to economic regeneration. In the context of an ecological crisis, wherein wildlife species continue to decline (Goulson, 2019), their net loss will have a greater negative impact on both ecosystem function and the delivery of ecosystem services in lower-income human communities (Marselle et al., 2020).

Similarly, in her 2020 book Working-Class Environmentalism, Karen Bell shows blight to be a spatial environmental justice issue, most prevalent in more deprived urban areas. This term captures 'litter, graffiti, dumped cars, fly-tipping, dog mess, vandalism, derelict land, broken glass, potholes, and broken pavements' (2020:52). It is synonymous with issues Bristol City Council identify in informal green spaces (2008a:8). It undermines human health and wellbeing (Kondo et al., 2015) whilst creating toxic conditions for local flora and fauna (UNISAN, 2020). Those who perceive high levels of blight in their local area report frequent episodes of anxiety and depression more than twice as much as those who perceive low levels (Bratman et al., 2019). Fears around crime and safety also increase when the local environment is not well-maintained. This can lead to more isolation, due to unease around leaving the house (SDRN 2004:26). In addition, vermin and associated diseases are more prevalent around blight like rubbish and litter. Whilst the issue of blight is often attributed to local residents' behaviour, but Bell explains in her book that it often results from ineffective policy-making and funding issues resulting from unequal environmental service distribution (2020). By way of example, it has been shown that in the UK, more deprived areas generally receive lower standards of street cleaning and waste collection services (MacIntyre et al., 2008).

Effective public green spaces management for the restored health and functioning of urban socio-ecological systems requires a shift away from the 'fallacy' that cities are 'biological deserts' (Spotswood et al., 2021:148). The discussion of urban ecologies has focused on the negative impacts of human society on nature, impinging on possibility of the public to contribute expertise about their everyday environments. Meaningful public participation in environmental policy hinges on a view of neighbourhoods in cities as ecological milieus; valuable habitat wherein dense networks of multispecies interaction exist, and environmental knowledge is gained. Advocating this view of lively, multispecies cities has been the work of many scholars across multiple disciplines. Ecologists assert that cities contain important habitat and can be refuges for threatened species that provide ecosystem services, like the insect pollinators that thrive in urban forage and nesting sites (Hall et al., 2017:26).

Theoretical engagements from within urban political ecology and the environmental humanities have challenged city-nature conceptual dualisms. Urban political ecologists suggest that 're-naturing' the city, that is, restoring ecological health, demands an approach to nature that considers ecosystems and biodiversity as a social product (Pietta and Tononi, 2021). They have given

the entanglements and interdependencies of human and non-human life various names, such as 'vital materialities' and 'nature-cultures' (Bennett, 2010; Haraway, 2003). In this view, human residents are not apart from urban nature, but congruent with various facets of a city's complex ecological processes. This work recognises the importance of everyday, creative, and collaborative human action in shaping urban spaces, opening up rich ground for public engagement. Anthropologist Anna Tsing describes how the 'work of many organistms, negotiating across difference' forges 'assemblages of multispecies livability in the midst of disturbance' (2015:52). In other words, a liveable environment is a fluid, ever-changing web of purposeful actions that depend upon each other. In the context of the ecological crisis, this assertion is at once desperate and hopeful for those who face environmental injustice. It situates all members of urban socio-ecological systems, human and non-human, as fundamental to the work of actualising a survivable future. Loftus describes the 'latent radicalism' inherent in 'working with day-to-day reality as it really is' (2012:ix). Similarly, Searle and Turnbull (2020) assert that 'humans often play an active role in resurgence and the cofabrication of worlds' which emerge as a result of crises (*ibid*:292). In this view, all urban dwellers (human and non-human alike) are important agents in the timely project transforming of their everyday environments. Multi-species survival is an always-emergent possibility. But, whilst it lies within reach of urban citizens, it depends on how we perceive, engage with, and choose to cultivate our ecological milieus.

Despite these theoretical advancements, local communities are rarely afforded the status of "expert" when it comes to sensing local ecologies and the lively terrain in which they live, aside from ad hoc citizen science engagements, and are rarely afforded the financial and material resources to usher in biodiverse landscapes. More broadly, academics and environmental researchers must increasingly work with other actors such as city planning authorities, private development firms, landscape architects and urban wildlife managers to ensure that cities are included as part of the solution to the global biodiversity crisis (Searle and Turnbull 2020*;* Baldock et al., 2019; Palmer, 2019). However, the growing recognition that cities are key to an ecologically sustainable future (Soanes et al., 2019) has yet to shift beyond the remit of "experts." Lack of meaningful knowledge exchanges between academic researchers, environmental planning and policymakers and the public profoundly limits the scope and success of interventions for urban multispecies liveability in the face of the ecological crisis*.* To explore this further, this study applies the multi-disciplinary arguments from ecology, environmental justice scholarship, urban political ecology, and the environmental humanities within one particular, hyper-local urban milieu: informal green spaces.

2.2 Informal Green Spaces

Informal green spaces are where local groups mobilise to make the socio-natural worlds they wish to exist within and alongside. They are liminal, quasi-public green spaces, defined here using Rupprecht and Byrne's (2014) 'provisional, non-exclusive' definition and typology (see Table 1 below). Within these spaces, recreation is informal and transitional, taking advantage of their liminal characteristics (*ibid*:598). They are explicitly socio-ecological in character, existing as a function of anthropogenic disturbance (*ibid*), and their lack of formal designation does not negate their ecological importance. For example, railway sidings, roundabouts and abandoned lots can provide dispersal routes and protective habitat for vulnerable species through the vegetation that emerges as a result of their management (or lack thereof). They have been termed 'refugia,' 'islands of biodiversity' or 'eco-

ducts' (Gandy, 2013:1305; Saint-Laurent, 2000). They form an intrinsic part of green spaces networks, which includes nature reserves, historical sites, parks, roadsides and woodlands, and the spaces that link them (such as river channels, railway sidings and wildlife corridors). Their transformative potential as the target of urban conservation strategies has been highlighted by a group of ecologists who recently conducted a large-scale biodiversity hotspot modelling project across four UK cities, Bristol included (Baldock et al., 2019). Whilst they found the healthiest, most diverse populations of insect pollinator species and higher floral abundance in allotments and residential gardens, 'other' (informal) green spaces and verges were seen to make up 20% of the city. Therefore, their enhancement could have widespread impacts on urban ecological restoration, and should provide a focus for conservation activity in the future (Baldock et al., 2019).

IGS	Examples	Description	Management	Form	Substrates
Street verges	Roadside verges, roundabouts, tree rings, informal trails and footpaths	Vegetated area within 5 m from street not in another IGS category; mostly maintained to prevent high and dense vegetation growth other than street trees; public access unrestricted, use restricted	Regular vegetation removal (≥ once per month); governmental and private stewardship	Small: <100 m², linear	Soil, gravel, stone, concrete, asphalt
Lots	Vacant lots, abandoned lots	Vegetated lot presently not used for residential or commercial purposes; if maintained, usually vegetation removed to ground cover; public access and use restricted	Irregular veg. removal, medium to long removal intervals; private stewardship	Small–medium: <1 ha, block	Soil, gravel, bricks
Gap	Gap between walls or fences	Vegetated area between two walls, fences or at their base; maintenance can be absent or intense; public access and use often restricted	Irregular veg. removal; variable removal intervals; private stewardship	Small: <100 m², linear	Soil, gravel
Railway	Rail tracks, verges, stations	Vegetated area within 10 m adjacent to railway tracks not in another IGS category; usually herbicide maintenance to prevent vegetation encroachment on tracks; public access and use mostly restricted	Regular veg. removal (monthly to yearly); corporate or governmental stewardship	Medium–large: >1 ha, linear	Soil, gravel, stone
Brownfields	Landfill, post-use factory grounds, industrial park	Vegetated area presently not used for industrial or commercial purposes; usually no or very infrequent vegetation removal and maintenance; public access and use mostly restricted	Irregular veg. removal, long removal intervals; corporate and governmental stewardship	Medium–large: >1 ha, block	Soil, gravel, concrete, asphalt
Waterside	Rivers, canals, water reservoir edges	Vegetated area within 10 m of water body not in another IGS category; occasional removal of vegetation to maintain flood protection and structural integrity; public access and use often possible with some restrictions	Irregular veg. removal, long removal intervals; governmental stewardship	Small–large: >10 m² to >1 ha, linear	Soil, stone, concrete, bricks
Structural	Walls, fences, roofs, buildings	Overgrown human artifacts; often vertical; occasional removal of vegetation to maintain structural integrity; public access and use mostly restricted	Irregular veg. removal, medium to long removal intervals; varying stewardship	Small: <100 m², block	Soil, stone, gravel, wood, metal
Microsite	Vegetation in cracks or holes	Vegetation assemblages in cracks, may develop into structural IGS; maintenance can be absent or intense	Irregular veg. removal, variable removal intervals; variable stewardship	Very small: <1 m², point	Deposits, soil, stone, concrete
Power line	Power line rights of way	Vegetated corridor under and within 25 m of power lines not in another IGS category; vegetation removed periodically to prevent high growth; public access and use mostly unrestricted	Regular veg. removal (less than yearly); utility or governmental stewardship	Medium–large: >1 ha, linear	Soil

Table 1: Rupprecht and Byrne's informal green space (IGS) typology (2014).

Informal green spaces also represent spaces of 'resurgent' urban nature, which have been variously called 'novel' (Yung et al., 2013) and 'emergent' ecologies (Kirksey, 2015), or 'marginalia' (Mathey et al., 2016). They are co-produced by the biotic forces of nature, and human intervention and impact (Yung et al, 2013:247). Per Eben Kirksey (2015:215), emergent ecologies are those flourishing 'in the aftermath of order-destroying disruptions,' and are 'shaped by a multitude of creative agents.' This work demonstrates how ecosystem resurgence, or resilience, emerges through

the relations between social and natural systems, and how humans can play an active, constructive role in this process (Hobbs et al., 2013). Informal green spaces as liminal and co-produced through multispecies interactions therefore also challenge traditional urban conservation and environmental management practices in the Anthropocene. They demonstrate the practical impossibility of recreating historical, pre-human ecologies within pristine urban wildlife reserves (Marris, 2013).

Given that they include brown and greenfield sites, informal green spaces are the category of urban green space most likely to be lost to developers (Sikorska et al., 2020). They capture the everyday environmentalism upon which environmental justice is built, providing a critical focus for reframing urban nature, and incorporating the public into fair, inclusive planning processes. They are the roadside verges, river channels, roundabouts, gaps between fences and walls, tree rings, micro-scale vegetation assemblages in cracks and walls, informal trails and footpaths, and more. As we have seen, working-class neighbourhoods may be home to less robust wildlife populations. Strategies that promote individual action, like enhancing residential gardens or focus on restoring the ecologies in parks and reserves that are fewer and further between in more deprived areas (de Zylva et al., 2020) miss an opportunity to strengthen the socio-ecological connections necessary to carry working-class communities towards more just, multispecies urban futures. On the other hand, given their ubiquity in the urban landscape (Baldock et al., 2019), informal green spaces can help urban planners address problems of access to selected urban ecosystem services, and health and wellbeing disparities within the urban population.

Deborah Bird Rose and Thomas van Dooren describe this aim as multispecies 'conviviality;' something that cannot be engineered, but can be 'accommodated and planned for,' through an effort towards inclusiveness, and endeavouring in all our shared spaces 'to make room for that other' (2012:17). This aim does not seem to oppose community development goals; research has found that urban residents prefer the features that distinguish informal green spaces from formal ones; their naturalness as indicated by an abundance of trees, the presence of good quality water, their degree of wilderness, and their biotic diversity (Chon and Schafer, 2009). Participants in Chon and Schafer's study disliked the characteristics of formally managed parks, namely their uniformity, artificial modification, and high formality (*ibid*). In the UK, Southon et al. have also shown the public's preference for open spaces that contain more plant species, and some structural diversity (2017).

It is important to note that such preferences will differ between individuals due to various factors, including age, gender, ethnicity, and level of expertise (Rupprecht and Byrne, 2014; Wang and Zhao, 2017). Further, management strategies for informal green spaces are usually contested, with unruly or apparently 'spontaneous' vegetation often being viewed negatively and associated with abandonment, despite what this may mean for ecological health (Mathey et al., 2016). By way of example, on the 30th of May, Hackney residents were appalled to find that the local council had weeded tree pits around London Fields, which had been in full flower after their efforts to sow and plant in wildflowers in an effort to create wildlife eco-corridors, colour, joy, and biodiversity to their streets. Gerry Tissier of the Union of Hackney Gardens asserted that 'residents have worked hard to care for mini-gardens that are also miniature nature reserves,' and that people were demoralised that their work to care for and boost biodiversity was 'demolished.' Whilst the public often feel powerless when confronted by the spectre of ecological collapse, helping nature at street-level an

achievable task. It is therefore important for both human and ecological wellbeing that 'the council does not go around pulling up flowers that we have planted' (Tissier in the English Times, 2022).

This example also demonstrates how informal green spaces are sites where a disconnect between the actions and pledges of local politicians is made manifest. Caroline Woodley, cabinet member with responsibility for families, parks, and leisure in Hackney tweeted in response to residents' concerns. She asserted that the removal of vegetation was 'opposite to the work we've been doing around green infrastructure' (Woodley in the English Times, 2022). It reveals the lack of a conversation between residents and green space management authorities about local desires for the landscape. It also shines a light on the wider issue of an urban green space management program which is still occupied with street tidiness even amidst desperate calls from the public and ecologists to restore healthy, rambunctious, functioning ecological networks of urban wildishness (Goulson, 2019).

Given the importance for both local's sense of empowerment around the ecological crises as well as their transformative potential for ecological restoration and multispecies conviviality, it is timely to map the factors informing perception and valuation of by urban citizens whose lives and health outcomes are bound up in their functioning. To support and scale up the efforts of the public to protect and enhance urban ecologies that they value, these perceptions must be elicited and legitimised. PPGIS has been a useful method for achieving such aims. For example, Pietrzyk-Kaszyńska et al used an 'online geo-questionnaire' to uncover the non-monetary values that the public attributed to formal and informal green spaces in three Polish cities. Their results exhibited a wide range of values associated with urban green spaces. Crucially, they showed that the places which were valued for their 'greenness, pleasant views, uniqueness, wild character, and role as natural habitats' were predominantly marked *outside* of formal green spaces. This highlights the importance of including the place-based knowledge and expertise of locals in urban green space governance, and concomitant need to address procedural and participatory injustices that inhibit it (2017:85).

This study takes as its starting point the need to undertake such mapping in Bristol to find out how informal green spaces could be managed fairly in the context of the co-existent ecological and housing crises. The next section highlights the importance of moving beyond normative applications of green space GIS towards a PPGIS approach in order to generate these insights whilst maintaining a commitment to procedural, participatory environmental justice.

2.3 Valuing Informal Green Spaces: GIS and Environmental Knowledge Politics

As environmental justice scholarship has developed, GIS mapping has played an increasingly prevalent role in enabling patterns of environmental exposure and benefit to be represented and understood (Mitchell and Walker 2007; Mennis 2011). Historically, this involved the spatial plotting of industries or land uses that posed potential environmental and human health risks, then analysing affected local populations to determine their economic, racial, or ethnic characteristics (Mantaay, 2002). More recently, geospatial mapping and survey data has been used to reveal injustices of access to quality green spaces. As we have seen, in England and the UK this spatiality is directly and inextricably tied up with issues of racial and socioeconomic health disparities.

Whilst the spatiality and strategy of ecological management and stewardship to local mitigate environmental injustices is most rationally informed by the situated knowledge of those affected, much of this work has been conducted without directly involving the communities in question. A significant portion of this research has been characterised by the same top-down, exclusive, technocentric approach that defines environmental policy more broadly. Researchers have generally used geographical datasets and information to analyse local environmental conditions, then, per Haklay and Francis, either 'act with the local community to change the situation or publish the results together with NGOs to advocate policy changes' (2017:300). This approach has been attributed by critical cartographers to the wealth of official national data available in the UK, such as high-resolution digital maps from the Ordnance Survey that are useful for large-scale analysis. This is a participatory justice issue; such datasets are often inaccessible for community organisations, due to the costs associated with accessing them and the technical skill necessary for analysing them effectively (*ibid*). Nonetheless, communities that wish to elevate environmental justice arguments must have evidence supporting their claims (*ibid*), due to the technical-scientific logic that underpins environmental decision-making. As such, addressing environmental justice issues from the ground up is often an expensive process with many barriers in place for local communities who need to collaborate with experts from environmental organisations. Therefore, there is a need to facilitate community-led research, data accessibility, and stronger engagements between ecological and geospatial scientists and local communities.

Despite inherent procedural exclusivity, geospatial environmental research has been the predominant method for mapping and defining urban green space ahead of the creation of strategic management plans, such as uncovering opportunities to target investment to improve access to green space (WENP, 2018:2). Globally, ecosystems are assigned value through the framework of urban ecosystem services, which appraises the outputs, functions, and benefits natural processes contribute to sustaining and improving human livelihoods. Haase et al. carried out a large-scale quantitative review of how this assessment occurs and concluded that these mainly include 'biophysical, empirical, GIS-based, statistical, and survey-based models' (2014:423). Ecological value mapping usually forms part of very technical analysis, carried out by select "experts" a priori of public engagement. This fits the 'technical-rational' decision-making model, identified by James Palmer (2019:144), which implies not only that the realm of science and the realm of politics are mutually exclusive, but also suggests that scientific evidence alone is sufficient to resolve contentious planning controversies. Qualitative studies, whilst important for obtaining local values, are less widely applied. They are deemed more time intensive and costly (*ibid*), despite the very real,

lived consequences for social knowledge, representation, and power that such policy-facing research engenders.

Some critics have pointed out that the framework of 'ecosystem services,' is fundamentally flawed, reducing nature to 'objects of calculated value in decision-making,' (Ernstson and Sörlin, 2013). Other *s*cholars have advocated the inclusion of public perception, understood here as the 'subjective and context-dependent definition of ecological services and their importance' (Langemeyer and Connelly, 2020:5) in mapping. Bringing the qualitative aspect of human perception together with traditional quantitative aspects of geospatial research could help to address distributive environmental justice, for example, by revealing place-based insights such as individual and group psychological barriers to green space accessibility.

However, unequal power relations persist in the way green space data is represented, communicated, and accessed using emergent digital tools (Katsh & Rabinovich-Einy, 2017; Gieseking, 2019). The power of cartography to objectively arrange things and the relations between them; be they 'physical or social objects, landforms, lines on a page, or pixels on a screen' (Willmott, 2019:44) has been brought to attention by critical cartographers, who describe it as a 'god trick' (Haraway 1998). Critical geographic engagements with GIS arose in the mid-1990s. The societal impact of increasing GIS use by central governments and large corporations for monitoring and surveillance was gaining attention, and whilst the increased use of digital maps within planning and management processes sped up decision-making processes, it also marginalised those without access to the systems or and information they contained (Pavlovskaya, 2020). GIS quickly gained scientific authority, thanks to its rapid integration with geospatial technologies, geolocation services, and digital information (such as GPS, remote sensing, mobile phones and the Internet). These were tools of political power, with the potential to support 'hierarchies of race and gender, imperial ambition, capitalist exploitation, and pervasive surveillance' (*ibid*:30). Nonetheless, critical cartographers chose to rethink, rather than reject, these GIS technologies. Specifically, they were of interest to feminist cartographers (Elwood and Leszczynski, 2018; Marianna Pavlovskaya, 2020) because of their inherent capacity to develop and democratise spatial knowledge, facilitating fairer decision-making and public participation. Insights from critical feminist cartographic scholarship will be explored below, as they have generated new mapping practises for gathering situated, embodied spatial knowledge, and therefore guide the methodological shape of this project.

2.4 From Feminist and Indigenous Cartography to Critical Ecological Perception Mapping

Feminist critical cartographers have uncovered the vast possibilities of GIS' qualitative mapping functionality, despite its common perception as a quantitative tool (Pavlovskaya, 2020:31). As feminist and gender studies are preoccupied with interrogating the contested dimensions of participatory research, and the power relations that shape research processes, they sought to transform and enrich normative GIS by applying its visual and analytical power to creatively merge non-standard, narrative spatial data with GIS (Kwan, 2002). This allowed critical feminist cartographers to construct geographic stories that official data sources didn't tell. PGIS (participatory GIS), PPGIS (public participatory GIS), VGI (volunteered geographic information), and a recent growth in other open-sourced digital data have enabled technology-driven public engagements for

highly localised environmental data to be collected, taken up and used in novel ways by communities in participatory settings. Many of these mapping projects are employed as 'counter-mappings,' which uproot cartography's own power, and disrupt the forms of exclusion and disempowerment that are technologically-mediated (Elwood, S. and Leszczynski, 2018; Peluso, 1995). They increase the power of communities to gain control of spatial representations of themselves through participation in the mapping process, using the maps generated to 'increase their control of resources' (Peluso, 1995:387). As with the community mapping system developed by Mapping for Change, for example (Kloetzer et al., 2017).

However, many applications of this work perpetuate participatory injustice by leaving the power to actually produce spatial knowledge to the cartographically literate, "expert"[2] researcher (Dunn, 2007). Indigenous cartographers and researchers have drawn attention to this fact, making concerted efforts to engage with the potential of participatory mapping as a decolonial tool. To an extent, PPGIS can challenge the 'prevailing Cartesian-Newtonian' epistemology of mapping which does not prize key characteristics of Indigenous thinking (Rundstrom, 1998:7). It can allow cartographers to step away from normative spatial knowledge production by drawing broad knowledge sources together, generating a combination of representative and non-representative data. It can adhere to Indigenous principles of relatedness; non-anthropocentricity; non-dualistic thinking, the advantageousness of ambiguity and emphasis on performative and narrative means of representation (*ibid*). PPGIS research employing these alternative mapping and sensing applications can legitimise multiple knowledges and local expertise. The maps are not contingent on precise categorisations, as they embrace ambiguity through their ability to demonstrate the vagueness inherent to individual, place-based perceptions of geographic phenomena. As such, they present a 'more socially aware type of GIS' and can privilege and legitimise local or Indigenous spatial knowledge, serving as a means of integrating local and Indigenous knowledge with "expert" data (Dunn, 2007:616). Crucially, decolonial cartographers locate the transformative power of their work within the research project itself, by enabling the community to become the agents of their mapping projects (Johnson, 2005:88).

Due to the rapid take-up of mobile digital devices with integrated map software as well as the advancement of internet access at home, PPGIS mapping platforms are increasingly within reach of individuals and communities (Haklay and Francis, 2017). Those affected by the use of GIS for planning in their local areas can benefit from more equitable access to and use of this technology, and the evidence it generates (*ibid*). PPGIS also represents 'thick' mapping, defined as a way of 'revealing, collecting and visualising several layers of landscape environmental and socio-cultural information and synthesising them all in a map' (Presner et al., 2014). This polyvalence, afforded by the capacity to layer information using geo-spatial software, enables PPGIS maps to complement the scientific dependence of the environmental decision-making process. PPGIS is, therefore, critical, because it speaks the same cartographic language as environmental and city planners (Haklay and Francis, 2017) whilst enabling deeper engagement with place-based knowledge by the PPGIS community. Such engagement also follows the Foucauldian notion of critique as at once 'the historical analysis of the limits that are imposed on us, and an experiment with the possibility of going beyond them' (1997:132). Maps produce knowledge and exercise power, therefore, they can be powerful tools for promoting social change (Kitchin et al., 2011). Feminist and Indigenous GIS applications of PPGIS uphold a particular commitment to explore ways of working with knowledge as 'multiple and situated' within digital mappings (Elwood, 2008:178). This experimental approach

redirects attention towards that which has been muted and overlooked in previous GIS representation; the fact that there are as many ways of multiple ways of knowing environments, engaging with places and of imagining futures as there are beings within them (Åhäll, 2015). Such applications are 'counter-mappings' in that they avoid the path-dependencies of institutionalised knowledge production through GIS and question the strictly policed boundaries of modern science and philosophy. They enable GIS technology to visualise, legitimise, and encourage a greater sensitivity for the ways people give meaning to their life-worlds.

