

A mixed methods perspective on the health and wellbeing benefits associated with inland blue space exposure.

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Abstract

In response to rising demand for complex health services, there is a need to devise sustainable strategies to improve public health outcomes and alleviate the intense pressure faced by health systems. Encouraging access to natural environments is one health pathway that has received increasing attention in recent years. The fundamental importance of accessing inland blue spaces, such as wetlands, rivers and lakes, for agricultural purposes and the provision of drinking water is well established. However, the potential for inland blue space exposure to influence public health and wellbeing outcomes remains under researched. In recognition of this key research gap, this thesis utilised novel mixed methods research approaches to provide a greater understanding of inland blue space exposure outcomes across varying timeframes for the Scottish adult population. The results presented demonstrate the significant value of inland blue spaces in terms of enabling leisure activities, encouraging relaxation, and facilitating connections with nature and the wider community. Analysis of solicited research diaries indicated that frequent inland blue space exposure positively influenced restorative health outcomes over three-month time periods. Qualitative interviews allowed individuals to reflect on their experiences of inland blue spaces in recent years, demonstrating the perceived benefits of accessing freshwater environments during times of uncertainty, such as the COVID-19 pandemic. National surveys further evidenced the value of these environments for the Scottish population and helped to clarify the specific environmental and social factors that influence people's perceptions of these areas. The collective findings from the wide range of research methods used in the thesis highlights that inland blue spaces can support sustainable improvements to public health outcomes across the Scottish adult population. The thesis demonstrates the strong emotional connections individuals typically develop to familiar inland blue spaces and the significant range of positive health benefits afforded by such environments. To maintain this and recognise the role inland blue space plays in maintaining a healthy society, effective legislation should be introduced to preserve the unique character and quality of these environments.

Author Statement

I, Megan Grace, wish to submit the thesis detailed above in accordance with the University of Stirling research degree regulations. Ethical approval was granted for all research reported in this thesis. I declare that the thesis embodies results of my own research and was composed by me. Where appropriate, I have acknowledged the nature and extent of work carried out in collaboration with others. All research material has been duly acknowledged and cited. Artificial Intelligence was not used in the production of this thesis.

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Chapter 1. Introduction

1.1 Overview

This thesis has been submitted to obtain the degree of Doctor of Philosophy in Environmental Science from the University of Stirling. The overarching aim of this thesis is to investigate health and wellbeing outcomes and understand public attitudes and perceptions concerning access and exposure to inland blue space using a mixed method research approach. The research was funded by the *Natural Environment Research Council via an IAPETUS2 PhD studentship*.

1.2 Thesis Rationale

1.2.1 Defining Health and Wellbeing within the Environmental Research Context

1.2.1.1 Wellbeing

Despite having intrinsic value to society and acting as a prominent focus in public health policy and practice, a universal definition of wellbeing is yet to be established (Simons and Baldwin, 2021; Henderson and Knight, 2012). Perspectives on wellbeing are commonly categorised into hedonism and eudaimonism. Hedonic wellbeing is focused on life satisfaction, facilitated through achieving happiness and experiencing positive emotions (McMahan and Estes, 2011). In contrast, eudaimonic wellbeing is concerned with personal values and pursuing purpose in life to achieve long-term satisfaction (McMahan and Estes, 2011). To provide a comprehensive understanding of the impact of inland blue space exposure on wellbeing, this thesis will consider hedonic and eudaimonic wellbeing to be separate yet interconnected aspects that are fundamental to human wellbeing. Wellbeing will be defined throughout the thesis as achieving positive emotional health outcomes through life satisfaction and fulfilment. Human wellbeing will be assessed using quantitative approaches including validated Likert-scales, as well as subjective qualitative approaches such as semi-structured interviews.

Within human-environment research and the corresponding field of environmental psychology, the potential for nature to facilitate human wellbeing has been firmly substantiated (Ferreira

and Venter, 2016). A range of conceptual theories have been proposed to explain the pathways that link human wellbeing with the environment, including Stress Reduction Theory (SRT) and Attention Restoration Theory (ART) (Ulrich et al., 1983; Kaplan and Kaplan, 1989). SRT proposes that access to nature alleviates stress levels and facilitates positive emotional health outcomes through psycho-physiological pathways (Ulrich et al., 1983). ART shares similarities with SRT and focuses on the potential for visual stimuli in natural environments to promote recovery from cognitive fatigue and consequently enhance attention levels for individuals. To build on these theoretical concepts and advance current understanding of human-environment interactions, the potential for the relationship between wellbeing and nature to vary over time due to different personal, environmental, and societal stresses should be considered in greater detail (Ferreira and Venter, 2016; Howell et al., 2011).

1.2.1.2 Health

Closely correlated with human wellbeing, the concept of health can vary significantly depending on the cultural context. In academia, the most widely agreed definition of health is “a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity” (World Health Organisation, 1948). This definition has received substantial criticism since the word ‘complete’ may infer that those with disabilities or chronic diseases could not be deemed healthy. To ensure an inclusive approach to health, this thesis will utilise a more recent conceptualisation of health from the World Health Organisation (WHO) as “a resource for everyday life, not the objective of living. Health is a positive concept emphasizing social and personal resources, as well as physical capacities” (WHO, 1986).

Causal research is yet to underpin the precise pathways that link inland blue space exposure with positive health outcomes. However, it is likely that these health pathways will share distinct similarities with those suggested in corresponding green space literature. One of the most frequently cited conceptual models to explain the health outcomes associated with nature exposure was developed by Hartig et al., (2014). This model suggests that natural environments can influence human health and wellbeing outcomes through stress reduction, improved air quality, opportunities for physical activity and opportunities to socialise (Hartig et

al., 2014). The conceptual model allows for significant variability in health outcomes, highlighting the potential for natural environments to lead to positive or negative health outcomes depending on individual and environmental circumstances.

When considering the impact of natural environments on health, it is also important to account for intersectionality and the potential for overlapping political and social factors to create heightened health inequalities (MacBride-Stewart, Gong and Antell, 2016; Ergas, McKinney and Bell, 2021). Statistical analysis of a nationally representative survey conducted in England identified environmental and health inequalities arising from the combined interaction of education levels, health status, sex and ethnicity (Garland, 2025). In comparison to others, educated white males in good health had the highest accessibility to green space environments (Garland, 2025). Given the context-specific nature of environmental experiences and accessibility, research should continue to use an intersectional approach across different geographical regions to better understand barriers and enablers to accessing natural environments. This form of in-depth human-environmental research is necessary to develop sustainable environmental management strategies and reduce disparities between different social groups (Williams et al., 2022).

1.2.2 Current Human-Environmental Interaction Research Field

Traditionally, natural environments have been associated with the promotion of human health and wellbeing, both through the provision of plant-based drugs and herbal medicines, as well as the creation of ‘therapeutic’ environments (Gesler, 1992). A growing body of scientific research now demonstrates that direct and indirect exposure to natural environments has the potential to provide health benefits across communities (McDougall et al., 2024; White et al., 2020). Lower levels of loneliness, reduced anxiety scores and improved blood pressure are among the broad range of health outcomes that have been attributed to accessing natural environments (Phillips et al., 2023; Nguyen et al., 2023; Li et al., 2025). The effective conservation and management of natural environments therefore offers significant potential to reduce healthcare inequalities and improve overall health outcomes at the population level.

Within the human-environmental interaction research field, there has been a significant focus on the benefits of green space. Green spaces, such as forests and parks, can promote positive health outcomes through the regulation of environmental stressors, including reducing air pollution and mitigating the effects of extreme heat (Gascon et al., 2018). For the purpose of this thesis, green space is defined as an open area of vegetation. A significant proportion of environmental research has however broadly classified all natural environments, including water-based habitats, as green space (Taylor and Hochuli, 2017). This broad classification of green space may limit the effectiveness of environmental policies as different environmental types can lead to variations in health-related exposure outcomes (White et al., 2020; McDougall et al., 2022). Whilst current research has highlighted the potential of green space to improve public health outcomes, further targeted research into distinct landscape types is now required to ensure that nature-based interventions can be sustainably introduced in different environmental contexts.

Inland blue spaces - such as lakes, rivers and canals - can offer alternative recreational opportunities and sensory experiences to those available at terrestrial green space environments (Donald, 2019). Due to their immersive characteristics, inland blue spaces, may encourage positive health outcomes through stress-reduction and increased mental resilience (Yin et al., 2023; Tieges et al., 2022; Li et al., 2025). Specific demographic groups, including the elderly and young children, may benefit significantly from the leisure activities associated with freshwater environments (Wang and Sani, 2024; Stehl et al., 2024; Vitale et al., 2022). Inland blue spaces are often highly accessible to communities, with approximately 50% of the global population residing within 3 kilometers of a freshwater area (Kummu, 2011). Capitalising on a broader range of research methodologies to develop detailed insight into the health benefits associated with inland blue space exposure is therefore essential given the accessibility of these areas alongside their promising health promoting potential.

Whilst academic interest in inland blue spaces is continuing to grow, the current evidence base has several limitations relating to a lack of longitudinal insight, limited understanding of the mediating factors influencing exposure outcomes, and a lack of research into public opinion of

inland blue space. This thesis will seek to address three central research gaps to provide novel insight into the impact of inland blue spaces on public health and wellbeing outcomes. An overview of each inland blue space research gap is presented below.

1.2.2.1 Research Gap (i) a limited understanding of longer-term variation in environmental experiences on health outcomes

To date there has been a strong reliance on the use of cross-sectional research methods, including surveys and interviews, to investigate inland blue space exposure outcomes (Hunter et al., 2023). These methodologies have enabled the health benefits of inland blue spaces to be demonstrated; however, cross-sectional research alone cannot establish a causal relationship between blue space access and improved health outcomes. Developing a greater understanding of the long-term public health impact of inland blue spaces through the application of longitudinal methods is vital to establish effective environmental strategies and encourage regular use of these environments (Ma, 2023). Changes to surrounding vegetation, fluctuating water levels, weather patterns, and evolving nearby land-use, can alter the appearance and accessibility of inland blue spaces over time. To inform the introduction of sustainable public health policies, research must establish the impact of this environmental change on inland blue space exposure outcomes. The application of longitudinal research methods such as diaries and repeated surveys would be particularly beneficial to achieve this and better characterise the environmental and social factors that may influence exposure outcomes.

1.2.2.2 Research Gap (ii) the impact of environmental characteristics on exposure outcomes

There has been growing interest in the aesthetic value of inland blue spaces and the effect of environmental characteristics on health-related exposure outcomes (McDougall et al., 2022; Luo et al., 2023). Initial insight suggests that the type of waterbody visited may impact environmental usage and health-related exposure outcomes; with rivers, canals and areas of fast-flowing water shown to provide visitors with greater restorative benefits (Zhao, Hu and Huang, 2024; McDougall et al., 2022). The current evidence base however does not account for

the diversity of inland blue spaces and the varying perspectives of blue space user groups. Developing a large evidence base is necessary to understand the multiple confounding environmental and social factors that may impact blue space aesthetics and exposure outcomes. The application of targeted mixed method research strategies will help to provide alternative stakeholder perspectives on blue space usage and better inform public spending priorities.

Research in the field of environmental psychology has established that environmental preferences are strongly influenced by social and cultural factors (Brady and Prior, 2020). To strengthen the blue space evidence base it would be beneficial to conduct culturally sensitive research across a wide range of research contexts to identify the reasoning behind individual and regional preferences. Adopting participatory research methods including solicited research diaries and focus groups would provide a greater understanding of differing environmental perspectives and underpin effective policy decision making processes.

1.2.2.3 Research Gap (iii) public awareness and use of inland blue spaces

Sociodemographic factors can influence access to natural environments, with individuals on a higher income more likely to have regular access to nature (Fian, 2024). For inland blue spaces, research also suggests that those of a higher socioeconomic status, who are homeowners rather than renting accommodation, have greater familiarity with local freshwater environments (Haeffner et al., 2017). The existence of structural and cultural barriers to inland blue spaces will inherently shape attitudes and perceptions towards natural environments across the population. Developing a greater understanding of variations in public perceptions of inland blue spaces is therefore a necessary step towards ensuring equitable environmental access. Currently however, research often fails to include individuals who do not regularly engage with blue spaces (Pitt, 2019; Lund et al., 2023). To understand the wide-reaching implications of environmental inequalities and capture the subtleties of environmental interactions, there is a need to utilise a range of inclusive research strategies. A stronger focus on mixed methods research approaches could encourage engagement from multiple stakeholders providing robust environmental insight.

1.3 Aims and Objectives

By addressing the three research gaps outlined above, this thesis will further consolidate the inland blue space evidence base linking inland blue space exposure and health outcomes. The overarching aim of the thesis is to investigate health and wellbeing outcomes and understand public attitudes and perceptions concerning access and exposure to inland blue space using a mixed method research approach. The specific research objectives of the thesis are outlined below:

- 1) To determine the perceived health and wellbeing benefits of accessing inland blue spaces for different sub-groups within the Scottish adult population.
- 2) To investigate the potential for variation in inland blue space exposure outcomes over time due to personal changes, environmental changes, and broader societal changes.
- 3) To assess the impact of inland blue space characteristics on recreational usage and health-related exposure outcomes for Scottish adults.

1.4 Research Context

In Scotland, where the annual disease burden is projected to rise by 21% between 2019 and 2043, the use of natural environments as public health resources may offer a cost-effective opportunity to sustainably improve population health and wellbeing (ScotPHO, 2022). The quality of Scotland's inland blue spaces has long been regarded as a source of national pride with an extensive collection of Scottish literature and music focused on Scotland's lochs, rivers, and streams (Blair, 2019; Hawitt, 2021). Additionally, the Scottish Government has outlined aims to become a 'Hydro Nation' through the effective management of water resources (Scottish Government, 2023a). Considering the political and cultural interest in Scotland's freshwater environments, alongside the need to improve public health outcomes, this thesis will focus on the health-related benefits of inland blue space exposure for the Scottish adult population.

1.4.1 Nature-based Interventions in Scotland

In recent decades, the Scottish Government has placed a strong focus on harnessing natural environments to promote public health outcomes (Scottish Government, 2023a). The government recognises the potential for investment in Scotland's 'Natural Capital' to reduce strain on the current healthcare system and encourage greater economic benefits through international tourism. To date, the Scottish Government's approach to nature-based interventions has concentrated on two central strands: the management of natural environments surrounding hospitals and the introduction of green prescriptions (Loria-Rebolledo et al., 2025; Howlett et al., 2025). Investment in hospital grounds has created valuable natural assets for patients, staff, and the broader community, with the Scottish public spending approximately 87 million hours a year accessing these open spaces (Loria-Rebolledo et al., 2025; Lafferty, 2015). Given the benefits provided by investment in hospital grounds, it would be worthwhile targeting other public spaces in Scotland, including freshwater environments, to promote wider use of natural environments across communities.

The Scottish Government first introduced green prescriptions in 2018; whilst not yet a national policy, prescriptions are available in three Scottish health boards (Dundee, Scottish Highlands and North Ayrshire). Service users have shown significant appreciation for the availability of green prescriptions and the associated physical and mental health benefits (Howlett et al., 2025). However, green prescriptions have remained largely segregated from NHS services and therefore organisational barriers limit the likelihood of GPs referring patients to these services (Howlett et al., 2025). It would also be worthwhile investigating whether accessing different environments, such as inland blue spaces, can impact service user outcomes.

1.4.2 Inland Blue Space Interventions

Stringent Scottish policies are in place to govern the management of water as a societal resource, including for the provision of drinking water and wastewater services. However, there has been a lack of political focus on water management for public health purposes. The government has identified the potential societal benefits of increasing public transport links to

coastal areas; yet improving access to inland waters remains a key policy gap (Scottish Government, 2023b).

In 2021, the Scottish Government introduced the Nature Restoration Fund (NRF) to improve biodiversity levels across Scotland and to address the potential implications of climate change (Scottish Government, 2025). Within the NRF, the restoration of freshwater habitats and rewilding of these areas has been highlighted as a key priority. The NRF has succeeded in restoring the natural course of over four kilometres of Scottish rivers and reinstating over 300 hectares of wetlands (Scottish Government, 2025). Whilst improved health and wellbeing has been cited as an expected outcome of the NRF, the Scottish Government has not provided a detailed evaluation of the public health outcomes arising from this project. Given the intrinsic link between ecosystems, climate change and public health, future freshwater restoration projects would benefit from adopting broader interdisciplinary approaches and considering the public health, socioeconomic, and environmental outcomes associated with ecosystem interventions (Bunch et al., 2011).

1.5 Mixed Methods Research Approach

The thesis utilises a mixed methods perspective to examine the health and wellbeing benefits associated with inland blue space exposure. The term ‘mixed methods’ refers to the combination of qualitative and quantitative methodologies to develop a rich understanding of a research topic (Schoonenboom & Johnson, 2017). Increasingly in the field of environmental science, there is an appreciation that effective resource management and conservation cannot be achieved through the continued use of traditional research methodologies (Bennett et al., 2017). Similarly, within the human-environment research field, there is widespread acknowledgement that integrated mixed methods research approaches are required to establish a comprehensive understanding of the complex interactions between individuals and the natural environment (Molina-Azorín and López-Gamero, 2016). Therefore, this research will seek to advance the current blue space research field through combining quantitative and qualitative methods to provide a more comprehensive overview of the public health implications of freshwater environments for the Scottish adult population.

1.6 Positionality

Before presenting the findings of this thesis, I acknowledge that the results will be shaped by my own academic background and research interests. Prior to undertaking this PhD, I completed a Masters of Public Health at the University of Edinburgh and developed a strong interest in achieving health equity. Throughout the PhD process I maintained an awareness of the intrinsic value of inland blue spaces for health promotion. My research interests, however, evolved as I developed a greater understanding of people-place relations. As the PhD progressed, I became more interested in social science concepts such as sense of place; this resulted in the research focus shifting to allow for a more detailed understanding of individual's interpretations of and relationships with inland blue spaces.

In completing the PhD, I became interested in the concept of environmental justice, whereby access to natural environments and environmental resources can be restricted depending on geographical location and sociodemographic factors (Schlosberg et al., 2023). Having grown up in rural Scotland, with access to private transport, I recognised from the outset that I was in a privileged position to readily visit high quality inland blue spaces. After reading research papers and conducting my own qualitative research, I was made further aware of my privileges in relation to environmental access and the hidden environmental inequalities affecting the Scottish adult population. This increased awareness of environmental justice and privilege particularly influenced the findings presented in Chapters 5 and 6 of the thesis.

I acknowledge that my enthusiasm for nature alongside my background in public health is likely to have influenced the data collection and analysis processes detailed within the thesis. To account for my personal influence, I utilised reflexive research practices and recorded qualitative research processes, carefully considering how my personal experiences may have shaped each stage of the research. Reading a range of literature from environmental psychology to ecology and hydrology helped to highlight and challenge my existing assumptions regarding environmental and social issues. For Chapter 3, I was able to minimise my direct influence on the data collection since the inherent nature of solicited research diaries enables participants greater control over the research process. The qualitative research approaches

adopted in Chapters 4, 5 and 6 required greater input from myself to gather data, however, I placed a strong emphasis on adopting participatory research practices to enable the findings to represent as accurately as possible the unique experiences of research participants.

1.6.1 Ontological and Epistemological Perspective

As a researcher, I appreciate the potential for inland blue space experiences to be shaped by environmental determinants alongside political and social forces. Therefore, my research is underpinned by critical realism. Critical realism is an ontological perspective that suggests the observable events analysed and recorded in research studies are often created and impacted by a series of unobservable factors (Koopmans and Schiller, 2022). Adopting a critical realist perspective throughout this thesis, I have co-created knowledge with research participants and utilised abductive reasoning to identify the most appropriate interpretation of research findings. In all qualitative methodologies, I have taken care to ensure that the findings remain as close as possible to the meanings and explanations outlined by research participants.

This thesis is informed by a contextualist epistemological theory. Contextualism highlights the context-sensitivity of knowledge, whereby the situation alongside the standard of knowledge required impacts the overall research outcomes. Therefore, I acknowledge that the results presented are subjective and have been influenced by my own practices alongside the individual experiences of participants. Across the qualitative research methodologies, the key objective was to generate rich detailed accounts of inland blue space experiences rather than to create generalisable data.

1.7 Thesis Structure

Following on from this introduction, the thesis includes a literature review and four data chapters. The literature review critically assesses existing evidence on inland blue space exposure outcomes and demonstrates the merits of a mixed methods research approach. Chapter 3 uses a novel solicited research diary methodology to explore blue space exposure outcomes over three-month intervals. Chapter 4 provides an overview of public perception of inland blue space environments using a three-phased research approach consisting of large-

scale data analysis, a nationally representative survey, and focus group sessions. Chapter 5 focuses on the impact of the COVID-19 pandemic on public perceptions of, and access to, inland blue spaces. Chapter 6 considers whether flooding incidents can alter the relationship between inland blue space exposure and health outcomes. The key commonalities from each of the four empirical studies alongside relevant policy recommendations are outlined in Chapter 7.

Chapter 2: Understanding Health Outcomes from Exposure to Blue Space Resources: Towards a Mixed Methods Framework for Analysis

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Abstract

With healthcare systems facing growing pressure from ageing populations and associated complex care needs, attention is increasingly focusing on sustainable strategies to improve health outcomes across populations. Encouraging access to natural environments is one form of preventative public health strategy that has been shown to lead to improved physical and mental-health outcomes at the population level. A significant body of research has documented the health benefits of accessing a wide range of natural environments, including green space and coastal areas. However, freshwater resources, or inland blue spaces, have received less attention in the field of human-environment interactions. This critical review highlights current research opportunities for developing rich and nuanced insight into inland blue space experiences. Future research must take steps to account for the dynamic and unique nature of inland blue spaces, through the application of a wide range of flexible and sensitive research methodologies, alongside the application of broader mixed methods research approaches. To effectively utilise inland blue spaces as public health resources, it is vital that research captures the influence of temporal changes on blue space interactions and considers the overarching impact of context-specific factors. Addressing current research gaps in combination with advancing research methodologies offers the potential to consolidate inland blue space findings and create a robust evidence base for the implementation of effective public health policies.

Keywords: blue health; blue-green space; public health; wellbeing; mixed methods research.

2.1 Introduction

Water environments are an important natural resource, that supply drinking water, support biodiversity, enable food and energy production, and provide recreational opportunities (Pradinaud et al., 2019; Bayart et al., 2010; Żywiec et al., 2023; Hartig, 2023; Adeeyo et al., 2022). Visiting blue spaces, such as lakes, rivers and oceans, also has the potential to make a positive impact on population health and wellbeing. All visible surface waters, including both marine and freshwater environments can be described as blue spaces (Volker and Kistemann, 2013). Exposure to blue space, in the form of viewing water bodies from indoor settings, submersion in the water, and close proximity to water-based environments, is associated with numerous health-related benefits. These positive health outcomes include higher levels of wellbeing, higher levels of self-reported health, and a better quality of life (Garrett et al., 2019; Finlay et al., 2015; McCartan et al., 2023; Jarvis et al., 2020; Haeffner et al., 2017). In recognition of the benefits of nature, interest in nature-based interventions, such as the promotion of blue space exposure, is increasingly growing, with governments and organisations beginning to introduce these interventions into policy and practice (Frantzeskaki, 2019; Sarabi et al., 2020). A significant advantage of nature-based interventions is that they act in a preventative manner, helping to mitigate the development of non-communicable diseases and consequently reducing pressure on healthcare systems (Maller et al., 2006; Shanahan et al., 2019). However, despite the proven potential of exposure to nature for improving both mental and physical health outcomes, research findings from blue space studies are only just beginning to be translated into policy. Blue spaces along with other natural environments are currently undervalued resources that remain significantly underutilised in public health policy (Maller et al., 2006; Richardson et al., 2018; Brückner et al., 2022).

Whilst the term blue space applies to a diverse range of environments, currently not all of these environments have received equal attention in the field of blue space research. Most research on the benefits of blue space exposure has focused on coastal areas and the benefits associated with accessing marine environments; this can help to inform effective management of coastal areas but is not applicable for managing the health and wellbeing benefits of freshwater areas

that differ substantially from coastal environments in terms of biodiversity, ecosystem services and aesthetic values. An extensive range of freshwater types are categorised as inland blue space, including canals, waterfalls, rivers, lakes, and reservoirs. Compared to marine blue space, often inland blue space incorporates a greater diversity of environments with vastly different aesthetic characteristics, contrasting spatial scales, and distinct differences in the flow of water and presence of nearby vegetation.

To further consolidate the blue space evidence base and help to promote a range of blue spaces as public health assets, inland blue space exposure should be considered in more detail. Proximity to natural environments is a key factor that influences environmental usage, with individuals more likely to frequently visit nearby blue space environments (Elliott et al., 2020). Given that inland blue spaces typically have broad geographic coverage and national distribution, with correct management in place, freshwater areas therefore have the potential to regularly benefit a significant proportion of the population. A greater focus on inland blue space research is warranted to better understand the complex relationship between inland blue space exposure and health and wellbeing outcomes. Initial research has identified differences in the wellbeing outcomes associated with recreational activities at different blue space types, with coastal recreation often leading to higher wellbeing outcomes for visitors than activities at inland blue space (Garrett et al., 2023; Próchniak et al., 2023; Pasanen et al., 2019). Differences have also been identified in user groups between blue space types, with inland blue spaces shown to attract visits from individuals with a higher socioeconomic status compared to coastal areas (de Bell et al., 2017). To encourage equitable access to inland blue space and help to promote positive health and wellbeing outcomes for all user groups, greater insight is required to gather definitive conclusions and effectively translate blue space research into policy.

A particular challenge when considering inland blue space exposure is to adequately account for the wide range of variables that impact on blue space experiences and consequently affect health-related exposure outcomes. This insight is vital for informing land management strategies, yet due to the dynamic and subjective nature of personal experiences with nature,

key information on the impact of environmental and socio-economic variables can be difficult to obtain. A variety of different but complementary research approaches are required to develop an intrinsic understanding of user experiences at blue spaces and determine definitive patterns in exposure outcomes (de Bell et al., 2017; Poulsen et al., 2022; Pitt, 2018). The available evidence and future research directions for two broad categories of blue space exposure variables will be considered in this critical review: temporal and spatial factors. Within these broad categories, the effects of both environmental and personal determinants on blue space experiences and health outcomes will be discussed.

This critical review will focus on inland blue spaces and highlight the research limitations that need to be addressed to help facilitate efficient policy decision making. The three key objectives of this critical review are to: i) evaluate critically the current gaps in our understanding of the impact of spatial and temporal factors on inland blue space usage and exposure outcomes; ii) determine how our understanding of inland blue space exposure outcomes could benefit from the evidence base associated with human interactions with other environments; for example, green space; iii) identify the potential for an enhanced analytical framework focusing on qualitative and mixed methods approaches to provide novel insight into the importance of blue space environments through more nuanced and richer accounts of human experiences.

2.2 Sense of Place and Temporality

Globally, freshwater environments are utilised as community resources, therefore at the individual and community-level, blue spaces are often associated with a strong 'sense of place'. Multiple definitions exist regarding sense of place, however, for the purposes of this review, the concept will focus on the significance and emotional value that individuals ascribe to specific locations (Devine-Wright, 2013; Erfani, 2022). A significant body of research, spanning several decades, has considered the importance of people-place relations (Devine-Wright, 2013; Erfani, 2022; Cesário et al., 2022). Within blue space research, there are increasing reports of a strong sense of place associated with different inland blue space environments (Julian, Daly and Weaver, 2018; Plieninger et al., 2018). Sense of place is a significant cultural factor, allowing for improved health and wellbeing outcomes at the individual level (Escalera-Reyes, 2020). Local

waterbodies can instil a sense of place for individuals and communities, through personal experiences or day-to-day observations, helping to form a community identity (Volker and Kistemann, 2013; Vaeztavakoli, 2018). Since sense of place is a key factor influencing an individual's environmental attitude towards and preference for specific environmental types, it can in turn influence visit frequency to inland blue space types (Wilkie and Clements., 2018; Wilkie and Trotter, 2022).

The process of 'place-making' and developing an attachment to an environment, involves two separate entities, the people or users of the environment and the environment itself (Bonaiuto et al., 2017). Therefore, changes in individuals' personal circumstances alongside alterations to the landscape itself can impact human-environment interactions and place-based relations (Bailey et al., 2021). Social context is an additional underlying influence that shapes the place-making process. This is because socio-economic factors can significantly affect how an individual perceives, uses and experiences an environment (Kyle and Chick, 2007). Since place-making processes are socially constructed and rely on dynamic relationships between humans and the environment, it is recognised that sense of place can evolve significantly across different time scales and depending on environmental change and socio-cultural practices (Lewicka, 2005; Brown, Raymond and Corcoran, 2015; Stokowski, 2002). A wide range of personal and socioeconomic factors such as length of residence, age and education have been associated with levels of place attachment (Lewicka, 2005; Jansen, 2020, Kaltenburn, 1997). Additionally, numerous environmental factors including urban change, wildlife interactions and environmental threats can also influence attachment to an environment (Folmer, Haartsen and Huigen, 2013; Anton and Lawrence, 2014; von Wirth et al., 2016).

To advance blue space research, there is a need to focus on how spatial and temporal changes can alter place-based relations and consequently affect the health outcomes associated with blue space exposure. Short-term temporal changes in blue spaces, such as fluctuations in water quality, have been extensively studied in relation to environmental health (Saha et al., 2021; Pulicharla et al., 2021; Tan et al., 2021). However, further research is required to reach a better understanding of the potential for larger scale and longer-term temporal factors to influence

place attachment and impact the relationship between blue spaces and health. Additionally, the potential interplay between contextual and temporal factors on inland blue space exposure outcomes should not be underestimated. This critical review will evaluate three broad categories of temporal changes that can affect sense of place and consequently influence blue space exposure outcomes: i) environmental changes; ii) broader societal changes affecting environmental perceptions; and iii) changes in personal circumstances for blue space users (Figure 1). Alongside this, the overarching influence of two key contextual factors, relating to the rural-urban dichotomy and differing cultural practices will also be considered.

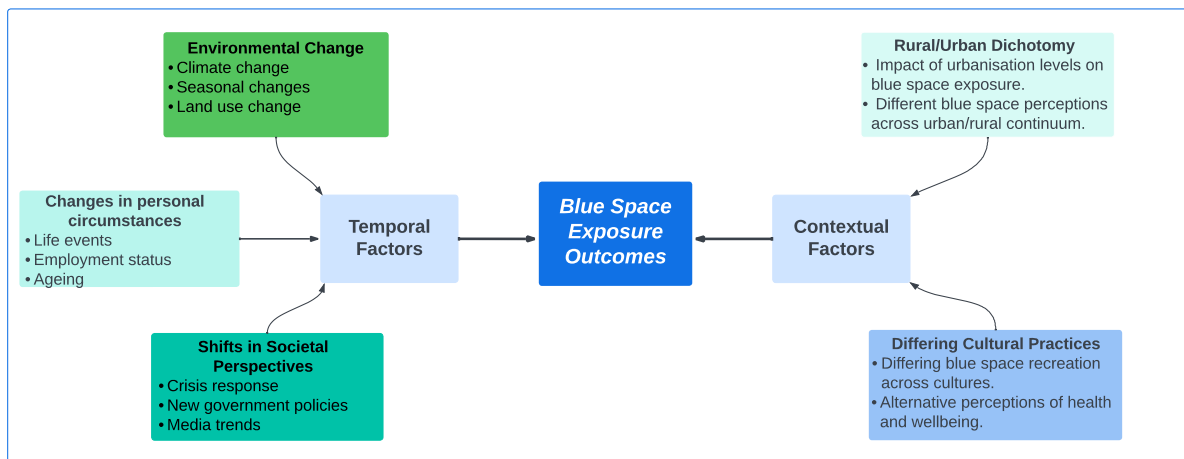


Figure 1: Examples of key temporal and contextual factors that can interrupt the relationship between blue space exposure and health outcomes.

2.2.1 Environmental Temporal Changes

The dynamic nature of water in both space and time means that blue space environments are continually changing. Changes in water characteristics can be observed across multiple time scales, from minutes (e.g., responses to rainfall-runoff) to months (e.g., river base flow vs spate) to years (e.g., drought year vs flood year). The ambience of blue space environments can significantly alter as a function of time of day, wildlife presence and shifts in visitor numbers (Game and Metcalfe, 2011). This can in turn influence user-groups, with research conducted at the river Rhine identifying that young adults were more likely to visit the river during evenings

at the weekend, whereas families and older adults used the riverside space more frequently during the daytime (Volker and Kistemann, 2011).

Over the course of a year, the nature of inland waterbodies will significantly alter due to changes in the surrounding scenery and vegetation as well as alterations to the flow of water. This can influence visitor behaviour at inland blue spaces and consequently influence exposure outcomes. Across the seasons, the frequency of visits to inland blue spaces can vary alongside the visit purpose and aesthetic preferences for blue spaces; however, research findings remain inconclusive, indicating the significant complexity of seasonal effects on outdoor recreation and exposure outcomes (White et al., 2021; Zhou et al., 2022; Ma, 2023). In line with seasonal changes, exposure outcomes can also vary because of weather conditions. Unfavourable conditions, such as high wind speeds and extended periods of drought have been linked with blue space users avoiding these areas or reducing the length of time they spend near inland waters (Vaeztavakoli et al., 2018; Elliott et al., 2019). During calm conditions exposure to a waterbody is likely to promote relaxation and stress-relief; whereas in extreme weather conditions such as excessive rainfall or prolonged periods of drought, blue space environments could cause severe anxiety and depression for nearby residents (Volker and Kistemann, 2011; Mason, Andrews and Upton, 2010; Vins et al., 2015; Yusa et al., 2015).

Over the next few decades, climate change has the potential to further alter inland blue spaces by detrimentally affecting hydrological regimes and negatively impacting biodiversity (Hassan, 2020). As noted by the United Nations “Water is the primary medium through which we will feel the effects of climate change”, therefore blue space research should pay particular attention to this (United Nations, 2019). The impact of climate change and associated environmental impact mitigation strategies can significantly affect communities by leading to the loss or alteration of areas deemed to be of cultural or historical significance (Adger et al., 2013). For instance, the introduction of hard engineering strategies to prevent flooding can notably change the appearance of rivers. Due to a sense of place and attachment to local community sites, it is often the case that affected communities cannot be adequately compensated for their significant cultural loss resulting from environmental changes (Garrett,

2010; Kirsch, 2001). This is particularly pertinent for indigenous communities who have a strong connection to their land (Dew, 2020). The Australian concept of 'solastalgia' is often used to refer to this pain experienced by communities when environmental changes alter their homelands (Albrecht et al., 2007). Vulnerable communities are also more likely to face inequalities with regards to accessing clean drinking water and safe blue space environments (Patel, Schmidt and Lee, 2017). This issue will continue to be exacerbated because of climate change leading to increased water shortages in future (Abedin et al., 2019). Without the introduction of sustainable management strategies, the significant interaction between climate change, sense of place and community identity has the potential to have a considerable negative impact over time on the potential for blue space environments to promote population health and wellbeing (Cunsolo et al., 2012).

Land-use changes affecting blue spaces and their nearby surroundings can have a significant effect on residents and blue space visitors. In relation to the urban regeneration of blue space features, the associated land-use change can have a positive impact on residents by encouraging a sense of pride in their community and creating a therapeutic experience (Brückner et al., 2022; Satariano, 2022; Wang et al., 2023). However, whilst regeneration projects may have an overall positive effect on a community, the relationship that individuals have with a location is subjective and so there will inherently be a degree of variation in how people react to land-use change. Longer-term residents who have memories attached to an area and a greater knowledge of its past, may feel more strongly about environmental change (Lewis, 2016; Torres, 2020).

An unintended consequence that can arise from land-use changes, particularly in the case of urban regeneration projects, is gentrification. The term 'green gentrification' has recently emerged to explain the process by which green and blue space development projects can improve a neighbourhood and lead to increased house prices and consequently the relocation of lower-income residents (Ali, Haase and Heiland, 2020). The process of green gentrification is intricate and dependent on several factors including, location and existing infrastructure (Rigolon and Németh, 2018; Rigolon and Németh, 2021). Therefore, not all regeneration

projects will lead to gentrification. However, when the process does occur, it can have a long-term detrimental impact on the health status of residents, particularly among groups who are already marginalised, often leaving individuals feeling like they do not belong in the new regenerated community (Torres, 2020; Jelks, Jennings and Rigolon, 2021; Kabisch, Haase and van den Bosch, 2016). Additional research is needed to better understand how policies and practices can facilitate community-led, sustainable regeneration of green and blue space facilities in deprived areas without leading to green gentrification and the further establishment of environmental inequalities.

Comparative research to understand how temporal changes in environmental conditions could alter the health outcomes associated with exposure to a range of different inland blue space typologies is now warranted. Several studies have assessed the impact of specific types of blue space environments on health and wellbeing outcomes (Julian, Daly and Weaver, 2018; Vaeztavakoli et al., 2018; Natarajan, Hagare and Maheshwari, 2018; Tieges et al., 2020). In comparison, few studies have researched the potential for variation in exposure outcomes across different typologies of waterbodies. Initial research in this area has indicated that exposure to rivers and canals is associated with greater mental wellbeing than lakes (McDougall et al., 2022). However, this research only focused on three broad inland blue space types – lakes, rivers and canals – given the diversity of blue space environments, further opportunities exist to quantify the impact of a broader range of inland waterways, including wetlands, ponds, streams and waterfalls (McDougall et al., 2022). In recognition of the overarching influence of environmental temporal changes on the appearance and ambience of blue space environments, research should also assess whether alterations to inland waterways and their waterside environments (both natural or management-related) can further magnify the variation in potential exposure outcomes from visiting different types of blue spaces.

Given the significant influence of environmental factors on blue space interactions, as well as the confounding effect of other variables including sense of place and cultural perceptions, it cannot be assumed that all inland blue space visits lead to positive exposure outcomes. Initial research has documented the more complex relationship between blue space and health,

highlighting the potential for blue space to create a sense of isolation, and cause frustration to user groups (Coleman and Kearns, 2015; Jewkes, Moran and Turner, 2020; Fox, Marshall and Dankel, 2021). However, so far this area of research has focused on coastal blue space, and so further insight is needed to capture a broader range of experiences at inland blue spaces. Additionally, most findings relating to negative blue space experiences are derived from specific case studies, therefore larger samples are required to create generalisable results.