The rise of PPGIS has seen local stakeholders become engaged in identifying and mapping a range of ecosystem services. Intangible variables, such as assigned values or subjective judgements regarding public perceptions of places, ecosystems, and species, have been geolocated to assess environmental realities as they are lived and perceived (Nahuelhual et al., 2016). The common approach in PPGIS is to map a diverse set of ecosystem services, which are accessible to, or received by, a broad set of stakeholders across landscapes of diverse use and complex structures (Fagerholm et al., 2019). It is also common to map only the subjective values of the public that link to anthropocentric ecosystem service categories, such as aesthetic value cultural heritage and recreation (*ibid*:9), rather than non-anthropocentric ecosystem categories, such as regulating and supporting habitat and biodiversity. Little PPGIS research has been done to map perception at the interface of humans and these intrinsic ecological services (Botzat et al., 2016). As such, the public have had limited opportunity to speak about their everyday experience of the non-anthropocentric facets of their entangled socio-natural worlds. Path-dependent methodologies of crowd-sourcing data about ecological perception, therefore, often perpetuate the abstraction of modern society from nature. Meanwhile, the ecosystem services framework has met critiques relating to its limitations as a 'vehicle for securing public interest and support for nature in its own right,' which Bekessy et al assert is 'crucial to securing long-term social mandates for its protection' (2018:72). In order to gain widespread public involvement in safeguarding the future of vulnerable invertebrates such as insect pollinators, a PPGIS-based framework for mapping the value of ecosystems needs developing further.

Doing so requires re-thinking about mapping as a vehicle for demonstrating knowledge that emerges from beyond the anthropocentric experience of the city. Whilst engaging with theoretical and conceptual themes around more-than-human encounter has been popular in geographic thought since the 1990s, 'methodological innovation and development,' for researching these 'non-human' geographies has been limited (Hodgetts and Lorimer, 2015:286). Thanks to its potential for mapping non-representational data and demonstrating abstract and embodied spatial information (Vannini, 2015), PPGIS could be a vehicle for thinking through more-than-human encounter. Whilst this has not been a popular application, if not used to foster such philosophical learning and reflection, PPGIS tools risk remaining merely instrumental devices for legitimising a city for humans and its unequally distributed environmental ills. It has been argued that normative language and conventions of western-centric scientific knowledge production profoundly limit the scope of the Anthropocene conversation (Castree, 2021). A critical PPGIS that maps urban ecosystems, then, must go deeper, and interrogate the very research designs and cultural imaginaries upon which claims to ecopolitical 'truth' rest (Schulz, 2017:131). Noel Castree argues that revisions to our existing frameworks for 'global environmental assessments' could provide new structures and

mechanisms for curating the high-level, multidisciplinary 'conversation of humankind' that needs to occur to safeguard sustainable ecological futures (2021:1791).

Castree also advocates for 'productive dissonance.' He argues that academics need to loosen their intellectual parameters and engage with disparate schools of thought, forms of knowledge, and argumentation about the Earth (2021:1788). In line with critical Indigenous scholarship, he promotes a pluriversal perspective that may enable the Anthropocene to be reframed in terms of what science misses; 'the diverse social values, needs and wants' that suggest 'alternate courses of possible future action.' This is a call which relates to Donna Haraway's assertion of the importance of 'staying with the trouble' in the context of our current geologic era, wherein the fates of multiple species are entangled (2016). Settling itself at the overlapping yet potentially awkward or uncomfortable boundaries of seemingly disparate disciplines, this project seeks to open up a novel approach research that facilitates multifaceted ways thinking about and managing shared urban futures.

At a more grounded level, opposing public opinions about informal green spaces point to fundamental differences between the ecological perceptions of different actors. In the context of the ecological crisis, promoting the social acceptability of management activities that enhance urban biodiversity and habitat provision is crucial. The tensions, confusions, and contradictions produced through processes of 'mapping-with' diverse people, landscapes, and histories are precisely why critical cartographers advocate it as a transformative, political, world-building tool (Willmott, 2019:55). Similarly, James Palmer's (2019) work on the politics of knowledge, expertise, and trust highlights how planning controversies can be embraced by participants on all sides as opportunities for slowing things down, deliberating and thereby maximising the potential for deep, transformative kinds of learning and reflection.

This critical, reflexive thinking guides the project towards embodying what critical GIS practitioners such as Presner et al coin as 'thick' mapping. It is an approach to digital mapping which indicates how staying with the multiplicity, heterogeneity, and ambiguity produced by participatory digital practises can transform our conception of 'mapping' into a 'practice of ethics' (2014:6). Central to this idea is the possibility of widening circles of participation, and of the value that knowledge can hold for 'the service of the public good' (*ibid*:7). There is a need for a 'thick' re-mapping of cities in the context of environmental injustices such as the ecological crisis. Thick information networks are reproduced across the Bristol's network of green spaces, and equitable access to the process by which this information is produced, shared, and reproduced spatially catalyses the present moment of ecological crisis and injustice. A re-mapping of contested informal green spaces therefore provides rich ground for the deliberative engagement needed to inform new, transformative strategies for the valuation, collaborative management, and celebration of convivial urban spaces for human and non-human nature.

The environmental justice frame of this project highlights the need for place-based experimentation with revised formats for environmental assessment that incorporates public voices into the conversation. As such, it pilots one methodology for incorporating these voices in urban green space planning debates. In subsequent sections, PPGIS is employed to surpass the 'empty ritual' of public participation in planning fora (Deacon and Baxter, 2013) by locating the body as the key site of participation through framing of perception as a vehicle of knowing the world. This brings the capacity to produce environmental knowledge through sensorial perception and emotional value

judgements to the public, and provides them with the ability to plot this information on an accessible, web-based map. The performative power of knowledge actively shapes perceptions of reality, 'counter-mapping' Bristol's informal green spaces by helping to re-determine 'what can and cannot be thought' about them (Hajer and Versteeg, 2005:178). Focusing on the affective quality of informal green spaces at once transforms the importance of local expertise and brings the more-than-human liveliness of everyday urban ecological milieus to the fore, thereby highlighting the potential ecological importance of informal green spaces for tackling the ecological crisis. This project is preoccupied with 'ecological perception,' used here following the use by Botzat et al, literally referring to how information is processed using all the senses (2016). However, it is also used more loosely here, as interchangeable with attitudes, impressions, and opinions. In this way, it comprises an investigation of the subjective perceptions of the landscape whilst connecting to its uses and the characteristics that determine what is valued by participants. Here, values are understood as core beliefs that prompt emotions, inform perceptions, and are instrumental to understanding the place-based character of urban ecologies.

Few studies that have used PPGIS as ecological perception mapping tools have engaged deeply with the possibility of 'perception' as a vehicle for investigating the sensory feedback between human and more-than-human worlds, much less the possibility that this engagement may open up for achieving environmental justice aims. As we have seen, cartographic lines configure our urban realities. As such, they should be constructed with care: in addressing the ecological emergency, it matters what knowledge is considered relevant, and made visible in mapped representations. Mapping the city to plan green spaces in the face of ecological crisis, therefore, requires ways of being aware how the urban landscape has been co-inhabited and constructed by a community of human and non-human beings that interact in ways may be determined by, or resistant to, political forces beyond their control.

2.5 Footnotes

[1.] This study is grounded in the fundamental tenets of place theory in human geography, which have been the focus of much work by urban planners, and therefore help to tie the interdisciplinary engagements of this study together. Place attachment refers to the process by which people form 'beliefs, emotions and attitudes' towards the reality that surrounds them, which is in turn, 'affected by their interpretation, construction and perception of it' (Casakin et al., 2015:224). It encompasses the emotional ties that individuals develop towards their local milieus, which reflect and help cultivate group and individual identities (Brown et al., 2003). They are generated by the affective quality of landscapes; the ability for more-than-human materialities to inform human action, values, behaviours, and judgements. This embodied knowledge is captured in the term place-based knowledge, which is central to this study as it also shares political ecology's 'ontology of an interconnected social and natural world' (Masterson et al., 2017).

[2.] The word "expert" is in inverted commas here because it refers to technical, scientific knowledge which fits neatly into the spatially specific demands of GIS. Whilst this has distinguished it from local, place-based, 'deep' knowledge, PPGIS scholars have rejected the idea that it is the only form of environmental expertise (Dunn, 2007). Other forms of knowledge place cultural value on landscapes, which manifests in ambiguous, emotional ways (McCall and Minang, 2005). It can be captured using PPGIS methodologies, setting people within their local environmental contexts by describing 'activity spaces and responsibility spaces' where ecological stewardship is undertaken, using a more accessible, locally understood natural language (*ibid*:343).

3. GIS IN BRISTOL GREEN SPACE POLICY AND PLANNING

The shift in focus of environmental justice scholarship towards procedural recognition and political participation acknowledges that formal decision-making tools, processes and structures generate injustice (Urkidi and Walter, 2011), as do the socio-economic contexts in which they are employed. Research in this vein seeks to elucidate the lines of exclusion and inclusion along which they operate (Paloniemi et al., 2015). As such, this project grounds its understanding of the ecological crisis in Bristol within the specific social and political setting of a place in which its effects are felt: Southmead. With a critical cartographic lens, this section looks at how digital spatial data about informal green spaces in Southmead has historically, and continues to, contribute to procedural and participatory injustices in their management, and the entangled socio-ecological outcomes of this data production.

In the last 13 years, Bristol's increase in levels of relative deprivation has been sharper than that of other English cities. 16% of residents now live in Bristol's most deprived areas. Southmead, being one of these, is the chosen study area. It ranks in the top 5 most deprived neighbourhoods in Bristol, as compared to 9th in 2015, now containing more areas within it that fall in the top 10% most deprived national deciles (Bristol City Council Insight, Performance and Intelligence, 2021). Between the two quality of life census publications in 2009 and 2021, the Southmead population has increased from 12,320 to 12,600. Fewer residents reported being happy and satisfied with life in 2021, with responses falling from 82% to 68% and currently sitting 3% below the Bristol average. Nearly 10% fewer residents were satisfied that public land was kept blight-free, and 84.6% of Southmead residents thought street litter is a problem (*ibid*). Previous public engagement research by the Bristol City Council has indicated that the main 'barriers' to use of parks and green spaces were caused by blight and poor maintenance; 'dogs' mess, litter, fears for personal safety and anti-social behaviour' (2008a:9). Alongside the more recent census data, this suggests that blight and the way that informal green spaces are managed in Southmead is having an increasingly negative impact on the health of both the human and non-human components of its urban ecologies.
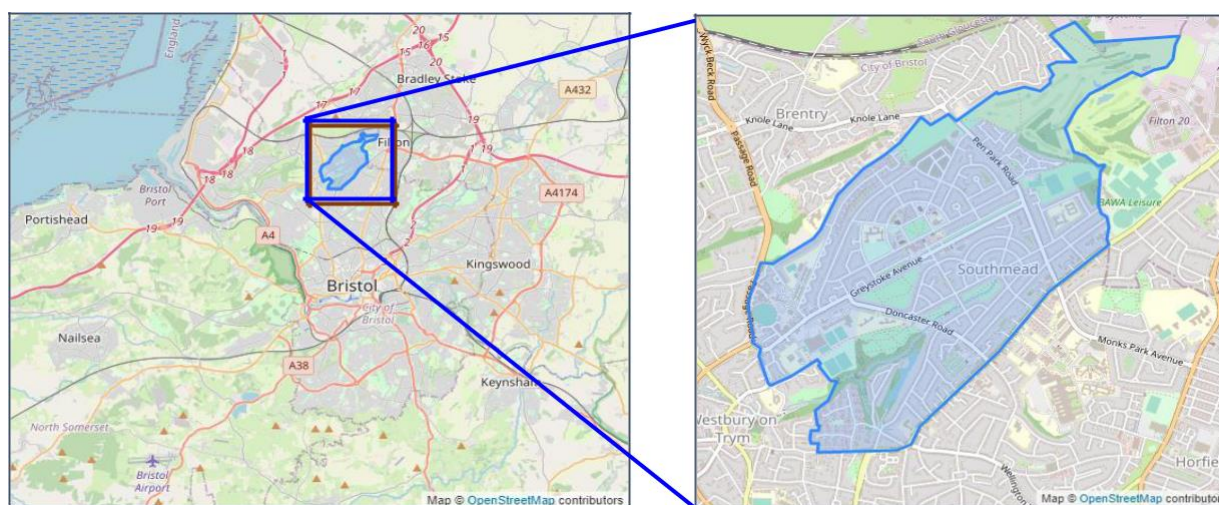
Map 1: Southmead Ward in Ordnance Survey (Mapit.mysociety.org, 2022).

Furthermore, the 'luxury effect' identified by ecologists indicates a pattern of higher diversity of plant species and canopy or vegetative cover in affluent neighbourhoods (Baldock et al., 2019). These factors directly influence insect species, such as pollinators, and have a knock-on impact on vertebrates such as lizards, birds, and bats. This suggests that addressing pollinator health through vegetation management in the green spaces of lower-income neighbourhoods could help to boost equality in the delivery of urban ecosystems services, like the pollination of crops grown in allotments, gardens, and community farms, and sustain the abundance and diversity of flora within cities, with direct benefits for human communities. For Bristol's most deprived areas to feel the benefits of healthy, functioning local ecologies, Baldock et al (2019:368) suggest initiatives including preferential investment by councils to enhance green spaces in poorer areas, distributing free seeds and holding demonstration plantings in public spaces. However, in more deprived areas, fewer resources are generally allocated for the establishment and maintenance of green space on private and public land (Leong et al., 2018).

A lack of understanding about how day-to-day ecological losses are experienced differentially by Bristol's diverse community is captured by the fact that the public have not been able to contribute significantly to ward-level green space mapping which informs planning and policy. The last ward-level green space GIS with a publicly accessible output was the typology and quality mapping done for the Bristol City Council's Green Space Strategy in 2007. These maps separated different categories of green space by function (human use type) and then assessed their quality based on a variety of value factors (see Table 2). The strategy defined informal green spaces as 'informal in layout and character, where the emphasis is on informal recreation' and as generally having 'few or no additional facilities' (2008a:6) Whilst this typology is broad, it distinguished informal green spaces from 'natural green space sites providing people with access to, and experience of nature… [which] includes woodland, grassland, scrub, hedgerows, and wetland' (*ibid:*6), ensuring their non-naturalness. In fact, this typology explicated the following:

"Where nature conservation considerations predominate, or where public use relates strongly to a sites natural experience, what might otherwise be regarded as an informal green space will be designated as Natural Green Space. These sites will typically be rich in habitats, diverse in flora, and provide abundant wildlife interest, in a way that will be apparent to users" (2008a:7).

When devising Area Green Space Plans, the strategy also excluded 'small pieces of land that don't serve any recreational purpose such as road verges and small areas within housing' (*ibid*), due to its focus on function. However, it did acknowledge that all these spaces contribute to Bristol's green infrastructure for wildlife (2008b:7) – green infrastructure being the 'strategic' urban network of 'natural and semi-natural spaces,' as per the European Commission (ec.europa.eu, 2013). In comparison to Rupprecht and Byrne's 2014 definition of informal green space as an 'integral part' of the city's ecological infrastructure (*ibid*:75), the city council's use-based typology, summarised in bullet-point form overleaf, excludes much of the city's publicly accessible informal green space.

Informal Green Space in the Bristol Green Space Strategy Typology		
• Informal in layout and character. • Meandering, unplanned pathways that connect each end of the green space, and are graded with the landscape. • In larger spaces, networks of paths are also informal in nature, providing casual rather than solely directional use.		
Green Corridors	Community Focus Space	Churchyards/Former Religious Grounds with legitimate public access
o Green corridors may be large scale and strategically significant, in having greenway routes passing through them. o [An example is] the Lower Trym Valley as it links Blaise Castle Estate to Sea Mills harbour. o They may also be smaller and local in scale (i.e. Trymside Open Space, Southmead, and Crow Lane Open Space, Henbury). o Sites which are informal green spaces with a corridor form that provides a secondary purpose. o This sub-type does not cover all green corridors in the city.	o This sub type is in acknowledgement that Community Focus Space may contribute informally, rather than formally…Such sites may have the character of a village green. They may fulfil their function, as focuses, in conjunction with other facilities. o Investment may be required to enhance quality of a Community Focus Space, to appropriately establish its status, and contribution to local area. o With appropriate management, such sites may serve as a community's town square.	o Such sites, with legitimate public access, are included within this sub type where they have the appearance and function, as described above, of Informal Green Space.

Table 2 Informal Green Space in the Bristol Green Space Strategy Typology (2008).

Mapping public green spaces using a use-based typology is the common approach in urban public domains, wherein markets and governments separate land rights according to their functional type, as this has reduced conflicts and lowered the transaction costs associated with their governance (Colding et al., 2020:4). However, demarcating land for recreation or habitats for wildlife etcetera separates and grants the rights to certain features of a green space to various user groups. This has alienated different groups from certain urban green spaces, whilst bits and pieces of public green space gradually become leaseholds for external development actors (*ibid).*

3.1 Ecological Significance of Informal Urban Green Spaces

As we have seen, the City Council's use-based typology for the Green Space Strategy created focused strategic enhancement opportunities for urban green spaces, but many green spaces fell entirely outside of its scope. Despite recognising their contribution to Bristol's green infrastructure, it did not give these smaller spaces any management designation nor recognition as Natural Green Spaces for conservation management. At the same time, it recognised that densely built-up areas of Bristol - wards - which are often the most deprived as per the 2019 Index of Multiple Deprivation (Bristol City Council Insight, Performance and Intelligence Service, 2021) - have limited capacity for providing optimum-sized green spaces, like parks and other green space typologies, with higher ecological value (Bristol City Council, 2008b:4). More recently, strategies like the Bristol Local Plan and the Bristol Future Parks Prospectus have focused on enhancing formal parks, whilst the Wildlife Trust has achieved the lottery-funded transformation of eight local wildlife sites to contribute to the Nature Recovery Network. Whilst all of the latter sites are 'open' and accessible to the public and within urban neighbourhoods, they are formally designated spaces for wildlife which don't make up the everyday urban ecological matrix. The omission of informal space inhibits a grounded, networked approach to ecological restoration in Bristol, wherein residents have the power to plan and maintain urban nature around their communities. It also curtails the potential positive impact that greening everyday green spaces in inner-city wards like Southmead could have on the wider, regional ecological restoration.

Bristol's marginal green spaces (roadside verges in particular) have been highlighted by ecologists Baldock et al as a crucial locus for ecological enhancement (2019:367). Improving their quality, for example, by ensuring that floral resources are available in greater number and quality, will be crucial for boosting Bristol's insect pollinator populations (*ibid*). As such, the current mapping approach which overlooks them curtails the success of urban ecological quality enhancements to tackle species losses, as well as strategic goals within Bristol's Ecological Emergency strategy to set aside 30% of urban space for nature by 2030 (Bristol One City, 2020:8).

3.2 Putting Informal Green Spaces on the Southmead Map

By comparing *Maps 2* and *3*, we can see that the majority of Southmead's informal green spaces were assessed in 2008 as lower quality than formal public green spaces. 'Lower value' green space was defined in the strategy as land which has 'limited value assessed by a range of factors including wildlife, historical, archaeological significance, and importantly, value placed on spaces by the local community' (*ibid*:18). *Figure 1* indicates where the public were able to contribute to, through the Strategy's customer research and consultation, conducted in the summer of 2007 (2008b:9). Value judgements about the intrinsic ecological aspects of public green spaces were not part of *a priori* technical analysis, to which locals could contribute. This led to management priorities for informal green spaces being to 'tackle anti-social behaviour on strategic priority neighbourhood spaces' and 'management to enhance legitimate access and informal recreation' (*ibid*:43). Whilst important, the focus on social issues alone means that the public could not speak at the intersection of their lives and urban biodiversity to advocate its restoration and enhancement, and as such, their ecological potential has been overlooked.
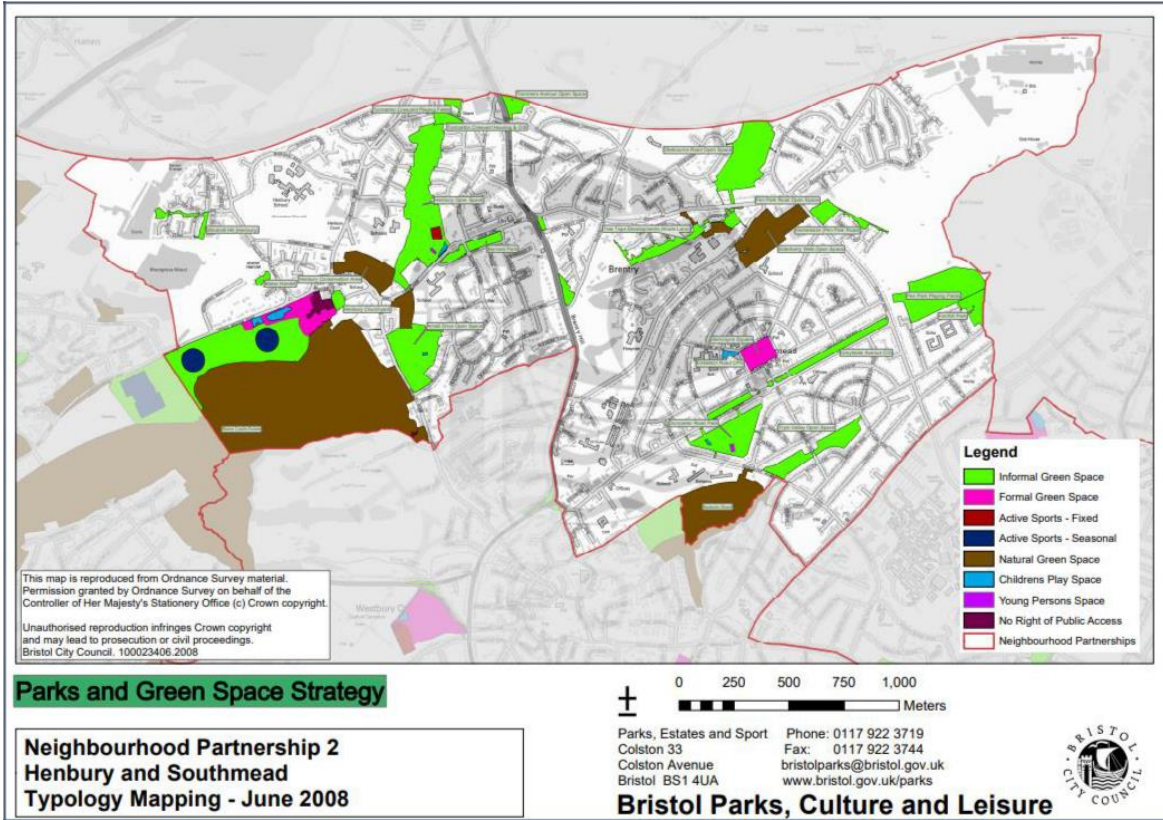
Map 2: Southmead Green Space Quality Mapping (Bristol City Council, 2008).
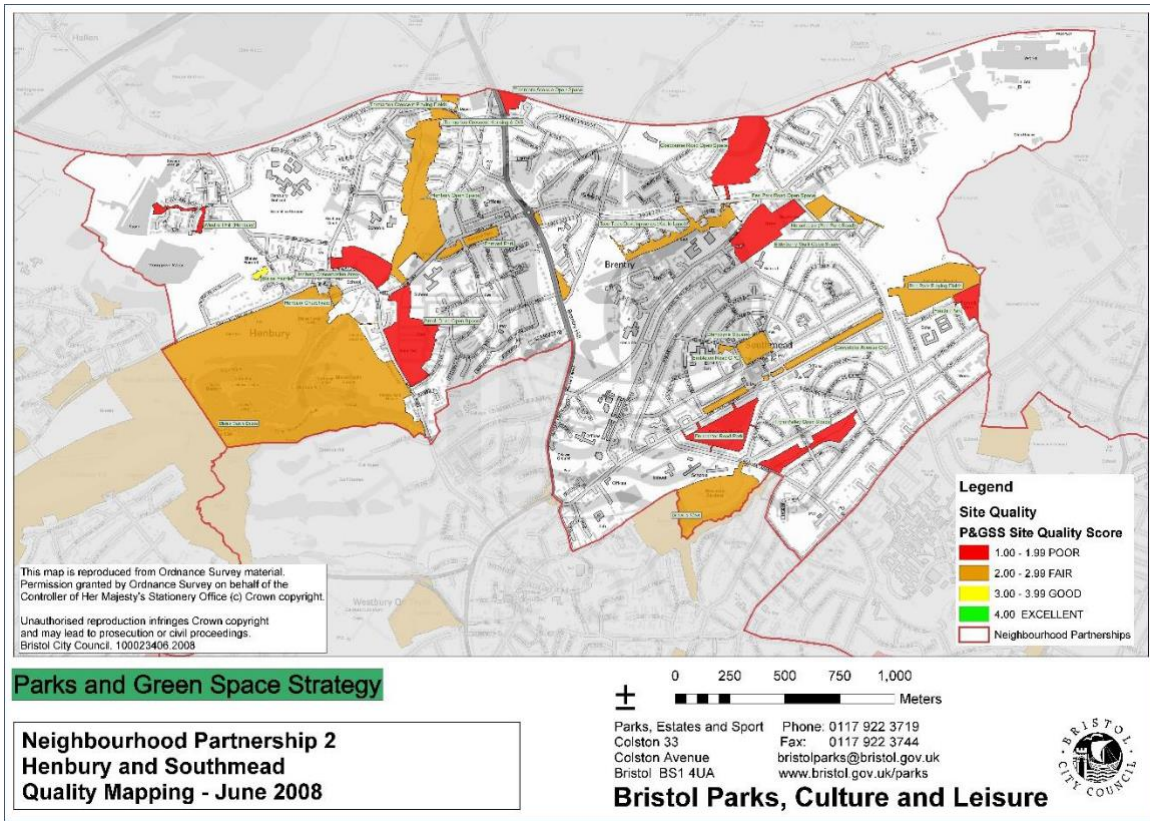
Map 3: Southmead Green Space Quality Mapping (Bristol City Council, 2008).