Environmental changes affecting inland blue spaces, such as seasonal variation in weather, land use change and climate change are to a certain extent interlinked. It would therefore be worthwhile assessing the potential cumulative effect of these environmental changes on the relationship between blue spaces and health through the application of versatile mixed methods research approaches. Earlier research focusing on aesthetic preference for blue space environments largely relied on the use of cross-sectional photo-based preference studies conducted in laboratory settings (White et al., 2010; White et al., 2014). Building on this, a mixed methods research approach using large-scale dataset analysis combined with a national survey and focus groups identified the significant range of factors that may influence aesthetic preferences for blue space users, including biodiversity levels, perceived busyness of an environment and surrounding green space quality (Grace et al., 2023). However, the application of additional novel research approaches is required to consolidate these findings and account for subjective differences across populations. In-situ methodologies may be particularly beneficial for capturing individuals' environmental perspectives of freshwater environments without the influence of recall bias.

2.2.2 Changing perceptions at the societal level

Whilst several studies have considered the benefits of blue space exposure at the wider community and population level, considerably fewer have considered how populations collectively regard blue space areas and the nature by which these perceptions change over time (Poulsen et al., 2022; Mishra et al., 2023; Nieuwenhuijsen et al., 2018). Public perception is a crucial factor that can alter people's willingness to adopt certain behaviours and so perceptions of inland blue spaces could have a major impact on environmental usage.

A pertinent example of how societal changes can impact the relationship between blue spaces and health is the range of lifestyle shifts brought about due to the onset of the COVID-19 pandemic. Research across twenty European countries discovered that at the beginning of the pandemic, there was a significant rise in online searches for topics relating to nature and the environment which suggests an increased awareness or appreciation of nature at the population-level (Rousseau and Deschacht, 2020; Jo et al., 2022). During the initial phases of the pandemic, blue spaces were associated with providing stress-relief and mental wellbeing at the individual level (Jo et al., 2022; Earl et al., 2022). However, for many, access to blue spaces was restricted during the pandemic due to public health interventions; this in turn affected overall wellbeing levels and altered the therapeutic nature of these environments for individuals (Jellard and Bell, 2021; Usher, 2023). As the impact of the Sars-CoV-2 virus, which causes COVID-19, continues to manifest, this will make a lasting change in society's perception of the importance of accessing natural environments and could consequently alter the health outcomes associated with blue space exposure. To enhance environmental and public health policies, the impact of the COVID-19 pandemic on the relationship between blue space and health across time provides a global exemplar for further investigation.

The introduction of new government policies can lead to a shift in how populations regard inland blue spaces and other natural environments as health promoting resources. One noticeable blue space policy trend across Europe is the increasing establishment of designated marine and inland bathing areas (Wuijts et al., 2020; European Environment Agency, 2023). Bathing waters are distinct from other water environments because the microbial quality of water in these areas is regularly monitored, and action is taken to ensure that the quality is within pre-defined pollution limits (European Union, 2006). As the environment of these blue space areas has been enhanced through the introduction of stringent policies on pollution, it is likely that bathing areas may positively impact the relationship between blue spaces and health. Furthermore, healthy and vibrant bathing waters provide social spaces, a source of wellbeing for recreational users, and a key source of jobs and revenue for local economies. A link has been determined between improved water quality and an increased frequency of visits and improved attitudes towards a blue space area (Borger et al., 2021; Pouso, Uyarra and Borja,

2018; Bonetti et al., 2016). In coastal environments, sites with lower water quality have also been linked with lower ratings of perceived restorative potential (Hipp and Ogunseitan, 2011). However, in relation to bathing areas, a focus on water quality alone fails to account for the value attributed to bathing water environments by the 'hidden majority' who rarely use the sea for immersive activities. For example, waterside environments promote social interactions and wider cultural ecosystem services (Ghermandi et al., 2011; Geordiou and Baternam, 2005).

Accounting for the wider value of coastal and inland bathing waters is critical to effectively manage and promote more generally the role of bathing water environments as important socio-economic resources. Considering the range of uses and the significant number of interlinked benefits associated with bathing areas, it would be valuable to conduct a range of comparative research studies to determine whether health outcomes and other cultural ecosystem services (CES) provided by inland bathing sites vary significantly from the benefits provided by marine bathing sites. The CES associated with environments are continually evolving and can be affected by environmental and societal changes, therefore, the potential for the perceived benefits of inland and coastal bathing sites to vary over time should also be considered (Small, 2017). This comparative and temporal insight will help to underpin a robust evidence base for the creation of tailored environmental policies.

Social media offers the potential to track real-time changes in societal perceptions and can be used as an effective tool to aid in environmental planning processes. A growing body of research has assessed the CES (such as aesthetic enjoyment and health and wellbeing outcomes) provided by a range of environments through the application of social media Big Data analytics (Ghermandi, Camacho-Valdez and Trejo-Espinosa, 2020; Retka et al., 2019; Richards and Friess, 2015; Zhang et al., 2022a). The information gained from social media derived environmental research studies has proven to be highly valuable and can aid in the evaluation of infrastructure and interventions as well as to help inform land-use policy decision-making processes (Oteros-Rozas et al., 2018; Barry, 2014; Guerrero et al., 2016). Currently, however, only a small number of CES studies have considered inland blue spaces in detail and less still have used social media analytics to assess the CES of inland blue spaces, therefore

there is scope to build on this. There are limitations to social media data, for instance the datasets can include much noise due to fake or spam social media accounts and establishing the generalizability of the findings can be challenging (Qiu, Chan and Chan, 2018). However, this form of data offers a host of opportunities for advancing the blue space research field, in terms of enabling the opinions of the local community and blue space users to be quickly assessed and consequently helping to establish sustainable management strategies. If Big Data analytics were to be integrated with qualitative exploratory methods, this could provide rich, valuable insight into blue space perceptions and the factors influencing blue space usage at the societal level.

2.2.3 Changes in Personal Circumstances

Within a population, individuals will have faced significant and unique life-events that can change how they view blue spaces at a personal level. This aligns with Conradson's concept of 'Therapeutic Landscape Experiences' whereby he suggests that the relationship between an environment and an individual is highly subjective and so different visitors to environments can experience vastly different health outcomes (Conradson, 2011). Furthermore, changes in personal circumstances can alter the way in which individuals' value natural environments and so could significantly affect the health benefits obtained from blue space exposure (Bell et al., 2015). Most research exploring the subjective relationship between the environment and health has focused broadly on natural environments rather than exclusively on blue spaces and so more specific investigation of how different life-events can alter perceptions of blue spaces is warranted. Combining in-depth personal information with broader population-level data trends could help to inform more effective management of blue spaces and ensure that these health-promoting resources are accessible to all.

As people age, their relationship with blue spaces can alter, leading to different age groups attributing different benefits to visiting blue space areas (de Bell et al., 2017). Some studies have identified that for children and young adults, an association exists between coastal and inland blue space exposure and mental-health and wellbeing (Huynh et al., 2013; Dzhambov et al., 2018; Oostenbach et al., 2023; George, Murray and Young, 2023). Research involving older

generations has also highlighted the fundamental importance of being close to blue spaces for maintaining quality of life and wellbeing (Garrett et al., 2019; Finlay et al., 2015; Coleman and Kearns, 2015; Costello et al., 2019). To advance blue space research, it would be worthwhile utilising cohort study designs to follow how the ageing process can directly impact the relationship between blue spaces and health. Cohort research studies are longitudinal and typically more resource intensive and time-consuming than other research methods (Thadhani and Tonelli, 2006). Despite these limitations, conducting longitudinal blue space research would be advantageous to effectively correlate available studies on blue space exposure and help to create a stronger evidence base than can be achieved through the application of multiple cross-sectional studies. Having more information on the effect of nearby environments on different age-groups can help to inform both environmental and public health policies to encourage healthy ageing across a population.

Coupled with ageing, an evolving employment status throughout an individual's life course could lead to changes in the health benefits gained from accessing blue space areas. The effect of the neighbourhood environment on health and wellbeing has been identified as having a greater effect on those who spend a larger proportion of their time at home or within their neighbourhood (Roberts, van Lissa and Helbich, 2021). As a result of this, those who are retired or work from home may be more impacted by nearby inland blue space compared to those who work away from home. For those who are employed, a modifying factor is the type of commute taken by an individual; commutes that pass through natural environments are often positively regarded by individuals and linked with improved levels of mental health (Zijlema et al., 2018; Marquart, Stark and Jarass, 2022). Those who are in higher income brackets typically have better access to high quality blue space environments, therefore employment status is likely to add further complexity to the relationship between blue space exposure and health outcomes (Sander and Zhao, 2015; Thornhill et al., 2022; Miró et al., 2018; Viinikka, Paloniemi and Assmuth, 2018). Whilst specific research into the effects of employment on inland blue space access and exposure outcomes has not yet been conducted, the insights outlined from relevant research fields indicate that this is an important knowledge gap to address.

Research has identified the potential for sociodemographic factors to influence inland blue space usage. However, to date most research has been cross-sectional, and so the reasoning behind sociodemographic trends in blue space access cannot be established. Developing a greater understanding of sociodemographic influences is vital to effectively address existing environmental injustices relating to inland blue space access. Given the potential for lifestyle factors to change across time, the application of more innovative and longitudinal qualitative methods would help to derive richer data and gain greater insight into temporal influences on blue space experiences. In line with this, diary keeping is one data collection method that could provide rich contextual knowledge relating to how changes in personal circumstances affect blue space experiences and exposure outcomes. Qualitative diaries can provide an effective means of unobtrusively assessing participants' emotions in real-life situations (Williamson et al., 2015). Research diaries are also useful for documenting short-lived events such as interactions with nature as these types of fleeting-events often do not have an overarching influence on people's lives and so could easily be forgotten (Hyers, 2018).

Diary methods have previously proved effective in documenting the personal and wider-spread effects of experiencing flooding in the city of Hull (Whittle et al., 2010). This diary project had a national impact with findings subsequently used to inform water management policies. More recently, diaries have been utilised to assess the restorative outcomes associated with inland blue spaces for Scottish adults (Grace et al., 2024). Conducting further diary-based research studies to track how personal and environmental changes affect blue space exposure outcomes clearly has potential to provide detailed personal insight into blue space exposure. The combination of diary methods with follow-up interviews has the potential to provide rich ethnographic-style insight into inland blue space experiences.

2.3 The Influence of Spatial and Contextual Factors

The relationship between blue space exposure and health is highly contextual and so, alongside researching the temporal changes associated with environmental and socio-economic factors, it is also important to consider the broad location trends that could have an overarching influence on exposure outcomes.

2.3.1 The Urban-Rural Dichotomy

The degree to which the area surrounding the blue space environment is urbanised could have an impact on blue space exposure outcomes. There has been continued debate as to whether the binary classification of 'rural' and 'urban' is still relevant and useful (Francis, Lorimer and Raco, 2013). Industrialisation and globalisation are continually blurring the boundaries between rural and urban areas; therefore, these two categories may no longer be distinct from one another (Urso, 2020; Merrifield, 2011). Additionally, there is no universal definition of what constitutes an urban or rural area and so this can lead to uncertainties and variations when comparing the health status of different populations. Despite the limitations of the urban-rural dichotomy, environmental exposure outcomes are heavily context dependent, with research continuing to identify that individuals from rural and urban settlements have significantly different place-based narratives (Bell, 1992; Neal and Walters, 2006; Belanche, Casaló and Rubio, 2021). As such it remains worthwhile to consider whether different levels of urbanisation can impact blue space exposure outcomes. There is also scope for investigating whether temporal factors affect individuals from contrasting backgrounds, such as rural and urban residents, in different ways (Bell et al., 2015).

Limited research has contrasted the impact of rural and urban blue space exposure (de Bell et al., 2017; Julian, Daly and Weaver, 2018; Huynh et al., 2013). Findings from such studies have been inconsistent with further in-depth research required to provide a greater understanding of the magnitude of the urban-rural effect and the reasoning behind any variations in health outcomes arising from blue space exposure. The current inconsistencies in findings may relate to the different blue space classifications included in the research, varying ages of the sample groups and the context-specific nature of blue space exposure outcomes. This variability suggests that longer and larger coordinated studies across a greater urban-rural spectrum may yield stronger evidence to underpin our understanding of how urbanisation can influence any variations in health outcomes from blue space exposure.

Currently, most blue space research has focused on better understanding exposure outcomes for urban blue space (Garrett et al., 2019; Smith et al., 2022; Fisher et al., 2021; Duke and

Soulsbury, 2021). Further research into rural blue space is required to ensure that freshwater management policies can be tailored towards the needs of both urban and rural residents. This research strategy would align with the policy of 'rural proofing' that has been adopted across the European Union to ensure that policies and resources are appropriately adapted to meet the varied needs of rural communities (Sherry and Shortall, 2019).

A greater focus on more dynamic research approaches in relation to the urban-rural continuum is required. Future research should appreciate mobility patterns, with individuals travelling from urban to rural areas and vice versa, irrespective of administrative boundaries, to access blue space and natural environments (Duvernoy and Gambino, 2021; Wolff, Scheuer and Hasse, 2020). It is possible that quantitative research studies that consider health outcomes strictly in relation to residential proximity to natural environments may underestimate people's willingness to travel on trips and outings in order to connect with nature (Duvernoy and Gambino, 2021). Therefore, a range of nuanced and complementary research approaches are required to understand motivations for accessing blue space environments across the urban-rural continuum. In addition, future research should carefully consider the way in which urban and rural areas are categorized. Relying solely upon administrative boundaries to define urban areas can lead to a significant over-estimation of green and blue space accessibility levels since administrative boundaries often include rural areas that are on the outskirts of urban settlements (Fletcher et al., 2021). Considering this, sensitive methods are required to better define land-use areas and inform resource management strategies; the application of urban footprints to better quantify the extent of cities could be an alternative approach.

Creating a versatile evidence base for policy decision-making across the urban-rural continuum will ensure that diverse needs of communities can be accounted for. Thus, multidisciplinary research detailing blue space community case-studies in rural and urban areas coupled with more broad scale comparisons of rural and urban exposure outcomes would be advantageous for achieving this (Figure 2). Participatory photovoice methods that involve communities and individuals taking photographs to represent issues of importance in their everyday lives are one such technique that has previously proved effective in providing detailed insight into specific

communities' blue space management concerns (Jelks et al., 2020). However, whilst participatory research can provide a greater understanding of issues relating to social and environmental justice, this type of research is typically limited in terms of scale. Therefore, the combination of contextualised participatory research findings with large scale population-based studies of high statistical power, would be an effective means of developing a robust blue space evidence base to inform the implementation of freshwater management strategies. An alternative option could be to utilise in-depth case study data in combination with Big Data analytics to help verify rural and urban blue space trends.

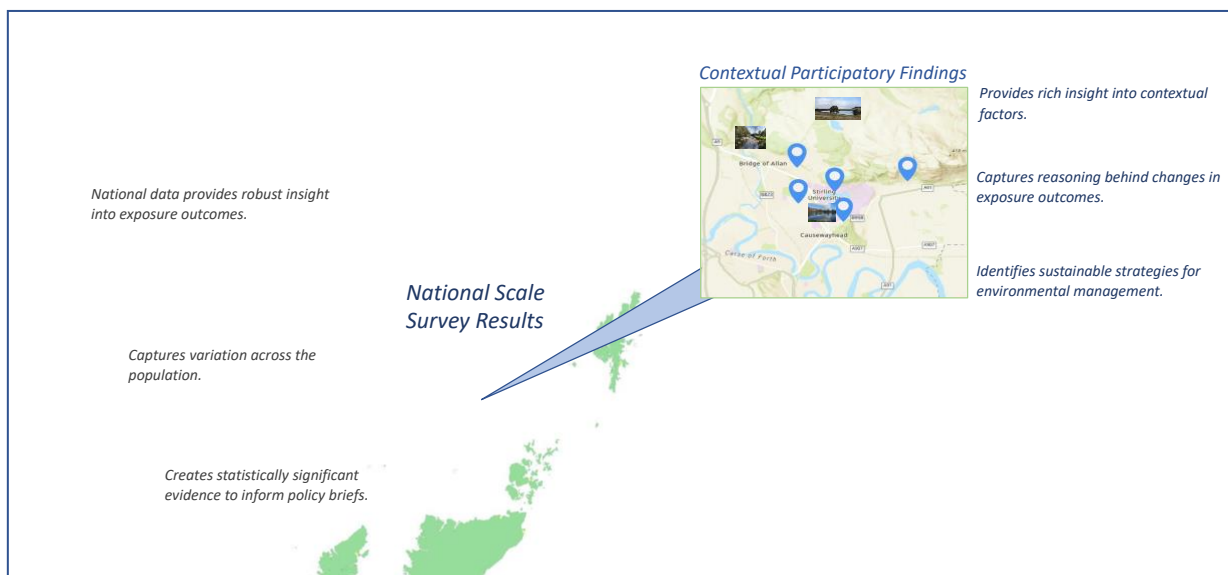


Figure 2: Exemplar of the potential for a mixed methods research approach at different spatial scales to provide detailed insight into a blue space research topic (Scottish Government, 2016; Forestry and Land Scotland, nd).

2.3.2 Differing Cultural Practices and Blue Space Perceptions

Blue space research is increasingly challenging the presence of dominant Western perspectives on wellbeing outcomes (Olive and Wheaton, 2020; Wheaton et al., 2020; Gould et al., 2020). Furthermore, there is an increased awareness that due to differing leisure practices and perceptions of water across cultures, the generalisability of research findings should be carefully considered (Wheaton et al., 2020). Participating in surfing or canoeing for example can have significantly different meaning for Maori populations as opposed to non-indigenous

groups who may not have the same traditional narratives or spiritual connection to the water (Liu, 2020; Wheaton et al., 2021). However, despite this growing recognition regarding the importance of context in determining leisure practices and health and wellbeing values, to date the majority of blue space research studies have been conducted in the Global North (McDougall et al., 2020). There is therefore a need to conduct research across a range of different cultural contexts. Furthermore, to gain insight into lived experiences across cultures, it is important that blue space research approaches continue to incorporate participatory and co-designed research methods that are sensitive to differing perspectives of health and recreation.

Health, happiness and wellbeing are all subjective concepts that can vary between individuals and communities depending on social context (Joshani, 2014; Exenberger et al., 2019). Given this subjectivity, the perceived wellbeing and health benefits gained from blue space exposure could vary significantly across different countries and populations. This further justifies the benefits of conducting cross-cultural blue space research. Due to the complex nature of health-related concepts, it would also be worthwhile adopting a multidimensional approach to measuring health and wellbeing outcomes. Currently, most blue space, health-related research has adopted a (semi)quantitative stance by focusing on health and wellbeing outcomes through the application of questionnaires and health-related datasets. This has provided a good overview of the potential of blue space environments to aid health outcomes. However, the current evidence base could be significantly strengthened through the application of alternative methods such as novel mixed methods research approaches. Mixed methods approaches are increasingly popular in health-based research due to their potential to provide multiple perspectives on complex problems (Tariq and Woodman, 2013; Regnault, Willgoss and Barbic, 2018). In terms of blue space research, combining quantitative and qualitative methods such as the application of robust nationally representative health-based datasets with detailed qualitative interviews, would significantly advance the research field by providing an enhanced understanding of the variables affecting freshwater experiences and health-related exposure outcomes at the individual and national-level.

2.4 An Enhanced Blue Space Analytical Framework

This review has highlighted the broad variety of spatial and temporal factors that influence inland blue space user experiences and identified several research priorities (Figure 3).

Alongside the need to address existing research gaps within the blue space evidence base, to effectively advance the translation of blue space research into public health policy and practice, an enhanced blue space analytical framework is required. Future research methods must be flexible and responsive to capture the dynamic nature of human-environment interactions. Mixed methods research approaches offer the potential to record spatial and temporal dynamics of blue space interactions across multiple timescales, allowing for rich insight into user experiences (Figure 4).

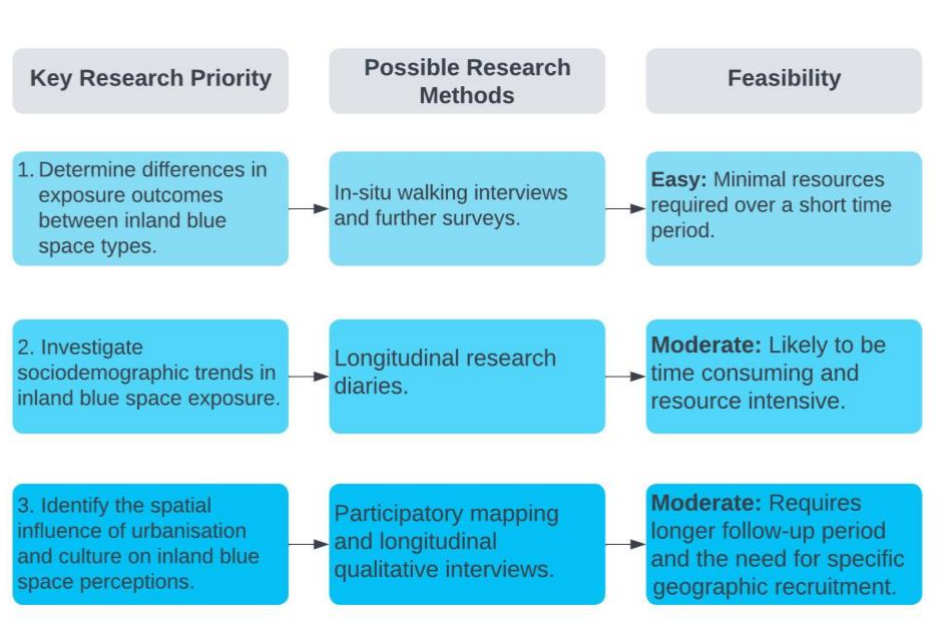


Figure 3: Three of the key research priorities identified in the narrative review presented alongside potential research methods for addressing the priorities and a feasibility assessment.



Figure 4: An outline of the advantages and disadvantages associated with conducting research across different timescales.

A significant number of green space studies have comprehensively assessed human-environment interactions using mixed methods research designs (Fisher, Blackstock and Irvine, 2021; Nagata and Liehr, 2020; Toews et al., 2020; Bojorquez et al., 2021). The mixed methods approaches adopted by these studies had clear benefits, facilitating a comprehensive exploration of the factors that can predetermine green or public space usage and providing a detailed understanding of environmental experiences (Toews et al., 2020; Bojorquez et al., 2021). Further mixed methods research in the blue space research field will help to consolidate current understanding of the complex, overarching impact which environmental factors can have on exposure outcomes. The application of a range of different methods enables multiple perspectives and insights into a topic area to be recorded, creating powerful insights into environmental interactions. For instance, the combination of qualitative walking interviews with geospatial data can help to create contextualised knowledge and provide a better understanding of how individuals relate to different environments (Jones and Evans, 2012). In the field of blue space research this merging of methods may in turn provide a greater understanding of the wide range of factors which influence blue space exposure outcomes. A mixed methods approach can also help to achieve ‘complementarity’ of research findings

whereby the findings gained from one method can be used to further understand or enhance the evidence gained from another method (Greene, Caracelli, Graham, 1989). This overlapping of research findings can create a more nuanced understanding of blue space exposure.

Alongside the application of mixed methods research projects, conducting further collaborative and cross-disciplinary research could help to facilitate the development of evidence-based policies. Typically, cross-disciplinary research involves engagement from a range of stakeholders. This engagement is beneficial to the research process as it helps to ensure the research outcomes remain relevant and applicable for aiding the target audience and facilitating a wider dissemination of research findings (Bracken, Bulkeley and Whitman, 2015; Thompson et al., 2017). The BlueHealth project is an example of how a multidisciplinary research approach can help to build a better understanding of the value, impact and public health potential of blue spaces across different populations (Borger et al., 2021; Mishra et al., 2021; Vert et al., 2020). The focus of the BlueHealth project was however largely on oceans and coastal environments, so the opportunity remains to advance inland blue space research through the application of innovative multidisciplinary research approaches. Inland blue space research aligns closely with public health, sociology, human geography and environmental science research fields. This alignment with other disciplines, offers a host of opportunities for close research collaborations to provide more powerful analytical methods, helping to strengthen research findings as well as increasing public awareness.

It would be particularly beneficial if future blue space research approaches utilised longitudinal data collection strategies. Whilst cross-sectional research projects are quicker and cheaper to conduct, these short-term data collection methods can only provide a relative snapshot into environmental interactions and often rely on participants reflecting and considering their blue space experiences from memory. Longitudinal blue space research would provide a better understanding of whether, and to what extent, temporal changes can subsequently impact blue space exposure outcomes for individuals, whilst minimising the risk of recall bias. A range of different methods could be used to carry out longitudinal research including, the application of wearable research technology over a prolonged period of time, ethnographic observation,

qualitative and quantitative research diaries and videography. Incorporating longitudinal research alongside short-term research methods such as interviews and surveys, could provide novel insight into blue space exposure outcomes. The creation of geospatial longitudinal datasets, through the application of mixed methods research approaches, would help to develop an increased understanding the dynamic spatial and temporal processes that impact human-environment interactions (Desjardins et al., 2023). This would allow for a triangulation of research methods to capture multiple perspectives on blue space temporal dynamics and help to create a more comprehensive understanding of the research topic (Patton, 1999).

Future research should also seek to include creative practice into mixed methods research designs. Blue spaces, particularly rivers, have commonly been used as inspiration for creative practice research in the fields of education and psychology (Stevenson and Girak, 2013). Community led projects, have also focused on blue space environments to encourage engagement from residents. The 'Our Living Rivers and Glens' project, is one such example of this, whereby professional musicians were informed by the words, sounds, videos and images collected from local residents' to create music representing environmental experiences during the COVID-19 pandemic (Dee Don Ceilidh Collective, nd). Whilst some blue space studies have used novel arts-based methods to gain in-depth insight into community perspectives, the application of creative practice remains underutilised (McEwen et al., 2020; Roe and Scott-Bottoms, 2020). In light of the success of previous projects, there is scope to develop creative methods further within the blue space academic research field to create a rich understanding of environmental exposure outcomes.

2.5 Conclusion

Blue space research is increasingly helping to uncover the wide range of complex and interlinked factors that can affect blue space exposure outcomes. Whilst an increasing number of research studies demonstrate the importance of blue spaces for population health and wellbeing, further research is required to ascertain the overall influence and impact of different temporal and spatial variables on blue space exposure outcomes in order to better inform environmental policy. Arguably one of the most effective means of facilitating the translation of

blue space research into policy and practice is to continue to develop transdisciplinary research projects and interventions. This would involve the collaboration of different stakeholders, including policy makers, blue space users and healthcare practitioners, as well as involvement from scientific researchers. Alongside this collaborative research, further focused research is necessary to address the key gaps in the blue space evidence base, which could prevent the development of evidence-based policies. One such gap is a lack of longitudinal research. This type of long-term prospective research is necessary to help establish causality and draw definitive links between blue space exposure and health and wellbeing outcomes. Future studies should also move beyond traditional research approaches and seek to capture embodied knowledge through a combination of sensitive quantitative and qualitative methodologies, such as solicited diaries, wearable technology and videography. The application of a range of methodologies alongside the effective integration of research findings, will help to increase the breadth of blue space research and enable a wider range of blue space exposure variables to be considered. Whilst an increasing portfolio of research findings indicates the potential of blue space environments to be utilised as a public health resource, further investigation is needed to fully understand the range of factors that can affect blue space experiences and modify the potential of these natural environments to improve population health and wellbeing.

Chapter 3: Using solicited research diaries to assess the restorative potential of exposure to inland blue space across time

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Abstract

Inland blue spaces, or freshwater environments, have been shown to provide people with positive mental health and wellbeing outcomes. Most inland blue space research focusing on wellbeing outcomes has so far been cross-sectional, utilising questionnaires and interviews. Therefore, there is significant uncertainty regarding the potential for inland waterways to benefit human populations over longer-term time scales. Across a sixteen-month data collection period, this study recruited four distinct sample groups to complete diaries for periods of three-months, focusing on inland blue space experiences in Scotland. The aim of the study was to use solicited diary methods to establish whether restorative exposure outcomes gained from visiting blue spaces may vary across time. Results from the diary data show that visiting freshwater areas consistently led to positive restorative outcomes, with minimal variation in restorative outcomes observed across time. Participants recorded three principal categories of blue space experiences: routine visits, getting fresh air; and day trips, with each visit type providing a range of restorative benefits. The findings highlight the potential for inland blue spaces to act as versatile public health resources and the need to consider long-term strategies to ensure these environments benefit populations across time.

Keywords: Inland waterways; Green Space; Mental Health; Restorative Outcomes Scale; Wellbeing

3.1 Introduction

A growing body of research highlights the potential for interactions with inland blue space environments to positively impact both physical and mental health outcomes across human populations (Pearson et al., 2019; Afentou et al., 2022; Finlay et al., 2015). Inland blue space refers to surface-level freshwater environments; these may be either naturally occurring (e.g., rivers, lakes and streams) or man-made (e.g., fountains and pools). Reduced stress-levels, improved wellbeing (measured using the World Health Organisation's 5 item Wellbeing Index) and a reduced prevalence of antidepressant medication usage have all been associated with accessing freshwater areas (McDougall et al., 2021; Poulsen et al., 2022; Garrett et al., 2019). Exposure outcomes can be derived from actively engaging in activities in or near the water itself and from viewing freshwater from a distance, for instance the view from an individual's place of residence (Garrett et al., 2019; Nutsford et al., 2016). This versatility may allow for a wide-cross section of the population to benefit from inland waters; however, additional research is required to effectively promote inland blue spaces as public health assets.

To date, most inland blue space research has been cross-sectional, assessing the impact of freshwater environments on populations at a specific point in time (Britton et al., 2020; Geneshka et al., 2021). One-off surveys and interviews have highlighted the extensive range of variables that may modify the relationship between blue space exposure and health outcomes. These variables include sociodemographic factors relating to gender, age and household income, as well as factors affecting the environment itself such as blue space type and water quality (Vert et al., 2019a; McDougall et al., 2022; Börger et al., 2021; Haeffner et al., 2017). To complement this emerging evidence-base, a broader range of methodologies can be applied within blue space research to facilitate greater understanding of exposure outcomes (Völker and Kistemann, 2011). Blue space visits incorporate cultural perspectives, sensory aspects and context-specific factors to provide multidimensional experiences; accounting for their varied and dynamic nature requires mixed methods research to explore how personal and environmental factors may shape blue space experiences.

An additional form of research required to bolster the blue space evidence base, is longitudinal research (Gascon et al., 2017). Freshwater environments are continually affected by temporal changes both from anthropogenic and natural sources; including seasonal algal blooms, changes in abundance of wildlife, and altering pollution levels (Rolim et al., 2023; Pinheiro et al., 2021; Boulton and Lake, 1992). Therefore, the way that people use these environments, may alter significantly across time, alongside the associated environmental exposure outcomes. Individual circumstances in addition with societal and global factors can also affect human-environment interactions. Furthermore, a growing body of research documents the overarching impact of COVID-19 on public perceptions of nature (Soga et al., 2021; Fine and Love-Nichols, 2023; Dushkova et al., 2021). Conducting further research, across various timescales, will capture the subtleties of everyday interactions with inland blue spaces and record the extent that exposure outcomes may alter across time, as a result of environmental and societal change. Developing high quality longitudinal blue space research will help to disentangle issues of reverse-causation whereby individuals who are already experiencing good physical or mental health may be more likely to visit inland blue spaces (Poulsen et al., 2022). Longitudinal insight can in turn better inform environmental policy and planning to ensure freshwater environments continue to benefit populations over long-term time scales.

In the field of blue space research, recording everyday experiences through the application of diary methods would provide invaluable long-term insight into the factors affecting freshwater exposure outcomes at the individual level. Through regularly filling in a research diary, participants provide detailed insights into their emotional responses and attitudes towards different events and interactions (Jacelon and Imperio, 2005). Diary methods allow participants to discuss topics and issues that are relevant to them at the time of writing, thus enabling a broad variety of research themes to be explored (Meth, 2003). In this sense, diary-keeping provides individuals the opportunity to document temporal trends and variabilities in their daily encounters. Solicited research diaries have been used effectively to gain rich insight into the everyday experiences of individuals recovering from floods (Medd et al., 2015). However, to date, solicited diary methods have not been applied to explore the health and wellbeing benefits of exposure to blue space. Due to the personal, unobtrusive nature of diary keeping,

this methodology is particularly well suited to exploring sensitive research topics (Meth, 2003; Harvey, 2011). Accordingly, research focused on physical and mental health outcomes has a long history of applying diary methods in contexts such as documenting the mental health impact of elections and exploring the impact of the COVID-19 lockdown (Ward et al., 2022; Roche and Jacobson, 2018; Elliott, 1997).

Given the benefits afforded by diary methods, this research uses solicited research diaries as a means of providing rich personal insight into blue space experiences. The overarching aim of this study was to investigate variation in everyday interactions with inland blue spaces for Scottish adults. The specific research objectives were to: quantitatively assess restorative blue space exposure outcomes over three-month time periods; qualitatively evaluate variations in everyday interactions with inland blue spaces; and explore the range of factors that may impact blue space exposure outcomes through an assessment of written diary entries.

3.2 Materials and Methods

To obtain a record of lived experiences and assess the restorative outcomes associated with blue space exposure, solicited research diaries were designed and utilised. Ethical approval was granted from the General University Ethics Panel at the University of Stirling. Data collection took place across Scotland from July 2021 to October 2022. Over this 16-month period, four distinct seasonal data collection phases allowed four different groups of participants to complete a three-month diary. Scotland has an abundance of freshwater environments, with over 30,000 freshwater lochs, thus participants were able to record visits to a wide range of inland blue spaces (NatureScot, 2023).

The length of the diary (three-months) was decided on as it enabled participants the opportunity to record multiple diary entries, allowing a comparison of blue space experiences over time. It was felt that if the diary was kept for any longer than three-months, participant fatigue would be a significant risk. Four participant groups were recruited at distinct time points to complete a freshwater diary, this enabled the research to compare how environmental and societal changes over the course of a 16-month period altered public perceptions of inland blue

space. Across the four participant groups, there was also a degree of overlap regarding when one group finished and when the next group started. This enabled a comparison of perceptions and experiences between groups.

The diary consisted of thirty-six repeated entries, to allow participants to complete the diary up to three times per week for a twelve-week period. This limit was introduced to help standardise the number of entries written across time per participant. Participants had the option to start the three-month diary at a time of their choosing, therefore the data collection period ended in October 2022, after the last participant completed their diary. It was made clear to participants that they could stop their involvement in the project at any time, and so some chose to record their diary for a shorter period than the suggested twelve-weeks.

The key recruitment phases took place in June 2021, October 2021, January 2022 and April 2022, using a range of recruitment strategies, including posters, emailing community groups (such as history societies, writing clubs, and wild-swimming groups) and advertising in online newsletters and social media platforms. The recruitment process was carefully monitored and adapted on a regular basis to ensure that no stakeholder groups, such as wild swimmers, were overrepresented in the research. Additionally, the geographical locations of participants were checked to ensure a range of adults from regions across Scotland were involved in the research. No incentives were offered for participating in the study and informed consent was required from all participants before taking part. Individuals who were 18 years or older and living in Scotland at the time of the data collection period were eligible to take part.

Over the course of the data collection phase, the COVID-19 pandemic was still considered a public health emergency by the World Health Organisation (2021). However, in Scotland, no active stay-at-home or lockdown measures were in place during the data collection period, and participants were not impacted in their ability to access inland blue space (Scottish Parliament Information Centre, 2023).

A total of 45 participants completed and returned a diary, there was a 71% response rate (18 recruited participants did not complete a diary, eleven female and seven male). The sample size is consistent with previous diary-based research (Medd et al., 2015, Beckers et al., 2016). Further information on non-respondents is available in the appendix (Appendix 3).

3.2.1 Diary Design

All participants had the option of completing a paper diary booklet or downloading a Microsoft Word diary, with both formats identical. An instructions page was included at the start, alongside a diagram page detailing different inland blue space types, and a background information form (see Appendix 1).

The diary entry structure consisted of thirteen qualitative and quantitative questions (see Appendix 2). Six categorical questions sought information on the weather conditions on the day of each diary entry, the impact of the weather on the experience, the modes of travel on the day of each diary entry, inland blue space type visited, the location, and the type of activity undertaken. Seven open-ended questions focused on sensory experiences, aspects of interest to participants and their likes and dislikes about the visit. Participants were informed that to minimise recall bias, entries should be completed on the same day that they visited a blue space environment.

Before finalising the diary, the structure was pilot tested on a sample of five participants who completed a diary over the course of a month. The pilot study proved effective with only minor changes required to improve the clarity of questions: for instance, the original question “Who/what did you interact with?” was altered to “Were you with anyone during your visit?” for the final diary structure.

The Restorative Outcomes Scale (ROS) was included in each diary entry. This scale has previously been applied to determine the restorative potential of a variety of different environments including forests, parks and coastal environments (Takayama et al., 2014, Ojala et al., 2019, Korpela et al., 2010). The scale consists of six statements relating to an individual's environmental experience. The wording was altered from the original version to specify that

the environment of interest was inland blue space. Each statement had a corresponding seven-point Likert scale response and participants were invited to indicate the extent they agreed or disagreed with each statement (results ranged from “1: not at all”, to “7: completely agree”). The total score from all six statements was used in the analysis; the lowest possible score was 6, indicating the experience was not restorative, and the highest score was 42, indicating a restorative experience.

3.2.2 Data Analysis

A mixed methods research approach was used to analyse the data. Analysis of variance (ANOVA) was carried out in R Studio (version 4.1.1) to assess the extent that ROS responses varied across time and in relation to weather. The responses were tested for distribution and homogeneity of variances before parametric tests were conducted. In instances where assumptions were not met, Welch’s ANOVA was used. Spearman’s rank correlation was used to test the relationship between ROS and blue space visit length. When comparing ROS scores per month for each data collection phase, only months in which at least ten diary entries were written, by a minimum of three participants, were included in the analysis. Statistical differences were considered significant with p values < 0.05 .

Responses to the open-ended qualitative questions were analysed using thematic analysis (Braun and Clarke, 2012). Initial thematic analysis took place in January 2022 after two data-collection phases had finished. This analysis was then repeated in April 2022 and finally, in October 2022 when all diaries were returned. An inductive, iterative coding approach was carried out by the lead researcher, with diary entries read in detail before identifying the key topics and themes of interest that related to the research objectives. To understand temporal trends, diary entries made by the same participant were compared across time, alongside diary entries made by different participants. During each analysis phase, the initial coding scheme from January 2022 was consulted and revised accordingly to reflect the information gained from analysing new diary entries. The thematic analysis was carried out using MS Office.

To add richer and more nuanced insight into temporal trends and complement the broader thematic analysis, four diaries were selected for detailed narrative analysis (Wiles, Rosenberg and Kearns, 2005). One diary was selected from each data collection phase. Only diaries that contained a minimum of fifteen entries were used and the diaries were chosen to represent a range of demographic factors, including age and gender. Diary entries were analysed as a whole, by considering responses to all the diary questions for each visit. This allowed an evaluation of the factors that were most important to the overall blue space visit. The narratives recorded by participants within diary entries often took the form of ‘small stories’, discussing fleeting blue space interactions (Bamberg and Georgakopoulou, 2008). Diary entries were compared over time to establish consistencies and variabilities in everyday blue space interactions.

3.3 Results

Over the sixteen-month data collection period, 45 participants, completed and returned a diary (Table 1). Participants were recruited from 14 out of the 32 council areas in Scotland, with inland blue spaces from across 21 different council areas recorded within the diary entries. A total of 737 diary entries were written, with an average of 16.4 entries per participant. The shortest diary completed consisted of two entries, however, four participants completed the entire 36 entries included in the diary. Variation was observed in the number of diary entries written per month (Figure 5). The length of diary entries also varied between participants; a small number contributed one-word responses to each open-ended question, whereas others wrote detailed paragraphs. The average length of diary entry per participant was 85 words.

Table 1: Demographic data and relevant background information for each sample group.

Sociodemographic and Background Variables	July-October	October-January	January-April	April-October
N	15	10	11	9
Age Group (n, (%))				
18-30	/	1 (10)	/	/
31-40	6 (40)	1 (10)	1 (9.1)	/
41-50	/	2 (20)	2 (18.2)	2 (22.2)
51-60	5 (33.3)	2 (20)	3 (27.3)	2 (22.2)
61-70	1 (6.6)	3 (30)	1 (9.1)	3 (33.3)
71-80	3 (20)	/	4 (36.4)	2 (22.2)
81-90	/	1 (10)	/	/
Gender (n, (%))				
Male	7 (46.6)	3(30)	5 (45)	3 (33.3)
Female	8 (53.3)	7(70)	6 (55)	6 (66.6)
Ethnicity (n, (%))				
White (English / Welsh / Scottish / Northern Irish / British)	14 (93.3)	10 (100)	10 (90.9)	9 (100)
White (Any other Background)	/	/	1 (9.1)	/
Prefer Not to Say	1 (6.6)	/	/	/
Education (n, (%))				
High School	2 (13.3)	3 (30)	3 (27.3)	1 (11.1)
College or Undergraduate Degree	7 (46.6)	7 (70)	6 (54.5)	4 (44.4)
Postgraduate Qualification	6 (40)	/	2 (18.2)	4 (44.4)
Employment Status (n, (%))				
Full-Time	8 (53.3)	2 (20)	5 (45.4)	2(22.2)
Part-Time	2 (13.3)	1 (10)	1 (9.1)	/
Self-Employed	1 (6.6)	1 (10)	1 (9.1)	/
Retired	2 (13.3)	4 (40)	4 (36.4)	5 (55.5)
Unemployed	1 (6.6)	/	/	/
Student	1 (6.6)	2 (20)	/	2 (22.2)
Location (n, (%))				
Rural	9 (60)	7 (70)	7 (63.6)	4 (44.4)
Urban	3 (20)	1 (10)	2 (18)	1 (11.1)
Suburban	3 (20)	2 (20)	2 (18)	4 (44.4)
Overall Life Satisfaction				

1	/	/	/	/
2	1 (6.6)	/	/	/
3	1 (6.6)	/	/	/
4	/	/	/	/
5	/	/	/	1 (11.1)
6	1 (6.6)	1 (10)	/	1 (11.1)
7	4 (26.6)	4 (40)	2 (18.2)	1 (11.1)
8	7 (46.6)	3 (30)	7 (63.6)	3 (33.3)
9	/	2 (20)	2 (18.2)	3 (33.3)
10	1 (6.6)	/	/	/
Blue Space Activities Recorded By Participants (n)				
Walking	14	10	11	7
Cycling	2	/	1	/
Swimming	4	2	4	2
Running	4	/	1	/
Watersports	2	/	/	1
Sitting/Observing	6	4	2	4
Wildlife Watching/ Wildlife Photography	3	3	4	3

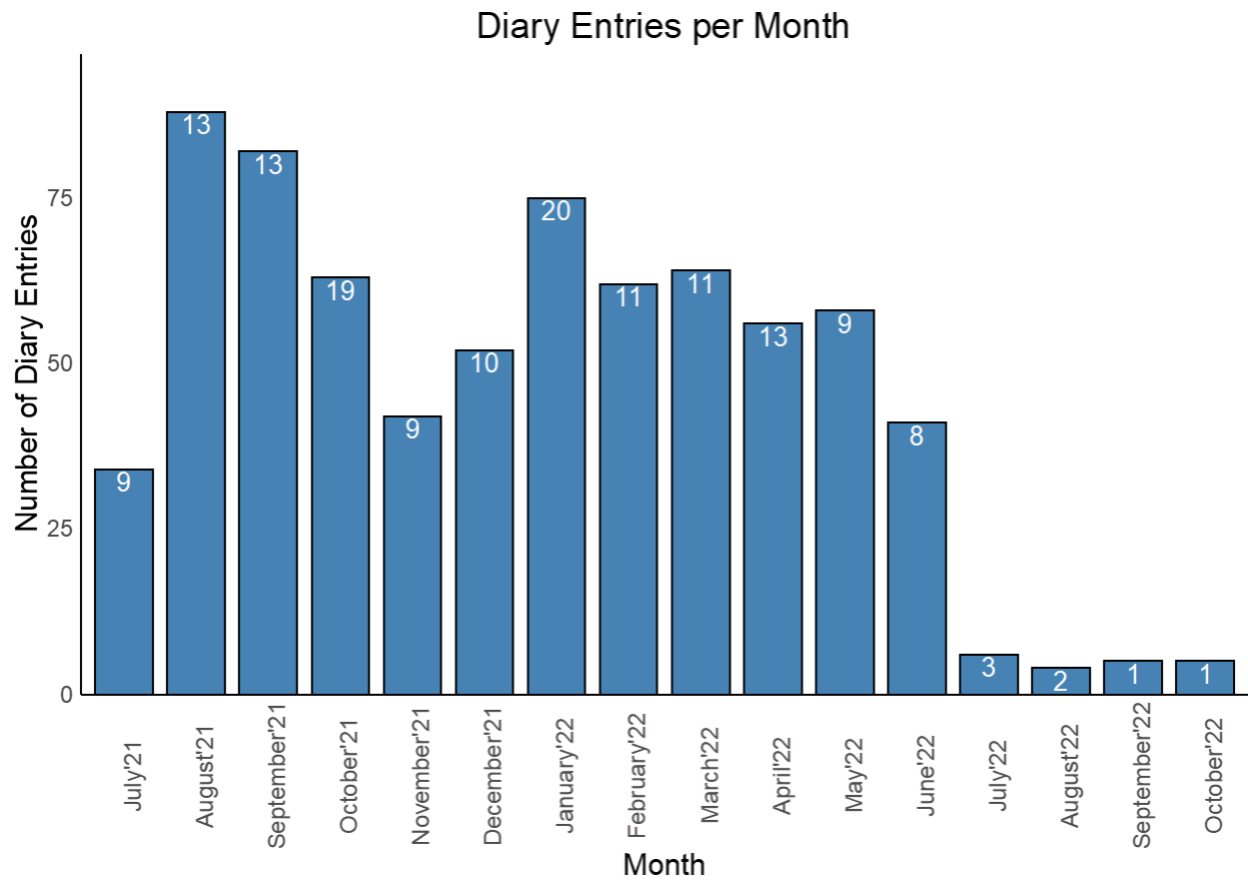


Figure 5: Diary entries per month over the course of the data-collection period. The numerical label in each bar represents the number of participants per month who filled in a diary entry.

3.3.1 Restorative Outcome Scores

The average ROS score recorded across all diary entries was 33.7 (SD $\pm$ 6.5) out of 42. Within each of the four data collection phases, ROS scores remained consistently high across each month with no significant difference recorded (Figure 6). Between the sample groups, the highest mean ROS score was recorded in the fourth data collection phase (Mean ROS: Phase 1 = 32.13; Phase 2 = 32.02; Phase 3 = 34.30; Phase 4 = 37.49). No significant difference in the mean ROS score was observed for the first two data collection phases (ANOVA: $F[3, 703] = 25.86$, $p > 0.05$); however, there were significant differences between the sample groups for all other phases (Figure 6, Phase 1-Phase 3: $p = 0.008$; Phase 2-Phase 3: $p < 0.001$; Phase 2-Phase 4: $p < 0.001$; Phase 3-Phase 4: $p < 0.001$).

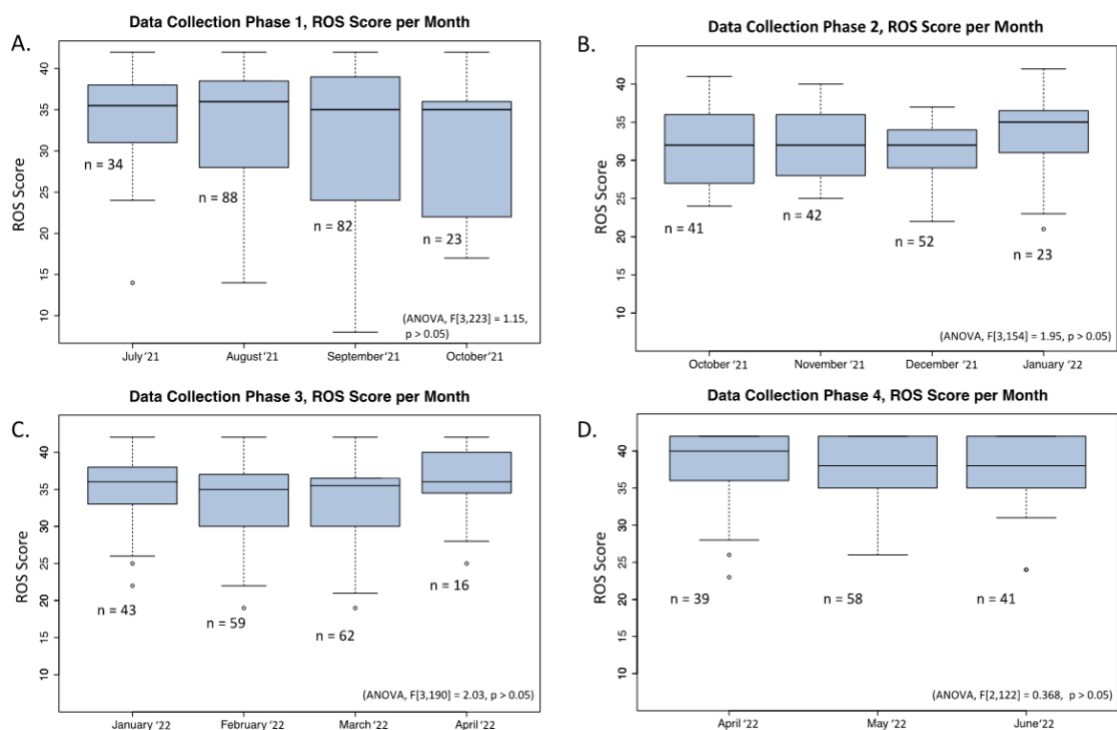


Figure 6: Restorative Outcome Scale Score per month for each data collection phase. Each boxplot includes the ROS results from the four different sample groups who contributed to the project. In the months of October, January and April, two different sample groups completed diary entries and so the responses for those months have been separated by data collection phase. Only months where more than ten diary entries were written were included. Centre horizontal dash, box and whiskers represent median, interquartile range and upper and lower limits, respectively.

The ROS scores were significantly affected by the perceived impact of the weather conditions on the overall blue space experience. Diary entries that took place when the weather conditions were regarded as having a strong positive impact on the overall blue space visit, were associated with significantly higher ROS scores compared to entries recorded in less favourable weather conditions (Figure 7, $p < 0.001$).

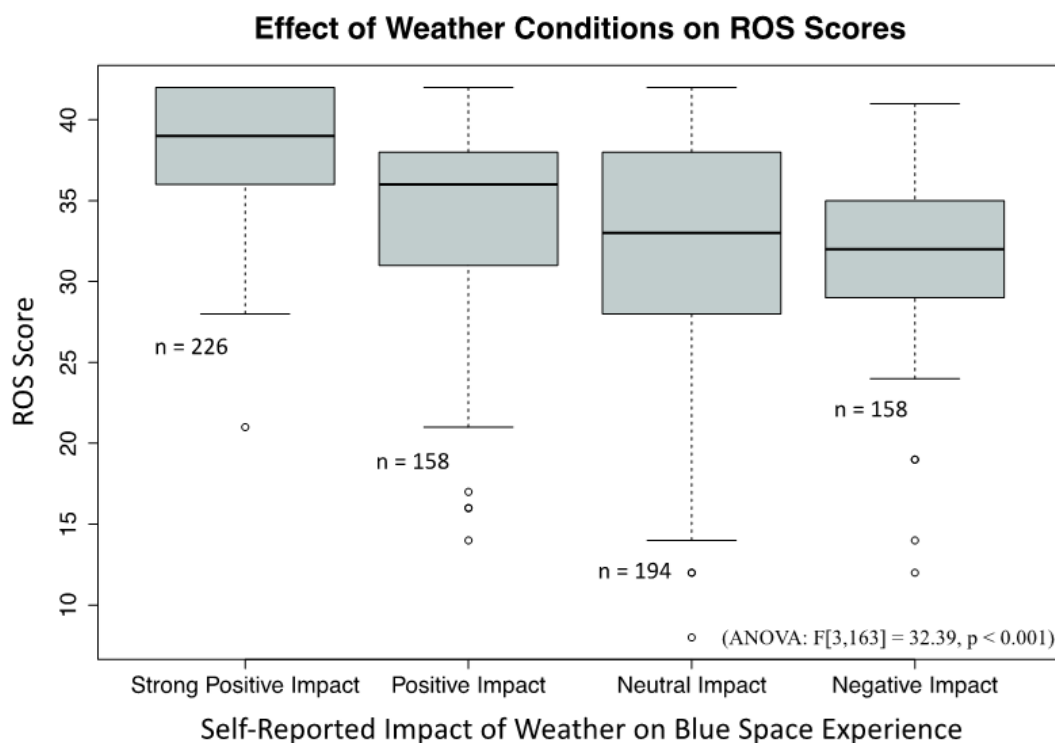


Figure 7: Impact of self-reported weather conditions on the Restorative Outcome Score attributed to blue space visits. Participants were asked to rate the weather conditions of each blue space visit as having either a “Strong Positive”, “Positive” “Neutral”, “Negative” or “Strong Negative” impact on their overall experience. Diary entries have been grouped according to the reported weather impact and the ROS results for each group presented in the boxplot. Centre horizontal dash, box and whiskers represent median, interquartile range and upper and lower limits, respectively. The weather was only recorded as having a “Strong Negative” impact in one diary entry and so this specific diary entry was excluded from the analysis.

The mode visit length recorded in diary entries was between 0 and 30 min, with 40% of diary entries recording this length of visit. There was considerable variation in the reported visit length, the shortest visit was recorded as two minutes and the longest at seven hours. However, no linear relationship was identified between the length of blue space visit and the associated ROS score (Spearman's $\rho = 0.12$; $p = 0.002$).

The type of blue space visited had a significant impact on ROS scores. Visiting still waterbodies, such as lakes and reservoirs were associated with a significantly higher mean ROS score (ROS = 34.84) than running bodies of water, such as rivers and streams (ROS = 32.77) (ANOVA: $F[2,122] = 9.66$, $p < 0.001$).

3.3.2 Thematic analysis

Across the diaries, the blue space experiences recorded by participants could be grouped into three broad categories: Routine Visits; Getting Fresh Air and Day Trips. Routine visits accounted for 67.9% of recorded diary entries, with getting fresh air and day trips accounting for 13.5% and 18.5%, respectively. The characteristics of each visit type are detailed below. Each quote included in the findings is reported alongside the ROS score associated with that particular visit.

3.3.2.1 Routine visits

The diaries were designed to record everyday interactions with blue spaces, therefore, participants frequently recorded visits to their local blue space environment. Often these blue spaces were located within reasonable proximity to the participants' address. Due to the frequency that participants used these areas, visits were regarded as routine. However, despite the everyday nature of these visits, participants experienced strong positive emotions, recording their overall enjoyment of visiting familiar environments, their fondness for the views and an appreciation of the wildlife within the environment.

“Hand fed the robin again today who sat on my hand several times to eat seed and then flew to a higher branch to feed a young robin.” Participant 6, Female, 61–70, April’22, ROS = 42.

This attachment to familiar environments left individuals vulnerable to the effects of environmental change. Smaller environmental changes, such as seasonal changes to plant life; active sand dunes; and altering light levels were viewed positively by participants. However, significant changes brought about by extreme weather events or land-use management strategies often caused participants to experience negative emotions, such as frustration or anxiety. The effects of storm Arwen that occurred at the end of November 2021, had a long-lasting impact and were mentioned by participants up until the 23rd of January 2022. Winter storm damage in general was recorded by participants over a four-month time scale from November 2021 to February 2022. The sight of damaged and fallen trees was the key environmental factor that prompted participants to discuss storm damage.

The erosion and degradation of riverbanks and green space environments near waterways also had a strong negative impact on blue space experiences. After observing that parts of their local riverbank had collapsed, one participant noted; *“that ‘man’ is first class at decimating his environment through thoughtless selfless actions”*, Participant 7, Female, 61–70, December’21, ROS = 24. Several participants were concerned that overgrazing was one of the key issues contributing to the degradation of riverside environments.

3.3.2.1.1 Recreational pursuits

Routine blue space visits often took place while participants were carrying out hobbies. One key benefit of visiting blue spaces, recorded in all diaries, was the opportunity afforded for exercise and recreation. Participants took part in a wide range of land- and water-based sports, including stand-up paddle-boarding, sailing, running and cycling. Several factors encouraged participants to visit these areas, such as the weather, the size and type of environment being fitting for the activity and the views of the water providing motivation for participants.

“The rain was initially a little frustrating, but it was nice to be out. The path was also quiet due to the weather, so the rain had its benefits. I enjoyed the native woodland on the river path and pausing for a snack at the riverside. My favourite parts of the walk were the river sections.”

Participant 10, Female, 31–40, October’21, ROS = 39.

Diarists highlighted how these activities were not just restricted to exercise, as blue spaces also afforded individuals a chance to take part in more sedentary hobbies such as wildlife monitoring and bird watching. Several participants were keen bird watchers and recorded their enjoyment of this activity alongside the sense of achievement they felt in spotting rare birds.

3.3.2.1.2 Socialising

Regularly visiting freshwater environments provided participants the opportunity to connect and socialise with the wider community. This varied from greeting passers-by to meeting friends and family for pre-arranged blue space activities and walks. Participants commonly noted that meeting others had an overarching positive impact on their visit.

“It was nice to meet the occasional other person walking, as they always exchange a greeting even if it’s just “Cold Day” Participant 2, Female, 81–90, January’22, ROS = 40.

Although participants highlighted the beneficial impact of socialising, there were occasions when the presence of other users had a negative impact on the overall blue space experience. Tension and conflict typically occurred when participants visited local environments and observed environmental changes they disapproved of. One user-group that was viewed negatively by several diarists were anglers, as participants felt that they often degraded the environment through littering. Participants also disapproved of those who took part in hunting and shooting.

3.3.2.2 Getting fresh air

Across the diary entries, participants recorded the perceived benefits of visiting blue spaces to access the outdoors and nature. Some individuals, particularly wild swimmers, described the benefits of the water itself, capturing their enjoyment of being immersed in the water and noting the positive impact it had on their mood:

“It was the first time this year that the edge of the loch had frozen (just lightly), but I absolutely love standing on it to break it before a swim. Very much highlights the ‘cold swimming’ effect we go for! As it was so cold, we were wearing woolly hats when swimming, and watching a

couple of my friends in front of me, they made me smile as they looked exactly like the iconic pictures you now see of wild swimmers in winter.” Participant 10, Female, 41–50, March’22, ROS = 41.

However, for others the act of getting outside was regarded as the key restorative benefit. Fresh air evoked strong positive responses in diary entries, with participants attributing fresh air with positive mental health outcomes, such as reducing anxiety levels and providing the opportunity to de-stress.

Although fresh air was frequently mentioned, diarists did not comment on the quality of the air and rarely mentioned air pollution levels. For participants, ‘getting fresh air’ was often used in a metaphorical context and associated with getting a break from current circumstances.

Individuals commented that visiting freshwater areas enabled them to both set themselves up for a day at work and to clear their head after work. Often, visits for the purpose of fresh air were to local neighbourhood environments, and took place in breaks between other events, such as during the working day, thus limiting the length of time individuals spent at blue space. The break provided by visiting inland blue spaces afforded participants the time and space to reflect on current challenges.

“Diary question: What did you hear of interest?

Participant Response: Wind through the trees, and my husband’s voice as we debated the best way to deal with a problem one of our kids is having!!!” Participant 10, Female, 41–50, March’22, ROS = 38.

The restorative aspect of blue space visits was not just restricted to those who were employed, as individuals who were retired, unemployed or stay-at-home parents also reported that visiting blue space provided them with the opportunity to have a break. Often focusing on small features of the environment, such as the appearance of seasonal flowers and wildlife helped participants create a sense of immersion in their surroundings.

3.3.2.3 Day trips

One form of blue space experience frequently recorded in diary entries was day trips to both familiar and new environments. Day trips typically occurred at inland blue spaces that were out with the participant's local area. This encouraged participants to spend longer periods of time at the blue space than they would for routine visits.

3.3.2.3.1 Familiar environments

Often revisiting familiar areas during day trips evoked a sense of nostalgia for participants. This sense of nostalgia was typically recorded by those over the age of 30. In some instances, participants discussed key life events that had happened at specific blue spaces such as celebrating weddings and birthdays. More commonly, participants reflected on informal events remembering barbecues, holidays and childhood experiences.

"It has been an important drive and venue in our lives this one, having marked several milestones/birthdays etc at the venue right on the lochside. Brought back fond memories"
Participant 3, Male, 31–40, February'22, ROS = 37.

As well as evoking nostalgia, day trips to familiar environments provided participants with a sense of belonging. For some, this arose from remembering past visits. For others, the belonging arose due to a family connection. As one participant described during a visit to a waterfall, they *"re-created' an old photo, with me standing in the same spot in which my late dad had stood in an old photo from 2004"* Participant 11, Female, 31–40, October'21, ROS = 36. Participants commonly revisited blue spaces near childhood homes and reflected on how they used to use the area.

3.3.2.3.2 New environments

Throughout diary entries, participants recorded their interest in visiting new and unfamiliar blue space environments. One of the benefits of visiting new blue spaces was the opportunity to learn information relating to the history and culture of the area.

“Likes - Learning fascinating information about the Korean War. Views of my home county. New views of Central Scotland in general.” Participant 12, Male, 41–50, August’21, ROS = 39.

Often this information was obtained via interpretation boards at natural environments, however, insight was also gained from informal discussions with other blue space users, as well as attending organised events held by communities and businesses.

3.3.3 Narrative analysis

This section presents a narrative analysis of four diaries, selected as exemplars. The results focus on the key themes pertinent to each individual.

3.3.3.1 Participant 1. July-October

While some variation in ROS score was observed between diary entries, participant 1 (Female, 41–50) regularly scored 36 out of a possible 42 (Figure 8a). This participant is a keen runner, and all diary entries were recorded while running past various types of inland blue spaces within their local area. Diary entries were typically classified as routine visits, with the participant taking part in regular exercise within their neighbourhood environment. Initially, the diary entries centered around larger environmental features such as discussing water level changes. However, as the diary progressed, smaller features were recorded such as a single falling leaf, and raindrops falling from tree leaves. The participant regarded this increased awareness of the environment as an increase in mindfulness and was pleased in their ability to notice small details whilst running. This awareness of the environment enabled the participant to realise that their principal environmental concern at blue spaces was the presence of litter. Over the three-month data collection period the participant frequently revisited the same viewpoint from a bridge and reflected on how changes in weather conditions and seasonal changes in light availability affected the familiar view of their local river:

“The lack of visibility was interesting. Standing on one bridge I could barely see the other. There was a flat calm [of the water] so there were hazy reflections from the lights. Also, a log floating slowly along the river. Spider webs all along the railings of the bridge, glistening with

moisture...It was fascinating to have a different view. I wish the lights on the old bridge had stayed on for a few more minutes.” Participant 1, August’21, ROS = 36.

3.3.3.2 Participant 2. November-February

For participant 2 (Female, 81–90), the mode ROS score recorded throughout the diary was 35 (Figure 8b). Diary entries were typically recorded after completing walks near the river within their local area, these were classified as routine visits. Towards the end of the diary, in January and February, several day trips to further afield inland blue spaces were also included. The participant focused on recording the information they had learned whilst visiting blue spaces. This information was obtained from a variety of sources, including information panels, speaking to others and observing changes since their last visit. Over the course of the diary the participant developed an increasing interest in the birds present at freshwater areas:

“I liked being able to observe the behaviour of the ducks and moorhens at close quarters. They were only inches away from where I was standing. They were unperturbed by the presence of the public and went peacefully about their daily routine.” Participant 2, December’21, ROS = 35.

As well as birds, the participant also documented their first sighting of otters at a local river and revisited the site two additional times in search of the family of otters. One of their key concerns regarding blue spaces was slippery paths or walkways, with the presence of mud and leaves on paths often limiting their ability to explore during the winter months.

3.3.3.3 Participant 3. January-April

There was a great degree of variation across the ROS scores associated with each diary entry for participant 3 (Male, 31–40) (Figure 8c). Most diary entries were categorised as ‘fresh air’ visits and were completed after site visits to different freshwater lochs whilst at work or during work breaks. However, some entries were recorded after day trips with family members to inland blue spaces, these day trips occurred more frequently as springtime approached. The participant commonly noted the bird species present during blue space visits, although their presence did not have an overriding impact on each diary entry as a whole. A key aspect that

the participant focused on throughout their diary was how their current state of mental health impacted their overall blue space experience. Often, their emotions were the most important factor in determining how much they enjoyed the environment, with low moods leading to a lower overall enjoyment. In certain entries, carrying out work tasks on site improved their mood and positively impacted their visit, allowing them to concentrate on the task at hand and forget their current concerns. Alongside this, good weather conditions and spending time in the company of family had a positive impact on their enjoyment of blue spaces. The participant finished the diary by announcing the upcoming arrival of their first child and contemplating how their child may enjoy nature in the future:

“A lovely final [diary] entry. Great lunch and walk. We are enjoying simple but special last weeks and months as a couple before it goes to 3 of us with the new arrival. Maybe they will enjoy the outdoors as much as us and feel better for it.” Participant 3, April’21, ROS = 34.

3.3.3.4 Participant 4. April-June

Across the 16 diary entries recorded by participant 4 (Male, 61–70), there was a cluster of ROS scores between 34 and 37 (Figure 8d). All entries were recorded from visits to the same freshwater loch, which is a two-minute walk from the participant’s home. Due to the nearby location of the loch, most diary entries were classified as ‘routine’ visits, however, some visits were carried out as part of a break from their current circumstances and so were viewed as ‘fresh air’ visits. There was a strong focus on the perceived energy of the environment. The movement of the water, the level of wind speed and colours in the environment all contributed to the blue space experience. Days that had high wind speeds, vibrant colours and strong water currents were regarded as interesting and exciting. In instances where the weather was calmer and colours were more subdued, the blue space experience was regarded as peaceful. The participant was also aware of how their own surroundings differed from others:

“the stillness and the lack of noise apart from the birdsong – sense of calm and peace. The complete contrast to what is happening in Ukraine and rest of the world.” Participant 4, May’22, ROS = 34.

Alongside the overall energy of the environment, sightings of birds were recorded in each diary entry and the participant was aware of how the bird species present changed over time. One species that the participant was particularly aware of was parakeets as they were regarded as a nuisance and associated with a 'screeching' noise.

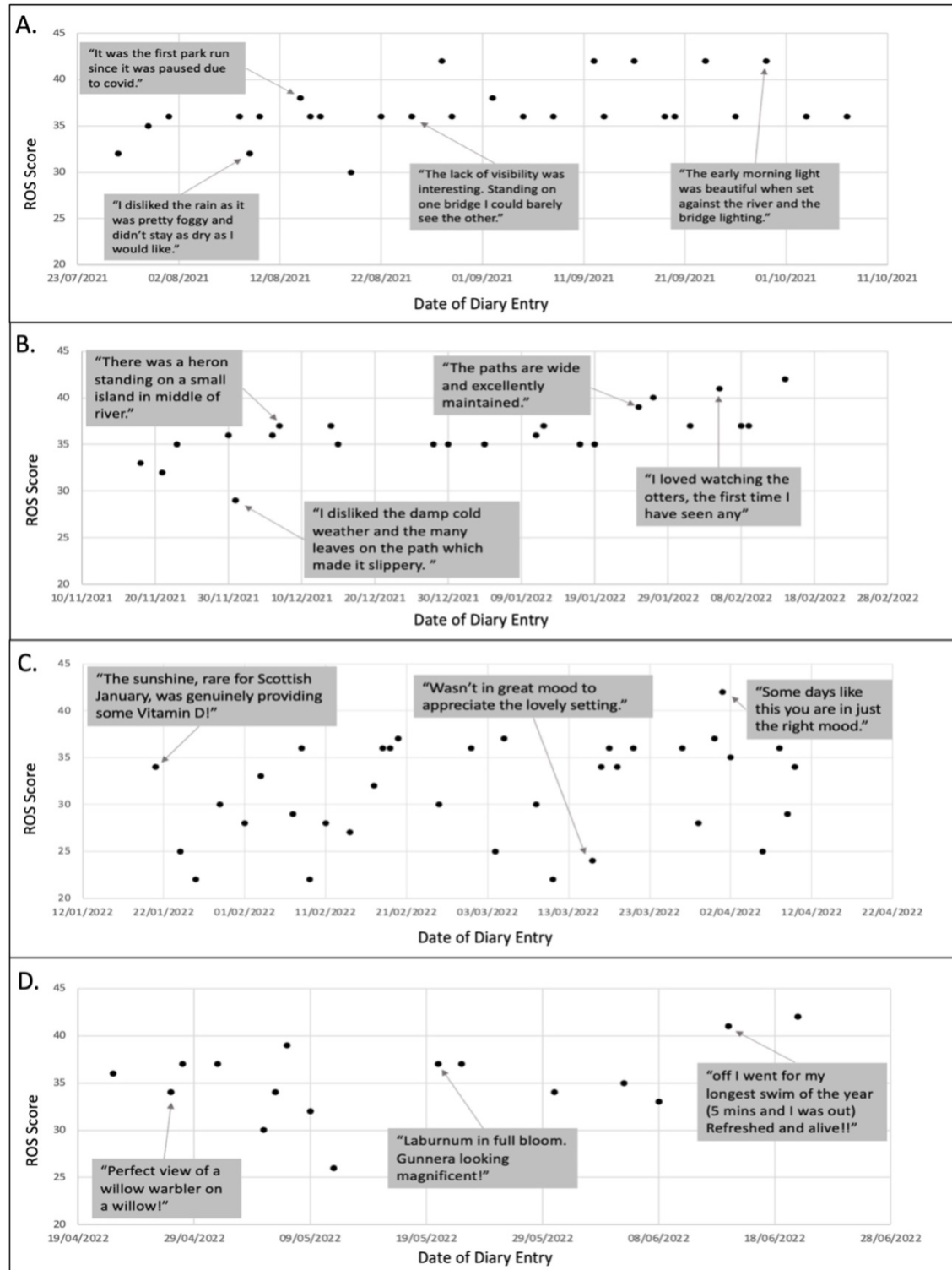


Figure 8: ROS Scores from four diary participants who all took part over different months of the project. Each marker represents a diary entry and the ROS score the participant attributed to the blue space experience recorded within that entry. The four

graphs have been annotated with notes from corresponding diary entries. A) Participant 1, Female, 41–50. B) Participant 2, Female, 81–90. C) Participant 3, Male, 31–40. D) Participant 4, Male, 61–70.

3.4 Discussion

This research has demonstrated the potential for diary methods to capture everyday interactions at blue space environments. The application of the validated ROS scale, alongside the use of closed and open-ended questions within the diary entries afforded detailed insight into inland blue space interactions and associated exposure outcomes. The ROS results have highlighted the potential for freshwater environments to lead to positive restorative outcomes, with consistently high ROS scores recorded by individuals across three-month time scales. The qualitative findings obtained from narrative and thematic analysis of diary responses, further emphasise the restorative potential of inland blue spaces and provide greater understanding of the wide range of interacting factors that may impact exposure outcomes. Taken together, the statistical analysis alongside the qualitative results provides robust insight into the benefits associated with regular inland blue space exposure.

The thematic analysis focused on three types of inland blue space experiences: routine visits; the opportunity to get fresh air; and day trips. Each visit type was associated with different overarching restorative benefits. Furthermore, during routine visits, participants exhibited a strong 'sense of place'. Sense of place is a concept that refers to the emotional connections established between a person and a particular area (Hay, 1998). There is strong recognition that positive wellbeing outcomes are closely related with developing a sense of place (Hausmann et al., 2016; Ellis and Albrecht, 2017). In line with previous research, the recreational opportunities carried out during regular blue space visits were considered an important part of individuals lives, helping to establish a sense of place and providing a sense of purpose and routine (Foley, 2017; Völker and Kistemann, 2013). Participants regularly used local blue space environments to socialise with others and recorded the benefits of this. The social aspect of blue spaces has been identified as a key factor encouraging positive wellbeing outcomes (Gascon et al., 2015, Chen and Yuan, 2020). However, social interactions within natural environments are complex

and dynamic, therefore it cannot be guaranteed that socialising will lead to positive health exposure outcomes (Dinnie, Brown and Morris, 2013).

Visiting inland blue spaces for the purpose of 'getting fresh air' was linked with restorative exposure outcomes through allowing participants to have a break from their current circumstances. Fresh air has been shown to be a strong motivator for accessing natural environments (Fongar et al., 2019; Smith et al., 2022; Guzmán et al., 2021). The notion of visiting inland blue spaces as a form of respite also aligns with attention restoration theory (ART). ART, developed by Kaplan (1995), is based on the premise that the natural environment provides stimuli that captures an individual's attention. The stimuli enable individuals to focus on the environment rather than their own circumstances, in turn providing the opportunity to mentally recover from stress. The narrative exemplars highlighted the significant interest participants ascribed to various environmental features within blue space environments, including species of birds, information panels and the flow of water; this may account for the sense of escapism participants experienced.

The impact of day trips was twofold: when returning to known blue spaces, participants exhibited a sense of nostalgia and belonging; whereas in new environments participants recorded information learned, displaying a sense of curiosity. Nostalgia can lead to feelings of unhappiness by creating a longing for the past (May, 2017), however, participants typically enjoyed the process of reminiscing about their previous experiences. This aligns with the idea that nostalgia is a multidimensional concept (Pickering and Keightley, 2006) and while it centralises around loss, it can lead to increased resilience for individuals, providing a link with the past (Sedikides et al., 2008). During day trips to new environments, participants conveyed their interest in their surroundings. Curiosity can encourage interaction with others (Phillips, Evans and Muirhead, 2015) and contribute to wellbeing outcomes (Kashdan and Steger, 2007; Losecaat Vermeer et al., 2022). The social aspect of curiosity was highlighted in multiple forms across diary entries and may have contributed to restorative outcomes. This complements previous research that demonstrates the benefits afforded by day trips to a range of

environments, including both green and blue space areas, in terms of improving overall mood and self-esteem scores (Barton, Hine, and Pretty, 2009).

Although commonalities were present in the inland blue space exposure benefits discussed during specific types of blue space visits, the benefits were not considered mutually exclusive. Indeed, a wide range of exposure outcomes were often recorded in single diary entries; consistent with the broad range of health and social benefits associated with various forms of blue space exposure (Earl et al., 2022; White et al., 2020; Völker et al., 2016). The narrative analysis complements the broader thematic analysis results by providing rich insight into the reasonings behind individual variation in exposure outcomes. All four exemplars highlighted how different temporal trends, unique to each participant, led to an evolution in blue space interactions across time. This aligns with previous research, where participants identified their relationship with blue spaces had changed over time, across their life-course (Poulsen et al., 2022; Bell et al., 2017).

The temporal insight gained from the narrative analysis highlights the versatility of blue spaces. Furthermore, despite the significant variation in the ages and interests of participants, all were able to benefit from blue space exposure by adapting their visits to suit their current needs. For participant 2, who was older, the adaptations involved enjoying blue spaces cautiously whilst maintaining an awareness of the potential dangers of slippery riverside pathways over wintertime; whereas participant 3 worked towards gaining a better understanding of how the length and type of blue space visits could be adapted to improve their mental health. Current findings demonstrate the need to ensure future land-management strategies and public health interventions foster the versatility of inland blue space environments to allow individuals to continue to adapt their visits to suit their personal circumstances. To create inclusive environments, blue spaces should have the ability to alter across time as local communities change, and design ideas should be introduced in collaboration with local residents (Brinkhuijsen and Steenhuis, 2015; Lovell and Taylor, 2013).

Throughout the diary entries, there was a significant focus on the characteristics of nearby green space, with participants tracking the presence of a variety of seasonal plants. Blue spaces are often located near green space, such as lakes in urban and country parks or green corridors located along riverbanks. The combination of green and blue environments can be preferable for individuals (Finlay et al., 2015), therefore the vegetation surrounding freshwater may influence exposure outcomes. It has been proposed that the impact of green space may be more significant at smaller blue space types such as streams that are heavily surrounded by vegetation (Völker et al., 2018). However, an awareness of green space was present throughout the diary entries. This included visits to smaller blue spaces like urban ponds as well as visits to larger blue space areas like Loch Lomond and is consistent with a contingent valuation study that identified that lakeside vegetation has an important influence for visitors (McDougall et al., 2020). As suggested by Li et al., (2023), there is a need to move on from over-simplifying natural environments through the colour-coding of “green” and “blue” space environments. Research should instead establish how different landscape components, such as plants, water features, and rocks contribute to exposure outcomes (Li et al., 2023). Additionally, the importance of biodiversity or perceived biodiversity levels on inland blue space experiences should not be underestimated. A growing body of literature highlights the intricate relationship between human health, wellbeing and biodiversity (Marselle et al., 2021; Irvine et al., 2023). The findings from previous research, in combination with the diary results, suggest the need for a greater awareness of the potential interplay between green and blue space, alongside biodiversity levels, when considering environmental exposure outcomes.