Community value factors	Custodial value factors
Level of use	Local context and significance
Community views of the space	Accessibility
Community involvement	Landscape significance
Equalities considerations	Nature Conservation significance
Educational significance	Archaeological/Historical significance
Demographic change	Legal Status
Level of anti-social behaviour	Contribution to the local economy
Events potential	Sustainability significance

Figure 1: Factors for assessing green space value in Bristol's Parks and Green Space Strategy (Bristol City Council, 2008:36)

Bristol City Council's Green Space plans have been updated, with new white papers such as the One City Ecological Strategy and the Bristol Future Parks prospectus. However, they are still identified by their typological designation based on the 2008 strategy. In the latter, only formal parks have been mapped using GIS. Further, though the Bristol Parks Service has 15 years' experience of GIS data mapping, analysis, and asset management, and has produced Council wide web GIS systems for all staff and the general public, 'asset' (green space) data is mapped using 'Back Office Asset Management systems' for integrating with condition surveying, mobile inspections, customer enquiries, works management and other reporting (Dando, 2019). The public do not contribute directly to this process, and there is a dearth of detailed informal green space data for public use.

In 2018, the West of England Natural Partnership created a map of access to 'open' (publicly accessible) green space in the West of England (see *Map 4*). This encompassed Bristol. Open green space was identified through Greenspace OS, with additional local data provided by unitary authority partners and other partners (which includes the Avon Wildlife Trust, Bristol City Council, Bristol Water, North Somerset Council, the Environment Agency and more). This data was normalised by population to indicate density (using ONS 2017 Ward Level Population Estimates), and also overlaid indices of multiple deprivation. This was a resource for partners and the public to understand the best opportunities to target investment to improve access to green space (WENP, 2018:2). Open green spaces were mapped because of the multiple wellbeing benefits they bring to people, as well as the critical and connected spaces they provide for nature to thrive, carbon sequestration, effective natural flood protection. However, areas that are mapped as 'deficient in access to open green space' were not posited areas where ecological enhancement could be important for improving this access for the health and wellbeing of residents and their enfolding urban ecologies (*ibid*:4).

Map 4: WENP's open green space map (WENP, 2018).

A later map produced by the WENP proposes a Nature Recovery Network (see *Map 5*). This also maps strategic networks of woodland, grassland, and wetlands to demonstrate opportunities for protecting and enhancing these habitats, making them bigger, creating new habitat areas and ensuring these join up to create 'functionally connected,' resilient ecological networks (WENP, 2020:6). Whilst such mapping is crucial for conservation results at scale, smaller, human-influenced, inner-city, green spaces which could play a crucial role in joining up a wider ecological corridor across the city remain unmapped, hindering the success of these efforts. In order to shift this perspective, it is imperative to look at how the quality of everyday, informal green spaces is perceived by urban residents who use and coexist with these spaces.

Finally, the 2018 report states that quality perception is a crucial factor in 'encouraging more people to get outside and stay well.' As such, they advocate the development of a quality metric for the West of England's green spaces (WENP:8). However, we have seen that ward-level, in depth quality analysis of Bristol's green spaces has not been conducted since 2008. What is needed, then, are community perception maps of ecological value within informal urban green space. This data could help address the environmental knowledge politics currently hindering community-driven biodiversity interventions, as well as timely cross-stakeholder dialogues about the way urban nature is valued and managed in the face of the ecological crisis.
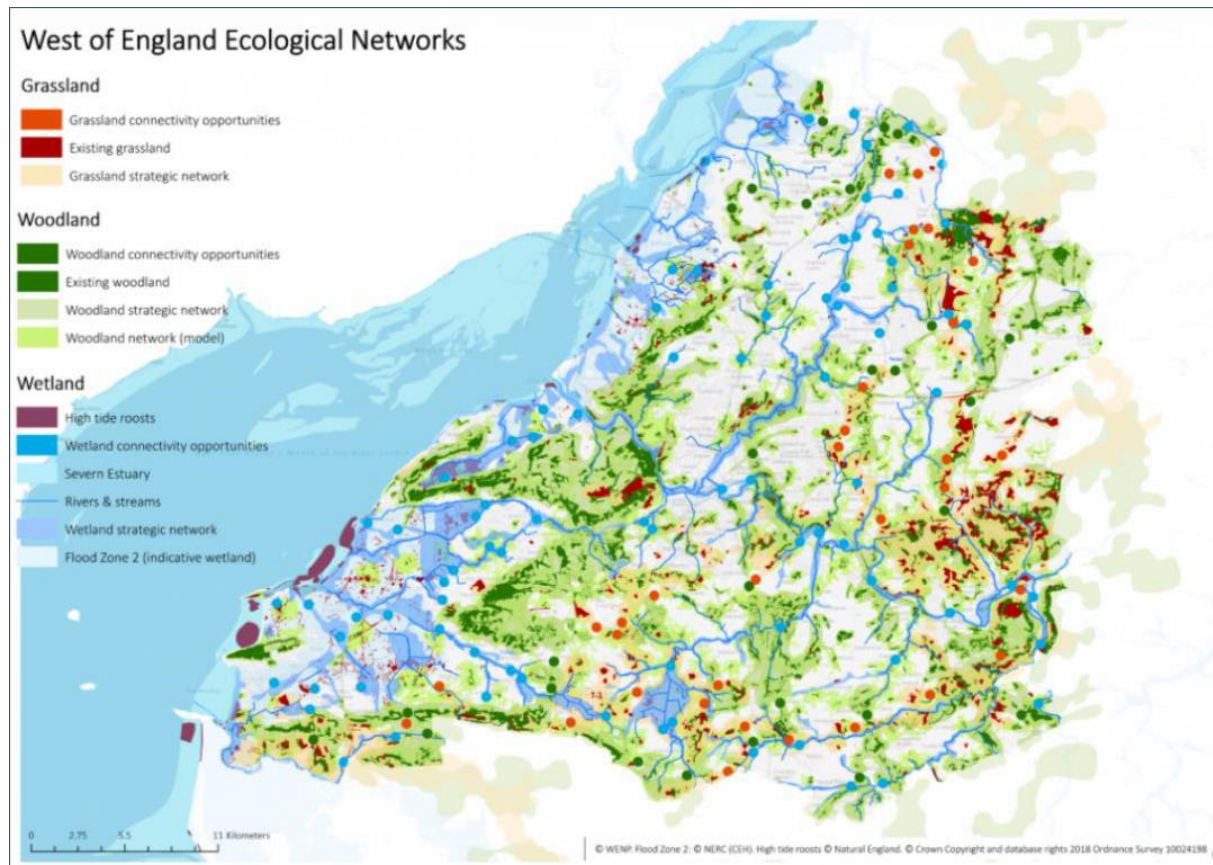
Map 5: the WENP Nature Recovery Network map (2020).

More recently in Southmead, GIS mapping has been done by local planning committees (see *Map 6*). A 2018 report prepared by The Nash Partnership and Streets Reimagined mapped Southmead's green spaces using GIS on behalf of Southmead Development Trust, a community-owned and managed charity. It was set up to deliver sustainable community projects. Whilst not detailed, the map demonstrates considerably less informal green space in Southmead in 2018 than in the 2008 City Council maps. Further, per the 2008 Green Space Strategy, the amount of Green Space per Capita was 31.15m^2 in Henbury & Southmead. According to the UK Green Space Index by Fields in Trust (2021), this has decreased to 23.458m^2. This decline may be attributed to the diverse pressures identified by the European Green Capitals partnership; an 'ever-growing population, urban development pressures, and budget constraints' (Cömertler, 2017:2). Because the provision of green spaces is not mandatory, they are often lost to meet the need for more housing and commercial development. If not lost completely, the result of these pressures is generally thought to be the

'overuse and poor maintenance of open areas, and so less the contribution to quality of urban life and sustainability' (*ibid*:2).

Map 6: Southmead green spaces and access routes (Nash Partnership, 2018).

These pressures compound the inadequate assessment of local value placed on informal green spaces through the inability for the public to speak about their potential. Alongside financially strained local government budgets, and given that the UK faces recession due to the Covid-19 pandemic, this situation is set to worsen. Informal public green spaces have eroded in Southmead, and they are likely to continue to disappear first under the guise of landscape upgrading. For example, Doncaster Road Park has been the locus of recent anti-social behaviour and blight, such as arson and graffiti, and has poorly maintained derelict buildings nearby. Nonetheless, it's otherwise widely used. A recent proposal has been developed by the Bristol Council Housing Delivery team, which would see a row of houses built on the park (Southmead Future Housing, 2021). In a normative planning framework, the function of informal green spaces must be changed in order for them to be valued.

Conversely, local Friends groups have campaigned hard for funding for park upgrades that better suit the community, resulting in more accessible entrances and better bench provision, and have come together to plant Spring wildflower bulbs in the park. This suggests that local expertise exists about how to enhance these spaces for human and non-human conviviality. Despite increasing concerns around blight and decreasing overall provision of green space, the percentage of Southmead residents who were 'satisfied with the quality of parks and green spaces in the area' increased from 68% in 2009 to 74% in 2021 (Bristol City Council Consultation, Research &

Intelligence, 2009:4; Insight, Performance, & Intelligence, 2021:6). Their quality has, therefore, drastically improved locally, implying that local action rather than top-down management strategies has been pivotal in the enhancement of local green spaces. This resonates with the view of political ecologists: that local actors are a key transformative force in the everyday project of 'remaking' the world (Loftus, 2012:ix). They work within mundane spaces in which numerous entanglements of so-called social and natural relations exist. The expertise and knowledge generated by this sensorial, immersive, and active engagement with informal green spaces is critical to reframing the possibility of sustainable, ecological futures.

As this section has shown, achieving procedural justice in the informal green space planning process begins with re-mapping Southmead's informal green spaces beyond their use-type, as per the Bristol Green Space Strategy Typology. From a procedural justice perspective, this demands more equitable access to the fora wherein environmental knowledge is produced. Also, viewed through the lens of a 'nature-culture,' which understands urban ecologies as co-evolving alongside the changing socio-spatial imperatives of a developing city (Haraway, 2003), there is a need to re-map these spaces and the everyday action and interaction of residents complicit in their production. This is to afford those who interact with, and already act to enhance, informal green spaces in Southmead can have a say in safeguarding them. A novel, digital, participatory mapping methodology is developed in the next section. It draws on the experimental web-based mapping approaches of feminist critical cartographers, as it seeks to use the privileging logic of GIS to legitimise local knowledge for use in community-driven biodiversity interventions.

4. METHODOLOGY

This project seeks to elevate the role local place-based knowledge plays in the management of marginal urban nature in Bristol by piloting a novel PPGIS methodology. It aims to reveal and legitimise place-based knowledge about local ecologies by investigating community perceptions of their health and benefit of informal green spaces, and desires for their management, within the context of Southmead's informal green spaces.

PPGIS research, as defined by Renee Sieber, uses GIS and modern communication technologies to inform stakeholders and the public, broadening engagement in enrolling them in participatory planning and policy-making processes for urban and regional development (2006). It has been a procedural justice tool for the management of cities (Brown and Weber, 2013), demonstrating 'location-specific human values, perceptions, behaviour, and preferences for future land use and development' (Fagerholm et al., 2021:2). The most pervasive use of PPGIS for mapping perceptions of place-based ecologies has been in engaging local stakeholders in the identification and mapping of ecosystem services. Using PPGIS to map ecosystem services enables the geolocation of intangible variables, such as assigned values or subjective judgements about species, ecosystems and places (Nahuelhual et al., 2016). As we have seen, to achieve procedural justice in light of the ecological stresses currently borne by more deprived communities, PPGIS needs to be conceptually and methodologically committed to assessing environmental realities as they are lived and perceived by those experiencing inequality at the intersection of human wellbeing and urban biodiversity. To do this, the non-anthropocentric, intrinsic benefits of urban ecologies and services they provide working-class communities (such as regulating and supporting of habitat and biodiversity) should be mapped in more detail, as perceived by members of these communities.

4.1 PPGIS approach: Emotional Mapping

Whilst PPGIS has not traditionally been a vehicle for thinking through more-than-human encounter, it poses an opportunity to collect usable spatial data whilst encouraging map users to do so. Specifically, through use of the Emotional Mapping methodology. This was first piloted as a participatory tool for urban planning in 2016. Cycle routes in Reykjavík were mapped by a community to incorporate their views and emotional responses where official mapping had previously focussed only on infrastructure (Pánek and Benediktsson, 2017). In addition to providing valuable information for planners, its proponents argue that Emotional Mapping can increase levels of participation by specific interest groups and stakeholders in urban planning (*ibid:65*). What differentiates Emotional Mapping from other PPGIS applications is the fundamental tenet that frames its use; emotions connect people to spaces and places through subjective, relational flows of information, and have a crucial spatial dimension. Emotional Mapping understands that emotions are inherently tied up in place-attachment (Brown and Raymond, 2007). They impact the 'spatial distribution' of our sensory experiences, and therefore perception, just as the physical layout of an environment affects our perceptions of a place (Pánek and Benediktsson, 2017:66).

Arguably, then, 'emotions' are not exactly what is mapped, but perceptions of a place that emerge as a result of interaction with it (*ibid*). Nevertheless, the developers and authors using the platform continue using the title of 'Emotional Mapping' based on the argument made by Chris

Perkins (2009:130); that this relational, participatory form of cartography allows users to 'devise and customise their own emotional landscape, choosing what kinds of thoughts or experiences, feelings or passions, to map'. This is important, because it enables the users to have a degree of agency within the Emotional Mapping survey, being co-collaborators in the map's vernacular and design and co-creating the knowledge it portrays. Emotional Mapping therefore offers the perfect PPGIS tool for mapping beyond what is already known and assumed about urban ecologies and represent the embodied practices (emotions, conscious thoughts, subjective and normative judgements of individuals) as the relational assemblages which constitute urban ecologies themselves. This specific application of Emotional Mapping was developed with the assistance of Jirka Pánek, the original developer of the PocitoveMapy.cz platform.

The Emotional Mapping platform used builds on the existing PocitoveMapy.cz web-application[1]. This was developed from a Leaflet library that allows the collection of spatial data by participants on a familiar slippy-map interface. Due to considerations of participants' health and social distancing measures, participants necessarily contributed data from their own homes, therefore an entirely web-based approach was suitable. The participatory element integrated spatial mapping using polygons with survey procedures enabled by the Emotional Mapping platform It is accessible, in that unlike other web-based, interactive mapping tools, it did not demand participants register to or install any external servers or software. It was appropriate to use this pre-existing map interface due to the limited temporal scope of the project, as well as restrictions on access to on-campus computer labs. The application is a single-page web application which can be accessed via desktop or mobile.

As a tool of GeoParticipation (Pánek 2017); Emotional Mapping enables civic participation by providing an accessible platform for social engagement, whilst creating the feeling of amongst participants of belonging to a social group (here, people who live in Southmead or visit regularly; the Southmead community). It therefore contributes to the political, transformative aims of this project; per Sara Ahmed, emotions help to explain 'not only how we are affected in this way or that, but also how those judgements then hold or become agreed as shared perceptions' (2014a:208). Shared perceptions are social arguments, therefore analysing the maps of individual, subjective value judgements about landscapes lends an insight into wider socio-cultural ones. Layering individual Emotional Mapping responses can reveal points of consensus or confusion and use this information to inform a wider shift towards shared, ecologically convivial futures. The analysis itself occurred without group deliberation, however, results are discussed with respect to their potential outputs that serve community interests regarding informal green space management.

Much PPGIS work supports the idea that interactive and iterative processes are best suited for mapping complex data on social and ecological systems (Haklay and Francis, 2017; Salovaara, 2016). In this study, these stages included the Emotional Mapping platform design, stakeholder outreach, participant recruitment, individual mapping and data collection, and informal stakeholder interviews, followed by data analysis. An iterative process was elected as it facilitates researcher deliberation. This is in light of assertions by feminist and Indigenous cartographers that attention must be paid to how we define 'genuine collaboration' in PPGIS studies (Kahila-Tani et al., 2019:53), particularly where the goals of such research are collaborative action for social change. It was important to reflect on the research project as it progressed, and to incorporate flexibility into the

design so that the methodology and its tools could be updated where it appeared that commitments to gathering local knowledge could be upheld better. This enabled an adaptive, reflexive approach and for data sources to expand into online community green space action group fora as needed, which will be further discussed in this section.

4.2 Research Area

The research area was found through preliminary analysis of secondary data, by comparing Baldock et al's pollinator hotspot map shown below (2019:367), and Bristol City Council's LSOA index (see *Map 7*). The hotspot map was used as a proxy for biotic diversity. This led to the selection of Southmead as the study area, as the two datasets together indicate how the community in this ward stands to be affected by the ecological crisis; the biodiversity declines and the associated obstruction of ecosystem service delivery. Degradation occurring along political and socio-economic lines, has increased the precarity of Southmead's green spaces. Particularly, its informal ones, which are already compromised by management regimes which overlook their potential value. A dearth of publicly accessible spatial data relates to the value of Southmead's informal green spaces as perceived by the local community, meaning that there is little evidence for the community to use to assert their value and secure their futures. However, further a priori investigation showed many local community groups are taking action to restore and enhance their formal and informal green spaces in Southmead, such as Sustainable Southmead who organise regular litter picks, flower and tree planting, Growing Support (a community gardening group at the Greenway Centre), Friends of Badock's Woods, and Trout in the Trym, who have been prolific in managing the lower Trym Valley ecosystem, to name a few. Conducting the study in this area could therefore draw attention to the work that locals are doing, enabling them to secure funding, assistance, and protection for informal green spaces. Given that communities in more relatively deprived wards, like Southmead, stand to benefit most from enhanced procedural justice in the management of informal green spaces, this could provide an insight into how research can facilitate environmental knowledge sharing between local actors and planners to secure just, convivial futures for urban green spaces.
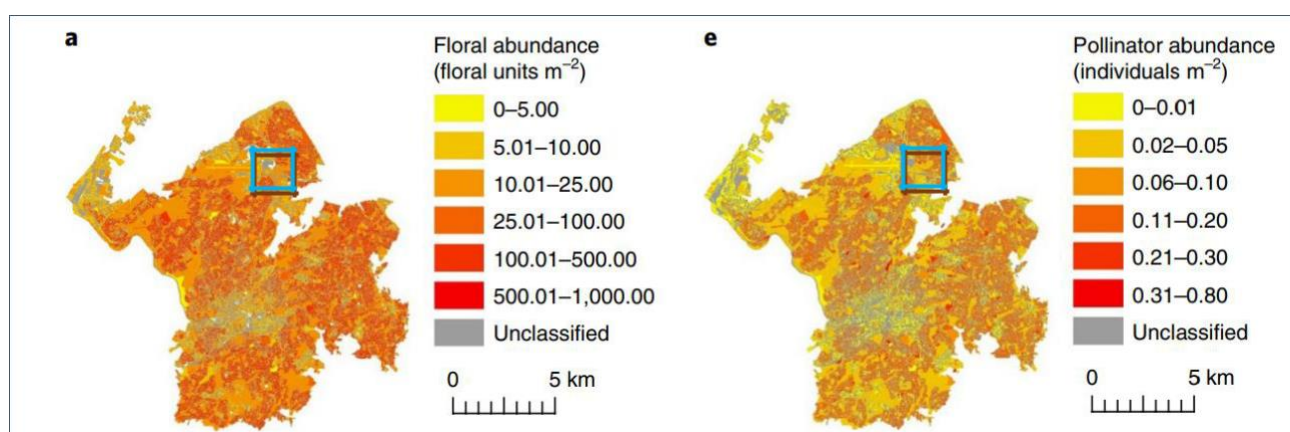
Map 7: Baldock et al.'s pollinator hotspot map of Bristol (2019:367), with Southmead highlighted.

4.3 Spatial Focus: Informal Green Spaces

Despite advances in urban ecology that are shifting the view of cities' ecological importance (Hall et al., 2017*),* informal public green space is still overlooked in PPGIS mapping of ecosystem services.

Botzat et al identified that perception mapping of urban biodiversity predominantly focuses on forests, parks, and gardens (2016). Greater attention should be given to mapping them, due to their extensive spatial cover, and potential for transforming cities in the face of the ecological crisis, but also because they represent a particular challenge for managing marginal urban green spaces for conservation. More than any other green space type, they have a diverse heterogeneity of land-users, ownership, and management regimes (Rupprecht and Byrne, 2014). This has resulted in their ambiguity consequently, their political, legal, and aesthetic contestation (Rupprecht and Byrne, 2014:605). 'Unruly,' or apparently 'spontaneous' vegetation, is often viewed negatively and associated with abandonment by residents and land managers, despite what this may mean for ecological health (Mathey et al., 2016). It is important to reduce conflict between stakeholders, whilst promoting management strategies that enhance urban biodiversity and habitat provision. This project will, therefore, focus on informal, public green spaces as a singular spatial category, rather than taking the common approach in PPGIS studies of ecosystem services benefits that map multifunctional landscapes (Fagerholm et al., 2019). There is a clear need for focused research to engage with local stakeholders, investigating place-based knowledge about and desires for the management of informal green spaces. Within cities, multiple stakeholder groups (such as the public, landowners or managers and policymakers) are under increasing pressure to find ways of working together effectively to create urban areas that fulfil their potential as ecological refuges and habitat (Baldock, 2020:68). A grounded focus is crucial for achieving procedural and distributive justice in the planning and management of ecologically healthy and resilient urban areas. As such, this project will investigate local resident's perception of ecologies in a category of urban green space that has been identified as a potential opportunity for providing the habitat and biodiversity necessary to support healthy flora and insect pollinator populations (Baldock et al., 2019).