The statistical analysis highlights that at the sample level, blue space exposure can lead to positive restorative exposure outcomes, regardless of the length of time spent at the freshwater environment. However, at the individual level, the combination of ROS scores and qualitative analysis indicated that due to a range of personal and environmental factors, not all inland blue space experiences lead to beneficial exposure outcomes. Whilst the majority of blue space research has focused on ‘healthy blue spaces’, there is now a growing recognition that blue space exposure is multifaceted and in certain circumstances may lead to negative health outcomes (Jewkes et al., 2019; Lengen, 2015; Fox et al., 2021). One key factor, which was

emphasised in the narrative and thematic analysis, is the need to maintain the quality of blue spaces. Participant's strong sense of place left them prone to being affected when an environment that was of significance to them was degraded. This vulnerability to environmental change has been highlighted in previous research documenting the detrimental impact of climate change on affected communities (Albrecht et al., 2007), and 'ecological grief' as a mental health response to climate-related loss of ecosystems and landscapes, including valued blue spaces, is an area of growing research interest (Cunsolo and Ellis, 2018). The widespread implications of the COVID-19 pandemic also led to feelings of solastalgia for coastal blue space users as they re-negotiated their relationship with local environments (Jellard and Bell, 2021).

This research captured the blue space experiences of forty-five adults from across Scotland. Further research is now required to identify how other populations perceive freshwater environments and to determine whether restorative outcomes may vary for different communities. Demographic factors have been associated with visit frequency to blue space areas (Laatikainen et al., 2015; Poulsen et al., 2022) and with influencing exposure outcomes (de Bell et al., 2017). Currently, most research has utilised cross-sectional methods, therefore, additional longitudinal research involving different community groups is required. To reduce health inequalities, there is a need to focus on social deprivation to ensure that individuals from across populations have equitable access to high quality natural environments and the opportunity to benefit from these areas (Mitchell and Popham, 2008, Geary et al., 2021).

Despite the data collection phase taking place between 2021 and 2022, the COVID-19 pandemic was only directly referred to in two diary entries. It is therefore not possible to determine the extent that the pandemic impacted the strong appreciation of outdoor environments recorded in diary entries. An increased use of natural environments among members of the public, as well as an increased recognition of the importance of these environments has been recorded in response to lockdown mitigations (Ugolini et al., 2020; Venter et al., 2020; Sneddon et al., 2022). However, quantifying the impact of the pandemic was beyond the scope of this research.

This research involved the novel application of solicited research diaries to investigate inland blue space exposure outcomes. The three-month follow up period for each participant enabled the diaries to record everyday routines for individuals whilst capturing unexpected events, such as the impact of storms or changes in personal circumstances on inland blue space experiences. The length of the diary could have been extended to capture greater detail relating to the impact of seasonality on environmental experiences; however, the diary was limited to three-months to minimise participant burden and respondent fatigue. Personal insights into daily encounters at freshwater environments were recorded, demonstrating the restorative potential of these areas. Although, it is possible that the diary methodology may have influenced participant responses. Previous research has highlighted the therapeutic nature of diary-keeping (Spowart and Nairn, 2013; Meth, 2003); similarly in the current research participants noted that the diary encouraged reflection, providing the opportunity to be present and mindful within inland blue spaces. This therefore could have contributed to the positive wellbeing outcomes recorded within diary entries. Further longitudinal research into inland blue space usage would create a triangulation of findings and clarify the restorative nature of these environments. An additional consideration regarding the diary methodology is the limited capacity to prompt participants and uncover extra information relating to topics of particular interest. Whilst this could be regarded as a limitation, the restricted interaction between researcher and participant helps to foster a participatory research approach, enabling participants to establish boundaries and depict stories in their own words (Meth, 2003).

3.5 Conclusion

This mixed methods study used solicited research diaries to determine whether exposure to inland blue spaces can lead to restorative health outcomes. The results identified that across a sixteen-month period, accessing inland blue spaces consistently led to restorative outcomes for Scottish adults and reinforces the growing recognition that freshwater areas are important resources for facilitating positive mental health and wellbeing outcomes. The longitudinal insight gathered from the blue space diaries emphasises the need for the introduction of efficient long-term environmental management strategies to ensure that freshwater environments continue to provide restorative benefits across time. Further research is required to clarify the complexities of blue and green space interactions and disentangle the day-to-day emotions that are superimposed onto outdoor encounters. Society's interaction with inland blue space is a complex topic that requires a mix of methods and approaches to decipher the range of benefits gained.

Chapter 4: How do weather conditions and environmental characteristics influence aesthetic preferences of freshwater environments?

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Abstract

Freshwater (inland) blue space environments provide a range of public health benefits to visitors. However, health related exposure outcomes are dynamic and can vary depending on several factors, including the environmental characteristics of freshwater environments and their surroundings. Developing and managing inland blue spaces to promote health and wellbeing therefore requires an understanding of whether specific freshwater attributes, and prevailing weather conditions, enhance or devalue landscape aesthetics. The aim of this study was to utilise a mixed methods research approach to investigate aesthetic preferences of inland blue spaces. A three-phase data collection method was adopted involving (i) analysis of a national-scale landscape image dataset; in combination with (ii) a national-scale online survey; and (iii) a series of in-person focus groups. We found environmental characteristics associated with the waterbody itself, as well as the characteristics of the nearby green space, to have a significant impact on the overall aesthetic appeal of inland blue spaces. Strong preference was demonstrated for inland blue spaces perceived to be of a high environmental quality and which have a natural, rather than human-modified, appearance. The findings highlight the need to conserve the quality of both the waterbody and waterside environment to encourage frequent recreational use and maintain the beneficial public health outcomes associated with inland blue spaces.

Keywords: Health and wellbeing; Green and blue space; Natural environments; Landscape aesthetics; Environmental exposure outcomes

4.1 Introduction

Inland blue spaces, or freshwater environments, have been shown to improve mental health and wellbeing outcomes at the individual and population level (McDougall et al., 2021; Garrett et al., 2019). The enhancement of blue space environments through regeneration projects - such as the restoration of fountains; the introduction of riverside parks; and the reopening of canals – are associated with significant health benefits (Vert et al., 2019b; Tieges et al., 2020; Satariano, 2022; Brückner et al., 2022). However, blue spaces and associated regeneration projects have not been utilised effectively as public health resources and interventions (Brückner et al., 2022; Zhang et al., 2022b). To assist with the introduction of evidence-based public health policies, a greater understanding of the extent to which environmental characteristics influence perceptions of, and health outcomes associated with, inland blue spaces is required (Beute et al., 2020). The perceived aesthetic appearance of an environment can significantly impact an individual's behaviour (Wu and He, 2021) and influence how regularly an individual uses an environment (Ball et al., 2001). Environmental aesthetics may therefore have a significant impact on environmental exposure outcomes (Seresinhe et al., 2015; Hoyle et al., 2017).

Higher ratings of environmental attractiveness and an increased perception of nature are associated with the presence of water in a landscape image (White et al., 2010; Luo et al., 2021). There is however a degree of variability, as specific features of blue space environments, such as the colour, size and type of waterbody can impact perceived environmental aesthetics and exposure outcomes (Lengen, 2015; Pitt, 2018; Smith et al., 2022; McDougall et al., 2022). One environmental characteristic that may influence the aesthetic appearance of blue spaces is the availability and appearance of nearby green space. The presence of trees and bushes at outdoor spaces has been identified as a key factor affecting environmental appearance and people's perception of nature, as well as the extent to which the blue space and surrounding vegetation are maintained (Williams et al., 2019; Luo et al., 2021). A greater proportion of green space near blue space can lead to increased ratings of aesthetic appeal; with more biodiverse green space associated with improved preference for blue space environments (Luo

et al., 2021; Ćwik et al., 2021; White et al., 2010). Given the variation within, and diversity of green and blue space environments, there is a need to develop a detailed understanding of how the quality and characteristics of nearby green space can impact aesthetic ratings of freshwater environments.

How prevailing weather conditions can affect aesthetic ratings of blue space environments is poorly understood, despite substantially changing the view and appearance of water and surrounding areas (White et al., 2020). Photo-based research has identified that adverse weather conditions can reduce preference for blue space environments (White et al., 2014) and a correlation between adverse weather conditions and reduced levels of outdoor physical activity has been reported (Wagner et al., 2019). For inland blue spaces, increased windspeeds have been linked with a reduction in time spent near freshwater (Elliott et al., 2019). However, the impact of weather is multifaceted with qualitative findings demonstrating that on occasions, the experience of adverse weather conditions, such as rain, can enhance an individual's blue space experience by establishing a connection with nature (Smith et al., 2022). Mixed research findings in combination with altering weather patterns due to climate change signals a need to improve understanding of the impact of weather on environmental exposure outcomes.

Environmental aesthetics is a growing research field and as such several different research methodologies have been developed to determine aesthetic appeal, including machine learning and social media data analytics (Jahani et al., 2022; Langemeyer et al., 2018). One way to effectively evaluate public perception of environmental characteristics and aesthetics is through the analysis of crowdsourced data. The online resource, 'Scenic-or-Not' (Data Science Lab, 2009) offers a novel open-access dataset of users' opinions on the appearance of geotagged photographs from across the United Kingdom. This dataset has previously determined that greater levels of happiness and higher levels of self-reported health are observed for inhabitants of more scenic regions (Seresinhe et al., 2015; Seresinhe et al., 2019). The Scenic-or-Not dataset has not yet been applied to investigate public perception of inland

blue spaces, with such analysis offering opportunities to advance the current blue space research field.

This paper utilises the Scenic-or-Not dataset as part of a three-phase mixed methods research approach to evaluate the extent to which the physical features of the environment can impact aesthetic preference for inland blue spaces. Broad aesthetic trends were identified across a large range of blue space environments through analysis of the Scenic-or-Not dataset. A complementary nation-wide online survey was also deployed to gain a comprehensive understanding of freshwater scenic ratings at the population level. Finally, a series of focus group discussions were held with small community groups to gain further insight into aesthetic preferences at the individual level. The three key research objectives were to: (i) investigate aesthetic preferences for freshwater environments; (ii) determine the extent to which weather conditions, alongside blue space and nearby green space characteristics, can impact the overall scenic ratings of freshwater environments; and (iii) assess how recreational use of blue spaces might vary depending on environmental aesthetics and characteristics.

4.2 Materials and Methods

A three-phased data collection approach was adopted to capture a wide range of perspectives on blue space aesthetic preferences. The research design and methods were approved by the General University Ethics Panel at the University of Stirling.

4.2.1 Scenic-or-Not Dataset Interrogation

Scenic ratings of images were obtained from the Scenic-or-Not website where online users are invited to anonymously rate, from 1 to 10, how scenic they consider an image to be; with 1 indicating the image is 'not scenic' and 10 indicating the image is 'very scenic'. The images included on this site have been obtained from the Geograph website (<https://www.geograph.org.uk>). A total of 217,000 photographs taken from different environments across the United Kingdom are included in the Scenic-or-Not dataset and a total of 1,536,054 scenic votes have been submitted, averaging 7 votes per image. The corresponding images were downloaded from Geograph and processed using Places365-CNN

software (Zhou et al., 2017) to generate a list of scene classifications per image (e.g. pond, river, canal, park, water-tower). The Places365-CNN software can classify images in up to 365 different categories. The categories determined by the software were then used to select only those records that contained freshwater (2045 images). These were manually checked to ensure they portrayed freshwater environments and the location of each photo was viewed on an Ordnance Survey map to verify it was a photograph of a recognised freshwater area. In total, 1015 freshwater Scenic-or-Not photos remained following manual cross-checking.

To analyse the Scenic-or-Not dataset, R Studio Version 4.1.1 was utilised with p values <0.05 considered significant. The date each image was taken, and the type of blue space shown was obtained from a corresponding record on the Geograph web-based resource. Analysis of variance (ANOVA) was used to assess the extent that scenic scores varied in relation to the season in which each photograph was taken and the type of blue space photographed. The seasons were classified by month, according to UK Met Office definitions for the northern hemisphere. Only freshwater blue space types (e.g. waterfalls, lakes, rivers, canals) that had at least twenty-five associated Scenic-or-Not images were included in the analysis. Scenic scores were tested for distribution and homogeneity of variances before parametric tests were conducted. In instances where assumptions were not met, Welch's ANOVA was used. Across the 1015 freshwater images, the most common image attributes classified by the Places365-CNN software that were of relevance to the research question (relating to weather, blue space, green space, and surroundings), were identified. To compare the effect of the image attributes on scenic scores, Welch's t-test was used, and the effect-size (Cohen's d) was calculated for each t-test. Due to the nature of the software, there was a limit to how much the Places365-CNN generated image attributes could discern between different weather conditions, therefore for the Scenic-or-Not dataset interrogation, 'sunny' or 'cloudy' were the only comparable weather types.

4.2.2 Nationwide Online Survey

To complement the Scenic-or-Not database and provide an overview of the impact of environmental characteristics on aesthetic preferences, an online nationally representative survey was conducted using the Qualtrics UK platform (<https://www.qualtrics.com>). Using a Qualtrics online panel that consists of individuals who have previously agreed to be contacted by companies for research purposes, the survey was distributed to 1015 members of the Scottish adult population. An initial pilot study was carried out with 50 respondents to provide the opportunity to refine any questions for increased clarity. The main data collection period occurred between 07/06/22 to 29/06/22. Recruitment rates were managed by the Qualtrics UK platform, with key demographic information, namely age and gender, regularly reviewed to ensure the sample was representative of the Scottish adult population.

Before completing the survey, participants were required to complete an electronic consent form. Screening questions were used to confirm eligibility for the study (i.e., residing in Scotland and over the age of 18), after which panel members were directed to the survey. Socio-demographic information on gender, age, location and how often an individual participated in outdoor activities was collected. The main body of the survey focused on three images selected from the Scenic-or-Not Database. The images were selected because they all included a similar blue space (in this case a small stream, i.e., running water) but accommodated variations in waterside vegetation and surroundings (Table 2) to enable a comparison of the influence of the surrounding environment on blue space ratings. A total of three images were used in the survey as this enabled the impact of variation in the appearance of vegetation and environmental surroundings to be considered in detail, whilst minimising participant fatigue. All images were taken from ground-level, with an eye-level perspective and had a similar image quality, taken between 2006 and 2007 in the United Kingdom. The survey questions deliberately asked participants to focus on the landscape portrayed in the image rather than the image itself.

Table 2: Scenic-or-Not images selected for online survey.

Image Number	Image	Environmental Features of Interest
1		• Remote landscape • Natural appearance of grass • Monoculture of trees • Light blue sky colour
2		• Remote landscape • Short grass • Deciduous and coniferous trees • Strong blue sky colour
3		• Suburban landscape • Combination of long and manicured grass • White sky colour • Reflections in water

Within the survey, participants were shown the three images and asked to indicate how scenic they considered each photograph to be. The scoring approach was the same as that used in the Scenic-or-Not website with participants asked to rate images, from 1 to 10, with 1 being 'not scenic' and 10 being 'very scenic'. Participants were also asked to consider the three images and select their most and least favourite image. For each image, respondents were asked three Likert scale questions to determine perceptions of how weather conditions, the appearance of the green space and the suitability of the environment for recreation influenced the aesthetic appeal of each image. The full structure of the questionnaire is included in the appendix (Appendix 6).

Statistical analysis of the nationwide online survey was carried out using R Studio Version 4.1.1 and involved the use of Tukey's range test to compare differences between scenic ratings of the three selected Scenic-or-Not images (Table 2). Associations between the image displayed and the respondent's level of agreement with each statement was determined using the chi-squared test. Associations between scenic ratings, environmental conditions and recreational usage were tested for using Ordinal Logistic Regression and were reported as Odds Ratios (OR) with 95% confidence intervals (CIs). Three ordinal logistic regression models were developed, one for each image. All models were controlled for age, gender, and the location of the participant (rural, urban or suburban). Within each of the three models, all independent variables were included to account for the overall effect of environmental attributes on scenic scores. Spearman's Rank Correlation Test was used to determine associations (p) between environmental conditions and recreational usage. For all statistical tests, p values <0.05 were considered significant.

4.2.3 Focus Group Sessions

Four focus groups were held in different communities across Scotland from June to September 2022, with 20 participants taking part across the four groups. Most individuals involved were recruited from general community interest groups; however, those involved in group 4, all had a specific interest in hydrology and freshwater environments. For all focus groups a structured topic guide was followed, and the average length of each focus group session was 60 minutes. Each focus-group session was audio-recorded.

Demographic information for each participant was obtained using a short survey at the start of each focus group. The focus group began with an introductory map-based question where participants identified their favourite freshwater environments across Scotland. Participants were then asked to draw and discuss what they considered a scenic freshwater environment to be, before considering what factors would deter visits to inland blue spaces. Subsequent discussion centred around 15 photos taken from the 'Scenic or Not' database (See Appendix 6, Table A4), and participants were asked a series of three ranking questions that generated discussion regarding the reasoning behind aesthetic preferences. The 15 photos were chosen to represent a range of freshwater types, weather conditions and to display urban, rural and suburban environments. Four of the fifteen selected photos did not contain water and therefore provided 'control' scenarios. To focus discussions on the physical environment, no photos that contained animals or people were included. Before taking part in the research, informed consent was required from all participants and no incentives were offered for taking part in the study.

To analyse the focus group discussions, all audio recordings were transcribed to Microsoft Word documents. Qualitative analysis was carried out once all focus group sessions had taken place. A six-stage reflexive thematic analysis approach was used as outlined by Terry and Hayfield (2021). The discussions from each focus group session were studied in detail before identifying codes, themes and commonalities across the four transcripts. Throughout the analysis process, codes and themes were repeatedly adjusted to develop a robust representation of the data.

4.3 Results

4.3.1 Scenic-or-Not Dataset Findings

The mean scenic score of 1015 freshwater images obtained from the Scenic-or-Not dataset was 5.48 out of 10. There was a significant difference in the mean scenic scores for images taken across different seasons ($p < 0.001$; Figure A1); scenic scores for images taken in summer were significantly higher than for images taken in winter ($p < 0.001$). The scenic scores recorded for images taken in autumn were significantly higher than winter images ($p = 0.01$). A significant difference was also observed across the mean scenic scores associated with inland blue space types ($p < 0.001$) (Figure 9). Images that displayed waterfalls scored significantly higher scenic scores (mean = 6.74) than all other blue space types ($p < 0.001$). Lakes were associated with significantly higher scenic scores (mean = 5.32) than canals, ponds, rivers and streams ($p < 0.001$) as well as reservoirs ($p = 0.002$).

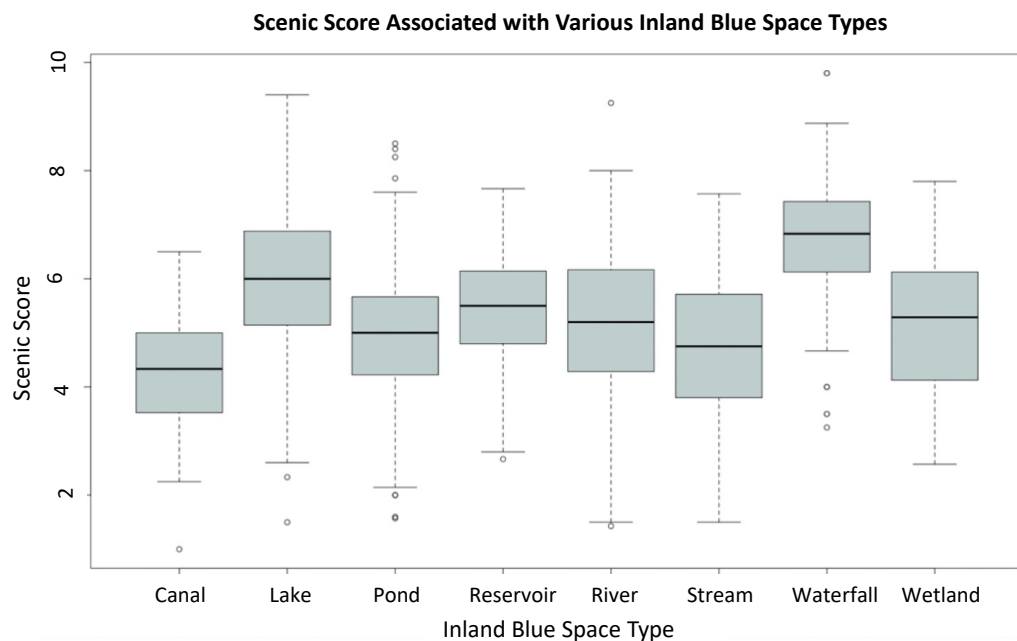


Figure 9: Variation of scenic scores across the Scenic-or-Not dataset depending on the type of inland blue space shown in each image. Centre horizontal dash, box and whiskers represent median, interquartile range and upper and lower limits, respectively.

Analysis of the Places-365-CNN tags identified that specific image attributes influenced scenic ratings (Table 3). Strong significant effect sizes were observed for blue-space environments that were considered to have ‘man-made’ characteristics (negative effect, $d = -1.03$; $p < 0.001$) and for areas with running water (positive effect, $d = 1.03$; $p < 0.001$).

Table 3: Effect of key image attributes of interest on scenic scores. All image attributes were categorised by the Places-365-CNN software. The term ‘man-made’ in this instance refers to the presence of any infrastructure, such as bridges, roads, fences and buildings. In each case, the p-value and Cohen’s d value are obtained from comparing the subset of images which contain the attribute of interest with the remaining images from the dataset which do not contain the attribute of interest.

Image Attribute	Mean Scenic Score	Mean Scenic Score of Photos Without Image Attribute	Effect Size - Cohen’s d
Weather:			
Sunny	5.28***	5.74	-0.32
Clouds	5.26	5.50	-0.17
Blue Space:			
Running Water	6.80***	5.37	1.03
Still Water	5.23***	5.59	-0.25
Green Space:			
Vegetation	5.43*	5.69	-0.18
Trees	5.33***	5.61	-0.2
Grass	5.15***	5.71	-0.4
Surroundings:			
Man-made	4.45***	5.81	-1.03
Rugged Scene	6.45***	5.27	0.86
Effect size: 0.2 = small; 0.5 = medium; 0.8 = large. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.			

4.3.2. Online Nationwide Survey Results

A total of 1015 Scottish adults completed the online survey in full (Appendix 6, Table A1). From the three images presented (Table 2), 59.6% of respondents rated image 2 as their favourite and 83.3% rated image 3 as their least favourite. There was a significant difference in the scenic scores attributed to the three photos (image 1: mean = 6.61; image 2: mean = 7.14; image 3: mean = 4.38; Figure A2; $p < 0.001$); with the scenic rating for image 3 found to be significantly lower relative to the scenic rating of images 1 and 2 ($p < 0.001$).

The mean scenic scores obtained from the survey were compared with the original score obtained from the Scenic-or-Not database. A significant difference between the survey score and the original score was only identified for image 1 (Survey Score = 6.81/10, Scenic-or-Not Score = 4/10, $p = 0.01$). For images 2 and 3, the larger survey population had a similar opinion of scenic rating compared to the users of the Scenic-or-Not website ($p > 0.05$).

There was a significant association between the image displayed and the respondent's ratings of the green space, weather conditions and recreational opportunity ($p < 0.001$). The environment shown in image 2 was preferred for recreation with 76.94% of participants indicating they would visit the environment for recreational purposes (Strongly Agree and Agree category), compared to 70.24% for image 1 and 30.04% for image 3 (Figure 10c). Similarly, the weather conditions and green space shown in image 2 were also preferred relative to other images. For green space, 79.11% of respondents considered the vegetation shown in image 2 to be aesthetically pleasing as opposed to 72.41% for image 1 and 34.77% for image 3 (Figure 10a). Additionally, 86.40% of participants considered the weather conditions to be pleasant in image 2, compared with 70.02% for image 1 and 52.02% for image 3 (Figure 10b).

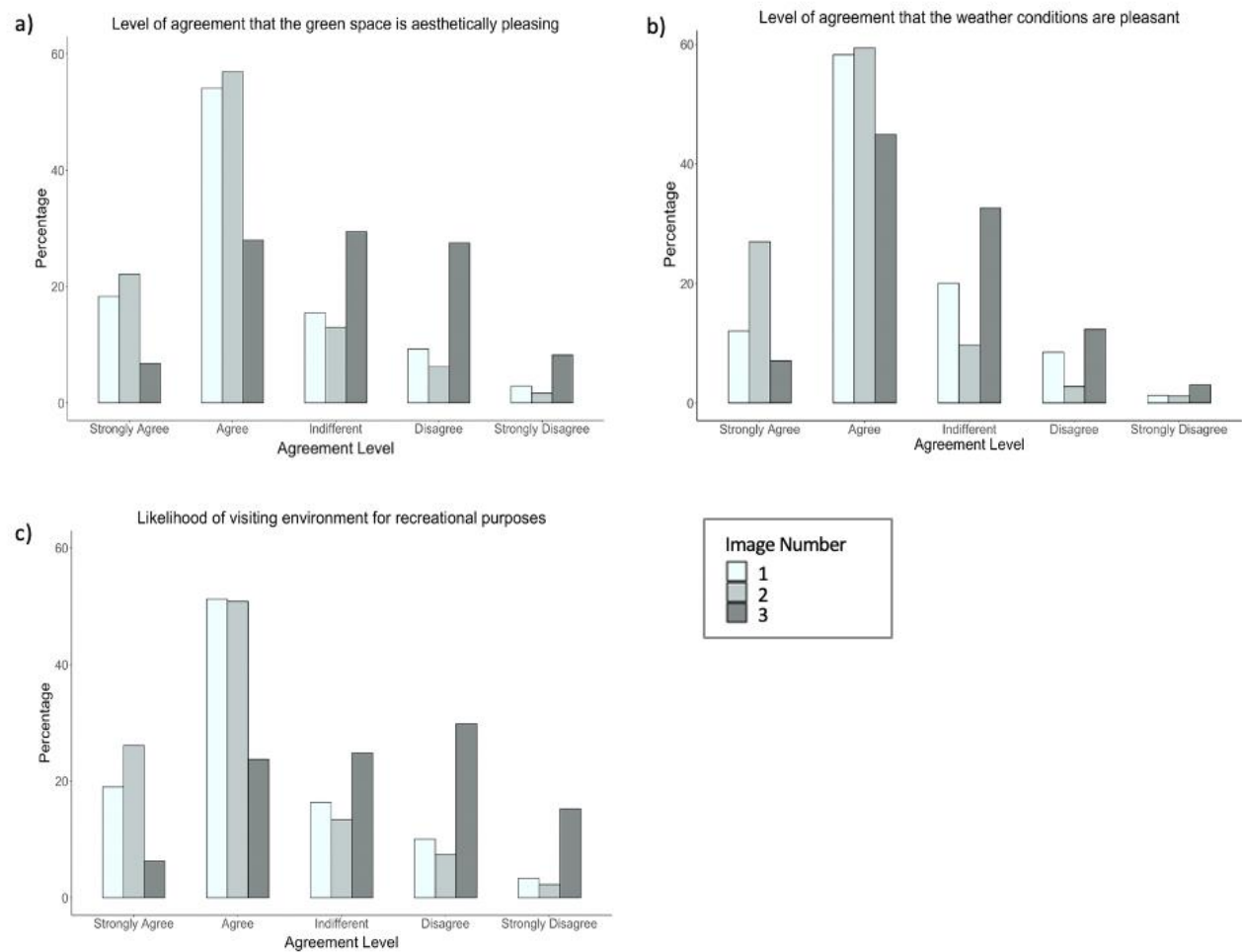


Figure 10: Likert-scale responses for each image to three environmental statements, namely: "The grass and trees shown are aesthetically pleasing."; "The weather conditions are pleasant."; and "This is the kind of environment I would use for recreational purposes

Ordinal regression models were used to develop an understanding of the reasoning behind the scenic scores assigned to each image. Each model was adjusted for age, gender and whether the respondent lives in a rural, urban, or suburban location (Table 4, Table 5, Table 6).

Table 4: Ordinal logistic regression model for the factors influencing scenic ratings of image 1. A higher odds ratio indicates the variable contributed to a greater likelihood of a high scenic score.

Image 1				
Statement	Level of Agreement	Odds Ratio	2.5%	97.5%
Green space – <i>“The grass and trees shown are aesthetically pleasing”</i>	Strongly Disagree	0.80	0.34	1.89
	Disagree	(ref)	-	-
	Indifferent	1.64*	1.03	2.63
	Agree	3.03***	1.93	4.74
	Strongly Agree	4.57***	2.65	7.89
Weather – <i>“The weather conditions are pleasant”</i>	Strongly Disagree	3.66*	1.15	11.99
	Disagree	(ref)	-	-
	Indifferent	1.47	0.93	2.33
	Agree	2.11**	1.35	3.29
	Strongly Agree	2.66***	1.51	4.70
Recreation – <i>“This is the kind of environment I would use for recreational purposes”</i>	Strongly Disagree	0.45*	0.22	0.96
	Disagree	(ref)	-	-
	Indifferent	1.05*	0.68	1.64
	Agree	1.50	1.00	2.25
	Strongly Agree	2.50***	1.51	4.12
*** p < 0.001, ** p < 0.01, * p < 0.05.				

Table 5: Ordinal logistic regression model for the factors influencing scenic ratings of image 2. A higher odds ratio indicates the variable contributed to a greater likelihood of a high scenic score.

Image 2				
Statement	Level of Agreement	Odds Ratio	2.5%	97.5%
Green space – <i>“The grass and trees shown are aesthetically pleasing”</i>	Strongly Disagree	3.16*	1.06	9.64
	Disagree	(ref)	-	-
	Indifferent	1.27	0.72	2.25
	Agree	2.99***	1.72	5.18
	Strongly Agree	6.49***	3.39	12.37
Weather – <i>“The weather conditions are pleasant”</i>	Strongly Disagree	0.32	0.08	1.25
	Disagree	(ref)	-	-
	Indifferent	1.17	0.53	2.57
	Agree	2.11	0.99	4.51
	Strongly Agree	2.34*	1.06	5.22
Recreation – <i>“This is the kind of environment I would use for recreational purposes”</i>	Strongly Disagree	0.43	0.18	1.06
	Disagree	(ref)	-	-
	Indifferent	0.79	0.47	1.34
	Agree	1.19	0.73	1.96
	Strongly Agree	1.62	0.94	2.84
*** p < 0.001, ** p < 0.01, * p < 0.05.				

Table 6: Ordinal regression model for the factors influencing scenic ratings of image 3. A higher odds ratio indicates the variable contributed to a greater likelihood of a high scenic score.

Image 3				
Statement	Level of Agreement	Odds Ratio	2.5%	97.5%
Green space – “The grass and trees shown are aesthetically pleasing”	Strongly Disagree	0.40***	0.24	0.65
	Disagree	(ref)	-	-
	Indifferent	1.50*	1.09	2.07
	Agree	2.35***	1.64	3.38
	Strongly Agree	3.36***	1.70	6.68
Weather – “The weather conditions are pleasant”	Strongly Disagree	2.15	1.0	4.65
	Disagree	(ref)	-	-
	Indifferent	1.29	0.88	1.89
	Agree	1.54	1.05	2.26
	Strongly Agree	1.15	0.59	2.22
Recreation – “This is the kind of environment I would use for recreational purposes”	Strongly Disagree	0.62*	0.42	0.91
	Disagree	(ref)	-	-
	Indifferent	1.61**	1.18	2.19
	Agree	1.84***	1.31	2.60
	Strongly Agree	3.15***	1.64	6.08
*** p < 0.001, ** p < 0.01, * p < 0.05.				

With regards to green space, the ordinal regression findings indicated that individuals who agreed or strongly agreed that the green space in an image was aesthetically pleasing were significantly more likely to rate the image with a higher scenic score ($p < 0.001$; Table 4, Table 5, Table 6). Likewise, for image 3, those who strongly disagreed that the green space was aesthetically pleasing, were significantly less likely to rate the image with a high scenic score ($p < 0.001$).

Respondents who strongly agreed that the weather conditions shown in images 1 and 2 were pleasant were significantly more likely to rate the image with a higher scenic score (Table 4, Table 5) (image 1: OR 2.66, 95% CI 1.51–4.7, $p < 0.001$; image 2: OR 2.34, 95% CI 1.06–5.22, $p < 0.05$). However, the association between the weather conditions and scenic scores was weaker

than that observed for green space and scenic scores. For image 3, no significant association was observed between strongly agreeing that the weather conditions were pleasant and rating the image with a higher scenic score. Respondents who strongly agreed that they would use the area for recreational purposes were significantly more likely to rank the image with a higher scenic score for images 1 and 3 ($p < 0.001$).

From responses to the Likert scale questions, Spearman's rank correlation was used to assess the relationship between willingness to use the environment for recreation and opinions on weather and green space for each image (Table 7). A positive relationship was found between rating green space as aesthetically pleasing and willingness to use the environment for recreation. Similarly, a positive relationship was found between considering the weather conditions to be pleasant and willingness to use the environment for recreation.

Table 7: Spearman's rank correlation results for each image.

Image Number	Relationship	Spearman's ρ
1	Weather and Recreation	0.39***
	Green space and Recreation	0.58***
2	Weather and Recreation	0.48***
	Green space and Recreation	0.62***
3	Weather and Recreation	0.33***
	Green space and Recreation	0.60***
Spearman's ρ : 0.01-0.19 = No or negligible relationship; 0.20-0.29 = Weak relationship; 0.30-0.39 = Moderate relationship; 0.40-0.69 = Strong relationship; ≥ 0.70 = Very strong relationship.		
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.		

4.3.3 Focus Group Findings

Out of the twenty individuals who took part in the focus group sessions, most lived in a rural area. Participant demographics alongside the Scenic-or-Not images used to stimulate discussion are included in the appendix (Tables A2, A3 and A4). The thematic analysis of focus group discussions centred around two themes: the importance of environmental characteristics on the appearance of blue spaces; and recreational use of inland blue space.

4.3.3.1 Thematic Analysis: Environmental Characteristics

Participants highlighted the overarching influence that green spaces had on scenic ratings. Green spaces that encouraged the presence of wildlife near freshwater areas were highly valued. Similarly, the presence of native plants and deciduous trees near freshwater environments were viewed positively during all focus group sessions. Participants disliked environments such as parklands, agricultural areas and forestry which they perceived to be ‘manufactured’ or ‘staged’. Coniferous plantations were considered to be dark, gloomy, and a blight on the landscape. When describing their ideal freshwater environment, one participant from a rural area stated they would prefer to have *“no forests around, but actual trees, nice trees”* (Participant 1, Group 1, Female, 45–54). Another participant said they would have *“none of your pine tree nonsense”* (Participant 2, Group 1, Female, 45–54).

Across the focus groups, there was a shared preference for areas of flowing water, rather than still or standing water. In line with this, rivers and waterfalls were highly regarded. For some, this preference arose because of the sound associated with flowing water. As one participant explained, the blue space didn't have to be *“a huge majestic waterfall but just to stand beside it, a burn that's gurgling and even a wee one, I think that's a really really peaceful place to be.”* (Participant 3, Group 3, Female, 65–74).

Similar to the preference for green spaces to be natural and unmanaged, participants preferred for inland blue spaces to be unaffected by human populations. Rivers that were free to change course and meander, were regarded as scenic. Participants disliked the presence of built infrastructure that affected the course of the river or quality of the water. Pipes were

associated with pollution and consequently had a negative impact on the aesthetic value of a freshwater environment. Industrial, agricultural and domestic pollution sources were frequently mentioned by participants as having a detrimental effect on freshwater areas.

During focus group 4, where individuals all had a specific interest in freshwater environments, participants highlighted how their education had altered their perception of the scenic value of blue spaces. One individual explained how they used to enjoy weirs because they provided a challenge when kayaking. However, since learning about the impact of weirs on the movement of fish and eels they no longer approve of these constructions. Participants in this focus group agreed that *“if some of the things that happened to fish and life in the river were more visible, like they would be in the countryside, then there'd be an outpouring of ‘we need to do something about this’.”* (Participant 4, Group 4, Male, 65–74).

Whilst the presence of man-made constructions in natural environments was typically viewed negatively by participants, bridges were associated with benefitting blue space experiences. Bridges were regarded as adding interest to blue spaces and provided the opportunity to explore freshwater environments further.

4.3.3.2 Thematic Analysis: The Impact of Environmental Aesthetics on Recreational Use of Blue Space

During group discussions it became apparent that participants felt that living in the Scottish countryside provided them with better access to inland blue space. It was assumed that individuals living in urban areas or in England would not be able to benefit from the same levels of access. Rural blue spaces were regarded as high-quality environments, in comparison, shopping trolleys, litter and other forms of pollution were frequently associated with urban blue spaces.

“I think we're quite fortunate in Scotland, I think if you were doing the same thing somewhere in Manchester it would be a completely different set of criteria that you're dealing with.”

(Participant 5, Group 3, Male, 65–74).

A key aspect that distinguished Scottish blue space from English blue space for participants was the ‘right-to-roam’. The right-to-roam, introduced in the Land Reform Scotland Act (2003), is the right for responsibly behaved individuals to access land and inland waters across Scotland, with a few exceptions such as quarries, railways, and farmyards. No focus-groups were directly asked about the right-to-roam; however, all four focus-groups discussed it in detail. The right is not established by law in England and participants observed the stark difference in access it created. As one participant explained; *“Well last year I was down in Coldstream and you walk across the bridge, you walk into England, the first thing you see is a sign ‘private no entry’.”*

(Participant 6, Group 3, Male, 75 years or older).

Although participants valued the accessibility granted by the right-to-roam, they highlighted that due to landowner hostility, it was not always possible to access Scottish inland blue spaces. Landowner hostility was discussed in numerous forms, from direct confrontation with landowners to the presence of off-putting signs. A wide range of signs were reported by participants, including ones that warned of ‘Bull in Field’ when there was no apparent presence of cattle and ones that banned dogs from accessing footpaths. There was a strong consensus that these signs significantly impacted their blue space visits and had a detrimental impact on the appearance of environments.

Within focus-group discussions, it became evident that quiet, remote, blue space environments were highly valued. Being able to access these areas without encountering other people was regarded as a key benefit. However, whilst participants valued quiet freshwater areas, some individuals did enjoy seeing others engage with inland blue spaces. Specific demographic groups, such as children and families were a welcome sight at freshwater areas and there was a recognition of the importance of encouraging younger generations to engage with nature. Regardless of demographic groups, if other users were behaving in what the participant's

considered to be an appropriate manner, then their presence did not have a detrimental effect on the experience.

“I do enjoy the loch when you get families who've obviously come out from the city, you can tell and they've got their picnic and they've got their family and the kids are all running. I do enjoy that, yeah” (Participant 7, Group 4, Female, 65–74).

Participants found it off-putting if they saw adults who were behaving recklessly in the water, for instance using inflatables, and not wearing buoyancy aids when taking part in watersports. Additionally, those who did not respect the countryside and used disposable barbecues or littered were regarded as having a strong negative impact on the environment.

“I think in Scotland, I say as an Englishman, I think we have some of the most beautiful scenic areas that are wonderful and I would agree that they are damaged by other people's lack of care really” (Participant 8, Group 2, Male, 25–34).

There was a general consensus that the most appropriate way to encourage greater access to freshwater environments would be through increased public transport and investment in appropriate transport infrastructure. Two focus groups discussed public transport in detail and emphasised the significant repercussions they felt government funding restrictions had on access to the Scottish countryside. Yosemite Valley was highlighted as an example of a natural area where the effective introduction of shuttle buses has enabled visitors to access the area without the use of cars.

4.4 Discussion

Through the application of a mixed methods research approach, this study has provided detailed layered insight into the subjective nature of aesthetic preferences for blue space environments. The analysis of the Scenic-or-Not dataset alongside the application of an online survey and focus group sessions enabled a triangulation of research findings and demonstrated the significant impact of environmental characteristics on the aesthetic value of blue spaces. Three key factors were considered, namely weather conditions, blue space characteristics and nearby green space. However, the combination of research methods enabled aesthetic appeal to be considered from multiple perspectives and highlighted an extensive range of additional environmental factors that can impact the appearance and enjoyment of inland blue spaces (Figure 11).

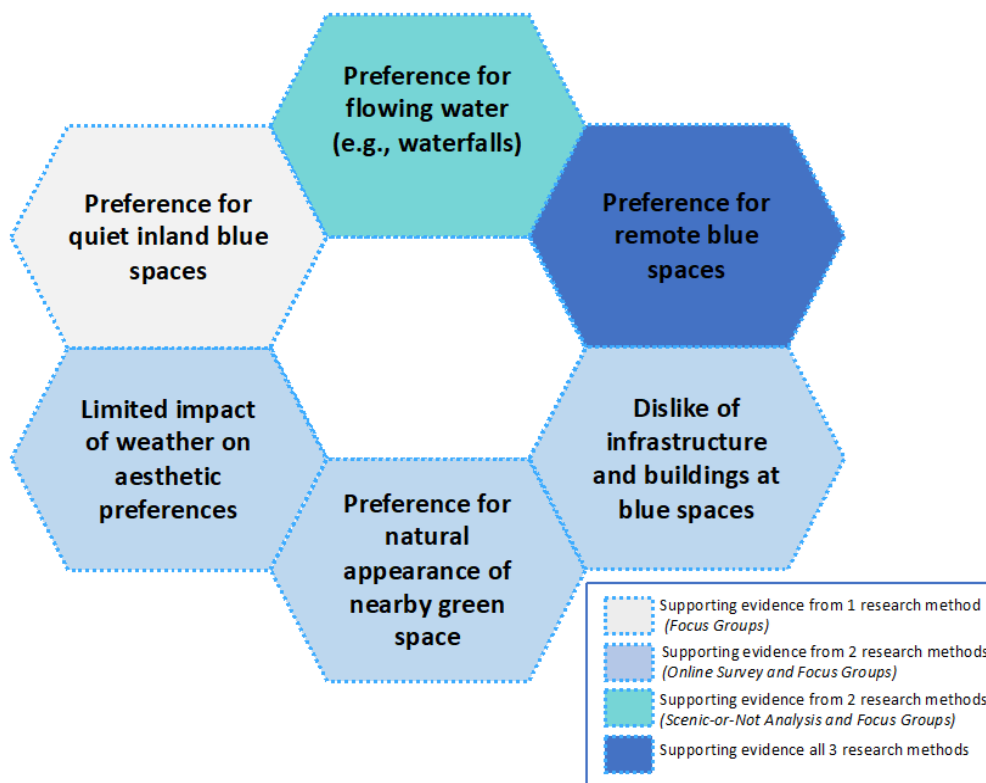


Figure 11: Triangulation of key findings from the three research methods used in the mixed methods research approach.

Research into environmental psychology suggests that humans exhibit an inherent preference for specific types of environments; preferences can however alter across time and are dependent on a range of factors including cultural and societal factors as well as familiarity with landscapes (Hartmann and Apaolaza-Ibáñez, 2010; Moura et al., 2018; Falk and Balling, 2009; Townsend and Barton, 2018). Over the past two decades, key factors that may have altered environmental preferences are the onset of the Anthropocene and consequently the effects of climate change (Auer, 2019; McCumber and Davis, 2022). With higher population densities and greater awareness of human impact on natural environments, there is growing interest in visiting environments which are perceived as ‘isolated’ or ‘remote’ (Chylińska, 2022; McCumber and Davis, 2022). The results from the current study further highlight the significant value attributed to remote blue space environments, with the Scenic-or-Not data-analysis and the nationally representative online survey illustrating this broad trend. Qualitative insight gained from focus group sessions also indicates that rural blue spaces with lower levels of human impact, are highly valued. However, given the tendency for environmental preferences to evolve, further longitudinal research would help to assess the extent that environmental preferences for blue spaces alter and the effect this has on recreational use. Social media data analytics are one research method that offers the potential to effectively track changes in public perception of landscape aesthetics over time and space (Havinga et al., 2021).

Despite the increasing recognition that environmental aesthetics can evolve over time, land use planning strategies have remained comparatively stagnant. As demonstrated by the thematic analysis, participants would not actively choose to visit ‘manufactured’ blue space environments. This reflects the challenge of successfully integrating nature and biodiversity into built-up areas (Hernandez-Santin et al., 2023). The incorporation of natural environments within cities typically provides ‘passive beauty’, following similar landscape designs regardless of the geographical and cultural context (Laurian et al., 2022). The current research findings, alongside previous research, demonstrate that blue space management strategies should incorporate a degree of re-wilding, through allowing greater freedom for ecological processes, such as enabling waterbodies to change shape and nearby vegetation to grow (Brierley et al., 2022; Usher et al., 2020). This will not only provide ecological benefits, but may also improve

aesthetic appearance, helping to provide positive health-related exposure outcomes (Milligan, 2022; Brierley et al., 2023; Usher et al., 2020). Re-wilding, however, incorporates a broad spectrum of land-use changes; equally broad are the emotional responses to re-wilding projects (Tanasescu, 2017; Wynne-Jones, 2022). Often when discussing re-wilding, participants were referring to smaller-scale blue space changes that they perceived to be aesthetically pleasing, such as growing native trees. Future research should focus on the practicalities of developing land-use management strategies to sustainably align aesthetic preferences with ecological benefits.

The research findings from the online survey and focus groups demonstrated a strong relationship between the appearance of nearby green space and the environmental appeal of inland blue space. However, results from the Scenic-or-Not data analysis were less consistent, with trees, grass and vegetation all found to have a negative effect on scenic scores. This discrepancy between the three data collection methods is likely because the Places-365-CNN software, used to test for the presence of green space in the Scenic-or-Not dataset analysis, cannot determine green space quality or biodiversity levels. The quality of green spaces, in terms of diversity of species and the presence of litter, can have a significant impact on perceptions and use of natural environments, with members of the public willing to pay to preserve waterside environments (McDougall et al., 2020; Talal et al., 2021; Arnberger and Eder, 2015; Luo et al., 2021). The focus group findings demonstrated the importance of high quality nearby green space for creating scenic inland blue space environments, with the presence of native species and a high biodiversity of plants being strongly valued by participants. In line with this, the BlueHealth Environmental Assessment Tool (BEAT) for comparing the quality of blue space environments, places a strong emphasis on the importance of vegetation for determining the overall quality of blue spaces (Mishra et al., 2021).

The fluidity of water has previously been ascribed as one of the key aspects contributing to the therapeutic nature of blue spaces; with areas of flowing water like rivers and canals associated with positive wellbeing outcomes (Strang, 2006; Pitt, 2018; McDougall et al., 2022; Volker and Kistemann, 2013; Vaeztavakoli et al., 2018). Findings from this research demonstrate that while

flowing waterbodies in general were highly valued, meandering rivers and waterfalls were preferred. The aesthetic appeal of waterfalls has been extensively explored in arts and literary fiction, and the economic benefits of these areas in terms of tourism are clear (Hudson, 2000; Hudson, 2006; Haghe, 2011; Oyelami et al., 2023); however, inland blue space research has not yet focused on waterfalls in detail. Given the positive response to images of waterfalls, further research into the potential health benefits associated with exposure to waterfalls is now warranted. Additional research will help to better inform blue space management strategies and create greater opportunities utilizing dynamic environmental management strategies at inland blue spaces.

Alongside the type of inland blue space, the perceived quality of the water was also important to focus-group participants. Frequency of recreational visits to blue spaces have been linked with water quality and pollution levels (Börger et al., 2021; Tienhaara et al., 2021). Similarly, high levels of pollution and the presence of litter in the water were identified as key factors that would deter participants from visiting a blue space environment. Most focus group participants lived in rural Scotland and felt this provided them with a clear advantage in terms of access to high quality blue space environments. Participants suggested that urban blue spaces were more likely to be polluted than their rural counterparts. Globally, urban waters have been shown to contain high levels of water pollution (Davis et al., 2022; McGrane, 2016; Hasan et al., 2021). However, there is a lack of blue space research into urban and rural differences in terms of relative access to and usage of high-quality blue space environments. This form of research would be particularly beneficial in Scotland, where public transport is limited in rural areas and so access to a car can significantly affect an individual's ability to visit natural environments. To assess the extent of environmental injustices, it would be worthwhile comparing perceptions of urban and rural inland blue spaces with a varied sample group from rural, urban and suburban areas.

In contrast to other environmental characteristics, such as the quality of green and blue space, focus group participants only briefly discussed the impact of weather conditions. Similarly, the weather conditions had a lesser effect on online survey respondents' willingness to visit an

environment for recreational purposes than the appearance of nearby green space did. Previous research has identified that sunshine and warm weather increases the aesthetic value of blue spaces and can encourage visitors (Grzyb and Kulczyk, 2023; White et al., 2014). However, given the complex range of weather conditions and the subjective opinions associated with them, further research is required to assess the relative importance of weather on blue space experiences and aesthetic appeal. It would be beneficial to deploy in-situ methodologies such as walking interviews and ethnography to gain detailed insight into the dynamic impact of weather conditions on blue space experiences.

The Scenic-or-Not dataset analysis and online survey provided insight into the relative importance of environmental characteristics, such as green space quality, on the aesthetic appeal of inland blue spaces. The discussions from the focus group sessions further emphasised the impact of these environmental characteristics; however, they also highlighted the multi-dimensional nature of blue space experiences. Furthermore, while environmental aesthetics impacted participants willingness to visit blue spaces, their personal experiences informed repeat visits. The sounds associated with an environment such as the noise of cars and wildlife had a significant impact on participants' experience. Peaceful and quiet landscapes were preferred, aligning with the significant body of research documenting natural and quiet soundscapes as valuable environmental characteristics for promoting wellbeing outcomes (Pijanowski et al., 2011; Thorne and Shepherd, 2013; Uebel et al., 2022). In addition to soundscapes, interactions with other blue space users also had an impact, with hostile landowners cited as a key factor contributing to negative experiences. Green space research has highlighted how due to socio-cultural relations different parks can be perceived as belonging to a specific community group, thus deterring other groups from using the environment (Collier, 2022; Hoffmann et al., 2017). The majority of blue space research investigating environmental injustices has so far focused on urban areas, documenting the significant impact of socioeconomic status on blue space access (Wessells, 2014; Haeffner et al., 2017; Korpilo et al., 2021). This current research highlights the need to assess the influence of power-dynamics in determining access to rural blue spaces.

Whilst the three-phase data collection approach provided novel insight into inland blue space aesthetic preferences, the limitations of the research should be acknowledged. Since environmental aesthetics are highly subjective and dependent on various cultural factors, the findings may not be generalisable to other contexts (Keleg et al., 2021). Additionally, as highlighted by focus group participants, there is an inherent limitation in the ability of a photograph to portray the nuances of an environment. Soundscapes, wildlife, and the presence of others all influence the overall appeal of an environment (Uebel et al., 2022; Fisher et al., 2021). Therefore, complementary future research into aesthetic preferences for inland blue spaces could focus on the application of in-situ methodologies, such as walking interviews, to capture the multisensory nature of inland blue spaces.

4.5 Conclusion

This study contributes important findings to a growing inland blue space evidence base by providing detailed insight into public perceptions on the appearance of freshwater environments. Whilst a diverse range of environmental preferences were recorded across the three data collection methods, key commonalities emerged. In relation to both the blue space and the surrounding green space, there was a common preference for natural environments that were not overly managed, and which were unaffected by pollution. The current research findings indicate that there is a need to preserve the quality of blue spaces to ensure that exposure to these environments continues to provide individuals with positive mental and physical health outcomes. In addition to this, sustainable blue space planning and management strategies should be introduced to re-wild aspects of urban and suburban blue spaces to increase the aesthetic appeal of these environments and encourage individuals to use inland blue spaces for recreational purposes.

Chapter 5: Health and wellbeing (dis)benefits of accessing inland blue spaces over the course of the COVID-19 pandemic

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Abstract

The COVID-19 pandemic led to widespread repercussions, affecting all aspects of society, from global economics to everyday social interactions. Due to the significant uncertainty caused by the pandemic, many individuals sought solace from nature. Freshwater environments, or inland blue spaces, are one type of natural environment that may have acted as a vital public health resource for communities during the pandemic. This research used semi-structured interviews combined with narrative analysis to capture detailed insight into the impact of, and nuanced benefits and challenges associated with, accessing inland blue spaces over the course of the COVID-19 pandemic. Participants from a range of backgrounds across Scotland were involved to determine the influence of their health and 'shielding' status on inland blue space experiences. In the initial stages of the pandemic, those who were taking shielding precautions described experiencing a heightened awareness of, and anxiety towards, other users of inland blue spaces. However, across the sample, individuals emphasised the overall beneficial impact of accessing freshwater areas for maintaining mental and physical wellbeing levels during the pandemic. Positive health outcomes were achieved through participating in a wide range of leisure and recreational opportunities at inland blue spaces. The research further justifies the value of accessing inland blue spaces and demonstrates the benefits of integrating access and exposure to natural environments into future pandemic response strategies. The qualitative insight also highlights the need for context-specific landscape management strategies to promote blue space access across user groups and address existing environmental inequalities.

Keywords: COVID-19; Blue health; Risk perception; Accessibility; Wellbeing; Pandemic response

5.1 Introduction

Since the onset of the COVID-19 pandemic in December 2019 (Wang et al., 2020), there has been an increased awareness of the importance of accessing natural environments for maintaining positive health and wellbeing outcomes (Pouso et al., 2021; Soga et al., 2021). The pandemic and associated public health responses have had a considerable impact on daily lives, at times curtailing an individual's ability to travel to, and access, outdoor spaces (Tomasso et al., 2021; Suligowski and Ciupa, 2023). As a result of this restricted access, society's relationship with nature and the outdoors has altered (Garrido-Cumbrera, et al., 2021; Soga et al., 2021). Furthermore, an increased appreciation of nature was recorded at the individual and societal level with governments supporting the call for a "green-recovery" from COVID-19 through the protection and enhancement of natural environments and resources (Beery et al., 2021; Brahmabhatt, 2021; Hanna, et al., 2023).

Inland blue spaces, such as lakes, rivers, canals, and streams, are increasingly associated with health-promoting properties (Britton, et al., 2020; White et al., 2020). A wide range of health benefits can be attributed to inland blue space exposure, including increased levels of physical exercise, relaxation outcomes, and a reduced likelihood of depression (de Bell, et al., 2017; Afentou, et al., 2022; Poulsen et al., 2022). Similar health benefits have been attributed to accessing green spaces such as parks and woodlands (Nguyen et al., 2021). However, in comparison to green space, the blue space evidence base is limited and key uncertainties remain regarding the potential for inland blue spaces to benefit populations over time. For example, the health outcomes associated with inland blue spaces may be dependent on a range of temporally variable factors, including land use, environmental quality and public perception (Dick, et al., 2016; Tew et al., 2019; Fisher, et al., 2021).

Investigation of the relationship between health outcomes and blue space access and exposure in the pandemic era provided an opportunity to understand the role of water environments during periods of widespread national concern. Early research has identified that visiting freshwater and coastal blue spaces helped to mitigate stress levels for individuals (Jellard and Bell, 2021; Pouso et al., 2021; Jo et al., 2022). To date, most blue space research has focused on

the early stages of the pandemic, including the initial 'lockdown' period, when governments encouraged individuals to stay at home unless strictly necessary (Astell-Burt and Feng, 2021; Earl, et al., 2022; McIntosh et al., 2022). Further research is needed to develop a greater understanding of how relationships with inland blue space have evolved since the onset of the pandemic. Public health responses varied significantly across countries, as did attitudes towards COVID-19, and so continued research will provide insight into the importance of inland blue space exposure for different populations (Summers et al., 2020). Developing a more comprehensive understanding of how inland blue space exposure impacted individual and community responses to the pandemic is crucial to better inform future public health policies and response strategies (Suligowski and Ciupa, 2023).

One group that were disproportionately affected by the pandemic were those who were 'shielding' (Halliday, et al., 2022; Lassetter et al., 2022). In the United Kingdom, individuals who were at high risk of developing serious health complications from COVID-19, were advised to 'shield' by reducing all non-essential contact with others (National Audit Office, 2021). Shielding individuals were at greater risk of experiencing social isolation and reported lower health and wellbeing outcomes during the pandemic (Bachtiger, et al., 2021; Di Gessa and Price, 2021; Fettes et al., 2021). However, shielding was not a simple classification, as many individuals who did not fit the government criteria voluntarily took precautions; whilst others for whom shielding was recommended, disagreed with the classification they had been assigned (Sauchelli et al., 2021; Sloan et al., 2021; Hearn et al., 2022).

It is likely that individuals who were on the shielding list, or who felt they should be on the list, experienced everyday interactions with natural environments differently to others due to the significant uncertainty and anxiety associated with COVID-19 (Roche et al., 2022). One key source of variation could derive from risk perception, as those with chronic health conditions may develop adaptive strategies to navigate everyday situations (Rettie and Daniels, 2021). Individuals must feel comfortable within an environment to obtain beneficial exposure outcomes (Milligan, Gatrell and Bingley, 2004; Sidenius et al., 2017). Therefore, risk perception

alongside shielding status may have contributed to the widening of environmental inequalities during the pandemic.

Understanding how COVID-19 impacted population access to the environment is important to help prevent the widening of health disparities and ensure that communities can continue to benefit equally from inland blue spaces. Research using questionnaires and social media data analysis has helped to establish the overall impact of COVID-19 on access to natural environments (Rousseau and Deschacht, 2020; Park, et al., 2022); however, to gain rich insight, the application of a broader range of research methods is required. Qualitative research methodologies offer the opportunity to gain a greater understanding of human-environment interactions (Fossey, et al., 2002; Pitt, 2018; Cronin-de-Chavez et al., 2019). Given the benefits afforded by qualitative research, this study used semi-structured interviews to evaluate the extent that the COVID-19 pandemic and associated public health mitigation policies have impacted the use of freshwater environments for adults living in Scotland. The three key research objectives were to: 1) investigate how the COVID-19 pandemic impacted access to freshwater environments in Scotland; 2) assess how risk perception of blue spaces has evolved because of the COVID-19 pandemic; 3) determine if health status affected inland blue space experiences and environmental access.

5.2 Materials and Methods

The research design and methods were approved by the General University Ethics Panel at the University of Stirling. Before taking part in the research, informed consent was obtained from all participants.

5.2.1 Study area

Scotland has an abundance of freshwater in the form of streams; rivers; canals; lochs; and reservoirs. A significant proportion of Scotland's inland blue space is in rural areas, with 98 % of Scotland's land mass considered to be rural (Scottish Government, 2021). Inland blue spaces are commonly regarded as natural assets in Scotland, with the Scottish Environment Protection Agency regularly monitoring these environments to record their overall quality. Figure 12. outlines the public health response to the COVID-19 pandemic in Scotland.

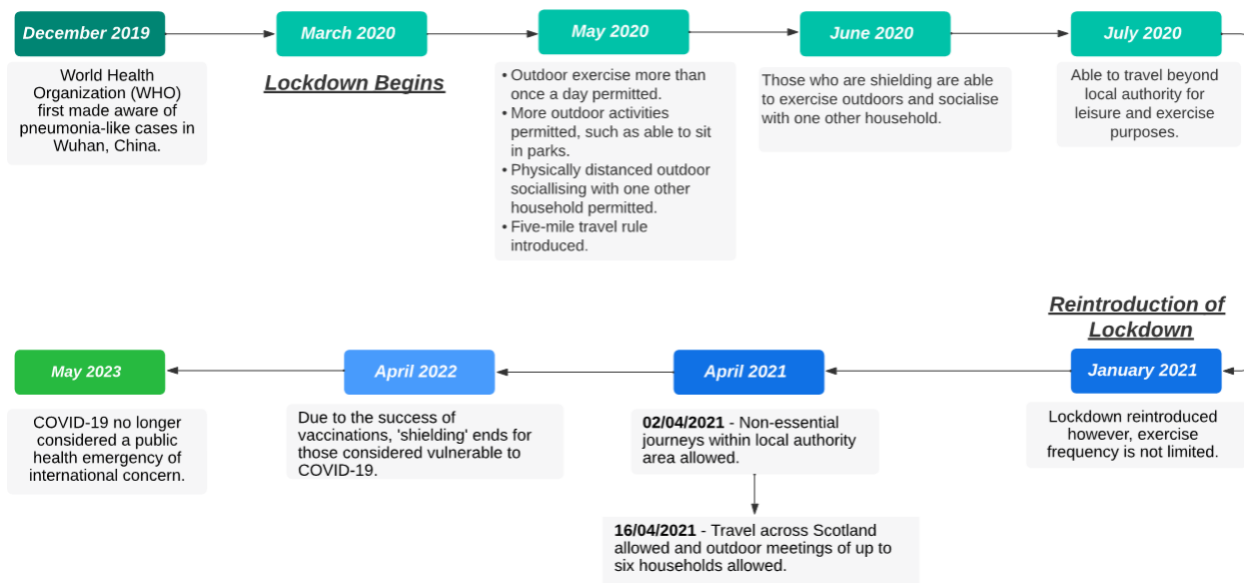


Figure 12: Timeline of the events of the pandemic and key changes in Scottish COVID-19 legislation over the course of the pandemic.

5.2.2 Recruitment and sample

In-depth semi-structured interviews were conducted with adults from regions across Scotland. The recruitment process took place between February and April 2023 and was carefully managed to involve a broad range of participants. A variety of recruitment strategies were used including placing posters in shops and community spaces, advertising on social media platforms, contacting charitable organisations (including environmental trusts and health charities) and emailing community groups. Over twenty community groups and organisations were contacted across rural and urban districts in Scotland, and, in addition, posters were advertised in community spaces across four council regions in central and Southern Scotland. Recruitment targeted a range of organisations: from student societies to welfare groups for older individuals. Community health groups (such as diabetes and chronic fatigue support groups) were also contacted to involve individuals who were classified as vulnerable to COVID-19, or who had voluntarily taken precautionary shielding measures.

In total, twenty interviews were conducted from February to May 2023, with each lasting between 30 and 60 min on average (Table 8). Six interviews took place in person at the University of Stirling and 14 interviews were conducted using Zoom.

Table 8: Demographic information and relevant background information for interview participants.

Demographic	Variable	Frequency
Age	18-24	1
	25-34	8
	35-44	1
	45-54	3
	55-64	1
	65-74	0
	75-84	4
	85+	0
Gender	Male	5
	Female	15
	Other	/
Region in Scotland	Angus	1
	Argyll and Bute	3
	City of Edinburgh	5
	Dumfries and Galloway	3
	East Lothian	1
	Stirlingshire	6
	West Lothian	1
Urban/Rural	Urban	8
	Suburban	1
	Rural	11
Blue space activities carried out by participants (n)	Walking	20
	Wild Swimming	4
	Watersports	3
	Conservation Work	3
	Cycling	3
	Sedentary Activities (eg. Sunbathing)	4
Previously contracted COVID-19	Yes	10
	No	10
Classified as vulnerable to COVID-19	Yes	5
	No	15
Shared a household with someone classified as extremely vulnerable to COVID-19.	Yes	3
	No	17

Voluntarily taken precautionary public health (shielding) measures to protect themselves and or others.	Yes	8
	No	12

A sample size of twenty was established to create a rich dataset involving a range of adults from across Scotland, whilst still allowing for each interview transcript to be analysed in detail. The sample was not intended to be representative of the Scottish population, instead the primary aim was to include individuals with a wide range of different views and interests. In recognition of the issues associated with achieving data saturation in qualitative research, this study sought to provide an interpretation of blue space pandemic experiences without attempting to generalise unique perspectives or achieve a finite end point for the data collection process (Braun and Clarke, 2021).

5.2.3 Interview Design and Protocol

Throughout the data-collection and analysis phase an interpretive qualitative approach was adopted. This enabled the research to capture the overarching impact of cultural context on inland blue space experiences and to identify different perspectives across the sample.

A semi-structured interview schedule (see Appendix 8) was developed to compare participant's experiences of visiting blue spaces over the course of the pandemic. To frame the interview, participants were first asked to recall a key memory of visiting freshwater environments during the COVID-19 pandemic. The overall discussion was then guided by the inland blue space experiences described. Interview questions focused on how individuals perceived their use of and attitudes towards inland blue spaces to have evolved over time, with example questions including; "Do you think the way in which you use freshwater environments changed over the course of the pandemic?" and "Do you think the way other people use and behave in blue spaces has altered since the start of the pandemic?". This enabled the research to capture temporal blue space trends. The interview schedule was adopted in a flexible manor to allow the researcher to probe other blue space topics and provide participants the opportunity to discuss in greater detail aspects of freshwater experiences that they felt were of relevance.

If participants lived within reasonable proximity to the lead researcher, then where possible, interviews were carried out in person. In instances where participants lived further afield, interviews took place online using the video-conferencing platform Zoom to minimise travel time and participant burden. The interview schedule and style remained consistent regardless of whether the interview was conducted in-person or online. After the interview, all participants were reimbursed with a £15 online shopping voucher in recognition of the time taken to attend the interview and the knowledge shared.

5.2.4 Data Analysis

Interviews were audio recorded and transcribed to Microsoft Word. It was recognised that whilst participants were recounting their own experiences of the COVID-19 pandemic, the narratives that emerged during interviews were co-created from the specific interactions between the interviewer and interviewee (Riessman, 1993).

Two levels of narrative analysis as outlined by (Polkinghorne, 1995) were utilised; analysis of individual narratives and analysis of shared narratives across the sample (paradigmatic analysis). The combination of two approaches created a rich dataset, allowing the study to capture the varied and uniquely personal nature of blue space experiences during the COVID-19 pandemic whilst still presenting broader trends observed across the sample.

For the narrative analysis at the individual level, the interview transcripts were read as a whole and key inland blue space experiences occurring over the course of the pandemic were highlighted. The researcher focused on the temporal nature of participant's narrative accounts and sought to identify whether opinions relating to, and usage of inland blue spaces, altered across time. The overarching experiences of participants were summarised by the researcher, with care taken to ensure that each summary provided sufficient context to capture the individual experience of each participant. Four participant summaries are included in the results to highlight the significant variation in inland blue space usage and interactions during the pandemic. The selected summaries demonstrate differences in opinions from individuals who

took 'shielding' precautions, compared to those who did not have to follow any stringent public health measures. To provide insight into the adaptability of inland blue spaces, the four participants included in the narrative analysis are from distinctly different life-stages and used freshwater environments for different purposes. The summaries are not designed to be representative of all participants involved in the research, or of the broader 'shielding' and 'non-shielding' groups, instead they provide rich insight into the personal meaning of inland blue spaces for select individuals during the pandemic.

To analyse thematic narratives at the sample level, interview transcripts were again read in detail before inductive coding was carried out. An iterative approach to coding was adopted by the lead researcher, with the aim to identify and code inland blue space experiences and perceptions. After coding had taken place, coded sections were compared to identify commonalities and generate broad categories of inland blue space experiences during the pandemic. These categories were further revised to develop narrative themes. Whilst defining the themes, the original coding scheme and interview transcripts were referred to in detail to ensure the final thematic narratives were representative of the sample. Throughout the analysis process, a significant focus was placed on comparing the experiences of those taking shielding precautions with the experiences of those who did not have to take shielding measures.

A reflexive thematic diary was kept by the lead researcher to record key aspects of the research, from first impressions of the interviews to the development of final narratives and themes. The diary enabled the researcher to track how representations of COVID-19 experiences developed in the initial interviews and evolved during the analysis stages.

5.2.5 Positionality

When the pandemic first began in late 2019, the lead researcher MG was studying for a Masters in Public Health. Whilst MG was not required to take shielding precautions, they closely followed the public health responses to COVID-19. Throughout the pandemic, the researcher lived in both rural and urban areas of Scotland but was always able to maintain

access to inland blue spaces for exercise and restorative purposes. During interviews, MG remained aware of, and sought to minimize, the potential for their own positive bias towards blue spaces to influence interviewees.

5.3 Results

Participants recalled a wide-range of freshwater memories from the pandemic, from discovering the calming benefits of wild-swimming for the first time, to the feeling of freedom gained from cycling alongside a river after COVID-19 restrictions were reduced. Within the interviews, participants typically discussed their experiences chronologically and reflected on how their perceptions and actions evolved over time as public knowledge relating to the COVID-19 virus increased.

A timeline of the events of the pandemic in Scotland, alongside participants experiences is presented in Figure 13. In recognition of the complexities associated with the shielding list, participants were categorised as those who shielded, those who voluntarily shielded and those who did not shield.

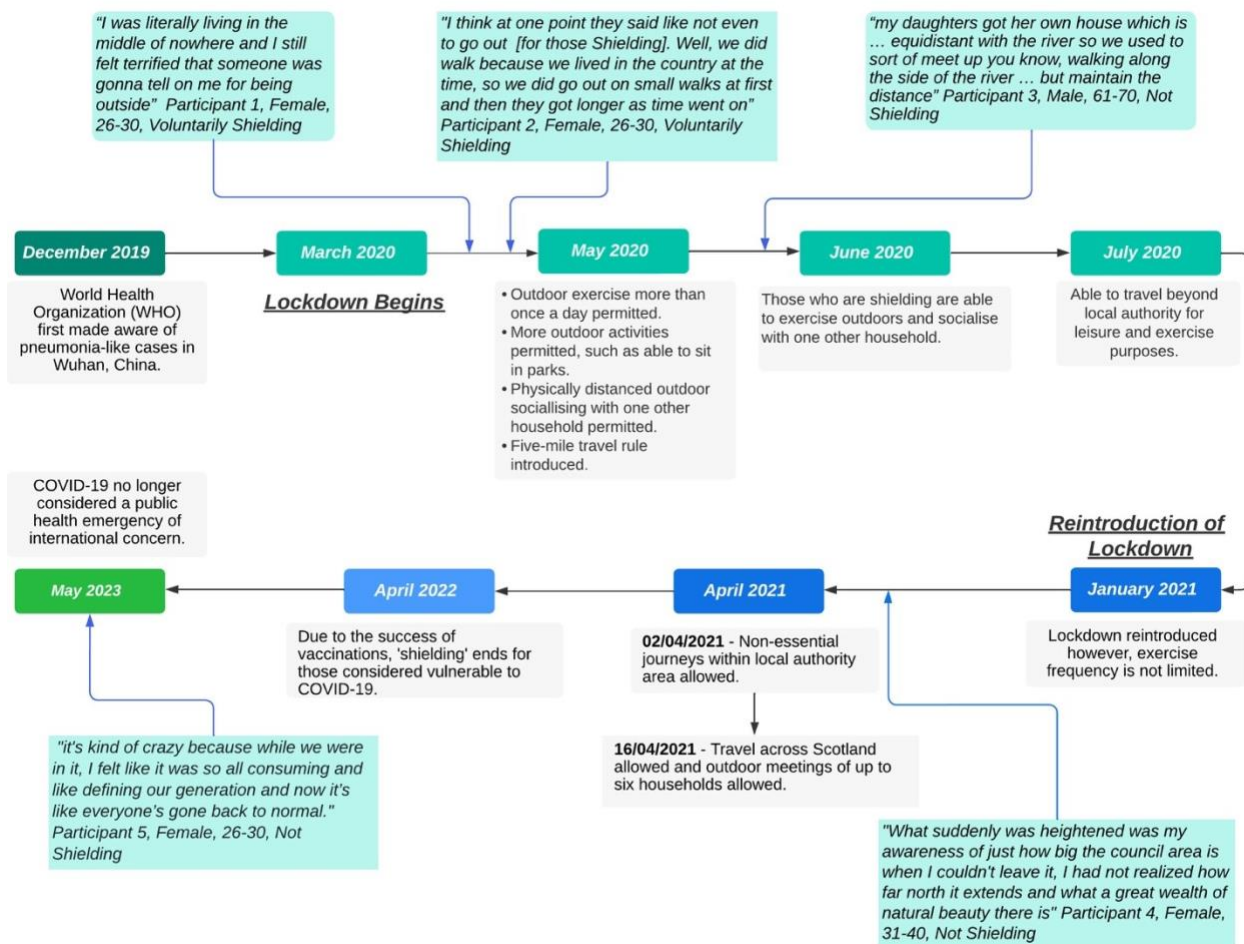


Figure 13: Timeline of the events of the pandemic and key changes in Scottish COVID-19 legislation over the course of the pandemic (grey boxes). Quotes from participants are included at relevant time points to illustrate altering perceptions and blue space experiences (turquoise boxes).

5.3.1. Narrative Analysis at the Individual Level

Narrative summaries of inland blue space experiences for four participants are presented below. The narratives are organised around the COVID-19 pandemic timeline, with a particular focus placed on how individual's perceptions relating to COVID-19 anxiety and blue space use changed across time. Each summary provides unique insight into the personal meaning ascribed to inland blue spaces during the pandemic.

5.3.1.1 Participant 1

In the initial phases of the pandemic, participant 1 (Female, 26–30, Voluntarily Shielding) recalled a high-risk perception of inland blue spaces and other outdoor environments. One of the principal concerns of participant 1 was to protect their partner from catching the disease. Throughout the interview, participant 1 repeatedly demonstrated how seriously they took this responsibility through discussing the preventative measures they adopted and highlighting the emotional impact of COVID-19. During the first two years of the pandemic, the participant described feeling trapped, and having a sense of unease about accessing outdoor environments.

“I don't want to re-live it. I felt bad going into uni. I felt bad for meeting up with people outside and going for a run which was so ridiculous, but like, if we stopped for coffee afterwards. There wasn't a moment where I didn't feel anxious about it at all throughout, like the whole year and a half, two years, definitely. And I guess I still do today. Yeah, but it's one of those things you just learn to live with it, yeah.” Participant 1.

The interview was held approximately three years since the beginning of the pandemic, at that time, the participant highlighted that they were now able to enjoy visiting freshwater environments.

“When I walk my pup along the lake like it makes me so happy seeing the sunrise over the lake [...] And I know that even if I've had a stressful day, if I just go along the lake like I'll feel happy.” Participant 1.

After their experience of the pandemic, participant 1 feels they have a greater appreciation of the importance of access to inland blue space and countryside environments. This appreciation has manifested in the participant actively choosing to visit scenic environments for walks and runs wherever possible. Whilst their anxiety levels have reduced over the course of the pandemic, participant 1 continues to take precautions in the form of washing their hands after touching gates during runs and prefers to socialise with others in outdoor environments where possible.

5.3.1.2 Participant 2

When the lockdown restrictions were first announced, participant 2 (Female, 26–30, Voluntarily Shielding), lived in the centre of a city and was placed on furlough. The participant was able to access the city's riverfront but found they were unable to relax because of the number of other people using the environment as part of their lockdown routine. Whilst lockdown restrictions were still in place, participant 2 decided to relocate to a rural area to stay with their partner who was classified as Clinically Extremely Vulnerable to COVID-19. One of the key benefits they found from moving to a more rural location, was the ability to relax at quieter blue and green space environments.

The participant demonstrated a moderate risk perception of inland blue spaces during the initial stages of the pandemic: *"If we saw people on a walk, we'd say hi but yeah, I guess we were a bit concerned that being close to anyone would be a risk"* (Participant 2).

Alongside their partner, participant 2 followed government guidance in relation to shielding; however, at times they felt that the guidance was not clear. Often in relation to outdoor access the participant chose to follow their own instincts. Instead of exclusively staying at home, as instructed by the government, the participant and their partner went for a walk first thing every morning during the pandemic. During this time, they regularly visited a nearby river.

"I don't think I realised beforehand how much I needed to be outside to be feeling well and yeah, I took it pretty hard being stuck [inside]. So, once you were able to be out in the country and we ended up being out for hours every day, which obviously you can't do now because of work and other stuff." Participant 2.

With the return to work after lockdown restrictions ended, the participant found that whilst their risk perception of freshwater environments had significantly decreased, they now have less time to access outdoor environments. Additionally, they have since moved house and no longer have access to local freshwater spaces.

5.3.1.3 Participant 3

In the initial phases of the pandemic, participant 3 (Male, 61–70, Not Shielding) perceived the risk of COVID-19 transmission at inland blue spaces to be relatively low. In-line with government guidance, the participant practiced social distancing during the lockdown restrictions; however, the enclosed nature of their local riverside walk meant that this was not always feasible. Additionally, the participant questioned the reasoning behind the prescribed social distance of two metres and wondered whether it was an arbitrary distance. During the lockdown restrictions, participant 3 worked from home and described the importance of being able to walk along the riverside path at the end of the working day to maintain their mental wellbeing. The participant visited the river most days during the height of lockdown restrictions.

“so I was sat looking at spreadsheets and financial stuff for sort of 6–8 h and then just getting up and walking... it sort of clears the head and just allows you to sort of refocus on what’s going on [...] a couple of times when I was working from home, basically you shut down your laptop and then you were in the living room, [work] is still sort of rattling about your head, so you just need that sort of natural gap.” Participant 3.

At the time of the interview, the participant no longer had any anxiety related to catching the COVID-19 virus and highlighted that their life had transitioned back to relative ‘normality’. The participant was newly retired and in place of walking after work, the riverside path is instead used as a place to socialise with friends and family and take part in environmental volunteering.

“I mean I use it all year round, it’s because the water changes [...] You know I find it quite therapeutic just looking at the water and the way it moves. Have you heard the one that you know if you stand beside the river, close your eyes for 10 s open them again, you’re not looking... at the same river because that river has moved on? So, it’s a sort of a philosophy.” Participant 3.

Throughout the discussion, the participant consistently emphasised that the river maintains an intrinsic value in their life, providing therapeutic properties across the seasons.

5.3.1.4 Participant 4

Participant 4 (Female, 31–40, Not Shielding) lives in a remote area and has a young family. Once the initial lockdown restrictions lifted, the participant decided to start wild swimming at a nearby lake after encouragement from a friend.

“I went to Loch Ard, which is my possibly my favorite loch, around here anyway [...] and it was just so beautiful and so calm. I have two small kids, so COVID was quite intense in the house. It was loud, and everybody was on top of each other all the time, so it was really nice to get out and do quiet things by myself.” Participant 4.