A broad definition of informal green spaces includes relatively small spaces identified as crucial opportunities to improve plant biodiversity and abundance, and therefore pollinator health by ecologists (Baldock et al., 2019; Baldock, 2020). In this study, informal green spaces includes these liminal vegetated landscapes, as they are classified following Rupprecht and Byrne's (2014) table (see page 10). Whilst this definition aligns with the City Council's 2008 functional, use-based typology because of its broad scope, it is, by contrast, non-functional. This is more appropriate for mapping ecological perceptions because these spaces are so dynamic, often serving as multiple functions at once for a range of human and non-human actors. A grassy verge of seemingly aesthetic function may for some people provide a useful cut-through to access shops and services, for example. It is precisely this dynamism and liminality that has resulted in their 'uncertainty with regard to the conservation status, maintenance regime, regulation, and legitimacy' (*ibid:*598). As such, using this definition of informal green spaces challenges the simple, systemic classification of a widely variable, diversely used, and perceived category of urban land based on several broad, generic characteristics. It enables the maps created here to speak back to the City Council's policy, and potentially inform new perspectives on informal green space.

4.4 Participant Recruitment

Within Southmead, invitations to participate were sent to residents online, via community associations. Residents who were involved in such groups are likely to be interested in providing useful data for place-based planning and management, and wish to be more involved in

these. Whilst this meant that they may have reflected the recruitment method, due to the participatory nature of the research, it was preferred over recruiting participants who may find the process unnecessarily time consuming or stressful. Invitations introduced the topic, methodology, and gave an example of the process which visited the typology of informal public green space and map language to ensure that all participants were confident to contribute. Any questions were invited, consent revisited, and participants were reminded that they could opt out at any time.

At the recruitment phase, participants were informed of the fact that the data will be hosted on the PocitoveMapy.cz platform until the collection phase finished, at which point it was to be stored by the researcher for aggregation and analysis. Participants could also indicate their consent for processed data to be made available in order for participants to use in future as evidence contestation or resource claims, following data protection regulations. Please see Appendix A to view the consent form.

4.5 Research Questions

This subsection details the research questions which guided the development of the novel PPGIS methodology, and research design used to pilot it as a tool for demonstrating demonstrate situated, localised environmental knowledge. The questions are broken down into sub-questions, and the rationale for each is explained. It also summarises how each question fits into the research design.

Research Question 1: What does the community know about Informal Public Green Spaces in Southmead? How is this knowledge produced?

The term 'informal green space' is one developed by both urban ecologists and city planners, but is likely not to be the local vernacular used by the public to describe small plots of green space in their neighbourhoods. However, it was important to use the term so that the data generated would be able to speak back to and expand the use-based typology used by Bristol City Council and normative green space mapping practice. To clarify what was being asked of participants, the introduction page on the mapping offered the following definition of informal public green spaces;

'*Areas of any size that contain nature and aren't privately owned or formally designated for recreation and leisure, farming, gardening, or wildlife conservation. They may be roadside verges, roundabouts, tree rings or other small, vegetated plots that do not have a clear function in the urban landscape.*' This definition is based on Rupprecht and Byrne's 2014 typology (see Table 1) for detail.

On the online Pocitovemapy.cz platform, participants filled out an interactive map-based survey. A user ID was generated for each participant, enabling their anonymity. The survey demonstrated two identical maps of their residential ward with different sets of questions alongside each.

Research Question 1.1. Where does the community perceive them to be, and what is their spatial extent?

Participants were asked to draw polygons - defined on the introduction page simply as irregular shapes – around what they perceived to be informal, public green spaces within their ward using a simple click and drag technique. This technique was facilitated by the slippy-map interface. A slippy-map tool was chosen because of its familiarity; this is the format of nearly all modern web-based

maps which let users zoom and pan around seamlessly when using a computer mouse or mobile touchscreen. It was important to focus on spatial extent to determine whether the public perceived IGS distribution differently to the council, based on the Rupprecht and Byrne definition given in the introduction page. This definition was included as it sought to be broad enough to encompass their own understandings of what the term might mean, as informed by the lived experience of Southmead. Making these differences visible in spatial terms would be a crucial step for reconciling local and "expert" knowledge (Dunn, 2007) in the mapping stage of green space planning processes in Southmead.

Research Question 1.2 Are they perceived positively or negatively, and what factors inform these judgements?

Depending on which map the participants were using, polygons were drawn either in a green or red colour to indicate positive or negative perceptions of ecological health and benefit within the spatial area they demonstrate. The survey format also allowed participants to give a written description of each unique polygon in order to generate a comprehensive understanding of the values, place meanings and attachment which inform how the ecology is perceived as positive and negative in terms of its health and benefit. Individual maps were compiled and layered using ArcGIS for visual analysis alongside qualitative, thematic coding of participant's survey responses.

As we have seen, mapping perception as embodied knowledge enables a critical interrogation of how we think about urban green space as co-created by communities of human and non-humans, who interact in ways determined by political forces often beyond their control. That non-expert, working-class publics have not been recognised in cartographic representations as legitimate knowers of the local ecologies of Southmead is problematic. It has kept the realities that they experience obscured within dominant social structures of environmental knowledge. Mapping the way that Southmead's informal green spaces ecologies evoke subjective judgements about their ecological health and benefit, or lack thereof, gives the mapper the power to demonstrate their own experience, but also imbues the mapped landscape itself with an aliveness and agency, opening an avenue for thinking beyond the boundaries between humans and their local ecological assemblages. These boundaries are transgressed by the very existence of informal urban greenspaces. The detail given in the survey responses therefore 'thickened' the map (Presner et al., 2014) - that is, joined with stories to indicate a multiplicity of worldviews - with insights into the embodied, interactive ways that individual participants' perceptions are formed, value judgements made, and what these are. This is explored in the next research question.

It was crucial to attend to the nuances of context throughout the analysis process. The community isn't homogenous, and this affects perceptions of urban green space. Antisocial behaviour is often a deterrent to spending time in urban public spaces, and signs of urban blight are linked to fear and anxiety. But the phenomenon linking blight to fear and anxiety is greater amongst social groups who remain within the local area for extended periods of time, such as those with limited mobility or transport options and older people (Mottus et al., 2012). As such, a demographic study was conducted. Participants were asked to indicate their age, the amount of time spent in green space in Bristol generally, and for comparative analysis, how much time is spent exploring green spaces in their own ward. Given the relationality of participant values, it was important to also investigate the extent of their engagements with urban nature in their local ward. Participants were also asked 'in what context do you encounter this green space' to elucidate how this knowledge is formed. These maps were analysed in QGIS. Participant's polygon layers were compiled for density clustering analysis, enabling an investigation of any consensus or conflict in responses. When responses and participants map layers are aggregated during analysis, areas of consensus appeared as coloured more densely. The number of polygons drawn by each participant as well as the aggregated spatial area of all the features will serve as an indicator of their perceived abundance.

Participants were able to decide the number and size of polygons they drew within the research area, and were able to draw beyond it if they wished. There were, however, practical limitations to the survey respondent's time and energy spent participating. Whilst the cognitive challenge presented by this research was highly individualistic, the consideration of concepts such as ecosystem services and place-related values are often more cognitively challenging to map than place-related activities and experiences (Brown, 2017). This led to a trade-off in the research design, relating to the quantity of polygons drawn versus the descriptive depth associated with them through the survey. The latter was more important for gaining a deep insight into local knowledge about informal green spaces. As such, collecting vast quantities of spatial data from a large sample was not the priority. Use of polygons in PPGIS research has shown that fewer polygon observations enable participants to engage more deeply with the significance of these spatial areas in qualitative data procedures (Lowery and Morse, 2013:1423). At the same time, participants had a degree of autonomy regarding how many polygons to draw and how much narrative detail to provide. It has also been recognised that web-based PPGIS mapping is much more challenging for participants than other approaches that involve hand drawn maps that are later digitised (Lowery and Morse, 2013). However, as noted above, it was not possible to perform this research in-person with paper-based maps during the research period. Thus, the data sources expanded into online community fora, where local ecological management strategies were planned and discussed, giving insights into the community's context of environmental knowledge production, and goals for informal green space management. A map of individual positive and negative perceptions was created based on interactions in Southmead's environmental Facebook groups. Two further maps were created to plot where these groups meet in person to undertake ecological management of informal green spaces in Southmead and beyond, and actualise multi-species conviviality across the urban ecological network.

Research Question 1.4 How does the community want Informal Public Green Spaces to be managed and by whom?

On the second map, participants repeated the polygon exercise of question 1., except this time drawing where they perceived informal green space to not be ecologically healthy or beneficial. Survey questions were again associated with each polygon. The survey questions were optional, again affording agency to the participants to determine the depth of their own engagement. Participants could describe how they thought the spaces represented could be better managed in future. Participants could either choose from a drop-down list of potential management strategies for improving these places as pollinator habitat, as recommended by David Goulson in the 2019 report for Somerset Wildlife Trust (2019:35), or describe in their own words what they would like to see in these places. The feasibility and appropriateness of these recommendations may have depended on topographic or biotic factors, and could be investigated at a later date by ecologists and the local planning authority. This stage of the investigation was based on evidence of Southmead's significant increase in green space satisfaction, as compared to elsewhere in Bristol, which suggests that local groups have been working to enhance the ecologies of their local green spaces through voluntary activities and management (Bristol City Council Insight, Performance, & Intelligence, 2021). It sought to address procedural injustice by addressing the ability of locals to speak on behalf of these spaces where they exercise environmental knowledge, care, and custodianship in the mapping phase of planning processes that determine their futures.

Research Question 2. Did the methodology achieve its aims?

Research Question 2.1 Could participants express their knowledge about Informal Public Green Spaces in Southmead and desires for their management using the map-based survey?

The project aimed to trial a novel, map-based methodology enabling the public to contribute their knowledge of Southmead's IGS for a more inclusive, constructive approach to ecological appraisal within a shifting environmental planning paradigm. It was therefore important to reflect on how the participants engaged with the Emotional Mapping platform, using empirics to reflect on the recruitment strategy and the platform's usability.

Research Question 2.2 Does this knowledge offer a critical counterpoint to normative cartographic representations of Informal Public Green Spaces in Southmead and beyond?

The critical commitments of this project compel an interrogation of social structures and cultural imaginaries upon which political, cartographic claims to ecological knowledge and expertise rest. Analysis of the data involved a reflection on the inherent and multifaceted tensions of a theoretically grounded, and yet digitally mediated, community-oriented mapping practice. This approach to analysis was employed to reveal how far the methodology addressed knowledge gaps across disciplines whilst enabling local knowledge to play a transformative role in green space planning and policy.

Research Question 3. What are the potential research outputs that could help achieve participatory and procedural justice in informal green space management in Southmead?

Under research question 1.4, participants were asked who should be responsible for enacting these management strategies, and were able to choose from a list or make their own recommendations. The map layers were compiled for density clustering analysis, enabling an investigation of any consensus or conflict in perspectives regarding the management of urban nature within the ward. It was envisioned for this research question to explore the potential for a significant amount of consensus to enable the maps to be submitted to the local council or Southmead Development Trust as evidence of local desires for future informal green space management. However, this hinged on all participants giving consent for data sharing. If data was too scarce or demonstrated more conflict than consensus, it instead would inform an investigation of future research directions. This was the research route pursed, given the obligatory methodological changes that arose during the data collection phase due to limitations to the reach of the study as brought about by COVID-19 risks to public health and associated social distancing measures.

4.6 Anticipated Challenges and Ethical Implications

Doing research targeted at members of a working-class community in Bristol carried some ethical implications and challenges. This section details those which were known at the time the project commenced, and how they were mitigated. Other challenges that arose and were addressed during the data gathering phase of the project are detailed in the Analysis section.

Firstly, the identities of potentially vulnerable participants were protected by making clear participants' right to remain anonymous in the consent form on the project information page. Participants' contributions to the online, map-based survey generated a unique, random user ID to ensure that their names were not used in any analysis of the data produced. Participants also had to check a box to demonstrate being over 18 in order to access the mapping platform.

Secondly, it was considered that participants may become more aware of certain environmental injustices in their community through their participation. For example, the fact that the local ecology is less resilient in terms of pollinator health, which may be distressing. This was weighed against a consideration of the ethical implications of not informing participants about the nature and context of this research project, and of not engaging community members in research that seeks to address these injustices.

Thirdly, during data collection, participants were asked their desired outcomes for the management of the spaces they have mapped. It was not within the scope of the MScR research project to guarantee that the issues identified could be addressed by planning authorities or desired outcomes achieved, nor enroll participants in further planning discussions which may have caused them stress or discomfort. The need to maintain both transparency of potential research outputs, as well as participants' trust in the research project and researcher, meant that the data was instead more appropriately used to design a more focused framework for collaborative, ecological research in Bristol's working-class communities.

The limited scope of the MScR links to a problem inherent to IT assisted PPGIS. Often, little of the knowledge produced is left with the community after their effort, as the political and

epistemological effects of involving outside researchers, NGOs and cartographers is overlooked and thus no long-term empowerment stems from the exercise (Johnson et al., 2005:88, Kosek, 1998:4). However, given the original possible output of the data as evidence for achieving local ecological management goals if scaled up to a representative community organisation, or informing future research, the ethical implications of opening, repurposing, or making the research content available had to be considered prior to data collection.

Based on the learnings from this project, the following commitments should be upheld for further University-facilitated research in order for the concerned communities to have ownership of, and become agents in their own collaborative mapping projects, such as that recommended in section 6:

- The final research outputs are to be stored in the University data archive and made available to a trusted entity nominated by the informants so that it can be used by them in future or safely archived, with the informed consent of participants.

- Only final participatory mapping outputs should be made available.
- Original, uncoded and unprocessed data should be stored in the University data archive unless those who generated are not consenting.
- Research findings should not be made available to external readers nor used further as evidence without participants' informed consent.

Whilst green space strategies addressing environmental justice can lead to healthier, more attractive neighbourhoods, they can increase land and property values. Checker asserts that the material efforts that local of environmental justice activists undertake to improve their neighbourhoods lead to those areas attracting 'an influx of affluent residents' (2011:212). In the long-term, greenspace enhancement strategies in Southmead could lead to gentrification, increased rent prices, and the displacement of the local community members whom they aimed to benefit. This should be a serious consideration for any multi-actor collaborations for green space enhancement in Southmead. The temporal scale of effective community-based research engagements that investigate local desires for green space management should be long-term, and that should keep up commitments to centring local voices. Urban planners, designers, and ecologists have a duty to work together with the explicit aim of protecting social and ecological sustainability (2014). A framework for further PPGIS research regarding informal green spaces in Southmead and beyond is outlined in section 6 of this project, providing a guideline for multi-stakeholder collaborations that uphold a commitment to protecting local assets and interests.

Whilst PPGIS data has provided planning and management support to communities in achieving environmental justice in specific land use planning contexts (Haklay and Francis, 2017), achieving this relies upon several factors. The first being the desires amongst participants to influence change in this regard, the second being the consensus met in their data, and the third being the extent to which local authorities find the data usable. Data usability is likely to be a function of participant's mapping efforts, as well as the accuracy, precision, and type of spatial data collected (Brown and Kyttä 2014). This challenging to ensure. In community participatory mapping projects, it is crucial to find a mapping 'language' suitable for participants. For example, with the typology of informal, public green space that local authorities may find usable, participants may not be familiar

with. The same is true for 'ecological health and benefit.' However, full community participation, knowledge generation and contribution to the mapping process are the priority in this study, therefore the survey enables participants to describe their perceptions of spaces mapped. A necessary balance has been struck here. Finding a suitable, local mapping vernacular about informal public green spaces is best achieved through in person, group fora in community settings. This was neither safe within the context of the COVID pandemic, nor within the temporal scope of this study. On the other hand, using a spatial typology in line with that used by planning authorities that creates more actionable data for them, and may avoid the need for repeat investigations, research fatigue, demands of participant's time. Nonetheless, the iterative design of this project enabled some language to change during participant recruitment and on the Emotional Mapping interface. For example, the commonly used term in GIS for irregularly sized spatial areas drawn on maps by participants is 'polygons,' but this was changed to 'shapes' to ensure usability. Further, having a survey wherein the participants could describe their mappings meant that local vernacular regarding informal green spaces could be elucidated, 'reworking the cartographic politics' of green space mapping (Gerlach, 2010:165).

A final challenge related to using accessible map-based language whilst considering that if planning authorities are invited to engage constructively with the information presented in these particular PPGIS maps, they may be unlikely to do so if they do not trust what they see. Presenting uncertain data, such as that generated by individual perception, may affect the level of trust these readers have in the map. This was addressed by combining qualitative and quantitative data and using a spatial typology broad enough to encompass different groups of actors' uses of the term (informal green space).

4.7 Limitations

Employing a web-based mapping platform for data collection in Southmead carried attendant limitations which were known before the project was undertaken, and were weighed against the potential for the methodology to achieve its theoretical and participatory justice commitments. Again, other limitations arose and were addressed during the data gathering phase of the project, which are detailed in the Analysis section.

Firstly, it was important to consider the digitally mediated inequalities in access to environmental planning and research processes, to which this project risked perpetuating. In Southmead, 10% of people don't have access to the internet at home. 27% of people aren't comfortable using digital services, and a significant proportion of the population are aged over 65 (Bristol City Council Insight, Performance and Intelligence Service, 2021:6). Compounding this multi-level digital divide (Hargittai, 2001), many people receive emails, use Facebook, and read the local news outlet on their phone. Whilst completing the map-based survey was possible on a mobile phone, it required a higher level of technological skill and dexterity and would have been more difficult for some participants. It was recognised that these factors could curtail the accessibility of the survey, and the extent to which the methodology contributes to the project's equitable knowledge politics objectives.

Secondly, there are other multitudinal power relations inherent in IT-led PPGIS mapping. The power dynamic between researcher and researched intrinsic to Western cartographic research (Johnson et al., 2005:86) is compounded by Southmead's relatively low levels inequalities of digital

literacy compared to other wards (Bristol City Council Insight, Performance and Intelligence Service, 2021), the researcher's institutional affiliation with the University of Bristol and the Cabot Institute, as well as age, gender, ethnicity, and nationality. This imbalance may produce hesitancy to participate, or generate certain responses from participants who may believe that there are a priori expectations about what contributions are acceptable. Possible implications for data quality have been weighed against the benefits brought by the procedural justice agenda of participatory research. To facilitate a two-way spatial learning between different sets of "experts" (Dunn, 2007) and local knowledge generation rather than merely data extraction, this methodology has been deemed appropriate and is only used where the agenda could not be achieved through another participatory method. Participants were supported to ensure that the data about their perceptions of their urban environment was collected processed, contextualised, visualised, and shared as they saw fit.

Thirdly, the phenomena of 'research fatigue' is well-documented in the context of university-community relations (Way, 2013). Individuals or groups grow tired of research engagements, and may avoid participating when there are continual calls for engagement. This can occur particularly where high levels of research are conducted, or participant groups are limited (*ibid*). This was an important consideration given the context of increasing public awareness of the ecological crisis and the importance of green spaces in urban environmental policy. Several surveys circulated Southmead's online community spaces during the same year as this research was conducted. These including a cleanliness perception survey run by Bristol Waste, two other university projects about the perceptions of sustainable technologies and green spaces, and a survey by Sustainable Southmead. Research fatigue is high when would-be participants do not believe they will see tangible results from the research (*ibid*). It was considered that, in Southmead, there may be a lack of obligation to contribute to university projects which are not guaranteed to contribute to local development objectives. However, this reinforces the importance of working with the public to build collective community-owned evidence bases, such as online maps, which could avoid the same data being collected repeatedly and avoid wasting participants' time by keeping data closed.

Temporal and seasonal changes may have also influenced participant's ecological perception maps. The study was open throughout the end of Spring until early Autumn 2020, which allowed a long-range variety of responses, but also encompassed the UK's warmer months in which people will use urban green spaces most. Finally, the influence of COVID may have meant that people were more inclined to visit Southmead's public green spaces more regularly, as research has shown that the proportion of people visiting green spaces increased during successive waves of lockdown restrictions in the UK (Burnett et al., 2022). Much evidence also suggests that socio-economic inequalities in visits also rose during the COVID-19 pandemic, highlighting the importance of centring environmental justice in the study. Burnett et al identified a gap between 'higher social grade' and 'lower social grade' groups (grading based on occupation and income, as per the Market Research Society, 2020) when it came to the probability of visiting green spaces. This gap increased 33% during the three waves of lockdown in the UK (Burnett et al., 2022:10). Other studies have also noted that socio-economic inequalities in the use of green spaces have been shaped by the pandemic (Boyd et al., 2018). Given the aforementioned inequalities of public green space access (Ramblers, 2020), and inequalities in vulnerability to virus transmission which may have meant that for 'lower social grade' residents, it seemed risker to visit neighbourhood green spaces compared to 'higher social grade' Bristolians in the context of this study.

These necessarily fluctuating, external social and environmental factors shift the embodied ways that human interpret and interact with local ecologies. Rather than impeding the study, they encompass the factors that influence human perceptions of them (Abram, 2017). Their unequally distributed impacts on the way that an interaction with local urban nature is embodied and perceived, so it important to recognise its influence on the results, though it was not the central tenet of this research. The environmental justice focus of this study was on participatory and procedural justice. Whilst the inclusion of a demographic study enabled an investigation into who which groups were speaking here on behalf of nature, future studies should go further to make diverse participant bases an essential element of their research design and adjust the reach of their mapping and ensure its accessibility to these groups (see section 6).

4.8 Footnotes

[1.] In simple terms, the Pocitovemapy.cz application allows survey participants to mark polygons on a basemap by clicking or free-hand drawing. The more complicated back-end programming has been designed as follows by Jirka Pánek and his collaborators: it uses two primary open-source JavaScript libraries: jQuery and Leaflet. jQuery is the library for 'basic user interactions and app control,' and Leaflet is for 'map interactions' (Pánek and Benediktsson, 2017:66). The data generated is saved in a 'MySQL database:' an open-source relational database management system which is available on most servers. Consequently, there is no need to install a 'specialised server with a geodatabase' (*ibid*).

Each entry in the database produces a randomly generated, unique identifier for participants. Their entries are stored based on the number of polygons drawn and their geometry, and later merged together using GeoJSON PHP library script. This implements the 'GeoJSON format specification,' 'allowing GeoJSON to store data from multiple users.' Simple SQL queries (the instructions that enable a database to conduct 'tasks, functions, and queries with data') allow the data analyst to filter data based on the user ID, or demographic categories, for example (*ibid*:66).

5. CRITICAL ANALYSIS AND DISCUSSION

Emotional Mapping was the central methodology for collecting local, embodied knowledge about green spaces as qualitative spatial data pertaining to perception on a participatory map interface. This spatial data was 'thickened' (Presner et al., 2014) with survey responses, public discourse, and empirical data about local action in green spaces. A mixed qualitative and visual spatial interpretation of the maps formed the basis of critical data analysis. In this section, I will outline the findings of the study and reflect on the extent to which the research questions were addressed using the pilot methodology.

Research Question 1: What does the community know about Informal Public Green Spaces in Southmead? How is this knowledge produced?