The participant explained that the proximity to nature and the ability to observe the sun-setting through the hills during evening swims were key aspects that helped to contribute to the relaxing experience. Despite the popularity of Loch Ard during the summer months, the participant was confident that there was minimal risk of COVID-19 transmission. However, the participant was concerned about the environmental impact of a significant increase in visitors to the lakeside environment and the overall rural community.

With the easing of COVID-19 public health restrictions, the participant found they had less opportunities to take part in wild swimming due to other commitments. The participant is still keen to prioritise swimming and has decided to make sure they always have their swimming kit in their car to increase the opportunities they have to swim. Additionally, participant 4 is looking forward to introducing their children to wild swimming.

“Now my kids are a bit older and a bit better at swimming, so maybe we can actually do some, you know, family evenings, going swimming. It’s obviously very different, because then the meditative aspect of it is ruined, but it will foster their love of the outdoors and freshwater and Scotland.” Participant 4.

5.3.2 Narrative Analysis at the Sample Level

Narrative analysis was conducted across the sample to document the shared commonalities in blue space usage and perceptions. Four key thematic narratives were identified from the interview transcripts. The blue space narratives are described in detail below.

5.3.2.1 During Lockdown Restrictions: Avoiding the “Slump” of the Everyday

The immersive nature of blue spaces provided participants with a break from their current circumstances, allowing for a much-needed sense of variation during stringent lockdown restrictions. Blue space visits were regarded by participants as a multisensory experience. While spending longer periods of time at home in lockdown, some participants were much more aware of indoor soundscapes and so for them, the natural sounds associated with inland blue spaces became particularly important. Observing nature during lockdown restrictions also helped to keep participants grounded, through tracking seasonal trends in wildlife and observing the continuous flow of rivers. Given the uncertainty of the pandemic, participants valued the sense of calm that visiting inland blue spaces provided.

“It’s not just freshwater, its kingfishers and otters and all sorts of other things as well. And the leaves watching the seasons and things, yeah.” Participant 6, Female, Voluntarily Shielding.

“It’s even just like, the sounds and then even like touching the water and like everything just brings like a bit of calm. And I don’t really know how to put into words, other than it’s just like adds a bit of serene that is outside of where we exist within four walls.” Participant 5, Female, Not Shielding.

The increased amount of leisure time reported during the pandemic resulted in blue space environments becoming more accessible to participants. In turn, this encouraged participants to engage with blue space recreational opportunities. Several tried out wild swimming and became regular swimmers due to the restorative health benefits they felt it provided. Younger participants who had exclusively visited inland blue spaces for exercise purposes in the past, also began to also visit these areas for relaxation, to spend time sitting and listening to music,

or sunbathing. Across age-groups, participants sought to introduce variation into their lives through exploring new waterways within their local area and spending longer periods of time outside at inland blue spaces.

5.3.2.2 Risk Perception: The Impact of Others

Participants typically perceived the risk of COVID-19 transmission to be higher in indoor areas than in outdoor environments such as blue spaces. However, individuals who were voluntarily shielding often reported greater anxiety levels at inland blue spaces during the initial stages of the pandemic. Whilst all participants were able to gain restorative exposure outcomes from blue space visits during the pandemic, non-shielding individuals often benefited more from access to these areas in the early lockdown period due to reduced anxiety levels.

“And I think what COVID did was it and I would say it’s not just about me, but certainly my friends, we all said we all we became more anxious about others and crowds and ... so that transferred to walking down somewhere like the riverside path, the anxiety about the numbers you sort of noticed you know, as I hadn’t done before.” Participant 6, Female, Voluntarily Shielding.

When larger groups of people were legally able to meet outside, participants explained that previously quiet blue spaces became noticeably busier. For younger non-shielding participants, this freedom to meet outside was viewed as a significant benefit as it enabled them to socialise with friends. However, for older participants (>30), the rapid increase in popularity was often regarded as a source of concern as they felt it exacerbated the degradation of inland blue spaces through an increase in litter and pollution levels. Some participants suggested that new visitors to blue spaces were not accustomed to spending time in nature and so were unaware of how to treat the environment, leading to the increase in environmental issues and degradation. Additionally, for individuals who were taking shielding precautions, the increase in visitor numbers was regarded as a greater risk for COVID-19 transmission. Due to a higher perceived risk of COVID-19 transmission, alongside frustration caused by observing

environmental degradation, several participants chose to avoid visiting specific inland blue spaces.

“I definitely noticed, walking up the reservoirs during COVID, I would come home and instead of being relaxed, I would just be really angry about the way people were treating the space because you’d have people camping but with that kind of music festival kind of mindset where they just leave their tent and all their other gear behind.” Participant 7, Male, Voluntarily Shielding.

Visitor numbers and associated environmental degradation were still regarded as an on-going issue by participants, with warmer weather in the summer months often exacerbating the issue. At the time of the interview, some participants still described taking precautionary measures to minimise the risk posed by other blue space users, including wearing masks while at outdoor environments.

5.3.2.3 Post Lockdown Restrictions: Shifting Priorities

A key central narrative captured during the interviews, was that of re-negotiating blue space usage after lockdown mitigations had ceased. For a range of reasons, including higher workloads, increased social commitments, and caring for young families, most participants now found they had less time to visit inland blue spaces. Despite increased commitments, participants still incorporated blue spaces into their routines for the purpose of socialising. Some stated that during the pandemic they had developed a routine of meeting friends and family for riverside walks or swims and now continued with this habit. Participants who had been shielding or voluntarily shielding during the pandemic, also preferred socialising outdoors due to the reduced risk of COVID-19 transmission.

“Me and my husband meet up with their family and we enjoy being by the water [...] they've got their paddle board and their canoe, and I'll swim near them. You know, we never used to do that.” Participant 8, Female, Voluntarily Shielding.

Those who had newly retired or reduced their workload since the onset of COVID-19 commented that they were now able to prioritise spending more time at blue spaces. For them, blue spaces now offered important opportunities to establish new daily routines through exercising, socialising and taking part in voluntary conservation work.

5.3.2.4 Nowadays: Reflections on Environmental Access

While narrating their COVID-19 experiences, participants were conscious to point out what they perceived as their own relative privilege during the pandemic. This awareness of privilege typically stemmed from having heard other's experiences of COVID-19 through news stories and word of mouth. Living in quiet locations, having good health and having access to high quality natural environments were independently regarded by participants as reasons to be grateful during lockdown restrictions. Those who were older expressed an inherent sympathy for children and younger generations. Whereas younger participants were grateful for their health status and not having to worry about taking heightened COVID precautions.

"I was an older person who loved walking alone and I could do it whether it was a pandemic or not, so I felt I was very fortunate compared to your generation or younger." Participant 9, Female, Voluntarily Shielding.

Across age-groups, differences were observed in perceptions of rural and urban inland blue space. Participants who lived in rural areas typically felt grateful for the opportunity to easily access nature and blue space during the pandemic. As a result, they felt their lockdown experience would have been significantly different from individuals living in urban areas. However, city dwellers were keen to point out their ability to easily access nature within their local community and felt sorry for anyone who did not have the same ease of access.

"I think in Edinburgh we're lucky [...] with sort of green spaces, with access to water. The Water of Leith walkway is quite good, you can pretty much walk the whole length of the Water of Leith walk now, it's about 13 miles [...] I think other people are sort of picking up on it because you see a lot of people walking along with dogs, dogs and kids cycling... things like that." Participant 3 Male, Not Shielding.

Participants who were shielding or voluntarily shielding, acknowledged the difficulties that taking precautionary public health measures entailed. However, access to natural environments during the pandemic was cited as a key factor that helped to maintain wellbeing levels during restrictions. These participants also expressed sympathy for those who they recognised as having a worse pandemic experience than they did.

One socio-demographic factor that did impact access to inland blue spaces was car ownership, this particularly affected younger participants, aged 18–30. Limited bus schedules were regarded as frustrating, and the length of time it would take to reach the train station often made visits to inland blue spaces unjustifiable. The cost of public transport was regarded as an additional barrier to accessing inland blue spaces.

“I feel like if I really have to plan for like an hour and a half of commuting on the bus then that kind of takes away quite a bit of the day and that does kind of put me off sometimes. I mean I go out less probably than I thought I would.” Participant 5, Female, Not Shielding.

While older participants typically owned a car, many also had access to a bus-pass and voluntarily made use of public transport to access freshwater areas. Often buses were used to allow individuals to complete longer riverside walks before taking the bus back. These participants acknowledged that they were less busy than younger participants and so it was easier for them to use public transport. Additionally, this age-group had often lived in their local area for a long period of time, and so had a greater awareness of bus routes and transport links to inland blue spaces.

5.4 Discussion

The qualitative insight gained from in-depth interviews demonstrates that in times of significant change, such as the onset of a pandemic, inland blue spaces can provide individuals with vital mental health and wellbeing benefits. Narrative analysis at the individual level highlighted the broad range of different circumstances faced by individuals during the pandemic, and the unique benefits that accessing freshwater provided. Further complementary thematic narrative analysis across the sample demonstrated shared commonalities in how participants recalled

their use of inland blue spaces during lockdown restrictions, with participants often accessing these areas to provide variation to their everyday lives and recalling a shared concern of the potential risk posed by other visitors at inland blue spaces.

Natural environments have long been regarded as therapeutic landscapes, providing health promoting properties to user groups (Bell et al., 2015). This research further demonstrates the therapeutic potential of inland blue spaces. Whilst participants appreciated the physical health benefits associated with accessing and exercising at freshwater areas, interviewees were often more enthusiastic about the mental health benefits of inland blue space exposure. This coincides with a growing body of research documenting the positive effect of accessing blue spaces and other natural environments for maintaining mental health and wellbeing levels during the pandemic (Pouso et al., 2021; Puhakka, 2021; Jo et al., 2022; Kanelli, et al., 2023, Oliver et al., 2023). Within therapeutic landscape research, there is an awareness that associated health benefits may change over time and that not all individuals may gain therapeutic benefits due to differing backgrounds and personal circumstances (Rose, 2012, Mossabir et al., 2021). Yet, during interviews, participants emphasised the overall therapeutic nature of inland blue spaces, regardless of their health and shielding status. The use of interviews as a cross-sectional research method may have influenced this response; alternative longitudinal research methods deployed shortly after blue space visits may have identified greater variation in human-environment interactions. However, the positive and restorative reports narrated by participants, provide novel insight into the overarching impact of access to freshwater environments during the COVID-19 pandemic.

A key aspect of inland blue spaces that contributed to their perceived therapeutic properties for participants was the multisensory, immersive nature of these environments. The combination of green space, wildlife and the movement of water created a restorative environment with multiple sources of interest for individuals. As with marine-focused blue space research, participants in this study described embodied connections with inland blue spaces and emphasised the associated benefits they gained from this (Bell et al., 2015; Kronsted Lund et al., 2022). For several participants, COVID-19 provided the time and

opportunity to take part in sedentary activities whilst at inland blue spaces. Previous research has focused on the nature by which physical activities, including wild swimming, can create an immersive restorative experience for individuals (Foley, 2015; Gould et al., 2020; Bates and Moles, 2023). The current research helps to advance the blue space evidence base by highlighting the diverse range of activities that can create an embodied blue space experience.

The increase in leisure time associated with the height of COVID-19 public health restrictions significantly increased the accessibility of inland blue spaces for participants. However, the small sample size may have influenced this finding. The consequences of the pandemic were interlinked with socioeconomic status, therefore different subsections of the population may have different recollections of inland blue space experiences and accessibility during the pandemic. Highly skilled employees were typically able to work remotely, enabling increased flexibility for accessing nature compared to lower income workers who continued to work on-site (Honey-Rosés et al., 2021; Rios et al., 2021). As highlighted by some younger participants involved in the current research, access to private transport also impacted blue space accessibility over the course of the pandemic. These findings align with quantitative survey results demonstrating that attitudes towards transport changed significantly during the COVID-19 pandemic, with journeys by public transport often regarded as an inconvenience (Eisenmann et al., 2021; de Haas, Faber, and Hamersma, 2020). Investment in both the availability and quality of public transport is vital to maintain public confidence during times of significant uncertainty (Bauer and Bauer, 2022). Further larger-scale research would complement the current findings and help to consider the complex implications of COVID-19 and socioeconomic status on perceived blue space accessibility.

Despite the overall sense that inland blue spaces contributed to restorative health outcomes during the pandemic, participants also highlighted the negative impacts of environmental degradation on blue space exposure outcomes and the perceived impact of other users. In line with the current findings, marine-based research during the pandemic identified that several sources of conflict arose between tourists and residents as lockdown restrictions ended (Jellard and Bell, 2021; Wheaton et al., 2021; Earl, et al., 2022). Heightened land-use conflicts were

observed globally, as individuals became more protective of their local area and concerned over the potential public health risks posed by the presence of visitors (McGinlay, et al., 2020; Nghiêm-Phú and Phạm, 2022; Vich et al., 2022). Our study further documents issues related to navigating busy natural environments whilst also highlighting the intrinsic link between land-use conflict and environmental privilege. Environmental privilege refers to the societal constructs that allow for sub-sets of the population to have greater access and control over environments and environmental assets (Argüelles, 2021). Prior to the onset of COVID-19, several participants were used to having almost exclusive access to high quality inland blue spaces. This may have intensified the anxiety associated with an increased frequency of visitors to local blue spaces. The pandemic increased environmental inequalities in numerous ways, with those with greater resources often still able to access alternative high quality natural environments that were less affected by visitors (Rios, Neilson and Menezes, 2021). Less research has focused on access to nature for underprivileged groups during the pandemic; however, vulnerable groups, such as those living in urban deprivation, were often more significantly affected by social and environmental injustices during the COVID-19 pandemic (Sharifi and Khavarian-Garmsir, 2020; da Schio et al., 2021).

The pandemic created novel risks that significantly affected human-environment interactions, this in turn may have altered the therapeutic properties of natural environments (Choi et al., 2022; Pan and Bardhan, 2022). The narrative analysis demonstrated that during the initial stages of the pandemic, higher levels of anxiety were associated with social interactions at inland blue spaces. This was particularly the case for individuals who were taking shielding precautions. Similar concerns were reported by individuals accessing a range of natural environments (Korpilo et al., 2021; Lopez et al., 2021; Burnett et al., 2022). For many participants, this initial anxiety had since subsided; however, individuals' awareness of others typically remained heightened. The shared response experienced by participants can inform land-management strategies to aid preparedness for future pandemic responses. Furthermore, the careful management of vegetation and built surroundings at inland blue spaces could allow for greater space and flexibility for the avoidance of close interactions with others, enabling individuals to gain positive exposure outcomes even in times of uncertainty. This style of land

management could help to foster a sense of solitude in nature that can in turn lead to positive environmental exposure outcomes (Long et al., 2003; Lee and Scott, 2017). Different demographic groups may use natural environments in different ways, with men and older adults more likely to access remote areas of parks (Sang et al., 2020). Encouraging landscape variation within blue spaces can help to create more inclusive environments, facilitating greater spatial dispersal of visitors and allowing for positive blue space exposure outcomes during future pandemics or periods of instability.

Our findings provide rich insight into inland blue space perceptions and environmental usage during the pandemic, enabling an in-depth comparison of the influence of shielding status on environmental experiences. However, the research was subject to limitations. Whilst the qualitative interviews enabled the reasoning behind blue space usage to be assessed, the methodology is inherently subjective and so the generalisability of findings to the wider Scottish population is limited. Further research with different communities in Scotland would help to bolster evidence-based policy making. Despite an extensive recruitment strategy, females were overrepresented in the sample. Gender has been shown to influence COVID-19 risk perception, therefore the overrepresentation of females may have impacted the research findings (Stephen et al., 2023). It would be beneficial to further investigate gender influences on risk perception in the context of access to blue space environments.

Individuals with a range of health conditions were involved in the research; however, all participants had good mobility levels. Likewise, there has been a tendency for research to focus on human-environment interactions of 'able-bodied' individuals (Foley and Kistemann, 2015, Bell, et al., 2019, Job et al., 2023). With 'long COVID' expected to have affected nearly 36 million individuals in Europe alone since 2020, it is vital that blue space research is more inclusive, through continuing to involve people with a range of health conditions and actively involving disabled people (World Health Organisation, 2023). People with physical disabilities may face greater barriers to accessing natural environments; however, equitable access should be facilitated across populations. Additionally, as highlighted by current participants, the immersive opportunities of sedentary blue space activities should not be overlooked. The

BlueABILITY model offers one solution to ensure the interlink between blue space, accessibility and health and wellbeing outcomes are sustainably considered within research and policy settings (Job, Heales and Obst, 2023).

5.5 Conclusion

Through the application of semi-structured interviews, the significance of accessing inland blue spaces during the pandemic for maintaining positive health and wellbeing outcomes at the individual level has been evidenced. Participants recalled the restorative nature of freshwater areas during the pandemic, with both individuals who had been voluntarily shielding from COVID-19 and those who had not been required to shield reflecting on the solace they found from accessing these environments. Inland blue spaces offered individuals the opportunity to establish a routine in times of significant uncertainty during the pandemic. The research findings further justify the growing recognition that regular access to natural environments is vital for maintaining health and wellbeing outcomes. Access to freshwater areas may be particularly beneficial during times of uncertainty and so there is the potential to utilise inland blue spaces to help individuals navigate future crises. However, to ensure future public health benefits, the quality of these environments must be preserved, and public health and environmental policies should work towards creating more inclusive environments that encourage a broad cross-section of the population to visit and benefit from these areas.

Chapter 6: Positive health and wellbeing outcomes from inland blue space exposure are not devalued by previous experience of flooding

Abstract

Inland blue spaces, such as rivers, lakes and canals provide a range of public health benefits through encouraging active lifestyles and helping to ameliorate stress levels for different users of, and visitors to, water environments. However, during periods of unsettled weather, inland blue spaces can also lead to adverse physical and mental health outcomes due to the devastating impact of flooding. Despite the dynamic and ever-changing nature of blue spaces, most research to date has concentrated on the positive effects of environmental exposure rather than considering the potential for fluctuations in health outcomes. To consolidate the current evidence base, this study utilised a mixed methods research approach to determine the overarching impact of flooding on public perceptions towards and use of inland blue spaces. The results demonstrate that whilst flooding has a significant impact on the life of affected individuals, it does not detract from the perceived benefits of inland blue spaces for local communities. The current findings highlight the need for sustainable interdisciplinary approaches to mitigate the effects of flooding and preserve the vital public health benefits afforded by inland blue spaces.

6.1 Introduction

Freshwater environments or inland blue spaces, are key features of urban design, facilitating recreational activities for residents, creating popular tourist attractions and regulating urban microclimates (Arif *et al.*, 2022; Dean *et al.*, 2022; Burda and Nyka, 2023). Research has demonstrated that the benefits provided by inland blue spaces also extend to improved public health outcomes (Murrin *et al.*, 2023; Overbury, Conroy and Marks, 2023). Specifically, increased levels of life-satisfaction, improved mental wellbeing and increased physical activity have been associated with accessing inland blue space (Maund *et al.*, 2019; McGavock *et al.*, 2019; Afentou *et al.*, 2022; Bergou *et al.*, 2022). Research has also demonstrated that inland blue space soundscapes can deliver restorative wellbeing benefits (Fisher *et al.*, 2021). The growing evidence base highlights the significant potential for waterbodies to be integrated as part of sustainable community-based health initiatives. However, to consolidate current research, and devise sustainable long-term policies, both the positive and negative health outcomes associated with blue space exposure must be accounted for (Foley *et al.*, 2020; Brückner *et al.*, 2022).

With the implementation of novel architectural designs alongside increased population pressures, the distinction between blue space and residential areas has softened over time (Burda and Nyka, 2023). This integration of blue infrastructure in public spaces and residential areas has led to improved health outcomes for residents and blue space visitors. However, for sustainable placemaking, effective flood mitigation measures must be introduced to account for increased residential proximity to bodies of water. This is particularly relevant given that the impact of climate change alongside anthropogenic pressure on the morphology of inland waters have led to an increase in flooding incidents over time (Best, 2018; Yin *et al.*, 2018; Foti *et al.*, 2022). In the United Kingdom (U.K.), flooding poses a serious risk at the population level, with rainfall levels having risen significantly in recent decades, and higher instances of extreme rainfall events observed (Thompson *et al.*, 2017). Most research investigating flooding experiences in the U.K. has focused on English populations (Mehring *et al.*, 2023; Waite *et al.*, 2017). Conducting further research in populations across the rest of the U.K. is necessary to

address regional disparities and support the development of placemaking practices at local and national levels.

Environmental experiences are relational, dependent on personal circumstances, and must be contextualised alongside wider societal and environmental factors (Conradson, 2005). Within populations, different sub-groups are likely to experience natural environments in varying ways depending on socioeconomic and sociodemographic factors (Haeffner *et al.*, 2017; Pitt, 2018). Blue spaces are dynamic environments, with significant changes observed in their appearance and characteristics over time; this may alter human-environment interactions and consequently influence blue space usage (Zhou *et al.*, 2022; Grace *et al.*, 2023). Whilst some blue space research has accounted for variability in exposure outcomes, particularly in relation to water quality, most research has not considered the potential for blue space interactions to lead to negative environmental experiences (Fox, Marshall and Dankel, 2021). The application of a broader range of sensitive research approaches is required to capture the unique nature of environmental interactions and document the complexities of blue space experiences.

Heightened perceptions of risk in an environment can lead to counter-therapeutic effects for user-groups (Rose, 2012). Therefore, flooding may have an overarching effect on individuals' relationships with blue space by leading to higher perceived environmental risks for a multitude of reasons. These include: water-safety concerns; fear of water-borne diseases; and concern over potential damage to property and possessions. Often flooding events can lead to long-term health problems for individuals, highlighting the significance of this as a public health issue (Twiddy, Trump and Ramsden, 2022). Given the detrimental impact of flooding on the quality and accessibility of inland blue spaces, there is a need to consider the long-term effect of flooding events on recreational use of freshwater areas and associated exposure outcomes.

Using a mixed methods research approach, consisting of a nationally representative online survey alongside semi-structured interviews with communities affected by flooding, this study aimed to develop a greater understanding of the potential for flooding events to impact how inland blue spaces are used and perceived. The three research objectives were to: i) assess the perceived impact of climate change and flooding on households across Scotland; ii) determine

whether individuals affected by flooding had differing views regarding environmental anxiety and perceived flooding impacts compared to those who had not been affected; iii) evaluate whether flooding events can significantly impact blue space usage over time.

6.2 Materials and Methods

6.2.1 Online Survey

To distribute the survey to Scottish adults, the Qualtrics UK (<https://www.qualtrics.com>) online panel was utilised. The Qualtrics panel incorporates individuals from a broad range of backgrounds who have previously indicated that they are interested in taking part in research opportunities. An initial pilot study with 50 participants was carried out to test the length and clarity of the survey. The pilot results were successful, with only minor changes required to refine the question wording.

The main survey data collection period then took place between 07/09/2023 and 09/10/2023. Recruitment rates were managed by Qualtrics UK to ensure that key demographic characteristics of the sample, namely age and gender, remained representative of the Scottish adult population. In addition, Qualtrics UK over-sampled in the town of Dumfries (Southern Scotland), with the aim of recruiting 0.5% of the adult population ($n = 113$) to allow for a case-study comparison. This oversampling was introduced to create a case-study comparison and align with the location of some of the qualitative interviews.

6.2.1.1 Survey Structure

Screening questions were included at the beginning of the online survey to obtain electronic consent from participants and ensure eligibility (i.e., aged 18 or over and currently living in Scotland). In the next section of the survey, participants were asked to respond to 12 statements from the validated Hogg Eco-Anxiety Scale to identify individual anxiety levels regarding the environment and climate change (Hogg *et al.*, 2021). Participants then considered the perceived risk of flooding in relation to other climate change related factors. A series of Likert-scale questions focused on perceptions of freshwater environments and the perceived

mental health and wellbeing benefits of these areas were included. Likert-scale questions were also used to determine knowledge regarding the Scottish Environmental Protection Agency (SEPA) flood forecast. The flood forecast is a national service that uses meteorological data to predict the risk of flooding in regions across Scotland.

In the third section of the survey, a screening question was used to determine whether participants had experienced a flooding event within their local community whilst living at their current address. Respondents who answered yes to having experienced flooding, were asked a series of questions related to the impact of the flooding event. These questions focused on the physical and mental health outcomes experienced because of the flooding. Participants were also asked to consider the impact of flooding on the local community. If a participant answered no to having experienced a flooding event, they were diverted to the final section of the survey, which focused on sociodemographic information. At the end of the survey, all participants were asked a short series of questions relating to their sociodemographic status. A full version of the survey is included in the appendix (A9).

6.2.2 Online Survey Analysis

For the survey analysis, R Studio Version 4.4.3 was used with p values <0.05 considered significant. Pearson's Chi-Squared Test of Association was carried out to assess demographic differences in participants' responses. In instances where Chi-square tests were found to be statistically significant, the strength of association was determined using Cramer's Φ analysis (ΦC). The following thresholds for ΦC were used to classify the association strength: Very Strong >0.25 , Strong >0.15 , Moderate >0.10 , Weak >0.05 , Very weak >0 .

Ordinal Logistic Regression modelling was carried out to determine differences regarding the perceptions of freshwater environments between individuals who had experienced flooding incidents and those who had not. Findings were reported as odds ratios (OR) using 95% confidence intervals (CIs). Three separate models were created, focusing on responses to three different Likert-scale questions, with each adjusted for age, gender, employment, and disability status.

Welch's t-test was used to compare survey results from the Dumfries sub-population with the remainder of the sample. Cohen's d was calculated for each test to determine the effect size.

To analyse responses to the Hogg-Eco Anxiety Scale, negative binomial regression modelling was conducted, and results were recorded as odds ratios. The model was adjusted for age, gender, disability status and previous experience of a flooding event. In addition, the Kruskal-Wallis test was carried out to consider trends in the Hogg-Eco Anxiety Scale scores across age groups.

6.2.3 Qualitative Interviews

Interviews were semi-structured, allowing participants to discuss their individual flooding experiences in detail. The interviews took place in person or online, depending on individual preferences. Interview questions focused on overall perceptions of freshwater environments, alongside the impact of flooding events at the individual and community level. The full interview guide is included in the appendix (A10).

6.2.3.1 Case Study Sites

Interviews were carried out with residents from two Scottish towns: Dumfries (Southern Scotland) and Tillicoultry (Central Scotland) (Figure 14). The selection of the case-study sites was informed by collaboration with SEPA. Both sites have been affected by frequent flooding events in recent decades and are considered by SEPA to have high levels of engagement with local flood prevention strategies. Different forms of flooding affect the two towns, Dumfries is affected by fluvial and pluvial flooding whilst Tillicoultry suffers from flash flooding. This allows for a comparison of the impact of flooding-type on health and wellbeing outcomes.



Figure 14: Locations of case study sites for qualitative interviews.

Case Study Site 1: Dumfries

Located in southern Scotland, Dumfries is a small town with a population of approximately 25,000 (Dumfries and Galloway Council, 2021). The town is built around the River Nith, close to the mouth of the river, with the river level affected by both rainfall and tidal levels. Both fluvial flooding, from the river itself, and pluvial flooding from excessive rainfall, frequently affects residential and non-residential properties in Dumfries town centre (SEPA, 2024). A flood protection scheme involving flood walls and gates was originally devised in 2017 and approved by the local council in 2023. However, installation is yet to begin (Dumfries and Galloway Council, 2025). The scheme has faced criticism from the local population, with the ‘Save our

Sands' group actively campaigning against the project due to concerns that flood defences will limit available parking spaces and restrict views of the river.

Case Study Site 2: Tillicoultry

Tillicoultry is a town in the central belt of Scotland with a population of approximately 6000 (Clackmannanshire Council, nd). The River Devon is located just south of Tillicoultry town centre with two fast flowing streams from the Ochil hills passing through the town to join the River Devon. The location of the town makes it susceptible to flash flooding from the two streams and fluvial flooding from the River Devon. A raised walkway and a pumping station were installed in Tillicoultry in 2012 to mitigate flash flooding. However, several notable flooding events have occurred since the introduction of these measures. A Tillicoultry flood group has been established to improve community resilience.

6.2.3.2 Recruitment

Individuals in Dumfries and Tillicoultry were recruited using a range of methods including placing posters in local shops and online advertising through social media such as the Tillicoultry Community Council and the Dumfries 'Save our Sands' social media accounts. Snowball sampling was also used whereby participants recruited other participants from their own social network.

6.2.3.3 Qualitative Analysis

All interviews were audio-recorded before being transcribed to Microsoft Word. The qualitative analysis process was carried out by the lead researcher, MG. Each interview transcript was read in detail before coding took place. Codes focused on participants' overarching emotions and perceptions relating to inland blue spaces. The coding for each interview transcript was revised several times to identify key commonalities and discrepancies across the sample group. After several revisions and consultation with the wider research group, the coding structures were categorized into broader qualitative themes. The analysis process was broadly modelled on the six-stage thematic analysis process described by Braun and Clarke (2017), consisting of an in-

depth reading of the transcripts; the creation of codes; organising themes from the codes; revising themes in accordance with transcripts; defining and naming themes; writing up the qualitative findings.

6.3 Results

6.3.1 Online Survey Results

The online survey was completed by 1003 adults living in Scotland, with key demographics for the sample displayed in Table 9.

Table 9: Demographic information and relevant background information for the sample group.

Variable	Category	Frequency	Percentage
Age	18-24	139	13.9
	25-34	265	26.4
	35-44	266	26.5
	45-54	146	14.5
	55-64	114	11.4
	65-74	52	5.2
	75 years or older	21	2.0
Gender	Woman	686	68.4
	Man	302	30.1
	Other	15	1.5
Employment	Full-time Employment	517	51.5
	Part-time Employment	202	20.1
	Retired	96	9.6
	Unemployed	85	8.5
	Stay-at-home Parent or Carer	65	6.5
	Other	38	3.8
Identify as having a disability	No	827	82.4
	Yes	153	15.2
	Prefer not to say	23	2.3
Affected by flooding while living at current address	Yes	271	27
	No	732	73

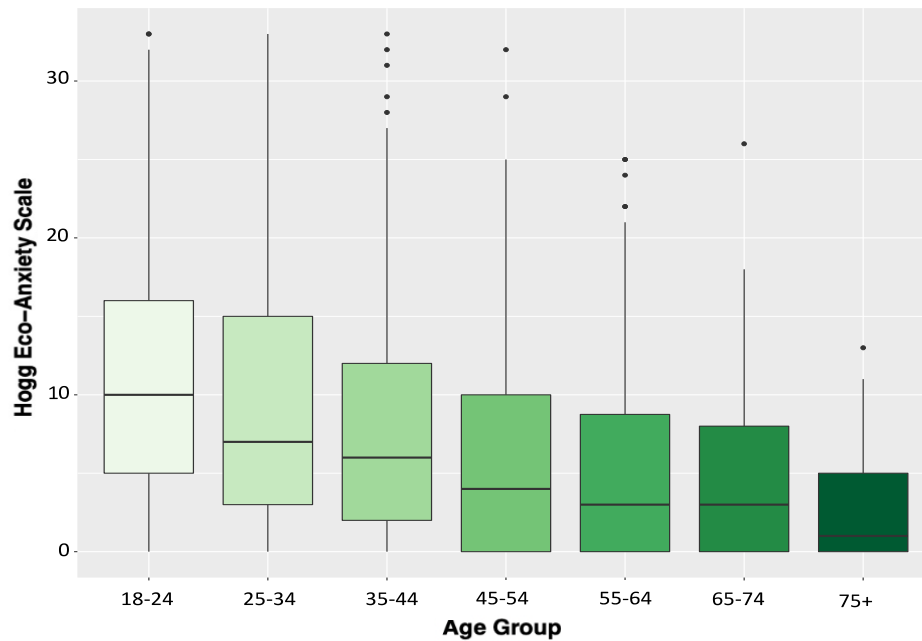


Figure 15: Hogg Eco-Anxiety Scale scores across age groups. A higher score indicates higher levels of climate anxiety.

Out of a total score of 36, the mode score recorded on the Hogg Eco-Anxiety Scale (HEAS) was 0, and the mean score was 8 (SD±8). The results demonstrated that the respondent's age significantly influenced their HEAS score ($p < 0.001$). Older participants typically recorded lower scores than younger participants, indicating that older age-groups had less climate-related concerns (Figure 15). Negative binomial regression modelling also revealed that those who had been affected by flooding were more likely to score higher in the HEAS, indicating that this sub-group had greater climate concerns (OR: 1.44; 95% CI: 1.24-1.68).

In total, 27% of respondents (n=271) had been affected by a flooding incident whilst living at their current address. Within the sample, those affected by flooding were significantly more likely to have heard of the SEPA flood forecast than those who had not been affected ($p < 0.005$, $\Phi_c = 0.22$). Of those affected by flooding, 79% (n=214) also experienced increased anxiety, stress or lower life satisfaction levels during or after the flooding event. For 63% (n=171) of individuals affected by flooding, this manifested as a short-term mental health issue (experienced up to 1 week after the flooding event), whereas, for 18% of individuals (n=44), mental health issues were experienced over a longer period (up to or over 3 months post flooding incident).

A significant association was identified between gender and experiencing a self-reported prolonged period (up to or over 3 months) of increased anxiety, stress or lower life satisfaction levels after a flooding event, with males more likely to be affected by this ($p = 0.001$, $\Phi_c = 0.20$). Those in the sample who identified as disabled were not significantly more likely to be affected by mental health issues as a result of flooding ($p > 0.05$). In addition, the length of residence was not found to have a significant influence on experiencing mental health issues due to flooding ($p > 0.05$).

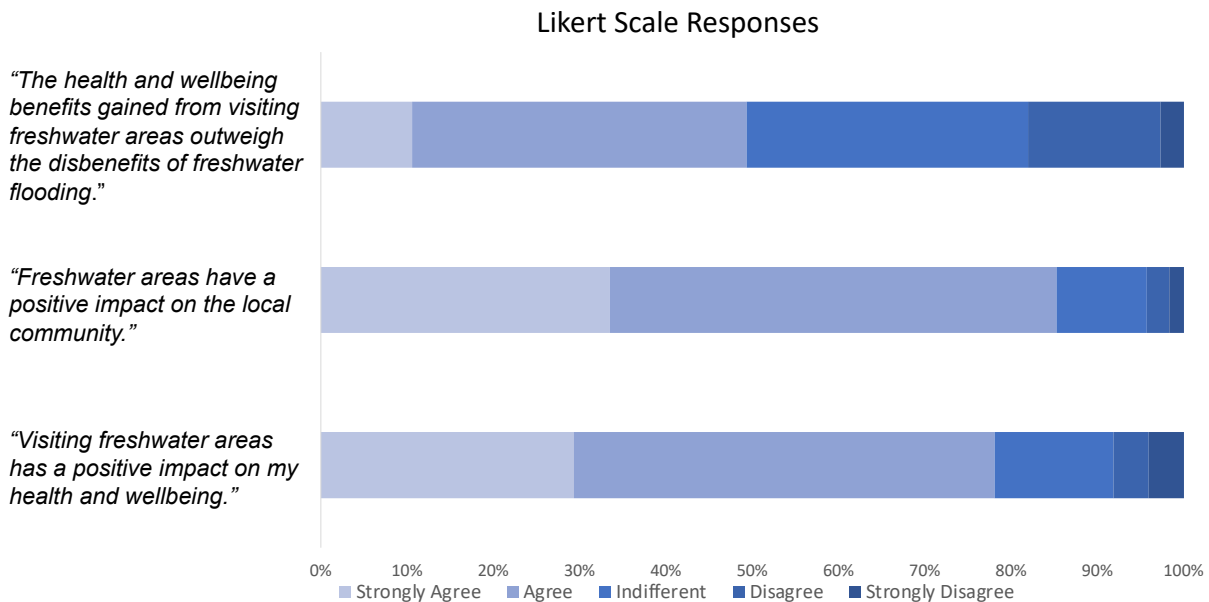


Figure 16: Distribution of Likert scale responses to inland blue space statements.

Across the whole sample, there was strong agreement that inland blue spaces positively impacted the community and individual health and wellbeing outcomes (Figure 16). Ordinal regression modelling demonstrated that experiencing a flooding event did not significantly impact individual's perceptions of the impact of freshwater on the local community (OR: 0.88; 95% CI: 0.67-1.16). Additionally, those who had been affected by flooding did not have significantly different views regarding whether 'the health and wellbeing benefits gained from visiting freshwater areas outweigh the disbenefits of freshwater flooding' (OR: 1.28; 95% CI: 0.99-1.68). Those affected by flooding were however, less likely to agree with the statement: 'visiting freshwater areas has a positive impact on my health and wellbeing' (OR: 0.74; 95% CI: 0.56-0.97), than those who had not been affected by flooding.

The age of the respondent was linked with their appreciation of freshwater environments. Compared with the 18-24 age bracket, older participants were more likely to positively value the impact of freshwater environments on their local community (Table 10). Similarly,

participants over the age of 24 were more likely to consider that freshwater areas had a positive impact on their own health and wellbeing (Table 10).

Table 10: Ordinal logistic regression modelling of responses to two Likert-scale questions. A higher odds ratio indicated a greater likelihood of agreeing with the statement.

Statement	Age Group	Odds Ratio	95% CI
<i>Freshwater areas have a positive impact on the local community.</i>	18-24	(ref)	(ref)
	25-34	1.78	1.17-2.71
	35-44	2.07	1.36-3.14
	45-54	2.74	1.72-4.36
	55-64	2.22	1.34-3.70
	65-74	2.65	1.22-5.75
	75+	4.71	1.6-13.41
<i>Visiting freshwater areas has a positive impact on my health and wellbeing.</i>	18-24	(ref)	(ref)
	25-34	1.71	1.16-2.54
	35-44	2.20	1.48-3.27
	45-54	2.90	1.86-4.54
	55-64	1.92	1.18-3.15
	65-74	2.96	1.38-6.39
	75+	1.71	0.60-4.87

6.3.1.2 Quantitative Case Study: Dumfries

The online survey recruited 85 adults from Dumfries, of which 58% indicated that they had been affected by flooding within their community. Out of those affected by flooding, 82% (n=40) felt that in the aftermath of Dumfries flooding events there was an increased sense of community. In addition, 88% (n=43) recorded experiencing an adverse mental health outcome

due to flooding. Analysis found no significant difference in the incidence of mental health issues due to flooding between the Dumfries population and the rest of the sample ($p>0.05$).

Responses to Likert scale statements indicate that blue spaces were regarded as a public health asset for residents of Dumfries (Figure 17). However, comparative analysis of Likert score results demonstrated that Dumfries adults had significantly fewer positive opinions regarding the personal health and community benefits of freshwater areas than the rest of the survey sample ($p=0.003$, $d=-0.373$; $p=0.02$, $d=-0.271$).