1.1 Where does the community perceive them to be, and what is their spatial extent?
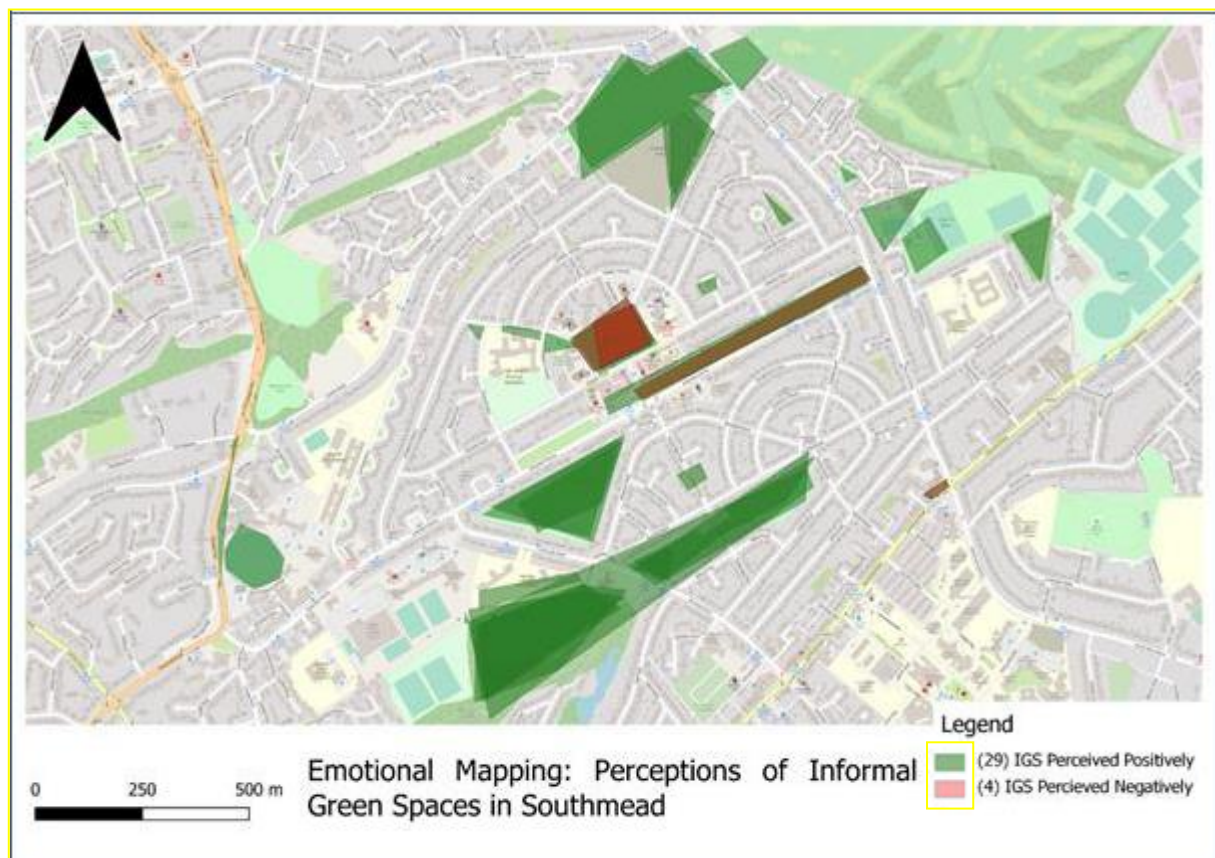
Map 8: Perceptions of ecological health and benefit of informal green spaces mapped as positive and negative spatial features, Southmead, Bristol.

The Emotional Mapping survey prompted participants to draw polygons demonstrating informal green spaces in order to compare the spatiality of their perceptions of informal green space with that represented in pre-existing mappings of Southmead. The findings of this spatial aspect of the research stress the imperative for mapping informal green spaces from the bottom-up in order to facilitate a mapping practice that integrates local values as into the planning process.

Firstly, some polygons drawn by participants would, following Bristol City Council's 2008 Typology Guidance, encompass spaces that fall under 'natural' green space, such as Badock's Wood, or 'formal' green space categories, such as Glencoyne Square (see *Map 2*). This indicates that participants do not regard Southmead's green spaces as per the use-based typology, thus, whether the green space is technically formal, informal, or natural, is unlikely to be a significant factor shaping participants' perceptions of it. Secondly, many of the participants' polygons are not in Southmead at all but surrounding areas. For example, several polygons are drawn over Pen Park Hole, which is in Brentry. Political boundaries do not translate to the everyday, embodied perceptual experience of one's community and its green spaces. This data demonstrates that current cartographic logics of GIS representation insufficiently integrate public values of informal green spaces to planning processes within porous, networked urban ecologies. This reinforces the need to explore novel methodologies for mapping green spaces which step away from legislative typologies and do not alienate the public, by enabling the public to reflect their own spatial understandings of informal green spaces and applying their own vernacular to their cartographic representation.

Map 8 (see previous page) shows the cumulative, positive, and negative informal green space perception data generated in the Emotional Mapping phase of this study. Participants' polygons were drawn in similar locations to some of the spatial features to those demonstrating informal green spaces in the maps in the previous section. However, they tended to be the smaller, more widely dispersed spaces. Interestingly, they were greater in number than those in *Map 6* in the previous section, which was created on behalf of the Southmead community; it indicates only 4 areas of informal green space, whereas there are roughly 18 in *Map 8*. These results suggest that participants have more nuanced and rich perceptions of the local landscape and its green spaces. Therefore, whilst the Emotional Mapping platform was mainly used for its ability to demonstrate intangible spatial data, the pilot shows the potential of using a slippy-map interface to elicit public spatial knowledge production and exchange.

Whilst this study used esoteric planning language regarding 'informal green space,' participants used different vernacular when describing the polygons drawn, showing that they know it by name rather than typology. They used their correct names, capitalised; Pen Park Hole, Doncaster Road Park, Fonthill Park, and the Trym Valley Open Space. This is insightful, as it shows their significance for participants whilst the PPGIS's 'thick' mapping approach allows participants to narrate the places which normative typological mapping threatens to obscure. The attendant survey was filled with local vernacular, which emerged within and pushed against its normative cartographic demands of them; to map the use-based spatial category of 'informal green spaces.' Thus, it politicises the map, allowing participants to speak back to a distanced, objective "expert" representation of their everyday environments which views them only through their function, rather than meaning.

1.2 Are they perceived positively or negatively, and what factors inform these judgements?

The Emotional Mapping responses demonstrate that informal green spaces are perceived positively. 29 of 33 of the polygons are perceived as healthy and beneficial for wildlife. This starkly contrasts the Bristol City Council green space quality map of Southmead (see *Map 2*) which demonstrated only one informal green space of 'good' quality. Per this map, Southmead only contains one 'formal green space' (Bristol City Council, 2008b). This is Glencoyne Square, which is a 'focal point and gathering space for activities and events' (Nash Partnership, 2018:17). Whilst formal public green spaces tend

to be the most highly valued and managed typology, we can see from *Map 8* that the ecological value of this space is contested amongst the public; more participants perceived it negatively than anywhere else on the map. This suggests that participants perceive more ecological health and benefit in the informal and 'natural' green spaces where voluntary action and public custodianship takes place, rather than in the 'formal' green spaces that would typically receive more legislative action and resource provision (Bristol City Council, 2008:a). Whilst unsurprising that informal green spaces are thought of as more beneficial for wildlife than urbanised land, it is important to understand the contextual factors that determined positive and negative perceptions of these spaces in order to compare them to other more highly managed and formal urban green spaces. As such, this mapping practice moves away from discrete typologising in a priori, technical, GIS-based value analysis, as marketed in the Future Parks Prospectus (Dando, 2019). Participants were also invited to briefly describe the green space, and why they did or didn't perceive it as healthy and beneficial for wildlife, reflects upon how far this enabled participants to 'thicken' the map with an understanding of the factors informing their mapping.

Responses demonstrated that the characteristics participants associate with ecological health tend to be those which bring benefit to both nature *and* people. Informal green spaces are perceived as more beneficial for wildlife where participants describe them as bringing a multitudinous benefits for the community, such as a 'safe play space,' a 'buffer between the road and homes, safe and green walking route to local amenities,' 'clean air,' 'gathering place for social or community activities' or even hold 'historical significance' (which refers to Badock's Woods natural space, where a round barrow lies near the wood's northern end), and 'greenspace for homes with relatively small or no gardens.' Therefore, the quality of green spaces for wildlife is directly linked to participant's sense of place, emotional, mental, and physical wellbeing. This entanglement seems fundamental to almost all participants of this survey. Only one participant perceived a particular informal green space to be more ecologically healthy and beneficial due to its inaccessibility for humans.

These results suggest that the public could contribute valuable knowledge to debates at the forefront of an urban planning paradigm shift towards nature-based solutions. In Bristol, this shift is epitomised by the One City Ecological Strategy, which entails working with nature to tackle the ecological emergency in ways which also achieve broader sociological aims of the One City Plan (Bristol One City, 2020:11). Bristol City Council is working with neighbouring authorities and developers to ensure that "net gain" for nature - where more habitat has to be put back than is lost to new developments - is achieved across the West of England Combined Authority area. Whilst quality standards frameworks such as Building with Nature set out how plans and developments can work for people and wildlife, the findings from this project show that the One City Plan should mandate meaningful, accessible public engagement practices in the planning phases of these new developments, to achieve both higher standards for wildlife and human wellbeing (*ibid*:10). The possibilities of public contribution to green space planning documents such as these should be extended beyond anthropocentric values such as those shown in *Figure 1*, enabling them to demonstrate how they come to know and produce value in the ecosystems where their bodies, lives and social worlds social worlds are entangled.

These findings also highlight how public thought corresponds with that at the forefront of academic debates seeking to transform understandings about the ecological importance of cities (Hall et al., 2017:27). Urban ecologists assert that shifting perspective away from cities as 'biological deserts' offers direct conservation benefits across a diversity of pollinator populations and can provide ecosystem services for humans (*ibid*). However, as 'urban ecology routinely necessitates reassessing established ideas in biophysical ecology' (*ibid)*, it may also seek to re-establish who is able to contribute to these shifts in perspective. The data here suggests that urban publics may have a greater awareness of the ecologies within their surroundings than ecologists or natural resource managers imagine, especially if they interact with green spaces over extended periods of time or and enhance this knowledge by contributing to citizen science and monitoring programs. Therefore, more meaningful conservation programming may shift away from traditional expert-led knowledge exchanges towards investigating local knowledge about green spaces and equipping communities with the means to monitor and enhance these in the long-term.

Indeed, participant observations of enhanced ecological value in these spaces suggest that the local community action has actively produced their perceptions of ecological value in Southmead's informal green spaces. For example, Greystoke Avenue is the main arterial road through Southmead which connects to Filton to the east and to the A4018 and M5 to the west, indicated as the two thin rectangular polygons in the middle of *Map 8*. One participant describes how 'planting has helped' its 'extended grass verges' become easier to enjoy, which is otherwise 'harder' due to its proximity to the busy road. Similarly, in the Trym Valley Open Space, the community is 'championing biodiversity with [the] Tiny Forest and increased planting [and] management,' leading to a perceived 'significant increase in wildlife in the last 3 years.' Local volunteer groups are responsible for actualising more multi-species conviviality in Southmead's informal green spaces.

The perceptions of Greystoke Avenue also tell us about how informal green spaces cannot be considered in isolation, or solely in relation to other green space typologies; their ecological value depends on their situation within the built environment. Similarly, the Trym Valley Open Space was perceived as beneficial by another participant because of how it connected to the Badock's Wood, a 'natural' green space per the Bristol City Council's 2008 typology map of Southmead (*Map 2*). It is a woodland conscientiously managed by Friends of Badock's Woods and the funding this voluntary action group has received from the National Lottery. The categorical use-based typology, therefore, does not go far enough to capture their perceived value for participants is bound up with their wider spatial contexts. This insight aligns local perspectives with the scholarly stance of urban ecologists who understanding of green spaces as inherently connected, multi-functional, and impactful for the protection wildlife movement across fractured urban habitat(Douglas, 2020).

Map 8 demonstrates a surprising lack of conflict in the map-based survey responses. Only the locations of Glencoyne Square and Greystoke Avenue contain polygons that are perceived both positively *and* negatively by participants, suggesting that whilst there are conflicted perceptions, as is to be anticipated with informal green spaces, these are limited; the community tends to share values about what does and doesn't characterise ecologically healthy and beneficial green space. This tells us about perception as a product of external factors, wherein features of the landscape coalesce in perceptions of informal green spaces that are shared between community members due

to various place-based histories and contextual factors. For example, collective positive survey responses show that people are aware of the efforts gone into upgrading green spaces as well as their aesthetic impacts. However, collective negative responses could demonstrate an awareness of inadequate bin provision and the historical issue of blight in Southmead. Given that participants would generally have done the Emotional Mapping survey whilst not actually in the informal green spaces, it matters what perceptions they have internalised and committed to memory. The factors most strongly influencing perception and the value judgments they determine needs researching further. Demographic factors will also influence this greatly, and will be discussed in the next question.

Given the sample size generated through Emotional Mapping, other avenues for data collection were explored. Facebook groups linked to the Southmead community, including Sustainable Southmead, an environmental action group, were investigated for any public discourse - textual posts and comments - they contained about informal green spaces. Media studies and digital sociology scholars suggest that concerns aired online provide a useful opportunity to trace how actors organise around controversial issues (Borch et al., 2020). As 5 of the 6 responses generated by this methodology were negative, it was useful for investigating how controversies around perceptions of informal green spaces unfold. User complaints generally concerned litter, blight, and lack of bin provision. Facebook users sought more information about why the grass had been left long over a double roundabout, and on Greystoke Avenue, which they perceived as looking unmanaged and 'awful,' and 'cut badly' (*Map 9*). Other users, who belonged to action groups like Sustainable Southmead, explained that this was an ecological strategy employed over 'no mow May' to benefit wildflower diversity and insect pollinator populations, which the original user agreed was important. Local Facebook users therefore lean across the online 'resonance spheres' (Fleig and Scheve, 2019) of different community groups to share knowledge about ecological action in other community fora, and address the social acceptance of ecological enhancement strategies in Southmead's green spaces.

As we have seen, various place-based histories and contextual factors determine the perceptions of informal green spaces. Examining the space of Facebook shows that even online community groups cannot be considered in isolation from these local relational dynamics; a knowledge transfer about urban nature occurs here which too is collaborative and unbounded. Knowledge is produced and shared within the community about the need to adapt social expectations of the physical environment, and the physical environment itself, to restore ecological health and its benefits. However, it also shows that better communication of, and collaboration around, nature-based management strategies occurring in informal green spaces may be needed to avoid confusion or concern as these changes occur.
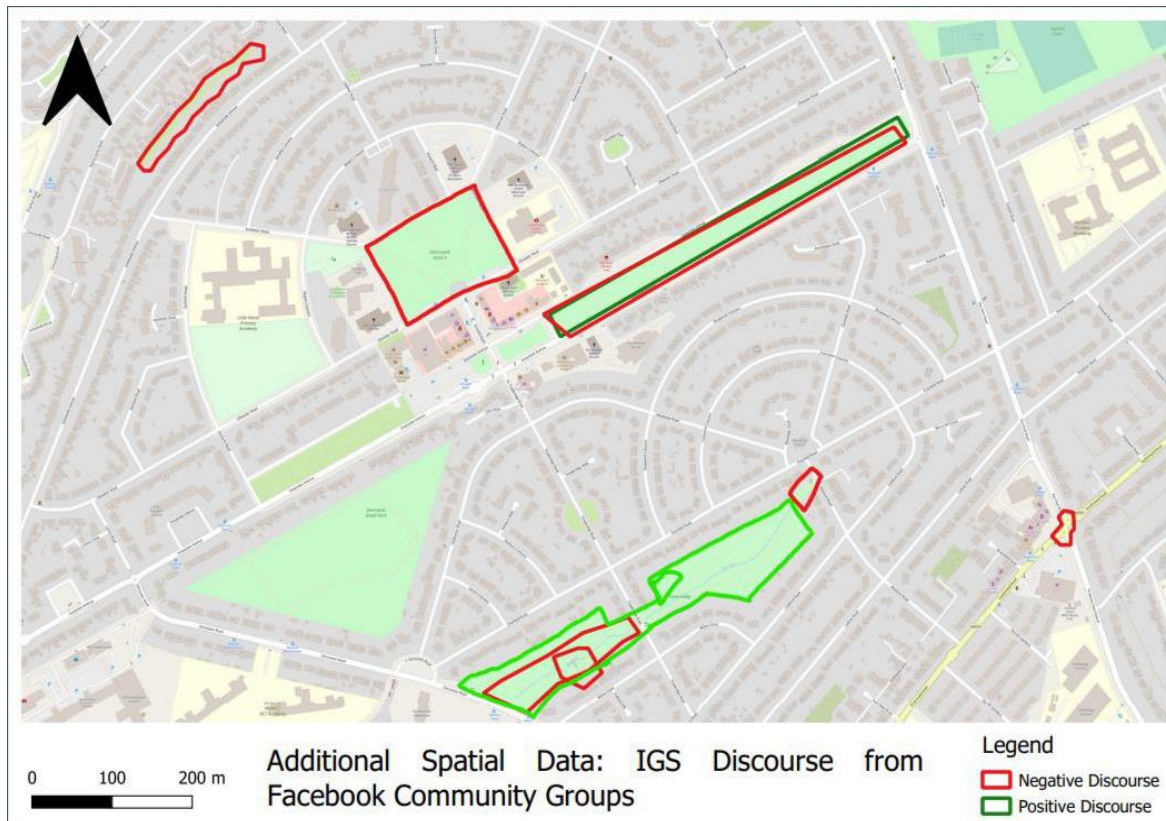
Map 9: Positive and negative informal green space discourse mapping from online community fora in Southmead.

1.3 How does the community interact with, and produce knowledge about, Informal Public Green Spaces?

In order to find out how the community's perceptions of informal green spaces are formed, the reasons for participants' interaction with them were investigated. This approach was appropriate because due to the project's orientation of perception as a vehicle for investigating the sensory relationships between human and more-than-human world. The first significant finding was that positive perceptions of informal green spaces are formed where they are seen to serve a multitude of both human community and environmental uses. *Figure 2* demonstrates that participants interact with most of these spaces (16 of 33) for multiple reasons, ranging widely from nature-oriented to activities such as 'nature observation' and 'research,' (referring to citizen science), to more anthropocentric activities like commuting and playing sports. The most popular reasons for interaction were recreation, walking, and volunteering. All 16 sites serving multiple purposes were perceived positively in terms of ecological health and benefit.

The two demographic characteristics considered in this study - age group and time spent in green spaces in parks within and beyond Southmead - paint a complex picture of participation (see Appendix A). Participants of the study were mostly between the ages of 25 and 54. Between *Figure 2* and *Map 8*, we see that people of these ages perceive informal green spaces mostly positively, and most frequently interact with them for volunteering. It has been noted that older and younger participants, and those belonging to BAME groups

stand to benefit most from increased interaction with quality green spaces (Sikorska et al., 2020). To understand what may encourage more engagement with informal green spaces amongst these groups, it would be pertinent to examine the frequency and nature of interactions with informal green spaces along other axes which relate to procedural and distributive environmental justice goals, such as gender, ethnicity, or socio-economic status, in future.
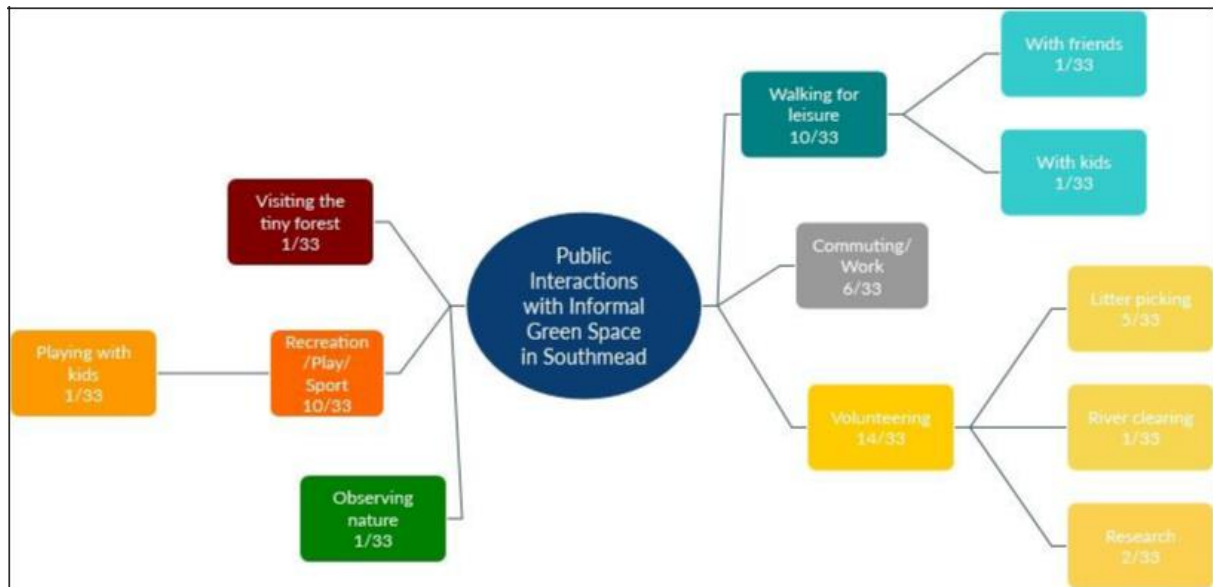
Figure 2: Participant's reasons for interacting with informal green spaces in Southmead

5 out of 6 respondents discussed the spaces mapped in the context of community litter picking activities. It is significant that participants who visit them in the context of litter picking do not necessarily perceive them negatively. Because of this phenomenon, and the fact that voluntary action like litter picking makes up such a significant proportion of the contexts of participant interactions with informal green spaces, further research was done to investigate the volunteering activities done in Southmead's green spaces and the knowledge that these activities produce. The specific locations of community activities and events run by local action groups in Southmead are displayed on *Map 10*, and surrounding wards on *Map 11*. These were mapped on QGIS, using data produced by qualitative empirical coding of the event descriptions, associated discussions on event pages, participation rates and discussions on Excel. The data came from Facebook groups and local action group websites. You can find these listed in the Appendix E. This element of the investigation confirmed that the informal green spaces where volunteering for ecosystem management takes place are perceived more positively, through a comparison of *Maps 8*, *9* and *10*, alongside the aims of each volunteering group activity. One participant in the Emotional Mapping survey also explicitly indicates their perception of the ecological health and benefit of the Trym Valley Open Space as stemming from this action.

These findings together suggest local action has contributed to the fact that residents who are 'satisfied with the quality of parks and green spaces' increased 6% between 2009 and 2021 (Bristol City Council Consultation, Research & Intelligence Team, 2009; Bristol City Council Insight, Performance and Intelligence Service, 2021:6). This signals a care for the spaces, and the proactivity of the Southmead community within a relatively active demographic window of the population actualises their desires for higher quality green spaces through collective action. Again, these insights reveal how participant's perceptions of informal green spaces hinge on the wider

social contexts of how they understand green space to be used and managed. Looking at external factors relating to site character and management to see how they influence informal green space use can inform how it affects biodiversity, for example, by impacting volunteer hours. Indeed, local groups such as Trout in the Trym have become more prolific in terms of activity frequency and spatiality over the last 12 months, new groups have formed over the last 6 months, such as the Pen Park Pickers and Friends of Doncaster Road Park and Embleton Road Playground. This may be explained in part by literature that describes a wider trend of increased use of urban green spaces during and after the COVID-19 pandemic (Ugolina et al., 2020), which includes a recent study by the Bristol Natural History Consortium reporting a 67% increase in use of Bristol's green spaces and parks (Future Parks Accelerator, 2021).

Local actors collaborate to protect ecologies and their own wellbeing, demonstrating how the ecological emergency in Bristol is a justice issue. If the One City Ecological Emergency is to uphold commitments to 'protect and support the natural spaces' in a 'fair, just, and inclusive' way (Bristol One City, 2020:2), it must recognise that uneven resource allocation across Bristol has led to more work being done by locals in deprived communities to maintain and improve ecological health alongside human health and wellbeing. To address this, insight into what and how community needs could be met to support nature's recovery and human well-being should be priorities. However, the 2018 Parks and Green Spaces consultation indicates how the Council have proposed to 'look for opportunities for community groups and organisations and businesses to manage, maintain or enhance local green spaces,' to save a minimum of 50k a year on management costs (19). Further budget cuts may unfairly impact the possibilities for nature's recovery in the green spaces of Bristol's more deprived areas.

The transformative potential of custodianship in Southmead has been recognised, to an extent. Partnerships between the community, Bristol City Council and other charity partners has led to the regeneration of the Trym Valley Open Space over the last 12 months. This space now has 1500 extra trees, a community orchard, native woodland nursery, native Spring bulbs planted and plans to stabilise the riverbanks, as well as regular litter pickers whose work has helped to 'prepare' the space for other enhancements. Now, more Friends groups have formed, and groups collaborate; Doncaster and Embleton Road playgrounds have been planted, too. Blight has also been approached, thanks to the efforts of Team Southmead and Inclusion Southmead, as these groups pressed for Bristol City Council to install more bins at Badock's Wood School, Greystoke Avenue, Southmead Hospital, and Turnbridge Road. Whilst this may mean Southmead is an example of increasingly prolific and successful custodianship of informal green spaces, wherein individuals and groups can increase their environmental literacy whilst improving the ecological health and benefit of their local spaces, the Emotional Mapping sample size and engagement, and event data in Appendix E, demonstrates a fragility. One person mapped 18 informal green spaces, and reported participation online appears relatively low and generally the same people. Further, Bristol Parks and Green Spaces describe the developments in the Trym Valley as 'one woman's dream,' which attests to the dedication and research of the Sustainable Southmead group leader, who has organised partnerships and engaged residents in activities. Alongside worsening health and wellbeing indicators in Bristol's most deprived areas (which includes Southmead), (Bristol City Council Insight, Performance, & Intelligence, 2021) and increasingly negative perceptions of the built environment

(*ibid*), the continued restoration of informal green spaces requires that the custodianship is made accessible and collaborative through financial support and incentives.

Per CABE, the government's advisor on architecture, urban design, and public space, it is (formally designated) parks that are 'community centres without roofs,' (Bristol City Council, 2008a:10). However, the sample data from this study, alongside event data indicates the custodianship the public are willing, and increasingly so, to be custodians of Southmead's informal green spaces. A more holistic view of green infrastructure as social infrastructure, then, should include informal green spaces as community gardens in which vegetation management by local action groups can and should positively influence the structure, type, and distribution of plant communities. These factors are prime determinants of habitat quality, therefore, they impact levels of biodiversity recorded in cities (Beninde et al., 2015).
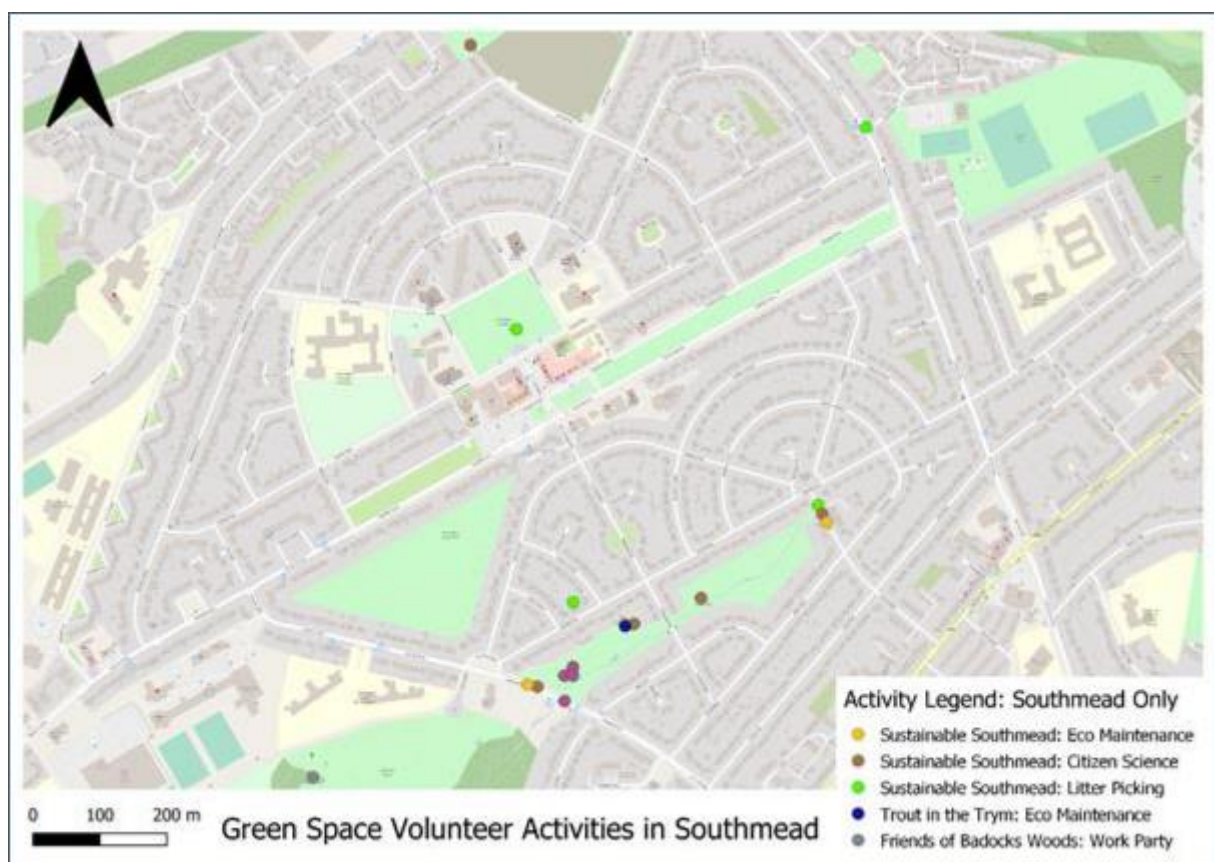
Map 10: Meeting points of green space volunteer activities in Southmead

Groups indicated in *Maps 10* and *11* gather with specific aims to regenerate natural systems by removing invasive species like Himalayan Balsam, doing ecological monitoring work through citizen science, and addressing blight by litter picking (see *Map 7*). Whilst the concept of urban green spaces as important health resources for urban residents has been explored (Hough, 2014; Triguero-Mas et al., 2015), the reciprocal potential for people to impact ecological health as they engage more deeply with their local ecologies and gain a better understanding of how to nurture them is less well-discussed. It is made evident, however, by the overlapping aims of these groups and their events within informal green spaces. For example, during the Big Butterfly Count held in July, people

engaged in ecological monitoring, counting butterflies in and around the Trym Valley Open Space and litter picking on the surrounding streets. Event descriptions for weekly litter picks include 'show your local neighbourhood and wildlife some love' (see Appendix E).

This data is not exhaustive, indicating action conducted only during the research period (17.01.21 – 18.09.21). It only indicates known groups active during the research period, which have been named on the maps. Work continues several times weekly, with litter-picking events, tidy-ups, community planning meetings, invasive weed management, and citizen science activities. Volunteers also undertake litter picks and ecological management activities like 'balsam bashing' (removing Himalayan Balsam) in their own time, as indicated by individual user uploads of images to Facebook. Individuals are reporting effluent spills into local waterways to Wessex Water, in the hopes that they come to clean them up, as well as collaborative citizen science efforts (namely Bristol Avon WaterBlitz 2021) in the hopes of reporting more fly species, which benefit fish and birds, as a result. Much activism has taken place online, too. In December 2020, there was a Change.org petition to ask Bristol City Council to manage verges and green spaces for wildlife. Further, local Councillor Brenda Massey has recently responded to requests from Facebook users, Team Southmead, and Inclusion Southmead for more bins to help address blight.

Finally, it is important to note that local groups team up and work together to achieve aims concerning ecological management, and litter picking and weeding in the ecosystems that transgress the political boundaries of Southmead and surrounding wards. For example, the Trout in the Trym is a network of community groups from areas through and near where the Trym river runs. Urban nature is treated by local groups as a system rather than a collection of discrete areas. Collaborative efforts within and across wards demonstrably results in its improvement, as with the recent, celebrated return of trout to the river Trym.

Map 11: Meeting points of green space volunteer activities in Southmead and surrounding areas.

At present, the labour and custodial care that the public have exerted planting, mulching and litter picking for the hope of greener, more ecologically healthy futures, indicated on *Maps 10 and 11*, does not factor into planning proposals to secure them, causing frustration and upset. For instance, complications with the delivery of housing for the Southmead Master Plan have led to planners proposing to encroach on the green spaces of Doncaster Road Park and Embleton Road playground (Southmead Future Housing, 2021), both referred to as important and ecologically beneficial by participants of the Emotional Mapping survey. Having already 'lost' informal green spaces like Dunmail and Greystoke Avenue to developments, members of the public are incensed by the potential loss of these more formally recognised green spaces, too. It appears that little protection is offered to green spaces within the context of an intensifying housing crisis, regardless of their typological designation. Thus, when granted permission to use a community owned PPGIS, the planners that need fast access to slow, qualitative data could 'thicken' their own GIS representations (Presner et al., 2014) with an understanding of the everyday value of green spaces for the communities who both enjoy and enhance them. Communities should also have the opportunity to share such data early on in the negotiation of current and future planning issues. At present, the majority of Southmead residents feel helpless when it comes to planning. In 2021, only 17% of residents agreed that they can influence decisions that affect Southmead (Bristol City Council Insight, Performance, & Intelligence, 2021). The possibility of their action having an impact on planning debates could be facilitated by a community-made PPGIS dataset which demonstrates this action alongside its ecological impact. If this was accessible for the public, it could serve as evidence in hand to put forward requests to influence planning proposals. This also would save the public from research fatigue, by making data available to planners as and when deemed appropriate by participants. The information generated under this research question has informed a proposal which will be explored in section 6.

Research Question 2: Did the methodology achieve its aims?

2.1 Could participants express knowledge about Informal Public Green Spaces in Southmead and desires for their management using the map-based survey?

The project aimed to trial a novel, map-based methodology enabling the public to contribute their knowledge of Southmead's informal green spaces for a more inclusive, constructive approach to ecological appraisal within a shifting environmental planning paradigm. The second, reflexive research question helps uncover local perceptions of informal green spaces, and the insights from this study which might inform how future research can better amplify local ecological knowledge in urban green space planning negotiations.

6 respondents drew 33 polygons, as compared to the 54 respondents to a Sustainable Southmead survey on the quality of Southmead's parks and open spaces, which was circulating at the same time. There may be several reasons for this low participation, relating to the online avenues of participant recruitment pursued. Leaders of Southmead-based community groups operating within its informal green spaces were contacted. This meant that they, or the secretaries of these organisations, could act as gatekeepers of community knowledge, choosing whether to share invitations to participate with their members or email recipients based on their impression of the project. Not all the contacted groups shared invitations with their members. However, it also meant that the invitation to participate, information and consent pages on the survey could be

reflexively updated after contact with these leaders, who knew their community members best and willingly gave advice for reaching these audiences based on their own understandings of appropriate language to use. This reflexive approach produced its own challenge, however: maintaining trust generated by credibility as a researcher, whilst also remaining open, flexible, and adaptable to create an accessible survey. A perceived lack of credibility due to this willingness to change the language around the project may have prevented some group leaders from sharing invitations with their members.

The recruitment process also involved an advertisement on a local online news outlet, as well as sharing invitations to participate on Southmead community fora on Facebook. These avenues were necessitated by the COVID-19 pandemic and associated risks to community health, and thus, the social-distancing and lockdown measures in place at the time. More participants may have been reached by in person canvassing due to the engagement and trust generated by in-person interactions. As outlined in the previous section, digital inequality is pervasive in Southmead. Also, low participation could be attributed to lagging interest and energy for online engagements at the late stage of COVID-19 lockdowns, in early 2021. These factors curtailed the accessibility of the survey, and the extent to which the methodology could contribute to the project's equitable knowledge politics objectives.

However, the web-based nature of this research meant that it was possible to source other data that helped to densify and thicken the qualitative maps (Presner et al., 2014), whilst surpassing some accessibility issues generated by the Emotional Mapping interface and broadening the spectrum of responses generated. Nonetheless, data pertaining to perception of informal green spaces, even when supplemented by web-based public discourse, may remain inherently exclusive; perception here references the processing of information delivered through a sensuous, corporeal exchange with the urban environment. Individuals are exposed to such experiences to various degrees depending on their mobility, sensory capacities, inclination, and tendency. As outlined under research question 1.1, some groups of people within the community spend more time in green space than others. These differences prompted a demographic survey, however, it was not within the scope of this study to make this element of the research as in-depth as it might have been, considering the complexity and intersectionality of these inequalities. For example, disabled and BAME residents experience greater concerns about anti-social behaviour in Southmead, which may curtail time they spend in green spaces. 15.7% of Southmead residents belong to a BAME group, 59% of residents believe that antisocial behaviour is a local problem, and for 23%, fear of crime affects their day-to-day lives (2021:6). In Bristol's 2021 Quality of Life survey, the amount of people reported being a victim of racial discrimination or harassment in the last year was up 18% in more deprived areas (up from 11% in those areas a year ago) as compared to 7% in other areas of the city (Bristol City Council Insight, Performance and Intelligence Service, 2021:5). In Southmead, 28.1% of respondents to the 2021 Quality of Life survey reported that their fear of crime affects their day-to-

day life, as compared to the Bristol average (19.4%). Whilst Southmead's largest age group within the population are ages 20 – 34, and over half do enough regular exercise each week (*ibid*), factors of physical health and mobility also impact green space engagement. The framework for future research in section 6 therefore highlights the need to use a more nuanced demographic analysis tool to target other groups in research that upholds commitments to participatory and procedural justice.

2.2 Does this knowledge offer a critical counterpoint to normative cartographic representations of Informal Public Green Spaces in Southmead and beyond?

The complexities outlined above demonstrate the difficulties of achieving participatory, procedural justice in environmental planning. They highlight inherent tensions between digitally mediated cartographic representation and community-oriented, inclusive mapping practice. It is crucial to shine a light on these tensions; staying with them allows a critical examination of both the potentialities and limitations of the methodology for enabling local knowledge to play a more central role in green space planning and policy. However, the methodology itself was reflexive as far as some of the map-based language did change to become more accessible for the public. It was also necessarily adaptive in addressing limitations to data sources, which helped uphold its commitment to redirect attention to that which has been overlooked, exploring alternative and pluralist ways of knowing urban nature by broadening data sources towards public discourse.

As previously mentioned, this project committed to referring to informal green spaces as such in order for the map output to speak back to planning processes in Bristol. However, this limited the extent to which participants could contribute to the production of a map-based language with which their understanding and knowledge about their locality was aligned. A fully participatory mapping practice would have been collaborative from the outset, including the design phase of the map-based interface as well as the research project itself. Haklay and Francis' scholarship on Participatory GIS and community-based citizen science for environmental justice action shows how integrating a 'discussion and initial priorities setting' stage early on in the research process can establish how a problem that was identified by the community can be fairly addressed through public data collection (2017:301). The insights of this project add to such scholarship, highlighting the need for a map-design element in any a priori discussion and priority setting stage, in order to ensure that the map-based participatory research is fully accessible and reflects local views and values.

Nonetheless, the maps produced provide a critical counterpoint to previous cartographic representation of Southmead which has informed green space policy by outlining discrete spatial areas and their typologies. *Maps 10* and *11* indicate the collaborative social networks that spread across the ecosystems in which they operate, demonstrating what is being discussed in academic circles; that a networked approach that will be crucial to enhancing the ecological health and benefit of green spaces across the city. It supersedes the spatial politics of urban ward boundaries, mirroring the way that green spaces are actually used by wildlife, like insect pollinators, and therefore, how they should be managed. It demonstrates that convivial thinking is something inherent to the public who use these spaces, and needs to be communicated to planners in order to transform the urban environment into a thriving, functioning socio-ecology.

Finally, the critical commitments of this project compel an interrogation of social structures and cultural imaginaries upon which political, cartographic claims to ecological knowledge and expertise rest. Participants demonstrated ecological value judgements, which had not been their remit in previous GIS representations informing green space planning in Bristol. Responses showed that perception of benefit for wildlife tended to be informed by values relating to their own wellbeing. Whilst demonstrating the capacity of a relatively deprived community to improve their environment, the responses 'enchant' and 'enliven' Southmead's urban nature (Schultz, 2017). Its ability to act upon the human psyche and physical wellbeing demonstrate its innate capacity to sustain human existence, to communicate, interact with the public; an experience, still lived within Bristol's most deprived neighbourhoods. This project has shown the possibility of integrating this understanding through a non-representational mapping practice.

The perceptions are informed by value judgements based on things like ground cover and activity type, not typology. As such, the cartographic data here allows participants to avoid the path-dependencies of institutionalised knowledge production around green spaces. It uses the power inherent to GIS technology to visualise, legitimise, and encourage a greater sensitivity for the ways people give meaning to their urban-natural life-worlds. By allowing this insight, the methodology, gives one crucial output; a framework for future research that informs green space planning in Bristol by employing an effective, community-oriented mapping practice for just knowledge transfer. The following section explores what this framework would look like in the context of Southmead, and uses it to outline a proposal for a future PPGIS project for mapping green spaces. It would aim to enable the public to contribute to better understandings about the ecological value of different green spaces, how they can be best managed and by whom, for restoring urban biodiversity. Whilst ecologists have done research showing how different types of ground cover contribute to the health and resilience of insect pollinators (Baldock et al., 2019), the results of this project demonstrate a gap urban ecological research; investigation of the ecological impact public action in green spaces has on biodiversity. The proposed research framework demands the collaboration of the public with organisations conducting ecological monitoring on an interface that is usable for the public, enabling them to stake claims to urban green space, resources, and the ongoing support of their efforts to restore ecological health.

There are several factors that make such a proposal appropriate and timely in the context of Bristol's communities and their green spaces. As outlined in the Bristol Future Parks prospectus, the Council have 'back-office asset management systems' for integrating asset (in this case, green space) data with 'condition surveying, mobile inspections, customer enquiries, and other reporting.' It is noted that these Parks GIS datasets can be 'integrated with a wide range of data from across the authority and external sources to aid decision making' (Dando, 2019:19). Therefore, it would be possible to produce qualitative spatial datasets that planners from Bristol City Council, such as Bristol Parks or the Housing Delivery Team, could integrate with their own GIS data early on in their development of projects. This would enable local communities to demonstrate the value placed on certain green spaces, how they are used, and the work being done to actualise convivial, healthy ecosystems within them.

6. FRAMEWORK FOR FUTURE RESEARCH

This section investigates research question 3, using the analytical findings of the Emotional Mapping pilot in Southmead to outline a framework for a future PPGIS research tool for public green spaces that is truly collaborative and community-centred. It transforms some of the key findings from the previous section into objectives for a future research project. The aim would be to build an evidence base for the protection of all green spaces within a locality such as Southmead, regardless of size or function, which locals and ecologists perceive has having current or potential value. This formal recognition of the public custodianship of fragile urban ecologies could usher in a paradigm shift wherein even the smallest scraps of urban nature are seen as valuable, the effort of local activists worthwhile and crucial, knowledge about one's environment accessible and useful, and having a say in the urban green space planning process as feasible for communities. This paradigm shift could manifest itself palpably in the avoidance of situations like in the management of informal green spaces in Hackney, or the new proposals for Doncaster Road Park and Embleton Road playground, where lack of prior public engagement or consultation has led to considerable upset (Southmead Future Housing, 2021).

It has the same wider aim as the Emotional Mapping survey: of demonstrating entangled ecological and social landscape values as qualitative spatial data. However, it zeroes in on procedural justice goal of empowering local stakeholders in the design, ownership, and use of an accessible, user-friendly GIS map for more timely and fundamental involvement in green space planning processes. In this way, it provides a framework for putting the transformational power of PPGIS towards achieving environmental justice in the face of the ecological crisis. Key research findings from the Emotional Mapping survey have demonstrated a series of key lessons, which inform this proposal and highlight why such a framework is important, helpful, and instructive for further research. These key findings are outlined below.

1. Not all members of public are aware of the work others are doing in green spaces, or why they are being managed in certain ways by either public volunteers or the Council, or in consensus about the ecological value of informal green spaces (as seen in Southmead under the Emotional Mapping investigation of research question 1.2). Collecting a variety of qualitative spatial data in one resource can facilitate cross-group learning and collaboration, enabling diverse groups of stakeholders to cross-examine their opinions and address any conflict.

2. Planning bodies like the Council need to be kept up to date about how citizens are enhancing urban nature in their localities, how these activities enable them to add meaning, perceived value, and ecological benefit. Web-based PPGIS can engage larger numbers of urban residents, and more diverse publics, than formal, legalistic public consultation meetings, simply because they are accessible at any time, from any location, on relatively familiar or user-friendly platforms (Kahila-Tani et al., 2019). As such, a PPGIS tool could also improve communication and understanding within the community about what action may occur or visible changes to landscape might be made, such as not mowing or planting, and why, further aiding the development of local ecological expertise and literacy.

3. We need a paradigm shift away from public green spaces as either highly managed or overlooked, based on an anthropocentric view of their 'function.' They can, as we have seen, can be multifunctional whilst serving the highest good for well-being and biodiversity. They can be spaces in which humans are empowered to have a hand in their custodianship, maintenance, enhancement, and enjoyment. This paradigm shift necessitates that those custodians are at the forefront of planning and changes to maintenance regimes.

4. A PPGIS that is future-oriented, unlike the a priori value analysis of green spaces that has excluded their ecological potential, can empower participants to demonstrate their desires and aspirations for public green spaces whilst imbuing them with the possibility of longevity and permanency. This re-orienting is a crucial part of shifting how urban nature is framed, as public green spaces have heretofore been characterised by their transience and thus are at risk of disappearing. It is crucial for the public, who depend on and work hard for public green spaces, to contribute to this shift.

5. The ethical implications of Emotional Mapping, highlighted in section 4, point to how employing PPGIS in working-class communities facing environmental injustice requires a research framework that centres an ethic of care and commitment to protect participating communities. Historically, digital knowledge politics have also risen from, and been perpetuated by, academic GIS research which has not prioritised public engagement and valued other activities much more highly – for instance, publishing in high impact journals, or engaging with other sectors like policy or business (Turnhout, 2018). As such, this proposal builds on the analytical findings whilst also employing Karen Bell's Checklist for Meaningful Inclusion in Environmental Decision-Making, and her Guidelines for Working Class Inclusion (2020:73) in order to promote a just PPGIS mapping practice. A community-owned evidence base would be useful for future initiatives, allowing participants to avoid research fatigue by making this accessible to planning authorities or researchers as and when needed, as decided in consensus by participants during subsequent iterations of the design and intention-setting workshop phase.