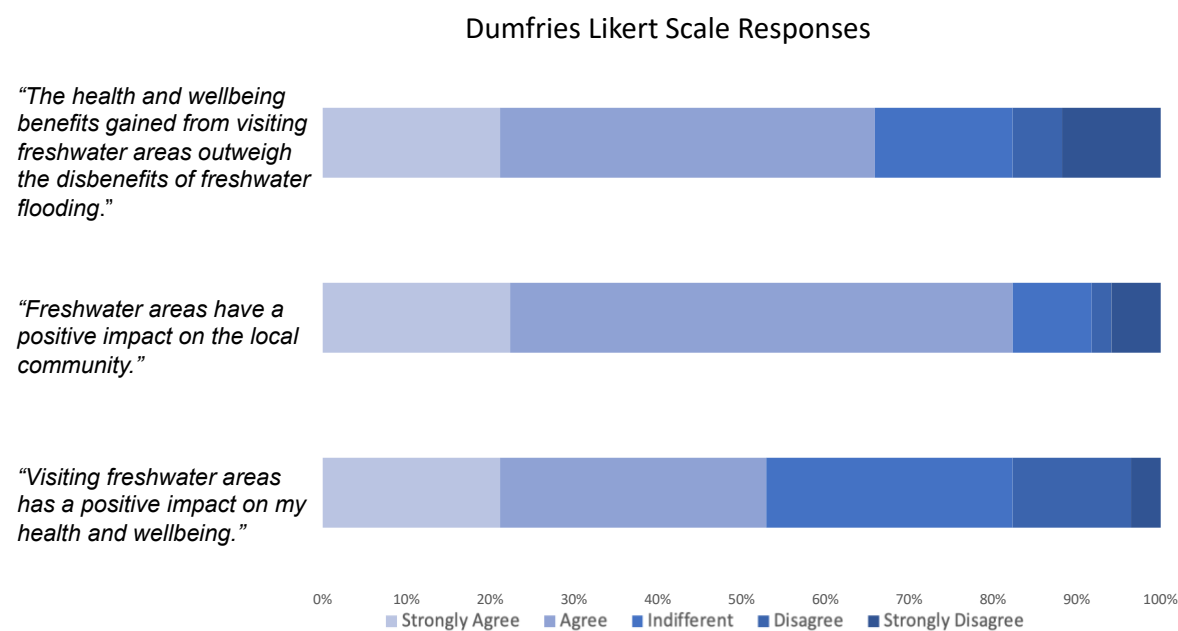


Figure 17: Distribution of Likert scale responses to inland blue space statements for residents of Dumfries.

6.3.2 Thematic Analysis

In total, 11 interviews were carried out across the two case study areas, each lasted between 30 and 60 minutes (Table 11). At the time of the interviews, participants had not been affected by flooding for at least ten months. After analysing interview transcripts, three overarching themes were identified that highlighted respondents' perceptions towards inland blue spaces in response to community flooding events. Each theme is discussed in detail below.

Table 11: Key demographic variables and relevant background information for the qualitative sample.

Demographic	Variable	Frequency
Age	21-30	1
	31-40	0
	41-50	0
	51-60	1
	61-70	5
	71-80	4
Location	Tillicoultry	4
	Dumfries	7
Gender	Male	5
	Female	6
Employment	Full-time Employment	3
	Part-time Employment	2
	Retired	6
	Unemployed	/
	Stay-at-home Parent or Carer	/
	Other	/
Involvement in Community Flood Response	Community Council Member	2
	Local Councilor	1
	No active involvement	8

6.3.2.1 Place-Based Knowledge

6.3.2.1.1 Lived Experience

Interview participants demonstrated a wealth of knowledge regarding flooding within their local community. This knowledge was strongly focused on the spatial aspects of flooding such as the height of floodwaters and identifying the geographical extent of previous flooding (e.g., houses, gardens and streets most affected). Prior experience of flooding allowed participants to gauge the severity of flooding events and compare changes to flooding incidents over time.

“It was only a small flood, like sort of 6 or 8 inches in the cellar, that’s a small flood.” Participant 1, Dumfries, 61-70.

“The next day, you could see the tideline and where all the rubbish had come along... and it was halfway up the hill. Wow. Nobody had ever seen that before, and.... you get all the old people out with their dogs going ‘ever seen anything like this?’” Participant 2, Dumfries, 51-60.

Participants in both Dumfries and Tillicoultry were aware of tourists or newcomers to the area who they felt had underestimated the impact of local flooding; either through attempting to travel through flooded areas or misguided investment in local property. In general, participants expressed sympathy for those who had been unprepared for flooding, however, they could also see the humorous aspects of others misfortune:

“I remember meeting a bank manager [...] he bought this house and thought he got a bargain I think, you see [laughter], he didn’t get a bargain, he got flooded out.” Participant 4, Tillicoultry, 71-80.

6.3.2.1.2 Application of Lay Knowledge

During the interviews, it was acknowledged that developing flood knowledge from lived experience helped individuals to feel more in control and better prepared for future flooding events. Participants had used their practical flood knowledge to develop flood mitigation and response strategies, with varying degrees of success. A wide range of strategies were described, including avoidance of riverside areas during periods of heavy rain, keeping cellars empty and developing a warning system.

“We’ve got a resilience plan. And our resilience plan, well it didn’t work 100% the last time because what it is, is the people downstream who are supposed to warn us if the flood banks break, and they didn’t because they were busy trying to rescue their livestock and keep the sightseers off the flood banks.” Participant 3, Dumfries, 61-70.

Whilst many individuals felt they could cope with what they considered ‘small-scale’ flooding, there was shared concern about the potential for climate change to exacerbate future flooding events. Participants felt the extent of flooding in Dumfries and Tillicoultry would likely increase over time. The broader implications of sea level rise were also a significant concern for those

who lived in Dumfries. Participants who were members of local councils expressed a sense of responsibility to use their lived experience and local expertise to help protect the community from future flooding events.

“Ironically Tillicoultry is the worst place in Clackmannanshire for flooding but in the last community plan we didn't mention flooding at all... Of course, what happens is that you get flooded out with stuff from the vast bulk of people who don't have any interest in flooding because if you've only got a tiny percentage of people who are really affected, then they just get diluted, and it got flushed. So, we'll address [flooding], even if the public at the community event haven't said it, then we'll say it anyway as if they had said it” Participant 4, Tillicoultry, 71-80.

Despite a desire to find solutions, community councillors described the difficulties of implementing successful flood mitigation strategies due to budget restrictions and conflicting opinions from both the public and other councillors.

6.3.2.2 Blue Health

The interviews highlighted the intricate relationship between inland blue spaces and human health outcomes. All interviewees had been negatively affected by flooding, with many recalling the fear and panic they had experienced during a flooding event. In Tillicoultry, participants recalled the speed of flooding as a source of concern, noting the often “violent” nature of the water. In Dumfries, where the flooding occurs at a steadier pace, participants felt they had time to respond to flood warnings; however, they still experienced anxiety about the potential impact and scale of flooding events. For residents of both towns, flood-related anxiety was attributed to several factors including driving through flooded roads, rescuing belongings from flood waters and observing the economic impact on local businesses.

One participant in Dumfries also described how, after finishing a night shift, a lack of awareness of weather conditions led to their parked car being submerged in flood water. Whilst no one

was injured, footage of their car was shown on the local news causing them significant embarrassment.

"I never told anybody for a while that it was me, I was just traumatised. It was afterwards when I started to tell the story and then I could laugh, and then I could see, oh, there's a funny side"
Participant 5, Dumfries, 61-70.

Throughout their interview the participant emphasised that because they are a resident of Dumfries, they felt they should have known better and avoided the area. Yet, despite the array of negative wellbeing outcomes experienced by the sample, all participants maintained an appreciation of their local river and shared memories of enjoyable blue space experiences. As summarised by one participant:

"I really love living near water... I think definitely the other 364 days that I live here outweigh the one day that it was really, really bad, but at the same time, every time it floods, I'm like, why does the wettest country in the whole world not have better flood management." Participant 6, Dumfries, 21-30.

During interviews, there was a recognition that local communities benefited from the riverside walks and leisure opportunities afforded by inland blue spaces. Older participants were interested in the history of their local rivers and felt the flow of the water provided a year-round source of interest. Some participants also expressed a strong sense of pride when discussing their local river:

"The Devon is iconic for a whole host of different reasons. I mean Robert Burns has been here, writing the poems about it. You've only got to walk along it to realise what an asset it should be, in touristic terms, and wildlife terms." Participant 4, Tillicoultry, 71-80.

In both towns, there was a perception that whilst floods had an overall debilitating impact on the community, the shared experience often encouraged a sense of community in the flood recovery process.

6.3.2.3 Living with the Landscape

Throughout the interviews, participants demonstrated an awareness that flooding incidents had been exacerbated by human activities and changes to land-use.

“I think that this is my biggest conjecture that they were busy doing their thing on the White Sands [River Nith] and up here they were busy doing all these improvements and putting the things in, and they didn't talk to each other. So, what hadn't previously flooded, started to flood.” Participant 3, Dumfries, 61-70.

Individuals felt that in addition to building near riverbanks, man-made alterations to straighten the course of the rivers had significantly exacerbated flooding issues experienced in recent years. Most participants were opposed to the introduction of further hard engineering infrastructure such as flood walls that may detract from the overall appearance of inland blue spaces. Alongside concerns over their appearance, individuals questioned whether hard-engineering strategies would be sufficient to control the flow of the river. Those who lived near the River Nith in Dumfries, feared that the proposed council flood management scheme could lead to the displacement of flood water further downstream and inadvertently increase the impact of flooding on their own properties.

Due to the shared belief that rivers were too powerful to control, many participants regarded flooding as an inevitable aspect of everyday life. One male participant who lived on the banks of the River Nith explained that they had chosen to not implement any permanent strategies to protect their property from flooding:

“When we came here, friends of ours came over and they said, ‘oh well if you want you could build a big dike across the bottom of the garden’. But, what’s the point? The flood water will just go around it, and how high do you build it? But as it is, we’ve got a panoramic view of the flooding when it happens.” Participant 1, Dumfries, 61-70.

Working with nature to mitigate flooding using wetlands and other vegetation was considered to be a proactive and sustainable strategy for protecting local communities. Whilst participants had varying levels of knowledge regarding flood defence, there was strong preference observed for natural flood management strategies. An older female resident who lived on the banks of the river Nith in Dumfries had taken direct action decades previously by planting numerous trees in their back garden when they first moved to the area. They felt that the trees were important in protecting the bank from collapsing and preventing their house from flooding.

6.4 Discussion

Negative experiences of exposure to blue space are often neglected in blue health research. This study therefore provides important real-world insight into the health and wellbeing implications of flood risk associated with inland blue spaces. The mixed methods research approach identified a broad range of individual and contextual factors - including age, place of residence and previous flooding experiences - that can mediate the impact of inland blue space exposure at the individual and population level. Qualitative interviews captured the temporality of blue space health outcomes whereby participants were able to overlook negative flooding experiences in favour of the more frequently experienced positive health outcomes. Both survey and interview participants who had experienced the detrimental impacts of flooding, strongly valued local inland blue spaces. The combined findings from both research methods highlight the significant impact of inland blue spaces on public health, influencing both positive and negative health outcomes for individuals and communities. Developing effective and sustainable flood management strategies to preserve the unique identity of inland blue spaces for local communities could therefore provide substantial long term public health benefits (Quinn et al., 2023; Verbrugge et al., 2019).

Through the combination of a national scale survey with focused case study insight, this research established multi-level perspective on blue space exposure outcomes and has further demonstrated the societal value of inland blue spaces (McDougall et al., 2020; Börger et al., 2021). Whilst qualitative interviews highlighted the overall positive impact of freshwater areas for Dumfries residents, quantitative analysis demonstrated that in response to the Likert-scale

statements, the Dumfries sub-population had a slightly lower opinion of the personal health and community benefits provided by freshwater than the general Scottish adult population. This variation in findings between the quantitative and qualitative methodologies is likely due to participation from different sociodemographic groups. Participants who were involved in interviews were typically older and tended to have a strong interest in the environment and the Dumfries community. The survey methodology has a significantly lower time-commitment than qualitative interviews, allowing for greater inclusivity of different socioeconomic classes (Bierer et al., 2021). An additional consideration is that the interview methodology allowed participants the time and space to reflect on inland blue spaces, leading to more balanced responses. However, in line with recent sociodemographic research, the discrepancies in findings indicate shifting opinions on blue space across the population, demonstrating the need to consider multiple stakeholder positions for the development of sustainable blue-green infrastructure and flood prevention strategies (Zhao et al., 2024; Romelli et al., 2025).

The combination of research methodologies identified key complexities regarding the influence of length of residence on blue space health outcomes. Quantitative survey results indicated that the length of residence did not predict whether individuals were impacted by mental health issues due to flooding. However, to maximise participant response and reduce the risk of survey fatigue, the short structure of the survey meant that individuals who had lived at a property for more than two years were categorised as a long-term resident. In comparison, qualitative findings allowed for a more detailed exploration of participants' experiences, highlighting the benefits of lived experience for providing individuals with a sense of security and control over flooding incidents. The marked discrepancies between the qualitative and quantitative methods demonstrate a key avenue for further research: understanding the impact of length of residence on place attachment and blue space exposure outcomes. Within the blue space research field there has been a strong focus on the influence of blue space proximity on short-term health outcomes (McDougall et al., 2021; White et al., 2021). Longitudinal insight has not yet established a significant association between blue space proximity and long-term health outcomes (Li et al., 2025; Klompaker et al., 2022). However, for longitudinal research such as this to be effective it needs to overcome key challenges, for

example accounting for changes to residential address over time. To encourage equitable health across populations, there is a need to understand whether repeated exposure to blue space and its benefits, or related adverse consequences, can have an overarching impact on health outcomes (Vert et al., 2020; Gascon et al., 2015). To achieve this, sensitive mixed methods research approaches are required to evaluate the impact of blue space across the life course and prioritise effective environmental management.

The current findings align with previous research to demonstrate that vital place-based knowledge regarding flooding is held within communities, through shared experiences and flood memories (McEwan et al., 2016). Knowledge of flooding captured in the research also highlights the broader issue of environmental justice affecting inland blue spaces, whereby members of the public have had to develop practical skills to cope with adverse environmental conditions (Korpilo et al., 2022; Parsons and Fisher, 2022). Quantitative survey results corroborate the existence of environmental inequalities with those affected by flooding recording higher levels of climate anxiety and commonly suffering from short-term mental health issues. Effective community engagement with environmental management plans is vital to protect communities from future flooding events whilst still preserving the identity of local freshwater environments for residents (Bild and Pachana, 2022; Zhao et al., 2024). Flood response policies should take advantage of the wealth of temporal and spatial knowledge available from local communities (McEwan and Jones, 2012; Lieberknecht et al., 2024). Further mixed methods exploratory research can help to achieve this; however, developing public archives from a range of academic and non-academic sources is also required to ensure that community knowledge is readily available (Tansay, 2016).

Within the blue space research field, there has been long-standing recognition of the healing power of aquatic environments (Völker and Kistemann, 2011; Buser et al., 2020). This research corroborates previous research findings, demonstrating the therapeutic potential of rivers for nearby communities (Ghosh and Pal, 2024; Wright et al., 2024). However, the mixed methods research approach also affords a balanced consideration of the broader impacts of blue space on society, documenting both positive and negative environmental experiences. To develop

climate resilience, research must continue to focus on the real-world implications of inland blue spaces for local communities and consider the wellbeing implications of proposed climate-adaptation strategies (Quinn et al., 2023; Heath, 2025). Whilst the current research highlights the potential for flooding to lead to temporal fluctuations in exposure outcomes, further research is required to consider the impact of a range of environmental and societal factors on blue space health outcomes over time. The application of longitudinal methodologies, including ethnographic approaches and repeated surveys would help to provide vital temporal insight.

To promote positive public health outcomes from inland blue space exposure, there is a need for local authorities to develop interdisciplinary flood mitigation strategies that consider community needs, such as environmental access, aesthetic preference and social values (Llancce et al., 2025, Bouwer et al., 2021, Alves et al., 2022; Heath, 2025). Both the quantitative and qualitative results of our study demonstrate the societal value of inland blue spaces in terms of facilitating recreational opportunities. Given the importance of blue space recreation for encouraging physical activity and reducing stress, it is vital that flood mitigation strategies accommodate current patterns of blue space access and expectations for future use, rather than restricting environmental access (Bark, Martin-Ortega and Waylen, 2021; Vert et al., 2019). The current research also highlights the importance of environmental aesthetics in influencing public perception of flood mitigation strategies, with interview participants strongly in favour of protecting the natural appearance of rivers. These findings support previous research focused on the aesthetics of flood management schemes, suggesting widespread approval for natural flood management strategies (D'Souza et al., 2021; Bark, Martin-Ortega and Waylen, 2021). However, due to the heterogeneity of inland blue spaces and flood management schemes, a greater evidence base is necessary to account for public preference and support for sustainable management strategies.

The application of an online survey alongside semi-structured interviews allowed for a triangulation of findings, emphasising the overall popularity of inland blue spaces in Scotland for maintaining health and wellbeing levels. Quantitative survey results provided robust insight into inland blue space perceptions at the population level. In-depth qualitative interviews

allowed for greater flexibility to explore survey findings in detail and added a temporal dimension to the research. The research is however subject to certain limitations. Firstly, whilst the quantitative findings provided important preliminary insight into blue health, it was unfeasible to account for all the environmental and social factors that may mediate blue space health outcomes. Secondly, for the qualitative research, the sample group tended towards older age-groups. The skewed nature of the sample had the benefit of capturing insight from individuals who had several decades of flooding experience and aligns with the ageing populations observed in rural areas of Scotland (Scottish Government, 2023c). However, the sample demographics limit the generalisability of findings and so it would be beneficial to conduct broader scale qualitative research across different stakeholder groups.

6.5 Conclusion

The current research further highlights the positive public health implications of inland blue spaces, demonstrating the overall popularity of these environments across the Scottish adult population for recreational purposes. The mixed methods research design has demonstrated that over the longer term, inland blue spaces provide substantive health and wellbeing benefits at the community and individual level. However, the qualitative and quantitative findings also highlighted the variability of inland blue space experiences, with flooding events having significant short-term implications on mental health and wellbeing outcomes. Implementing sustainable community-driven solutions is now crucial to prevent flooding events from further heightening environmental inequalities and ensure that populations can continue to benefit from access to inland blue space. To strengthen the existing evidence base and future proof our understanding of the benefits these spaces provide under a changing environment, further research must continue to evaluate human-environment interactions within the broader context of climate change and focus on the long-term public health implications of inland blue spaces.

Chapter 7: Synthesis and Conclusion

As evidenced throughout this thesis, further investment in the maintenance of inland blue spaces offers a sustainable solution to target public health inequalities and counteract the significant societal repercussions posed by the interconnected consequences of land degradation, climate change and environmental pollution (WHO, 2025). A mixed methods research approach was utilised across four empirical studies to address the overarching aim of developing a better understanding of public attitudes and perceptions concerning access and exposure to inland blue space. The empirical studies have provided novel insight into inland blue space usage, helping to bolster the current 'blue space, health and wellbeing' evidence base and the wider human-environment interaction research field. This final synthesis chapter will integrate research findings from the four empirical studies to consider the significance of the thesis within the current academic and policy context. The social, environmental, and public health policy implications of the thesis will also be considered.

7.1 Addressing Research Objectives

The mixed methods research approach allowed for each research objective to be considered from multiple perspectives. Figure 18 outlines the points of integration of the different methodologies used throughout the thesis to address the three research objectives. A detailed evaluation of how each research objective was achieved is provided below.

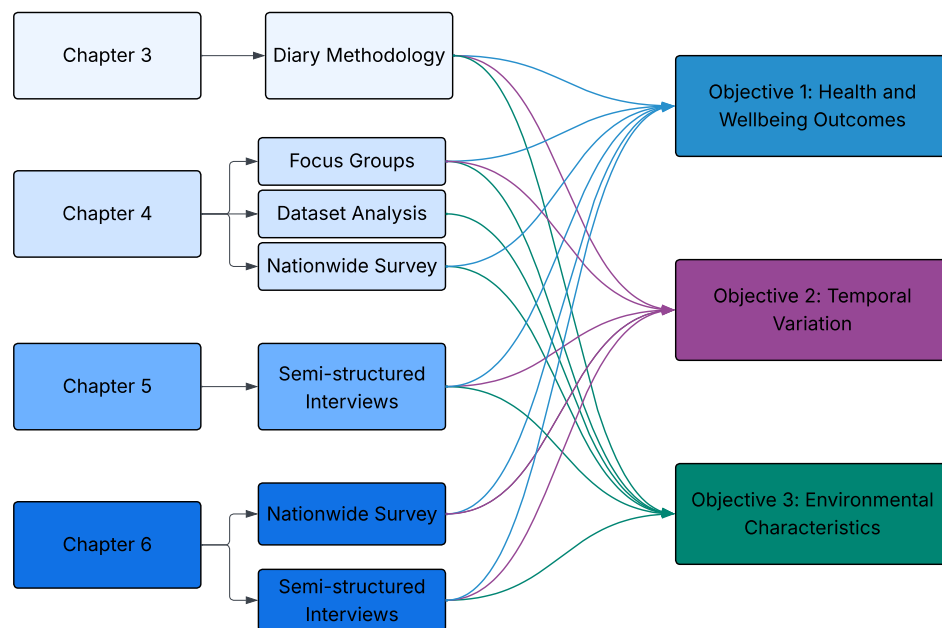


Figure 18: Flow diagram illustrating the contributions of each methodology in answering the three research objectives.

Objective 1: To determine the perceived health and wellbeing benefits of accessing inland blue spaces for different sub-groups within the Scottish adult population.

The health and wellbeing outcomes afforded by inland blue space experiences for the Scottish population was a key focus of all four empirical studies. Given the intricacies of environmental experiences, it is beneficial that this complex research topic was assessed through numerous

research methodologies. The different quantitative and qualitative methodologies used throughout the empirical studies demonstrate that whilst variation in exposure outcomes naturally occurs, accessing inland blue spaces has an overarchingly positive health impact for user-groups. The triangulation of research methods provides robust insight into the importance of these environments and corroborates recent blue space research (Guan et al., 2025; Rouse and Wishart, 2024).

Whilst the thesis provides strong evidence of the benefits of inland blue spaces, further research is required to determine variation in health benefits across different demographic groups. The questionnaire results from Chapter 6 (C6) demonstrated sub-population trends, with those affected by flooding recording a lower opinion of the potential positive impact of inland blue spaces on their individual health and wellbeing outcomes. However, survey methodology is not detailed enough to develop an in-depth understanding of sociodemographic differences. For qualitative methodologies, multi-modal recruitment strategies using a range of online and offline advertising strategies were deployed to seek broad participation; yet despite extensive recruitment phases, women and older age groups were often over-recruited. To address issues of environmental and health equity, an intersectional research approach is now required to better understand how social positions can impact inland blue space access and exposure outcomes.

Objective 2: To investigate the potential for variation in inland blue space exposure outcomes over time due to personal changes, environmental changes, and broader societal changes.

The use of qualitative research methodologies helped to address Objective 2 and establish a better understanding of the temporal factors influencing inland blue space experiences. The diary methodology used in Chapter 3 (C3) demonstrates the significant interest that environmental changes at inland waterways provide, with diarists observing a wide range of environmental modifications: from weekly fluctuations in water levels to river-bank erosion and the appearance of migrating birds. Anticipated changes to the environment, like seasonal

changes to the appearance of vegetation, were regarded more favourably than sudden unexpected changes, such as land degradation caused by different stakeholder groups. The observed public preference for naturally occurring, predetermined environmental change provides important insight for place making and the development of blue space infrastructure (Everrett, Adekola and Lamond, 2021). The collective interest in environmental change across the sample justifies the continued use of longitudinal research methods to further evaluate the public health implications of inland blue spaces across time.

Whilst C3 provides an overview of the interest afforded by environmental temporal changes, the results presented in Chapter 5 (C5) and C6 allow for a more detailed understanding of the impact of acute stress-inducing events on inland blue space exposure outcomes. In C5, qualitative interviews highlight the impact of the COVID-19 pandemic on inland blue space experiences, with societal and political changes leading to individuals adjusting their risk perception and recreational usage of these environments. Often inland blue spaces were regarded as vital for maintaining positive mental and physical health outcomes whilst facing extenuating circumstances. The mixed methods results from C6 demonstrate that whilst inland blue spaces can lead to periods of significant stress due to flooding, affected individuals still maintain an appreciation for the overall benefits provided by these environments. The collective findings from C3, C5 and C6 effectively highlight the potential for variation in inland blue space exposure outcomes over time. However, given the significant range of environmental, social and personal factors that may influence inland blue space experiences, further research is necessary to evaluate the long-term public health impact of these environments.

Objective 3: To assess the impact of inland blue space characteristics on recreational usage and health-related exposure outcomes for Scottish adults.

The findings from Chapter 4 (C4) directly address Objective 3 and identify the importance of environmental aesthetics for influencing recreational usage and exposure outcomes. Results

from a three-phase mixed methods research approach identified an overall preference for natural appearing rural inland blue spaces. Surrounding green space was found to have a notable impact on aesthetic preference for inland blue spaces and consequently recreational usage of an environment, with individuals demonstrating a preference for native plants and wildflowers. The results from C4 are further supported by chapters 3, 5 and 6. Research findings throughout the thesis repeatedly demonstrate that quiet inland blue space environments of high ecological quality, can consistently lead to positive exposure outcomes for individuals and encourage frequent recreational usage. This aligns with similar research identifying an association between perceived landscape and soundscape quality with stress recovery outcomes (Korpilo et al., 2024). The presence of 'natural' smells may also positively impact environmental experiences, however further research is required to understand the significance of multisensory environmental experiences on recreational usage for different user groups (Taufer et al., 2025).

7.2 Key Scientific Implications

Across the four empirical studies, participants demonstrated a significant appreciation of Scottish inland blue spaces, valuing the natural beauty of these areas as well as the beneficial health outcomes associated with blue space exposure. To gain balanced insight, inland blue space exposure was evaluated under 'normal' circumstances, as well as under more stressful situations such as during the COVID-19 pandemic and community flooding incidents. Whilst pressurised conditions were shown to alter the dynamics of human interactions with inland blue space and influence short-term health outcomes, the results indicate that they do not detract from overall public perception of these environments. The research thus offers further evidence to support the beneficial long-term public health implications of inland blue spaces (White et al., 2020; Stehl et al., 2024; Li and Trivic, 2024).

The thesis findings also align with a conceptual model proposed by Hartig et al. (2014) illustrating the six key pathways that influence human health outcomes from contact with nature (Figure 19). Based upon the thesis findings, two pathways have been altered to increase their relevancy for inland blue spaces; namely air quality has been changed to account for the broader impact of environmental quality, and physical activity has been changed to 'leisure activities' to consider the importance of more sedentary blue space activities (Figure 19). In line with current findings, the adjusted model also illustrates the important potential for effect modifiers such as age, gender and place attachment to alter health pathways at inland blue spaces (Figure 19).

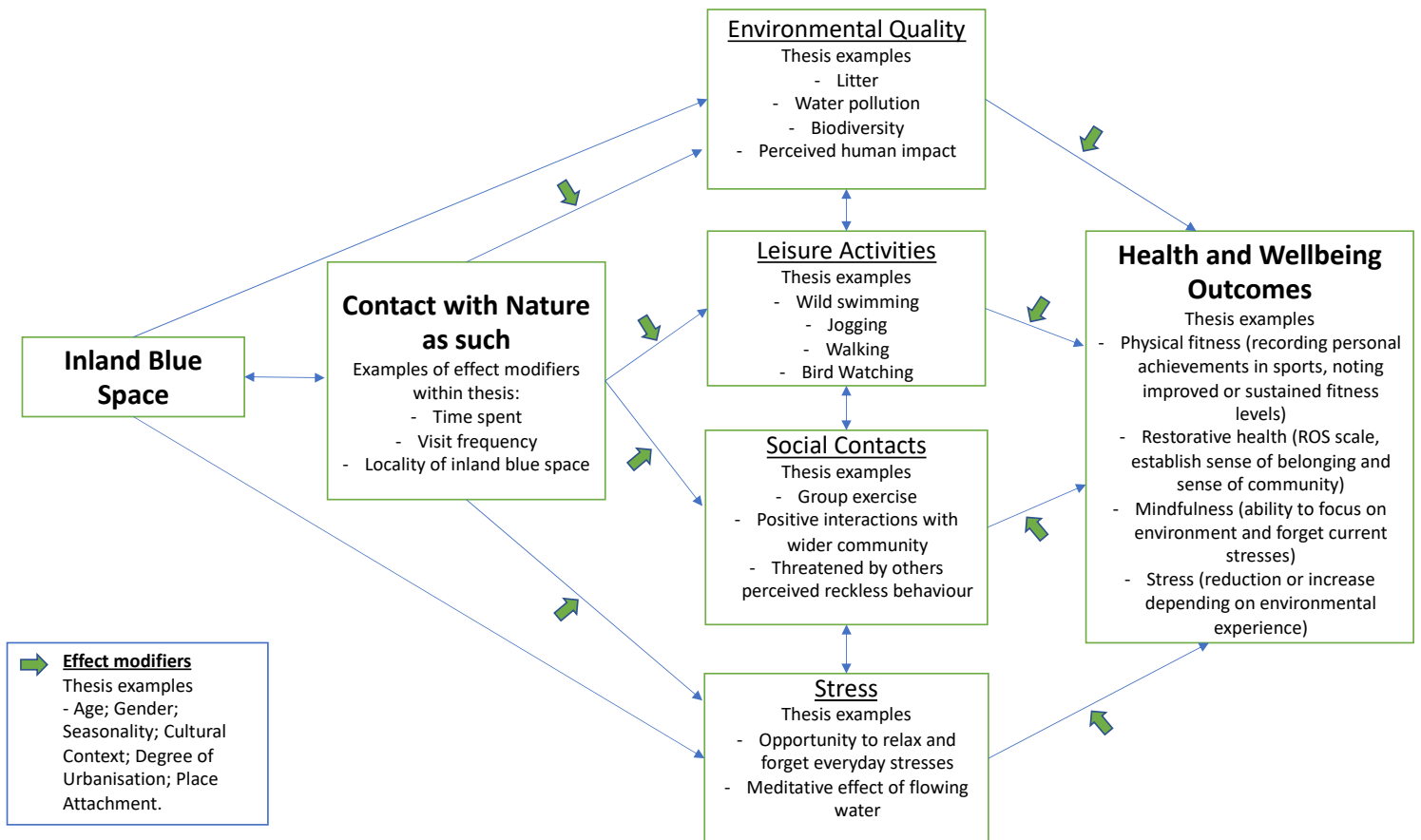


Figure 19: Conceptual pathway adapted from Hartig et al., (2014) to apply specifically to inland blue spaces. Two of the six pathways link directly from inland blue space to environmental quality and stress, highlighting that even without direct exposure or engagement, inland blue spaces can influence health and wellbeing outcomes.

Research continues to support the association between blue space exposure and positive mental health and wellbeing benefits (Hermanski et al., 2021; Ghosh and Pal, 2024). This thesis highlights the wide range of mental health benefits that can be obtained from inland blue space exposure, including stress relief, restorative outcomes, and feelings of escapism. Positive wellbeing outcomes from inland blue space exposure were recorded at the individual, community and population level. The flexibility afforded by the mixed methods research approach enabled the thesis to build on the existing evidence base and demonstrate an overall preference for obtaining beneficial wellbeing outcomes from inland blue spaces in addition to obtaining physical health benefits. Given this initial insight, further research should consider comparing whether the value ascribed to health-related exposure outcomes varies between environmental contexts and more specifically inland blue space typologies. Greater understanding of public preference can help to tailor future nature-based health interventions to sustainably address community health outcomes (Shanahan et al., 2019).

Multiple chapters highlighted the strong emotional connection individuals felt to inland blue space environments. Emotional connections in the form of place attachment were recorded for neighbourhood inland blue spaces and for locations of personal significance such as childhood holiday destinations and wedding locations. Attachment to freshwater environments had an overarching influence on blue space experiences and health-related exposure outcomes, contributing to positive health outcomes under calm conditions and leading to strong negative feelings when individuals encountered significant environmental changes. Notably, throughout the thesis, male and female participants across a broad range of ages recorded feeling this place attachment. The cumulative results from the empirical studies therefore help to consolidate the importance of sense of place and place attachment as key moderating factors influencing the relationship between inland blue space exposure and health outcomes. This insight aligns with previous green and blue space research conducted in different contexts and is crucial to justify resource allocation for improved maintenance of Scottish inland blue spaces (Foley and Kistemann, 2015; Colley and Craig, 2019).

Both qualitative and quantitative research methodologies demonstrated that inland blue space exposure outcomes are inextricably linked with green space exposure outcomes. Qualitative methodologies allowed participants to share their appreciation of seasonal and native vegetation in the vicinity of inland blue spaces. Additionally, a nationwide survey emphasised that the appearance of green space has a significant influence on aesthetic preferences for blue space environments at the population level. Whilst the thesis helps to address a key research gap regarding the interplay between green and blue space exposure outcomes, future research should place a stronger focus on identifying the specific environmental characteristics that directly influence exposure outcomes (Du et al., 2022). Initial insight highlights that the flow of water, and the presence of native plants are important in shaping environmental experiences; however, additional research is required to unpack the multi-sensory nature of inland blue spaces and consider the impact of hearing, smell, and touch alongside aesthetic preferences (Austen et al., 2021).

7.3 Policy Implications

One area of inland blue space governance that requires particular attention to encourage environmental and public health equity is accessibility. A universal definition of accessibility is yet to be established, however, for inland blue space policy recommendations, two aspects of accessibility are of relevance: physical and psychological accessibility (Farrington and Farrington, 2005; Levine, 2020). Physical accessibility refers to the relative distance to blue space environments whereas psychological accessibility considers individual's perceptions of and willingness to use blue spaces (Park, 2016).

The physical accessibility of inland blue spaces in both urban and rural regions is continually threatened (Korfmacher et al., 2015; Smith et al., 2022). Increasingly, in rural areas, private investors are acquiring Scottish forestry and agricultural land as part of carbon offsetting schemes (Sharma et al., 2023). This may provide benefits in terms of climate change; however, due to a lack of regulations, these schemes can often have significant social costs for local communities and threaten access to natural environments (Hannon et al., 2022). Urban waterways continue to be impacted by various anthropogenic pressures, including shoreline

modification where structural engineering leads to steep-sided waterways with minimal surrounding green space and an overall reduction in blue space habitat (Teurlincx et al., 2019). To ensure that individuals can continue to access and benefit from inland blue spaces, there is a need to consider more stringent regulations for controlling publicly accessible buffer zones around Scottish inland waterways. This would have significant public health benefits alongside promoting biodiversity and improved water quality (Han et al., 2025; Teurlincx et al., 2019). Existing grey infrastructure at inland waterways is increasingly affected by climate-stress, this therefore offers the opportunity to restore natural riverscapes and place a stronger focus on using natural infrastructure such as wetlands for water-basin management (Skidmore and Wheaton, 2022).

Concerns over safety have been cited as a reason for Scottish adults avoiding natural environments (Dinnie, Brown and Morris, 2013). The findings from this thesis also identify the potential for crowded blue spaces and perceived reckless behaviour from others to act as a significant deterrent. Socially vulnerable groups can feel heightened levels of insecurity whilst visiting inland blue spaces, therefore measures should be taken to ensure that these environments are psychologically accessible across populations (Pitt, 2019). Whilst addressing safety concerns at inland blue spaces will require further context specific research, some universal approaches such as litter picking and the installation of railings on the edge of water banks can help to improve safety perceptions and encourage more frequent environmental usage (Medway, Parker and Roper, 2016; Pitt, 2019).

Scientific communication is a cost-effective way to raise public awareness of the health-related benefits of freshwater environments and address the psychological accessibility of inland blue spaces. News articles and online press releases can disseminate key findings, at an accessible level, to large audiences (see Appendix 5 for an example inland blue space press release). There has also been increased interest in health promotion through individuals with high social media followings, otherwise known as social media 'influencers' (Michel et al., 2024). For many, influencers are regarded as a trusted source of information and so can help to effectively disseminate key health messages to those who may otherwise have limited interactions with

public health authorities (Kostygina et al., 2020). However, in recent years, social media has been associated with mass tourism and overcrowding in protected natural areas (Taczanowska et al., 2019; Gretzel, 2019). Therefore, careful management strategies are required to encourage the geographic dispersal of visitors and prevent adverse consequences arising from public health campaigns.

As highlighted in the thesis, environmental changes can impact how individuals regard familiar blue space environments. Dramatic environmental changes can detrimentally impact public perception of blue spaces. This thesis focused on flooding as a case study of environmental change, identifying the significant short term mental health impact of flooding incidents for individuals. To preserve the public health benefits of inland waterways, there is a need to build community resilience to flooding and other climate-related risks through community engagement and the co-development of sustainable blue space infrastructure (Everett, Adekola and Lamond, 2023). In recent years, there has been significant public and academic interest in conservation work to reintroduce beavers to Scottish freshwater environments (Holmes, Rowland and Fox, 2024). The landscape changes brought about by the re-introduction of beavers may increase nature-connectedness, provide natural flood-management solutions and help to promote positive wellbeing outcomes. However, for different stakeholder groups, including farmers and residents, the eco-engineering behaviour of beavers may increase anxiety and stress levels (Coz and Young, 2020). Conducting interdisciplinary research focused on the public health impact of beaver reintroduction would help to guide future conservation strategies to balance the complex social and ecological impacts of environmental change.

7.4 Implications for Practice

A consistent research gap documented throughout the thesis is a lack of representation within inland blue space research. To address this, there is the need to continue to develop and utilise more inclusive research methodologies. The use of design-based research methods may offer significant advantages for the inland blue space research field by allowing communities to collaboratively address complex issues such as safety concerns or flood-mitigation strategies (Anderson and Shattuck, 2012). A key benefit of design-based research is that it is conducted in-situ, enabling the specific community context to be accounted for (Stockless and Brière, 2024). Members of the community and local stakeholders are involved in the governance of design-based research, allowing for greater inclusivity. However, this style of research requires significant investment both in terms of resources and time. An alternative approach that may help to engage disadvantaged individuals is the use of smartphone apps as this can allow individuals who face greater time pressures and feel less comfortable with in-person research techniques to participate (Welford et al., 2022).