6. Environmental justice scholars have highlighted that an embodied engagement with informal green spaces is most important for less mobile, lower income, BAME, older people and children (Sikorska et al., 2020), but, as we have seen, these groups are most likely to be missing even from a critical PPGIS mapping which deals with perception. These factors should be considered during every stage of the research design, from reaching out to other groups during recruitment specifically, to encouraging people to participate with such research as best they can, providing information about green spaces which they see, such as from home, work, or hospital windows, as these are likely to be informal. For example, the experience of, and concern about, anti-social behaviour (which includes street harassment, harm caused to the environment as with blight, or to human individuals and groups) is unevenly felt by Southmead's BAME residents (and the same is true for Bristol more widely) (BCC Insight, Performance, & Intelligence, 2021). Further, given that digital inequality and exclusion maps onto particular kinds of offline disadvantage, recruitment should entail extra effort to reach and engage those without digital access and capital (Robinson et al., 2015).

6.1 The Research Design

Stage 1: Participant Recruitment

To recruit participants, in-person canvassing should happen in public green spaces and at voluntary events taking place within them, such as litter picks. It would be appropriate for the researchers to contribute to these activities whilst informally engaging the public to foster a research ethic of reciprocity crucial to community-based research (Maiter et al., 2008). To reach as many people as possible, participant recruitment should also happen by cross-posting on social media community channels and news outlets. Potential participants should be invited to an in-community talk about the project to explain it further, and decide on suitable dates for preliminary map design workshops.

Stage 2: Collaborative Map Design Workshops

Preliminary collaborative design workshops should be held in a setting which locals regularly attend to ensure that the project is welcoming and accessible (Bell, 2020:236). These workshops should have investigative, creative, and decision-making phases, and be iterated as many times as necessary to ensure high levels of involvement whilst accounting for safe participant numbers in light of ongoing COVID-19 concerns. Emotional Mapping responses showed how public green spaces are perceived as extending across ward boundaries, which informs the way communities act across these boundaries to protect the ecological networks which run through them. Therefore, this stage and the PPGIS mapping project as a whole should be open to the public and not just to Southmead residents. Representatives from Bristol Parks and Planning, and local planning authorities such as the Southmead Development Trust, and ecological researchers such as those from within the University's School of Biological Sciences or those monitoring on behalf of local and regional conservation organisations should also be present. Participants attending these workshops should be reimbursed for their time and effort in the form of expenses to help increase accessibility so that any travel, childcare, and other caring responsibilities can be compensated (Bell, 2020:236). Motivation for public participation may include the creative nature of the project, and the opportunity to engage with these actors and to represent the community directly to them.

Paper-based mapping of public green spaces in Southmead as perceived by participants should structure the investigative phase of the collaborative design workshop, with groups of participants drawing the boundaries of public green spaces on paper-based maps and reaching consensus on their names. Drawing on findings from the Emotional Mapping data, this should enable the public to reflect their own spatial understandings of green spaces and apply local vernacular to identify them, rather than fill externally prescribed typological categories. It has been shown that place names on web maps strongly influence the usability of the final web based PPGIS (Nivala et al., 2008).

In this creative stage, participants could also contribute suggestions about what the map features will be included, and their uses. For example, what the spatial extent of the map will be, and which land cover types and categories should be added (to be decided upon in collaboration with ecologists present at the workshop in order to align local place-based knowledge with data

useful for their research). Other mapping language to be decided would indicate land uses in public green space, and suitable markers to indicate these. Decisions would then need to be made about how participants could contribute data in the most user-friendly way possible. For example, through a Google form or similar survey format. As the previous section showed, Southmead residents were more familiar with and engaged more highly with online surveys than the Emotional Mapping platform. Further, this format for spatial data collection has been proved usable by Garcia et al (2020) who have evaluated the usability and applicability of a web-based PPGIS tool with a Google form questionnaire, with the aim of obtaining spatialised 'opinions' from the public to support participatory river management.

The paper base-maps would later be digitised and layered to find approximate borders of the public green spaces and map key features according to the survey data. This data layer would form the base map for the PPGIS. There are several ways of digitising paper-based spatial data, for example, using Huck et al's Paper2GIS methodology (2017), which could be done by the University cartography facilitator. This would save the public the time and effort of uploading data themselves, as the lead research facilitators or Bristol Council GIS analysts could do this.

Participants contributing to the planning and design phase of the mapping project will decide who is able to access it. They would determine which public organisations can add citizen science data, and which bodies are able to use the evidence it generates, for example, to make a funding application for conservation management resources. This agency is central to a commitment to participatory and procedural justice commitment which, as the framing of the previous project highlight, should underpin any research project that seeks to generate environmental knowledge to inform planning processes. Participants would also have to reach consensus about several factors: where the map lives, for example, on Southmead.org or on its own domain, which websites can provide links to it, who has access to it, if a login is needed to participate, and what it will be called. Re-iterating the collaborative design stage would be a good way to ensure that the map remains alive, usable, and useful (for example, participants may suggest adding or removing features as necessary), and secure.

Stage 3: PPGIS Data

Once the iterations of stage 2 are complete and the map has gone live, the rest of the collaborative mapping process would be done online, aside from regular re-iterations of the design workshops to ensure usability and data relevance. To encourage a high response rate, a brief and simple map-based questionnaire should be used, based on recommendations by Babelon et al (2017), which consist of only four research questions relevant to the aims of the project.

What ecological stewardship has taken place here? Who is responsible?

Participants would be able to place markers within the spatial area of the map. A pop-up comment box will enable them to describe any action undertaken in the public green spaces on the map to promote ecological functioning, either directly or indirectly. For example, it may be action without specific ecological aims like litter picking, or pertain specifically to biodiversity restoration such as native flower planting, invasive species removal, and species monitoring. A useful feature of the map tool would be to enable participants to upload photos as evidence as part of their geolocated responses, as combining visual and narrative mapping techniques increases the political power of

PPGIS for participatory and procedural justice, by allowing participants to bring everyday spaces of ecological and social entanglement into stronger focus when being considered as evidence during planning and decision-making (Bennett and Lantz, 2014). These photos will be displayed in a pop-out sidebar for each marker.

There would be another comment box for participants to describe the impacts of this action, whether for their own well-being or for local wildlife. Building on the insights from research question 2.2, it is crucial for all map users, and particularly planners, to gain insights into how the management of urban nature acts upon human inhabitants and is thus fundamental to their sense of place and quality of life. This element of the mapping will build a historical database of action being undertaken to enhance ecological value in the landscape, where, as well as how it has been produced and by whom.

What ecological issues can you identify in this area? Does this issue affect you, and how?

Participants would be able to place different markers and associated commentary within the spatial area of the map to identify and describe anything impinging on the ecological value of public green spaces in their locality. They would also be prompted to describe any impacts this issue has on their lives, and upload photos. Issues could be blight, such as litter, fires, effluent pollution in local waterways, or new developments in what were previously green spaces. This will draw conservation groups and planning authorities' attention to what the community perceive as issues degrade their everyday environments and lived experience of them. It will also provide a useful resource for local voluntary groups such as litter pickers, and citizen scientists such as those reporting on water quality for the Bristol Avon Rivers Trust WaterBlitz (2020).

What ecological stewardship should take place here, and who should conduct it?

This research question would the dearth of qualitative studies obtaining local values which inform green space planning, as well as a normative, technical approach to mapping ecological value in cities. This is to develop a PPGIS tool that facilitates procedural and participatory justice, rather than perpetuates the "expert"-led methodological approach heretofore employed in Bristol.

Participants will have the option to make recommendations for action to be taken in these green spaces, including by whom. A comment box will allow them to describe the action to be taken, for example, effluent clean-up in the river, more bins, wildflower planting, large items of litter to be removed and by whom. If the community is selected, they will have the option to add a further comment describing the resources needed to achieve this action, e.g., funding, volunteers, and gardening equipment. This question will prompt participants to draw a polygon covering the spatial extent of their recommendation, and generate GPS co-ordinates for each polygon to give planning authorities a spatial reference. The polygons will be transparently coloured, enabling denser shading to be observed where certain areas may be popular amongst participants, as the map would be collaborative and generative.

The map would provide a location for long term data across different sites, species, to be compared with include control areas where no ecological activism is taking place. This would show on the map the ecological importance of public green spaces, and the impact the activities displayed from question 4 are having, such as balsam bashing, flower, and tree planting. This would provide the community with evidence for securing funding and continued support for certain actions. The

cartographers will then upload all data from the survey and contributed by external groups to the map.

Stage 4: Citizen Science

Citizen science helps to increase ecological literacy and research capacity amongst the public. Examples from some citizen science projects show that participants are often highly committed and not only contribute to these projects, but can become "experts" in the scientific area of the project and develop many other skills (Jennett et al. 2016). To promote mutual learning and benefit for participants in this research design, ecological data which the community have been involved in collecting should be added to the map. This would also facilitate an investigation of if and how local ecological stewardship tangly impacts local ecologies, for example, their biodiversity and wildlife population density.

The reciprocity between researchers and participants that citizen science can bring is fundamental to the development of meaningful long-term participatory research partnerships between stakeholders. It would also be a unique opportunity to study the long-term impacts of applied local environmental expertise on urban ecologies in crisis. This project would be an ongoing creation, wherein stakeholders such as ecologists and residents are able to investigate and act upon mutual interest in the biotic health functioning of public greenspaces. It would therefore demand an ongoing, evolving, and open-ended analytical scrutiny (Leeuw, Cameron and Greenwood, 2012), and significant commitment from participants. Participatory models of research such as this have deservedly gained celebrated momentum within marginalised and particularly Indigenous communities, but can nonetheless unwittingly place a burden on communities by researchers who strive to 'meet ethical and institutional commitments to participation, consultation, and engaged, community-based research' (*ibid*:187). However, this points to another benefit of web-based PPGIS. Whilst the map should be accessible to participants and residents who wish to use the growing evidence base, it's existence in the digital sphere can lend it to more passive forms of engagement, such as viewing. Further, the merit of a digital platform it's s the potential of adding information integrating existing datasets, such as those gathered over the last year (such as the BNHC and iNaturalist BioBlitz, Bristol Avon River Trust's WaterBlitz which included the River Trym and Hazel Brook, and Butterfly Conservation's Big Butterfly Count). This would help save time, energy and financial resources which could be spent on enhancing informal green spaces and their ecologies.

From an ethical standpoint, it is critical that any researchers wishing to use the large, layered datasets that could emerge over the timeline of this project credit the participating members of the public, and commit to protecting their intellectual property. Participants should be able to opt out and remove their contributions at any time. Using a web-based mapping platform that does not require any software download or advanced technological expertise in future research would ensure that participants are in an appropriate position to oversee the transfer, manipulation, and analysis of the data.

Stage 5: Accessing and Using the Map

The link to the survey, and subsequently, invitations to use the map would be shared through online community fora. Keeping the platform open would allow the map to remain a living community

artefact, continuously growing and changing to reflect are more ecologically oriented green space management regimes or better supported community custodianship activities.

To use the map, participants would have to sign up with an email and password, or log in with the same credentials previously provided. Once registered, they will be able to view the markers on public green spaces. By clicking on the markers, they will be able to see information contributed about them through the Google Forms. Participants will be able to click buttons on pop ups to upvote or downvote public recommendations on the map. There will be a link back to the survey to contribute more information. Accessing the map and voting on recommendations, or making new ones, will be part of the ongoing, long term mapping process.

To increase the map's usability, all language should be plain (Bell, 2020:236), and include that which was decided upon in the planning phase. A short video tutorial could be produced to increase map usability amongst those with lower digital literacy (Gottwald et al., 2016). Providing a choice of two different topographic background layer choices - satellite and street-map - would further improve usability (Garcia et al., 2020). At a later stage, doing 'qualitative usability analysis' by reflexively evaluating the usability and applicability of the tool throughout the real participation process) could also lead to improved design per participant feedback and ensure their hand in its creation (*ibid*:10). This analysis could occur following Garcia et al's online usability evaluation survey, which used quantitative measures to evaluate their PPGIS tool's 'perceived effectiveness and satisfaction,' and focus group discussions for insights on tool satisfaction (*ibid*:3). Taking these steps would ensure that the PPGIS commits to participatory justice, as it supports a two-way knowledge exchange whereby participants can make recommendations and exchange ideas for the collection and use of the spatial data (*ibid*). This also ensures the PPGIS commits to procedural justice: as we have seen, the ability for local actors to contribute meaningfully to environmental decision-making processes is tied up with their ability to participate fairly in the generation of knowledge about their lived environments.

The outcome of this project would be a fair, inclusive and equitable spatial data exchange with multiple winners. Southmead could be the preliminary trial area, however, the highly replicable nature of PPGIS for place-based research (Brown and Weber, 2013) means that this project could be reiterated to improve a wider shift in the way that public green space planning is conducted across the city. However, these iterations would need to remain small-scale for maximum community impact. As a further note, the collaborative production of such data, to be used as a part of a priori research, also necessitates the proposal of an alternative policy framework, whereby local knowledge is sought ahead of planning proposals being made. In order to ensure an equitable knowledge exchange, it is crucial that the public are able to provide feedback on these plans, and be able to participate with the processual element of the PPGIS project on an equal footing with planners (Bell, 2020:239

7. CONCLUSION

In Southmead, as in other urban areas, residents take action to enhance the quality of green space at the micro-local scale, because this is often the only place where they can enact impactful positive change on what they are increasingly aware is a crisis-stricken living landscape. It is also the most familiar scale, where the highest level of expertise exists within the community who interact with such spaces daily. At the same time, it is the scale at which ecologists tell us urban authorities need to act in order to repair and restore damaged urban ecosystems, build nature corridors under street trees, along verges, on roundabouts and walls and roofs teeming with a mix of spontaneous and planted vegetation. This, then, is the scale at which planners and developers need to make plans for nature, with meaningful input from the public.

This study has captured the scale of mundane, everyday spaces of urban nature by using Rupprecht and Byrne's 2014 typology of informal green spaces. It has re-asserted that informal green spaces are key, overlooked ecological niches in Bristol's urban landscape by re-mapping them in terms of the value ascribed to them by the local community. It centres a critical cartographic methodological approach as fundamental to achieving procedural justice in ecological management strategies that secure their future. It does so by exploring how mapping the situated, embodied knowledge about these places, produced through physical interaction and the sensorial experience of perception, could enable members of local urban socio-ecological systems to transform the way that informal green spaces are viewed within wider context of the urban landscape.

An increased situational and situated awareness of the unique specificities of place is necessary for the planning and management of convivial urban landscapes, as within these, human and non-human nature is interdependent and entangled. By elevating and legitimising these insights through re-mapping urban green spaces to capture them, PPGIS as collaborative process of local environmental knowledge-creation could inform meaningful participation and procedural justice in map-based green space planning and management, in which community voices play a key role. Much like the critical Indigenous and feminist counter-mapping projects that come before it, this act of mapping could itself intervene in and disrupt the processes of disenfranchisement which exclude communities from meaningful participation in digital modes of green space research, and their material outcomes. This would also contribute to the academic project of realising more just digital geographies futures; indeed, this would be a critical project for a university academic to facilitate.

The data has also shown that, despite the limitations for meaningful engagement in environmental policy exerted by a knowledge politics and dearth of accessible, usable spatial green space data, in Southmead and surrounding wards, local activists are increasing their own environmental literacy by building value in their everyday environments. They take practical, collaborative steps to nurture the ecosystem services they derive from nature. Such public expertise should be encouraged and supported in green space management and planning by novel research which seeks out new ways to broaden ecological value considerations and integrate public knowledge. Participatory mapping to this end must engage the public as co-producers of knowledge, to inform policies and actions that account for the full breadth of systemic and contextual factors that influence everyday environmental realities, and that these have broad support.

Weathering the ecological crisis in the city will also demand dialogue about management goals across diverse groups of concerned publics, ecologists, charity partners and volunteers, land managers and decision-makers. For instance, whether management should be for biodiversity and conservation, human livelihoods, flood mitigation, carbon storage, or recreation. A fully participatory research design is critical to this project. Local knowledge must be included and generated at every stage, from initial goal setting to methodological design and data collection and evaluation of results or adjustment of the map, as it can enable 'diverse sources of local, traditional, and formal knowledge systems' to expand considerations of goals and approaches that should be employed to tackle the ecological crisis (Yung et al., 2013:253). An interface on which all these knowledge bases can layer and inform each other, as outlined in the previous section, would be a decision-making asset that assists ecologically robust management decisions in relation to their impacts on the surrounding communities (*ibid*).

The outcome of such knowledge sharing could be directed resources, including time, information and guidance, money, and energy, that improving the inclusivity of public engagement in action groups like those mapped here, generating further environmental knowledge amongst groups that have been disenfranchised from green space access or environmental politics more broadly. Enabling communities to take care of the pockets of refugia and habitat around them could provide a more just and inclusive strategy for developing a sustainable, thriving, multispecies Bristol. As we have seen, working-class neighbourhoods may be home to less robust wildlife populations. Environmental strategies that promote individual actions, like enhancing gardens, may do little to strengthen the socio-ecological connections necessary to carry us through crisis, towards a convivial future. A critical PPGIS thickened with local histories of activism and hopes for the landscape that also demonstrates the impact of this on restoring urban wildlife populations may provide a stepping-stone towards a more inclusive, collaborative urban conservation movement which recognises and empowers their expertise and encourages their environmental literacy, and an urban green space planning framework which incorporates this into its negotiations, proposals, and management strategies. It could inform new development proposals, for example, help developers devise 'biodiversity gain plans' alongside usual planning application documents, which the Ecological Emergency Action Plan seeks to make mandatory (Bristol City Council, 2021b). This can provide the basis for efficient and just negotiation of developments: because of the GIS format, development proposals can be overlaid onto the data provided by public participants. Further, a more empowering experience of involvement in the planning and delivery of these plans and strategies, as well as potential boost they generate to ecosystem service delivery by enhancing the biodiversity and functioning of local ecologies could have real, embodied health and wellbeing benefits for communities in more deprived urban wards (reference).

Challenges for future work in this vein include the commitments to time and energy by researchers, participating publics and organisations that are fundamental to any research project work grounded in an ethic of community-based care and reciprocity. It also includes access to diverse data sets, and finding appropriate fora within which to facilitate meaningful dialogue between participating groups: ecologists, GIS "experts," concerned publics, and decisionmakers. It will also be rendering map-based projects accessible to urban society's most marginalised groups, targeting these in an ethically sensitive manner, and constructing a mapping platform that renders local vernacular of place and green space in a way that is also useful for environmental planning authorities. These

challenges must be addressed throughout the research process in order to foster dialogues between groups that define how an ecosystem could be managed to meet the wellbeing and quality of life goals of the community, alongside goals for biodiversity, livelihood, species preservation. Nonetheless, this study has provided a glimpse into how research that informs community-driven biodiversity interventions in the city could shift traditional views of it as purely a space for human society, the abstraction of community well-being from ecological functioning, and the view of the public as either lacking expertise regarding their local ecologies or as powerless to transform them to something healthy, abundant, resilient, and enduring. These shifts are necessary in our present moment, wherein interwoven socio-ecological crises are felt acutely in the city, and particularly in its more deprived wards. Thus, a research project like that outlined using the insights from this study needs pursuing as a matter of urgency.

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9. APPENDICES

A. Participant Brief and Consent Form

Full Project Info for Participants (Separate web-page)

Bristol city and surrounding regions face an ecological crisis. Populations of insect pollinators, such as bees, moths, butterflies, hoverflies, and wasps, are experiencing significant declines. This is due to habitat loss and fragmentation and the pervasive use of chemicals in agricultural operations.

Pollinators are important for many reasons. They boost urban ecologies to provide benefits for humans, such as the pollination of vegetables and fruit, and can help improve Bristol residents be more food secure through more productive urban farming and growing. They assist plant reproduction, supporting and maintaining natural biodiversity and habitat, and provide food for animals such as birds.

Luckily, recent research shows that cities contain important refuges for insect pollinators in a variety of forage and nesting sites. Unfortunately, the distribution of these refuges is unequal within cities, leading to disparities in healthy pollinator populations and the unequal delivery of pollination benefits.

Certain wards, such as Southmead, have been identified as areas of lower insect pollinator health. Therefore, initiatives to support pollinators at community level are needed to improve pollinator health and the delivery of pollination services, with localised benefits that spill across Bristol and beyond.

Scientists have identified Bristol's informal public green spaces, such as grassy verges and roundabouts, as important potential opportunities to provide the habitat and biodiversity necessary to support healthy pollinator populations. An informal, public green space is simply an area of any size, that contains nature and is not privately owned or formally designated for recreation, leisure, farming, gardening, or wildlife conservation. They exist where urbanisation is pervasive and pollinators are threatened most, and are spaces many people engage with daily on their walks or commutes. However, this category of green space is often overlooked for wildlife conservation management.

Southmead residents know their ward best and stand to benefit from its ecological enhancement. So, it's important that management of overlooked spaces for insect pollinators is done with local resident's knowledge, values, and desires in mind. So far, little research has been done to date that includes social perceptions of urban ecologies beyond the importance of parks and formal green space for recreation, health, and wellbeing.

In the following survey, you'll map where you perceive informal, public urban green spaces to exist in Southmead by drawing shapes around them. You will be able to demonstrate your perception of where they contribute to healthy urban ecologies, and where they do not. You will be able to give recommendations for their management and whom should be responsible for it.

This methodology, also called Public Participatory GIS (PPGIS), is well-used in research to engage local stakeholders and represent their emotions, perceptions, and opinions in inclusive urban planning and management. Afterwards, you'll be invited to participate in an online, 1-1, informal interview. This is because your feedback on the mapping process will be useful for developing more inclusive ecological planning and management practices.

The consent form on the survey title page outlines your involvement in this research project and requests your approval for the potential use of your engagement in future outputs. Please read it thoroughly before you complete it and do the survey. If you have any further questions or concerns, please email bm20792@bristol.ac.uk.

Consent Form (**Opening page of the survey):**

My name is Dora Young. I am a Master's student investigating how Southmead residents perceive the ecologies of informal, public green spaces, and whether or not they would like them to be managed to benefit insect pollinators.

Informal, public green spaces are any area of any size that contains nature and aren't privately owned or formally designated for recreation and leisure, farming, gardening, or wildlife conservation. The following mapping questionnaire requires that you draw shapes on a map of Southmead to demonstrate your own knowledge of the spatial extent of informal, public green spaces. Associated questions will enable you to present your perceptions of them and desires for their management.

You will be asked a couple of short questions about yourself at the end, which will aid comparisons between responses. It should take under 20 minutes to complete.

We will not ask for your name – as your responses will be anonymised. We will ask for your age (within a broad range) as this provides us with important information of how views might be different across generations. This section is not compulsory.

Final, anonymised data will be accessible only by the researcher and staff the University of Bristol. It may be made available to a local planning authority for use as evidence in potential action for ecological management at the end of the research project. This will only occur if **all participants agree and are consenting**.

You are able to opt out and withdraw consent at any time. Should you choose to opt out, any data you have contributed will be deleted immediately and not used in further analysis.

You can find full details on the project **here [link to full brief above]**. Should you have any questions about the survey or the project, please email Dora Young at bm20792@bristol.ac.uk and I will respond as quickly as possible.

Before starting, please can you confirm that:

I am happy to take part in this survey and understand the project **[tick box].**
I am over 18 years old **[tick box].**

To be found on closing page of the survey

Thank for your responses – we appreciate your time and thoughts. Your taking part in this project is voluntary and you can withdraw from the study at any time. Your responses will contribute only to this research project, unless you and all other participants express that it should be used as evidence for resident's desired changes to ecological management in Southmead.

Please can you confirm that:

I am happy to take part in this map-based survey, and for my responses to be saved **[tick box].**

If my responses are matched by other participants responses, the anonymised data should be passed on to a local planning authority for further action **[tick box].**

B. Participant Demographic Profiles and Outdoor Engagement

Survey Questions

Age

18 - 24	
25 - 34	
35 - 44	
45 - 54	
55 - 64	
65 +	

	More than once per day	Every day	Several times a week	Once a week	Once or twice a month
How often do you spend leisure time in any public green space in your local ward?					
How often do you spend leisure time in any public green space beyond your local ward?					

Time spent outdoors

Survey Responses

User_ID	Date of Participation	Age	Time spent in public green space in ward	Time spent in public green space beyond ward	Data should be passed on to a local planning authority for further action (gdpr[])
ntlky5x4v	07.07.2021	45-54	Several times a week	Once a week	
yioywkwtz	23.06.2021	25-34	Once a week	Several times a week	
1kf0o1fnd	28.05.2021	55-64	Every day		
uet98zhps	27.05.2021	35-44	Several times a week	Once a week	

1ekyk919k	25.05.2021	35-44	Several times a week	Once or twice a month	
ed5ps35mc	14.03.2021	45-54	More than once per day	Several times a week	yes

C. Emotional Mapping Data

Informal Green Spaces perceived as healthy and beneficial for wildlife

User_id	Polygon Co-ordinates	Description	Context of interaction
1ekyk919k	[-2.596443,51.501877],[-2.59949,51.500795],[-2.599254,51.500622],[-2.600241,51.500208],[-2.600369,51.500328],[-2.602515,51.499687],[-2.601571,51.499286],[-2.599511,51.500275],[-2.597451,51.500942],[-2.596443,51.501877]	Trym Valley Open Space - it lots of different habitats and eco-systems, river, meadow, trees, forest. You can hear the insects and the birds.	Visiting the tiny forest, litter picking, walks with kids.
	[-2.589855,51.506525],[-2.588825,51.505537],[-2.588482,51.506953],[-2.589855,51.506525]	Fonthill Park - its a river overflow area, and they let the grass and flowers grow.	Walking with friends, playing with kids.
	[-2.606421,51.500889],[-2.605777,51.500301],[-2.603631,51.500916],[-2.602901,51.502225],[-2.606421,51.500889].	Doncaster Park - has a play park for kids, and space to run and play.	Litter picking.
	[-2.593503,51.506445],[-2.593031,51.505724],[-2.591958,51.506205],[-2.592602,51.506899],[-2.593503,51.506445].		
uet98zhps	[-2.598906,51.509551],[-2.598012,51.510183],[-2.598755,51.510672],[-2.599992,51.510321],[-2.598906,51.509551].	Wildlife habitats, Pen Park hole, beautiful and relaxing, air cleansing.	Volunteering and recreation.
	[-2.599503,51.509697],[-2.60076,51.510352],[-2.602127,51.50984],[-2.602703,51.510213],[-2.604451,51.508938],[-2.604284,51.507688],[-2.601306,51.508908],[-2.60129,51.507032],[-2.599814,51.508678],[-2.600569,51.509151],[-2.599503,51.509697]	Really varied flora and fauna, historic agricultural land, beautiful and relaxing, air cleansing, foraging.	Volunteering, observing nature, recreation.
	[-2.615864,51.502306],[-2.616551,51.500519],[-2.61649,51.499567],[-2.616459,51.499208],[-2.616515,51.499132],[-2.616019,51.502204],[-2.615864,51.502306].	Important wildlife corridor close to busy and dangerous road. Air cleansing and safer for pedestrians walking route next to busy road.	Walking, work, volunteering.

	[-2.616294,51.499935],[-2.6158,51.50047],[-2.614901,51.500219],[-2.614322,51.499745],[-2.614446,51.499335],[-2.615333,51.499109],[-2.616275,51.499539],[-2.616294,51.499935]	Sports and recreation, multi-generational activities.	Work.
	[-2.60551,51.504473],[-2.605599,51.504062],[-2.6043,51.504203],[-2.60551,51.504473].	There is a ground nest of bees here and the play park is heavily used by the community.	Volunteering.
	[-2.604558,51.504382],[-2.602628,51.50504],[-2.601742,51.504244],[-2.603718,51.503609],[-2.604558,51.504382].	Gathering place for social and community activities, air cleansing trees.	Walking, recreation, volunteering.
	[-2.598183,51.50743],[-2.597529,51.506713],[-2.597164,51.50684],[-2.598183,51.50743].	Diverse wildlife habitat.	Volunteering.
	[-2.594915,51.505873],[-2.594637,51.505508],[-2.603378,51.502759],[-2.603558,51.503094],[-2.594915,51.505873].	Buffer between the road and homes, safe and green walking route to local amenities, trees, wildflowers.	Walking, recreation.
	[-2.607343,51.500822],[-2.602865,51.502319],[-2.603917,51.500094],[-2.607343,51.500822].	Play, sports, diverse plant life in grass and around borders, used by local wild mammals, clean air.	Play, recreation, volunteering.
	[-2.607834,51.498332],[-2.604229,51.499174],[-2.602781,51.499081],[-2.605078,51.497422],[-2.607898,51.496742],[-2.607834,51.498332].	Waterways, habitat, historic significance (modern and ancient), beautiful scenery, attracts visitors to the area.	Recreation, volunteering, commuting.
	[-2.602564,51.499527],[-2.601797,51.499192],[-2.596769,51.500955],[-2.596652,51.501979],[-2.602564,51.499527].	Waterway, rare land type similar to Avon Gorge, wildlife habitat, community orchard (community food access), clean air, play space, trees and shrubs.	Walking, recreation, commuting, volunteering, research.
	[-2.595569,51.507946],[-2.595414,51.507622],[-2.594978,51.507751],[-2.595569,51.507946].	Greenspace for homes with relatively small or no gardens.	Volunteering.
	[-2.592609,51.507537],[-2.594871,51.507059],[-2.594346,51.506443],[-2.594091,51.506184],[-2.592609,51.507537].	Play and sports.	Play, volunteering.
	[-2.600393,51.505481],[-2.600201,51.505269],[-2.59972,51.505404],[-2.599791,51.505649],[-2.600393,51.505481].	Play and shared green space, wildlife habitat, clean air.	Volunteering.

	[[-2.601072,51.501501],[-2.600312,51.50174],[-2.600083,51.50143],[-2.600703,51.501179],[-2.601072,51.501501].	Safe play space and contributes to improved feel of the area.	Walking, volunteering, commute.
	[-2.605681,51.504512],[-2.606974,51.504629],[-2.606974,51.5045],[-2.605704,51.504324],[-2.605681,51.504512].	Passive drainage, clean air, attractive, traffic calming.	Walking.
	[-2.608145,51.50465],[-2.607737,51.504325],[-2.607576,51.504599],[-2.608145,51.50465].	Wildlife habitat, pretty and good use of very small piece of land.	Walking, volunteering.
	[-2.604487,51.499457],[-2.607737,51.499067],[-2.607741,51.498688],[-2.604302,51.499288],[-2.604487,51.499457]	Play, community growing, habitat, clean air	Volunteering, attending events.
1kf0o1fnd	[-2.601142,51.507354],[-2.599812,51.50909],[-2.600756,51.509437],[-2.599211,51.509677],[-2.600584,51.510479],[-2.601957,51.510051],[-2.602944,51.510318],[-2.604747,51.508742],[-2.603974,51.507914],[-2.601571,51.508929],[-2.601357,51.507594],[-2.601142,51.507354]		
	[-2.602816,51.498939],[-2.604189,51.499046],[-2.608094,51.498672],[-2.607665,51.496748],[-2.602816,51.498939]		
yioywkwtz	[-2.607748,51.498403],[-2.604265,51.499222],[-2.602983,51.498715],[-2.607539,51.496769],[-2.607748,51.498403]	This space has a diverse range of spaces which would allow for different types of wildlife to benefit. As well as open fields, bushes, lots of trees it has a stream and woodland area running through the middle that is pretty protected from public use. It's hidden away from the residential houses that surround it as well which makes it more protected from cars and humans.	Leisure walk.

	[-2.60277,51.499593],[-2.60137,51.499293],[-2.601251,51.499985],[-2.60277,51.499593]	I think some parts of this space are beneficial for wildlife particular where the stream of river runs through the bank. This is protected from humans generally going into the river bed so wildlife would be able to live here, however people can leave rubbish around and it can get generally quite dirty which is not beneficial for wildlife.	Leisure walk, commute.
ntlky5x4v	[-2.608202,51.498605],[-2.607386,51.496387],[-2.596486,51.50125],[-2.596722,51.501624],[-2.608223,51.498391],[-2.608202,51.498605]	Badocks Wood - well managed woodland, variety of terrain (fields, paths, river). Useful to walk through to get to Southmead\n\nTrym Valley -now championing bio-diversity with Tiny forest and increased planting\/management. Significant increase in wildlife in last 3 years.	walking, river clearing, litter-picking.
	[-2.607622,51.500662],[-2.60303,51.502265],[-2.604039,51.500208],[-2.607622,51.500662]	Recreational park, playground, fields.	Litter picking.

D. Informal Green Spaces not perceived as healthy and beneficial for wildlife

User_id	Polygon Co-ordinates	Description	Context of interaction	How could this space be better managed?	By whom?
ed5ps35mc	[-2.58419,51.479191],[-2.583418,51.456842],[-2.563419,51.457376],[-2.565651,51.47732],[-2.58419,51.479191]	fdscvsdfc	dfsdfds	Designate as wild, other.	Ecological management actors, Community organisations, Specific groups: fdsfds.
1ekyk919k	[-2.604661,51.504335],[-2.603889,51.503667],[-2.601957,51.504228],[-2.602773,51.505217],[-2.604661,51.504335]				
uet98zhps	[-2.592029,51.501399],[-2.591921,51.501253],[-2.592505,51.500985],[-2.592776,51.501085],[-2.592029,51.501399]				
1kf0o1fnd	[-2.603631,51.503721],[-2.601871,51.504308],[-2.602558,51.505083],[-2.603889,51.504682],[-2.603631,51.503721]				
ntlky5x4v	[-2.602515,51.503267],[-2.602236,51.503066],[-2.594576,51.505591],[-2.594876,51.505871],[-2.602086,51.503427],[-2.602515,51.503267]	Extended grass verges - better than nothing - but situated alongside main road and harder to enjoy. Planting has helped.	Litter picking.	Other: no action.	

E. Community informal green space management event empirics

Event Name	Event Type	Hosted By	Audience	Frequency	Time	Dates	Location	Co-ordinates	Response	Key Words
January 2021 Action Event - Trym Valley	Litter pick	Sustainable Southmead	Facebook: Members of Sustainable Southmead	Monthly	14:00 - 16:00	Sunday 17/01/2021	Trym Valley, Shetland Rd, Bristol, BS10 5	-2.600490, 50.500240	Going (7), Maybe (6), Invited (123), Can't go (2)	Regular, Monthly, Trym Valley, litter pick, clear rubbish, tree planting.
Socially-Distanced Monthly Litter Pick	Litter Pick	Sea Mills and Coombe Dingle Climate Action Group	Eventbrite: Public	Monthly	14:00 - 16:00	Sunday 14/02/2021			Following (10)	Monthly, local, litter picking, neighbourhood, wildlife, love.
Sustainable Southmead February Action Event	Litter pick, weed management, path maintenance	Sustainable Southmead	Facebook: Public	Monthly	14:00 - 16:00	Sunday 21/02/2021	Trym Valley, Shetland Rd, Bristol, BS10 6	-2.600490, 50.500241	Going (6), Interested (13).	Litter and rubbish clearance, newly planted trees, litter pick, nerby streets, litter being blown into site, clear rubbish, manage some overgrown brambles, maintain paths.
Socially-Distanced Monthly Litter Pick	Litter pick	Sea Mills and Coombe Dingle Climate Action Group	Facebook: Public, Eventbrite: Public	Monthly	14:00 - 16:00	Sunday 14/03/2021	Three Acre Covert, Bluebell Close, Bristol, BS9		Going (1), Interested (9)	Local, litter picking, local neighbourhood, wildlife, love.
Socially-Distanced Monthly Litter Pick in Coombe Dingle	Litter Pick	Sea Mills and Coombe Dingle Climate Action Group	Eventbrite: Public	Monthly	14:00 - 16:00	Sunday 11/04/2021	Westbury Lane / Harford Close, Coombe Dingle, Bristol, BS9	51.494472, -2.644272	Following (10)	Local neighbourhood, wildlife, love, nearby areas, streets.
April Action Event	Litter Pick	Sustainable Southmead	Facebook: Public	Monthly	14:00 - 16:00	Sunday 18/04/2021	Glencoyne Square opposite the Ullswater Road junction	51.5049704, -2.6034386	Went (6), Interested (7)	Litter picking.

City Nature Challenge Mini Event: Trym Valley Open Space	Citizen Science	Sustainable Southmead	Facebook: Public	Yearly	18:00 - 19:00	Friday 30/04/2021	Trym Valley Open Space, Shetland Rd, Southmead	51.500245, -2.60051826	Went (1), Interested (1)	Green spaces, citizen science, wildlife, plants, identification.
City Nature Challenge Mini Event: Doncaster Road Park	Citizen Science	Sustainable Southmead	Facebook: Public	Yearly	09:00 - 10:00	Saturday 01/05/2021	Doncaster Road, Just inside the Doncaster Road entrance	51.50057, -2.606114	Went (2), Interested (1)	Green spaces, citizen science, wildlife, plants, identification.
City Nature Challenge Mini Event: Elderberry Walk/Pen Park Road/Pen Park Hole Open Spaces	Citizen Science	Sustainable Southmead	Facebook: Public	Yearly	14:00 - 16:00	Sunday 02/05/2021	Elderberry Walk	51.50861, -2.604526	Went (2), Interested (1)	Green spaces, citizen science, wildlife, plants, identification.
Socially-distanced Community Litter Pick	Litter Pick	Sea Mills and Coombe Dingle Climate Action Group	Facebook: Public	Monthly	14:00 - 16:00	Sunday 9/05/2021	Sea Mills Library	51.49135, -2.648998	Went (4), Interested (8)	Litter picking.
Monthly Action Event	Litter Pick	Sustainable Southmead	Facebook: Sustainable Southmead Members	Monthly	14:00 - 16:00	Sunday 16/05/2021	Glencoyne Square, Southmead, BS10 6	51.504109, -2.602774	Went (3), Maybe (2) Invited (159)	Litter pick.
Great British Spring Clean Southmead	Litter Pick	Sustainable Southmead	Facebook: Sustainable Southmead Members	Daily until 200 hours reached	18:30	Friday 28/05/2021	Glencoyne Square, Southmead, BS10 6	51.50411, -2.602774	Went (2)	Litter pick.
Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	14:00 - 16:00	Saturday 29/05/2021	Glencoyne Square, Southmead, BS10 6	51.50411, -2.602774	Went (1)	Litter picking.
Tiny Forest Mulching and Trym Valley Litter Pick	Eco management and litter pick	Sustainable Southmead	Facebook: Members of Sustainable Southmead		11:00am - 13:00pm	Sunday 30/05/2021	Trym Valley Open Space, Shetland Rd, Southmead	51.5002448, -2.60051826	Went (3), Invited (4)	Tiny Forest, greener, trees, grass, litter picking.

Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	14:00 - 16:00	Sunday 30/05/2021	Glencoyne Square, Southmead, BS10 6	51.504109, -2.602774	Went (1)	Litter picking.
Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	14:00 - 16:00	Monday 31/05/2021	Glencoyne Square, Southmead, BS10 7	51.504109, -2.602774	Went (1), Interested (1)	Litter picking.
Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	18:30 - 19:30	Tuesday 1/06/2021	Glencoyne Square, Southmead, BS10 7	51.504109, -2.602774	Went (1), Interested (5)	Litter picking.
Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	18:30 - 19:30	Wednesday 02/06/2021	Glencoyne Square, Southmead, BS10 7	51.504109, -2.602774	Went (2), Interested (2)	Litter picking.
Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	18:30 - 19:30	Thursday 03/06/2021	Glencoyne Square, Southmead, BS10 7	51.504109, -2.602774	Went (1), Interested (2)	Litter picking.
Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	18:30 - 19:30	Friday 04/06/2021	Glencoyne Square, Southmead, BS10 8	51.504109, -2.602775	Went (1), Interested (2)	Litter picking.
Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	14:00 - 16:00	Saturday 05/06/2021	Jarratt's Rd, Southmead, BS10 6WH	51.508203, -2.594034	Went (1)	Litter picking.
Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	14:00 - 16:00	Sunday 06/06/2021	Glencoyne Square, Southmead, BS10 6	51.504109, -2.602774	Went (1), Interested (1)	Litter picking.
Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	18:30 - 19:30	Monday 07/06/2021	Glencoyne Square, Southmead, BS10 6	51.504109, -2.602774	Went (1), Interested (2)	Litter picking.
Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	18:30 - 19:30	Tuesday 08/06/2021	Glencoyne Square, Southmead, BS10 6	51.504109, -2.602774	Went (1), Interested (2)	Litter picking.

Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	18:30 - 19:30	Wednesday 09/06/2021	Glencoyne Square, Southmead, BS10 6	51.504109, -2.602774	Went (1), Interested (2)	Litter picking.
Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	18:30 - 19:30	Thursday 10/06/2021	Glencoyne Square, Southmead, BS10 6	51.504109, -2.602774	Went (1), Interested (2)	Litter picking.
Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	18:30 - 19:31	Friday 11/06/2021	Glencoyne Square, Southmead, BS10 7	51.504109, -2.602774	Went (1), Interested (2)	Litter picking.
Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	14:00 - 16:00	Saturday 12/06/2021	Glencoyne Square, Southmead, BS10 6	51.504109, -2.602774	Went (1)	Litter picking.
Great British Spring Clean	Litter Pick	Sustainable Southmead	Facebook: Public	Daily until 200 hours reached	14:00 - 16:00	Sunday 13/06/2021	Glencoyne Square, Southmead, BS10 6	51.504109, -2.602774	Went (1)	Litter picking.
Socially-distanced monthly litter pick in Sea Mills/Coombe Dingle	Litter Pick	Sea Mills and Coombe Dingle Climate Action Group	Eventbrite: Public	Monthly	14:00 - 16:00	Sunday 13/06/2021	Dingle Close, Sea Mills, Dingle Close, Bristol, BS9	51.486965, -2.646888	Following (10)	Litter pick, Great British Spring Clean
River clearance and Balsam bashing launch	Eco management	Sustainable Henbury and Brentry	Facebook: Public		10:00	Saturday 19/06/2021	Henbury and Brentry Community Centre.	51.4760751,-2.5854313	Went (3), Interested (36)	Clean up, Hazel Brook river, Blaise, Crow Lane Open Space, clear Balsam, river banks, biodiversity, Trym, rubbish.

Sustainable Southmead Balsam Bashing Action Event	Eco management, Litter Pick.	Sustainable Southmead, Trout in the Trym	Troutinthetrym.co.uk: Public		14:00 - 16:00	Sunday 20/06/2021	Trym Valley Open Space, Shetland Rd, Southmead.	51.500249, -2.600518	Went (3), Invited (4)	Himalayan Balsam, Trym Valley Open Space, River Trym, Hazel Brook, joining with other groups, Trout in the Trym, invasive non-native, British species, pollinators, bees and butterflies, erosion, insects, plants, river banks, river, ecosystem, improve, wild trout, Badocks Wood, Blaise, Wildlife, Removing... litter and fly-tipping, change, Westbury Wildlife Park.
Tiny Forest Monitoring Day	Citizen Science, Eco management	Sustainable Southmead, EarthWatch Europe	Eventbrite: Public		10:00 - 16:30	Wednesday 23/06/2021	Trym Valley Tiny Forest, Doncaster Rd, Southmead, BS10 5PX		Following (17)	Citizen science, action group, monitoring, benefits, forests, researching, biodiversity, butterflies, pollinators, wellbeing.
Balsam Bashing - Kick off session	Eco management	Sea Mills and Coombe Dingle Climate Action Group	Facebook: Public	Regular throughout summer	14:00	Saturday 26/06/2021	Blaise Castle Estate, the Dingle	51.492566, -2.638890	Went (2), Interested (6)	Himalayan Balsam, improve ecology, river Trym, partnership, Trout in the Trym, native plant diversity, pollinators.
Balsam Bashing	Eco management	Sustainable Westbury-on-Trym, Friends of Blaise	Troutinthetrym.co.uk: Public		11:00 - 13:00	Sunday 27/06/2021	River Trym and Hazel Brook Confluence	51.495693, -2.637104		Balsam
Balsam Bash	Eco management	Sustainable Westbury-on-Trym	Troutinthetrym.co.uk: Public	Weekly	10:15 - 12:15	Friday 02/07/2021	The Mill House in Blaise Castle Estate	51.50291364, -2.6332356		Balsam
Balsam Bashing round 2	Eco management	Sustainable Henbury and Brentry	Facebook: Public		13:00 - 15:00	Sunday 04/07/2021	Henbury & Brentry Community Centre, Machin Rd, Henbury, Bristol, BS10 7HG	51.5101334, -2.6194988	Interested (8)	Hazel Brook river, Blaise, Crow Lane open space, clear Balsam, river banks, biodiversity, Trym, rubbish.
Balsam Bashing	Eco management	Trout in the Trym	Troutinthetrym.co.uk: Public	Weekly	18:30 - 20:30	Tuesday 06/07/2021	Blaise Castle Estate, the Dingle	51.492566, -2.638890		Balsam

Balsam Bash	Eco management	Trout in the Trym	Troutinthetrym.co.uk: Public	Weekly	10:15 - 12:15	Friday 09/07/2021		51.495965, -2.637054		Balsam, Hazel Brook, tree, roots, plants, flower.
Balsam Bash - Hazel Brook	Eco management	Trout in the Trym	Troutinthetrym.co.uk: Public	Weekly	11:00 - 13:00	Sunday 11/07/2021	Tormarton Cres, Henbury, Bristol BS10, UK	51.51413827, -2.624133564		Balsam
Balsam bashing and river clearance	Eco management	Sustainable Henbury and Brentry	Facebook: Public		11:00	Sunday 11/07/2021	Henbury & Brentry Community Centre, Machin Rd, Henbury, Bristol, BS10 7HG	51.5101334, -2.6194989	Went (1)	Hazel Brook river, Blaise, Crow Lane open space, clear Balsam, river banks, biodiversity, Trym, rubbish.
Socially-distanced monthly litter pick in Sea Mills/Coombe Dingle	Litter Pick	Sea Mills and Coombe Dingle Climate Action Group	Eventbrite: Public Facebook: Public	Monthly	14:00 - 16:00	Sunday 11/07/2021	Sylvan Way, Bristol, BS9 2, United Kingdom	51.492191, -2.642639	Following (10)	Monthly, local, litter picking, neighbourhood, wildlife, love.
July Action Event: Butterfly Count and Litter Pick	Citizen Science, Litter Pick.	Sustainable Southmead	Facebook: Public		14:00 - 16:00	Sunday 18/07/2021	Trym Valley Open Space (Doncaster Rd Main Entrance).	51.500565, -2.606114	Went (2), Interested (5).	Butterfly, count, Trym Valley Open Space, litter picking, identify, surrounding streets, guides.
Balsam Bashing	Eco management	Trout in the Trym	Troutinthetrym.co.uk: Public	Weekly	18:30 - 20:30	Tuesday 20/07/21	River Trym and Hazel Brook Confluence	51.495693, -2.637104		Balsam
Balsam Bash	Eco management	Trout in the Trym	Troutinthetrym.co.uk: Public	Weekly	10:15 - 11:15	Friday 23/07/21	Grace Garden School (Cherry Orchards).	51.496366, -2.6327256		Balsam
Community COP26 Walk	Nature Walk	Sea Mills and Coombe Dingle Climate Action Group	Facebook: Public		10:00 - 12:00	Wednesday 18/09/2021	Café on the Square, Sea Mills	51.488024, -2.647614	Going (1), Interested (8)	Nature walk, river Trym, raise awareness, local, global, environmental and climate issues