Encouraging public participation with development projects is vital to preserve the landscape identity of inland blue spaces for user groups and local communities (Barnes, Newman and Sullivan, 2006). To aid the implementation of blue space infrastructure and other nature-based interventions, participatory research is required to develop a framework for community engagement within a human-environment interactions lens. Whilst current frameworks to promote and facilitate stakeholder engagement with blue-green infrastructure have outlined key principles, these frameworks are subject to limitations including accessibility and transferability across different organisational and community contexts (Walker, 2025; Everett, Adekola and Lamond, 2021). Given the specific context of Scottish inland blue space and the potential for varying perceptions across populations, it would be beneficial to build on existing research and develop a framework for community engagement with Scottish blue space development programmes.

7.5 Mixed Methods Research Approach

The unique, comprehensive insight into inland blue space environmental experiences could not have been achieved without the adoption of a mixed methods research approach. Table 12 summarises the different methodological approaches and level of integration achieved for each empirical study.

Table 12: Level of mixed methods integration achieved at each methodological stage for the four empirical studies.

Integration Level	Chapter 3 – Diary Methodology	Chapter 4 –Dataset Analysis, Focus Groups & National Survey	Chapter 5 – Semi-structured Interviews	Chapter 6 – National Survey & Semi-structured Interviews
Design	Convergent research design. Quantitative and qualitative diary questions completed simultaneously by participants.	Explanatory sequential design. Scenic or Not Dataset analysis informed development of national survey and focus groups.	Single method design incorporating two sub-types of qualitative analysis.	Convergent research design. Survey and interviews conducted during similar time-period.
Methods	Qualitative questions designed to provide complementary insight to quantitative restorative outcome scale (ROS) scores.	Focus groups and national survey use original images from Scenic-or-Not Dataset to gain in-depth insight into scenic ratings.	/	Geographical targeting of two locations within semi-structured interviews and national survey to allow for case-study insight.
Analysis	Iterative analysis approach with qualitative analysis informing lines of statistical inquiry.	Merging quantitative databases through a comparison of scenic scores between sample populations.	Iterative analysis approach with initial analysis at the sample level guiding the creation of individual narratives.	Iterative analysis approach with survey results highlighting potential topics of interest to query in thematic analysis.
Interpretation and Reporting	- Contiguous reporting - Joint display of ROS scores and qualitative data to illustrate environmental experiences.	- Contiguous reporting - Diagrammatic representation to illustrate relationship between mixed-method findings.	/	- Contiguous reporting - Narrative integrating of findings in discussion.

7.6 Reflexivity of Working with Mixed Methods

The thesis findings are presented in consecutive order; therefore, each chapter tracks an increase in knowledge of the human-environment research field alongside an increase in confidence as a researcher.

A large part of the learning process for the qualitative methodologies was navigating the participant-researcher relationship. In the diary project, I felt conscious that the diaries could be regarded as a burden for participants. This influenced how I engaged with the participants and dissuaded me from inviting the diarists to take part in follow-up interviews. However, after disseminating results with several diarists at a group meeting, I was relieved to find that most participants had enjoyed the overall diary experience. This provided me with greater confidence in establishing rapport with participants in subsequent chapters. Another aspect of the PhD that influenced my relationship with participants was taking part in a fellow PhD student's research project. The experience of being a participant highlighted to me the benefits of clear, concise information, presented in a professional manner. Whereas previously I had felt uncomfortable issuing formal instructions to participants as it may be construed as controlling, I realised the benefits of receiving this formal information to minimise confusion and streamline the research process. Within qualitative interviews I sought to maintain a collaborative and participatory approach, however, I had more confidence in providing clear background information and outlining the research protocol for participants.

During the PhD, I completed several different qualitative research training courses, particularly enjoying the courses provided by the Social Research Association. This training allowed me to progress from surface-level observations of qualitative data to recording a more interpretive, in-depth understanding of recurrent themes and patterns of data. In comparison to the latter chapters, the findings presented in C3 are closer to observations than detailed qualitative findings. This limitation is partly due to C3 representing my first attempt at qualitative research. However, the breadth of the dataset also shaped the findings as I felt conscious to present as wide a range of findings as possible to validate the significant research contributions made by each participant. Despite best efforts, the results presented in C3 still do not adequately

account for the richness of the diary dataset, therefore I would like to return to this project in future to conduct further, more detailed, qualitative analysis. In subsequent chapters, I had greater experience and understanding of qualitative and mixed-methods research, this helped with the overall data analysis, enabling me to better identify threads of interest within the research to establish detailed themes and narratives.

In C3, 4 and 6, the integration of research findings and presentation of results proved to be more time-consuming than I had initially expected. In all three chapters, very large datasets were collected, therefore an iterative data familiarisation process was necessary to establish the most relevant data for addressing each research objective. Over the course of the three projects, I gained more confidence in identifying commonalities between quantitative and qualitative data. However, despite this increased confidence and experience, C6 proved to be the most challenging in terms of data integration. For C6, the quantitative and qualitative datasets initially appeared to be very different from each other. In addition, despite participant's eagerness to discuss flooding during interviews, most of the interview data covered the practical logistics of flooding rather than emotional responses to flooding events. Therefore, this chapter required a more iterative analytical process alongside detailed discussions with the wider supervisory team to identify points of integration within the survey and interview data that clearly addressed the research objectives.

7.7 Limitations

Whilst specific research limitations are discussed within each chapter, this section presents reflections and observations that are pertinent to the collective research findings.

The thesis sought to consolidate the inland blue space evidence base through presenting a triangulation of findings from different data sources. The use of several different qualitative and quantitative methodologies to collect data from multiple sources, with repeated measurements and some long-term observations helped to achieve this consolidation and ensure research validity. A reflexive research approach was also adopted to consider the potential impact of personal biases on research practices (Creswell and Miller, 2000; Green, 2015). However, the generalisability of research findings is a key limitation of the thesis. Qualitative methodologies were used in the thesis to provide rich insight into inland blue space experiences at the individual level, rather than to provide population level data. Whilst a range of recruitment methods were utilised, qualitative methods were subject to volunteer bias with participants often having a keen interest in freshwater activities such as wild swimming. For the quantitative surveys, a nationally representative sample was recruited, helping to overcome the sample specific limitations of the qualitative methods. Further measures should be taken in future to focus on different demographic groups, specifically incorporating more passive inland blue space user-groups, such as commuters, as well as non-users of inland blue space. Alongside this, research should better consider the extent that social structures influence access to natural environments. In recognition of the broader global conflicts surrounding water accessibility, there is a need to consider the political, social, and cultural factors that influence human-environment relations with inland blue spaces (Cole, 2017; Tallman et al., 2022).

The transferability of research findings to other contexts and populations is limited for a variety of reasons. Firstly, Scotland has a unique relationship with inland blue space, with a pride in the quality and abundance of the natural Scottish landscape forming a key part of Scotland's cultural identity (Adams, 2022; Withers, 1999). This national pride is likely to shape individuals' perceptions of inland blue spaces and consequently may have influenced the current research

findings. Secondly, across different regions there is significant variation in the quality, typology, and availability of inland blue space. Even within the United Kingdom and Ireland, the unique characteristics of different geographical features, such as the rare chalk streams found in Southern England or the Irish turloughs (seasonal lakes), may lead to distinctly different inland blue space experiences for local communities. Finally, varying leisure and social practices across countries may prevent specific demographic groups from obtaining therapeutic health outcomes. For instance, in New Zealand, ethnic minority groups may actively avoid water-based activities due to a lack of confidence with swimming alongside social beliefs (Wheaton and Liu, 2024).

Whilst several different qualitative and quantitative methods were used throughout the thesis, all methodologies were conducted indoors rather than in-situ. It was intended that the interviews in C6 would be carried out as walking interviews, however, the timing of the data collection period with the winter season prevented this from happening. Conducting further research in-situ through the application of a range of wider and complementary methods including walking interviews and measurement of mental health biomarkers would better capture physical responses to inland blue space environments and help to determine the pathways through which environmental contact influences health and wellbeing outcomes (Hermanski et al., 2021; Jacobs et al., 2024). There has been increased interest in the value of conducting ethnographic-style research, with researchers joining participants for immersive water-based hobbies such as wild swimming (Foley, 2023; lisahunter and Stoodley, 2020). Utilising further immersive research approaches offers significant potential to record alternative perspectives on environmental experiences and disseminate the multisensory dynamics of inland blue spaces.

7.8 Conclusions

This thesis has considered inland blue space interactions from multiple perspectives to demonstrate the varied and often interlinked health-related benefits provided by inland blue spaces for the Scottish population. The mixed methods research approach adopted throughout the empirical studies allowed for a detailed exploration of a range of environmental, social, and personal factors that can influence exposure outcomes. Whilst current findings outlined the variable nature of inland blue space experiences, clear pathways are evident to limit this variability and encourage positive environmental interactions, including the introduction of effective blue space infrastructure to minimise flooding risk and allocating greater resources to protect the quality of environmental surroundings. In a time of increasing health pressures and continued austerity measures, the findings demonstrate the significant economic, social, and public health benefits of investment in inland blue spaces. To benefit the Scottish population, concerted action is now required to identify and address key barriers to inland blue space accessibility across different social groups.

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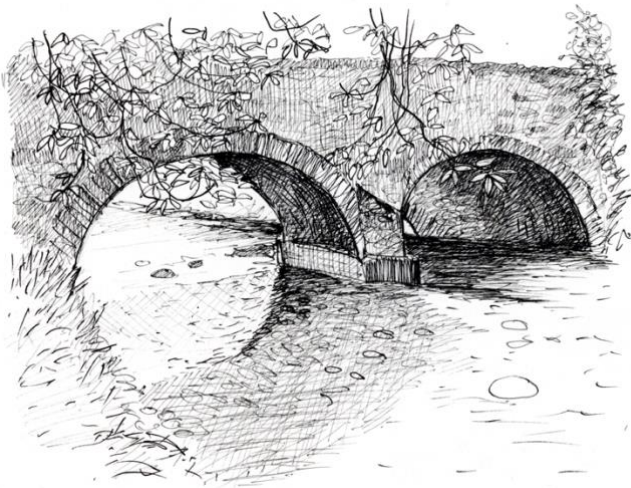
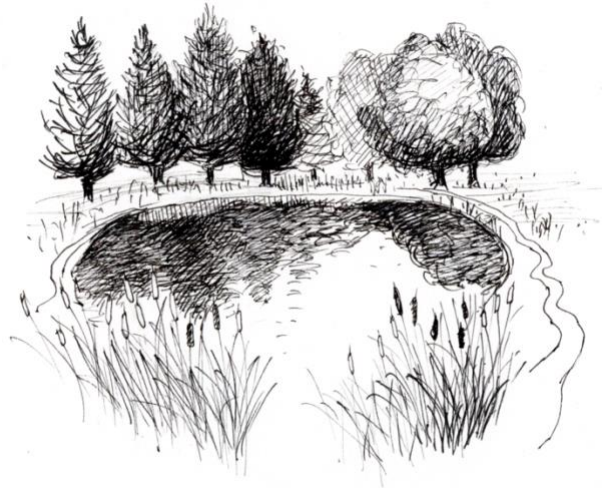
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Chapter 8: Appendices

Appendix 1. Diary Instructions

The following pages consist of the introductory pages and background forms included at the start of the diary.

Examples of types of Inland Blue Space...



Diary Instructions

Please fill in a diary entry when you visit an inland blue space area. Try to complete all sections of the diary entry as best you can and feel free to provide as much information as you like about your blue space visit. In the comments section included at the end of the diary entry, there are broad headings to help guide you. Within these headings, you could provide information on a range of different topics depending on what interested you during your blue space visit, for example, bird song, the flow of the water, changing seasons or evidence of pollution.

It is estimated that each entry will take between 10 and 20 minutes to complete. However, as you get used to filling in the diary, it is likely that each entry will start to take less time. You should fill in no more than three diary entries per week. The diary entry should be filled in on the same day that you visited the blue space area. If you forget to fill in the entry on the day of your visit, then count it as a missed entry and do not go back and complete it after the day of the visit.

Reminder – any type of natural or manmade freshwater environment counts as inland blue space. For example: estuaries, streams, rivers, lochs/lakes, reservoirs, waterfalls, canals, ponds. Whilst there are a wide range of inland blue spaces available in Scotland, to take part in this project, you do not have to visit several different types of blue spaces. This project is interested in determining what factors can affect your enjoyment of inland blue space areas so repeated visits to the same body of water are just as relevant as visiting numerous different types of freshwater areas. If you make a regular visit to a blue space area, try to think about what factors such as the weather and people make each walk unique, and note this down in each diary entry.

Additionally, it's fine if you only spend a brief period of time near the water, we are interested in capturing everyday usage of blue space environments and so recording any length of visit is highly appreciated as this gives a real insight into how people interact with blue space areas.

Each diary should be filled in over a period of three months before being sent back. You will be sent a reminder of this closer to the time.

Thank you very much for agreeing to take part in this project. I really appreciate it and hope you enjoy the process of creating your research diary. I will check in with you on a semi-regular basis to make sure that you are getting on ok with the project.

Best wishes,
Megan

Participant Information Form

Age: 18-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐
61-70 ☐ 71-80 ☐ 81-90 ☐ 90+ ☐ Prefer Not to Say ☐

Gender: Male ☐ Female ☐ Other ☐ Prefer Not to Say ☐

Please specify your ethnicity -

White - English, Welsh, Scottish, Northern Irish or British ☐ Irish ☐ Gypsy or Irish Traveller ☐
Any other White background ☐

Mixed or Multiple ethnic groups - White and Black Caribbean ☐ White and Black African ☐
White and Asian ☐ Any other Mixed or Multiple ethnic background ☐

Asian or Asian British - Indian ☐ Pakistani ☐ Bangladeshi ☐ Chinese ☐
Any other Asian background ☐

Black, African, Caribbean or Black British - African ☐ Caribbean ☐ Any other Black, African or Caribbean background ☐

Other ethnic group - Arab ☐ Any other ethnic group ☐

OR – Prefer Not to Say ☐

Education: What is the highest level of education you have completed?

High School ☐ College or Undergraduate Degree ☐ Post-graduate Qualification ☐

Employment Status: Please tick the box which best describes your current status.

Full-time Employment ☐ Part-time Employment ☐ Unemployed ☐ Retired ☐
Student ☐ Stay-at-home Parent ☐ Self-employed ☐

Location: Do you live in a rural or urban area?

Rural ☐ Urban ☐ Suburban ☐

Wellbeing Question

To help provide an understanding of how overall levels of wellbeing can influence the benefits gained from accessing freshwater areas, please now complete the following wellbeing question. There are no right or wrong answers for this wellbeing question. Please answer this question on a scale of 0 to 10, where 0 is “not at all” and 10 is “completely”.

This wellbeing information along with the background information will be used to assess trends across the sample group and will not be used to assess trends at the individual level.

Wellbeing Question: Overall, how satisfied are you with your life nowadays? (0 = “not at all” and 10 = “completely”).

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

Appendix 2: Diary Entry Structure

Date of Visit:

Time of Visit:

Length of Blue Space Visit:

In a couple of sentences, please describe where you visited today:

Weather conditions:

To what extent did the weather impact your blue space visit?

Strong Negative Impact ☐

Negative Impact ☐

Neutral Impact ☐

Positive Impact ☐

Strong

Positive Impact ☐

Type of inland blue space visited (for example, lake, canal or river etc):

How did you travel to the blue space area (car, bike, walking etc) and how long did the journey take?

What was your main activity at inland blue space (e.g. dog-walking, cycling, picnic, socialising, bird-watching, sitting/observing, jogging etc):

Was it in a rural, suburban or urban area?

As a result of your inland blue space visit today, to what extent do you agree with the following statements? (On a scale of 1-7 with 1 meaning not at all and 7 being completely agree):

I feel calmer after being at this inland blue space area.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐

I feel restored and relaxed after visiting the inland blue space area.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐

I gained new enthusiasm and energy for my everyday routines from visiting the inland blue space area.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐

My concentration and alertness increased while I was at this inland blue space area.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐

During my inland blue space visit, I could forget everyday worries.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐

Visiting here helped to clear and clarify my thoughts.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐



Please now provide some comments about your experience of visiting the inland blue space under the following headings-

What did you see of interest?

What did you hear of interest?

What did you smell of interest?

Were you with anyone during your visit?

What did you like and dislike about your blue space visit?

Was there anything particularly interesting about your visit today?



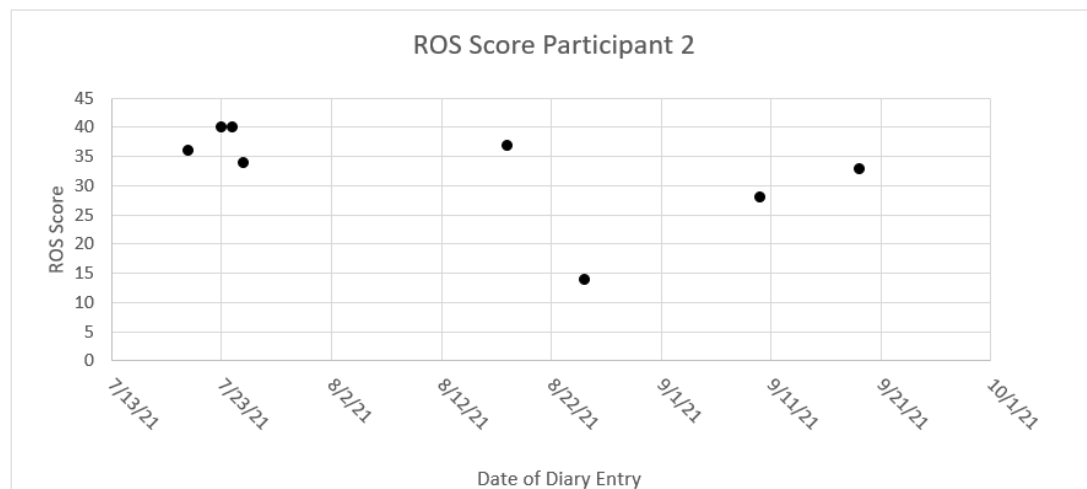
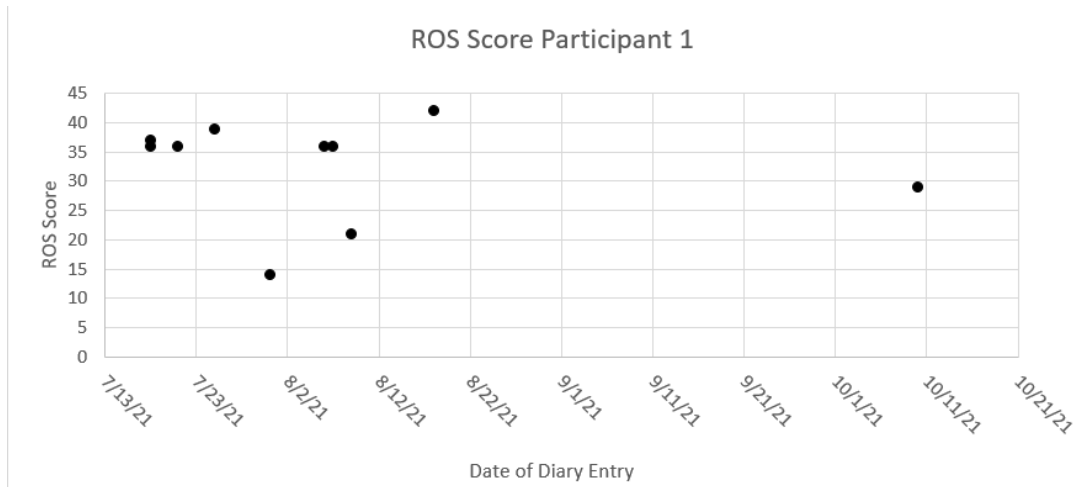
Appendix 3: Non-respondents

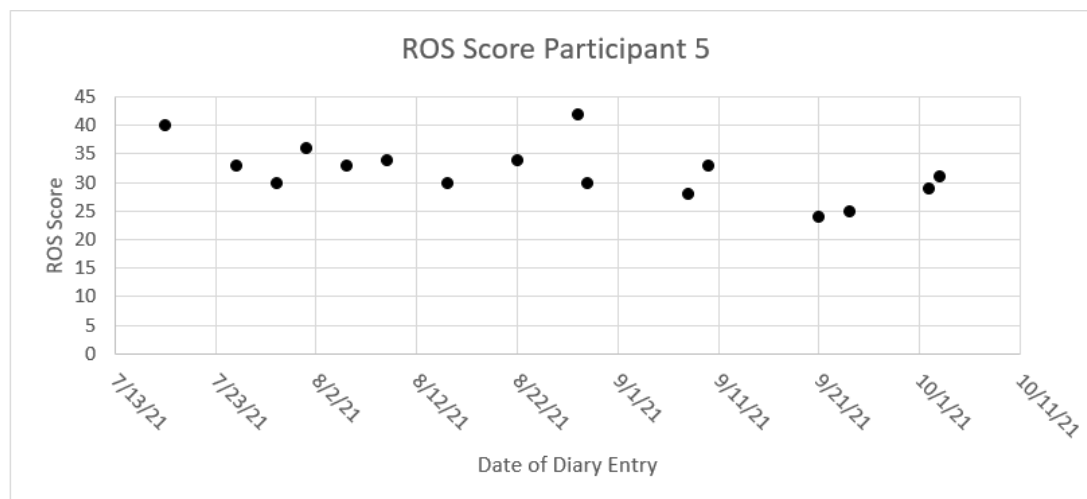
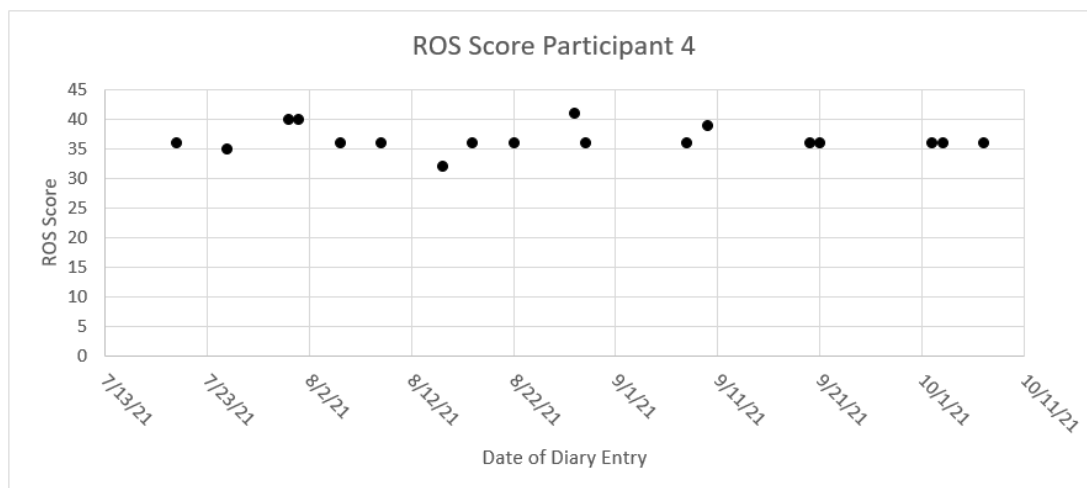
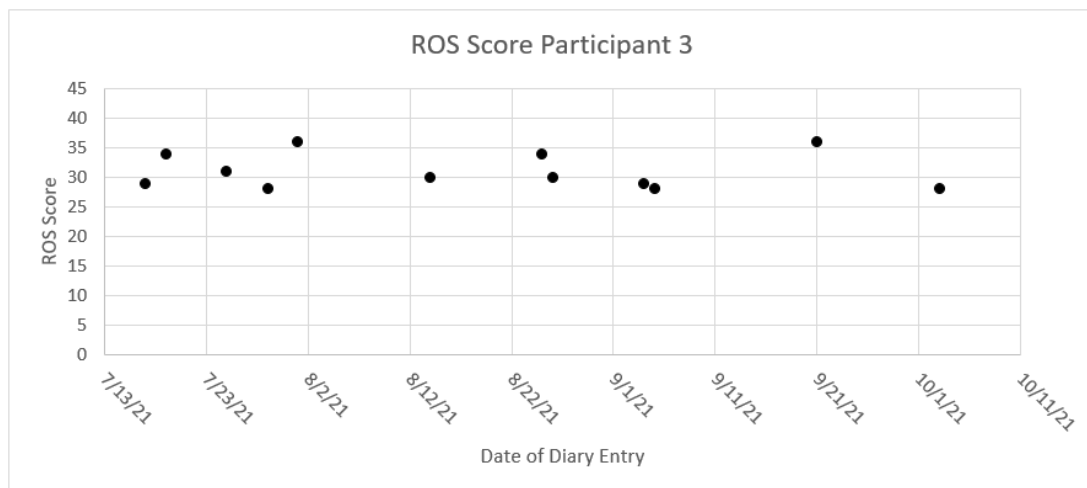
Demographic information for non-respondents across the data collection period. 'Key blue space activity of interest', refers to the factor that participants cited as their main motivation for visiting inland blue spaces.

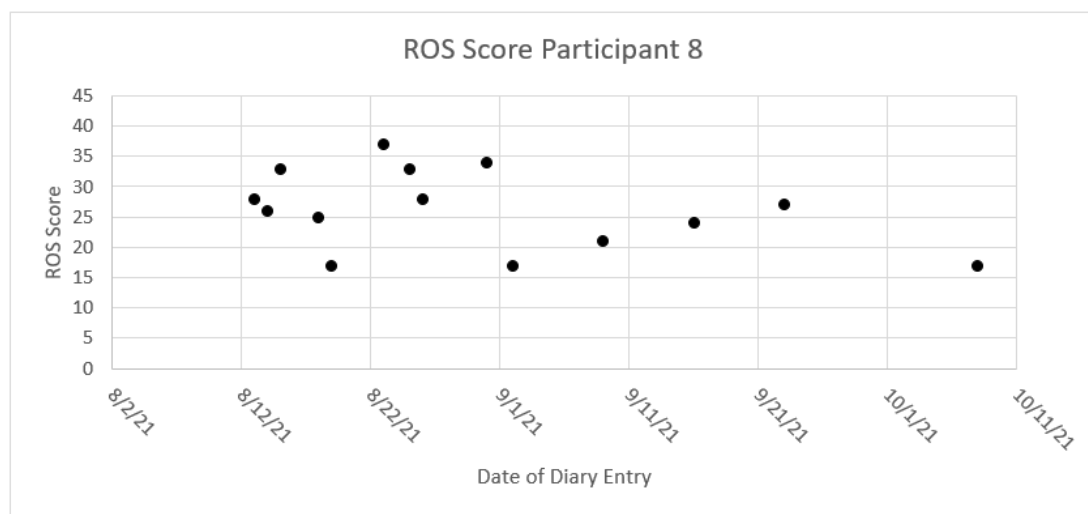
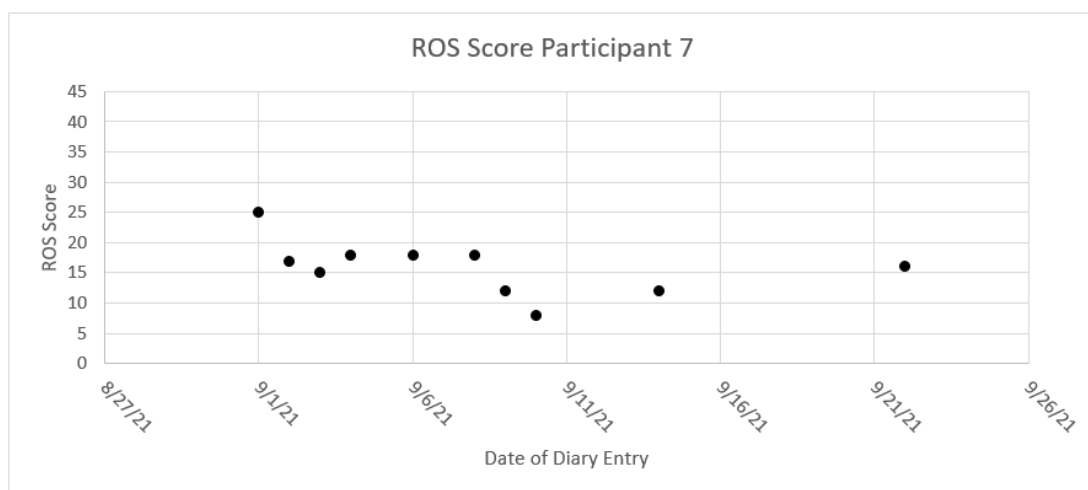
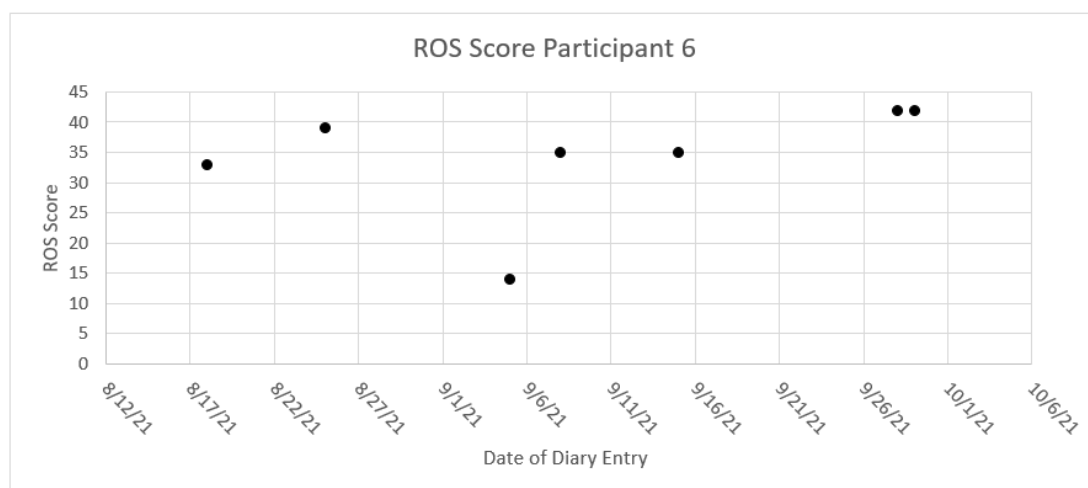
Demographic	July - October	October - January	January - April	April - October
Gender:				
Male	2	2	2	2
Female	1	4	4	1
Location:				
Rural	/	2	5	1
Urban	3	2	1	2
Suburban	/	2	/	/
Key Blue Space Activity of Interest:				
Swimming	/	4	3	/
Water-sports	/	2	2	/
Walking	3	/	/	1
Observing	/	/	1	2
Reason for non-response (if known):				
Illness	/	2	1	/
Lack of time	3	1	1	1
Unable to post diary back	/	/	1	/

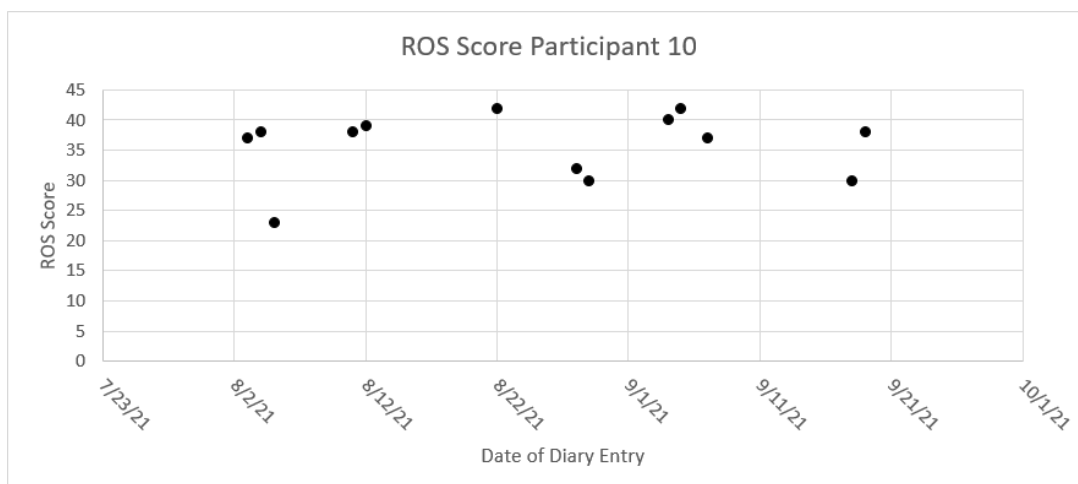
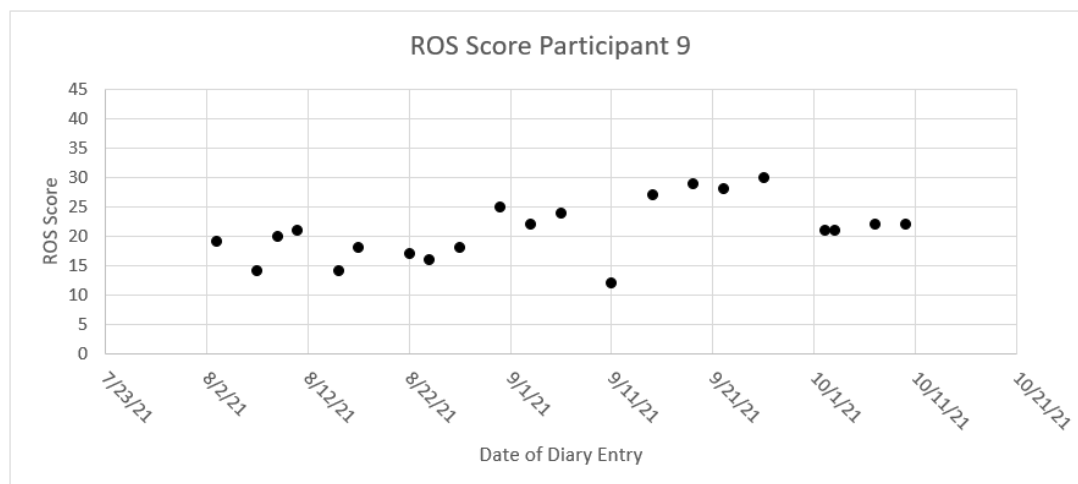
Appendix 4: ROS Graphs

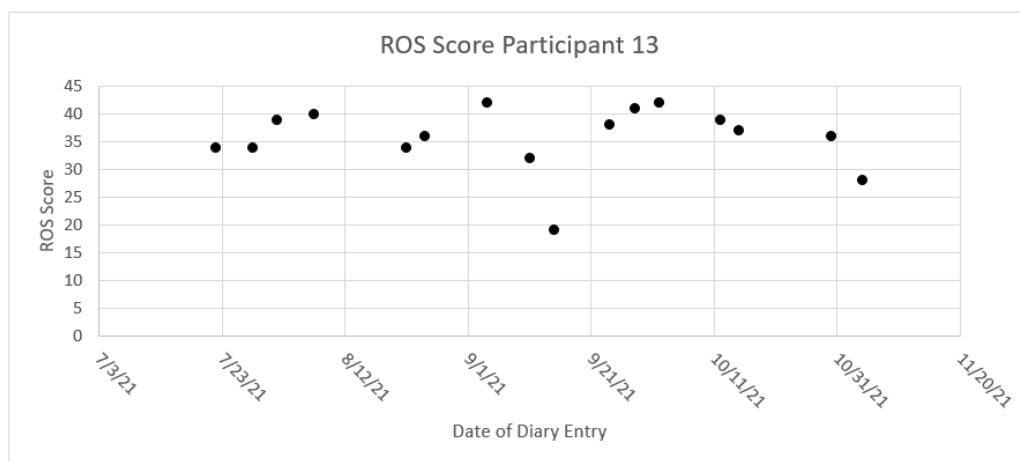
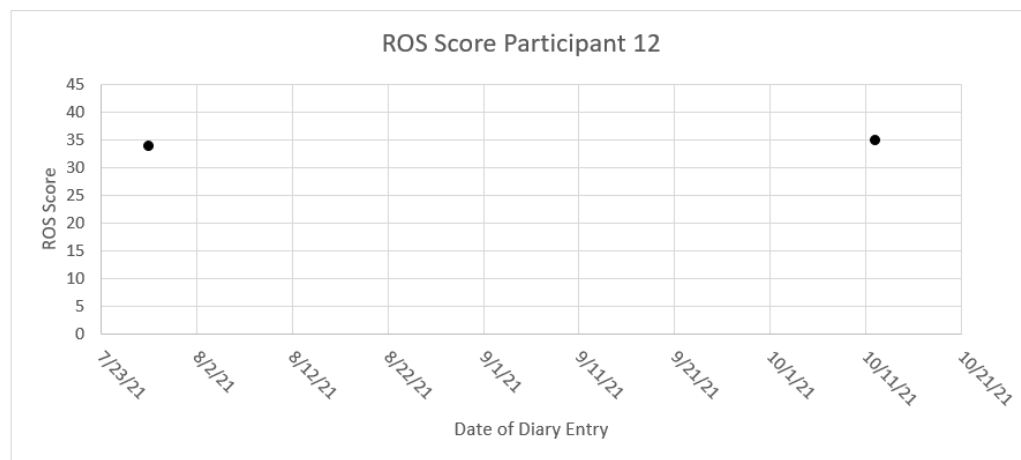
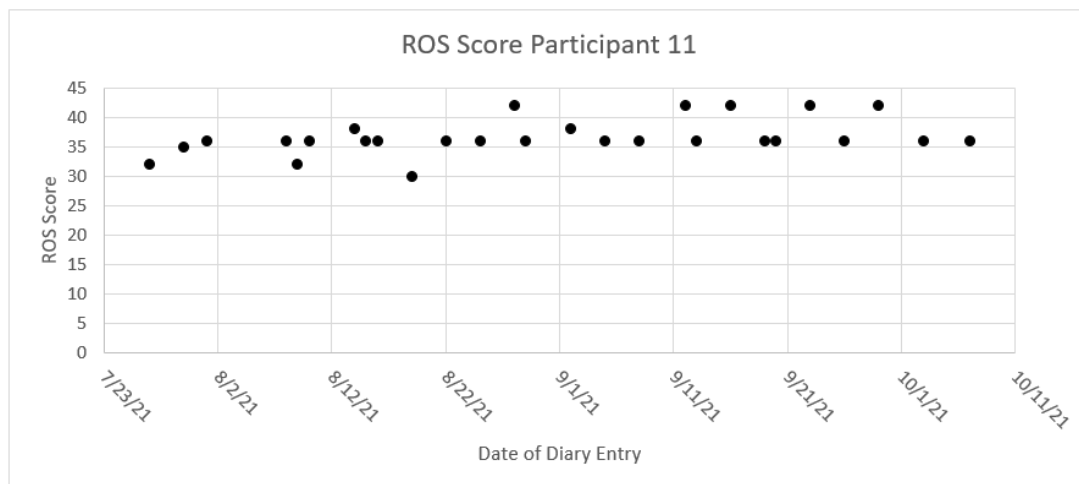
Nb: For simplification the participant numbers do not correlate with participant identification used in the data chapter.

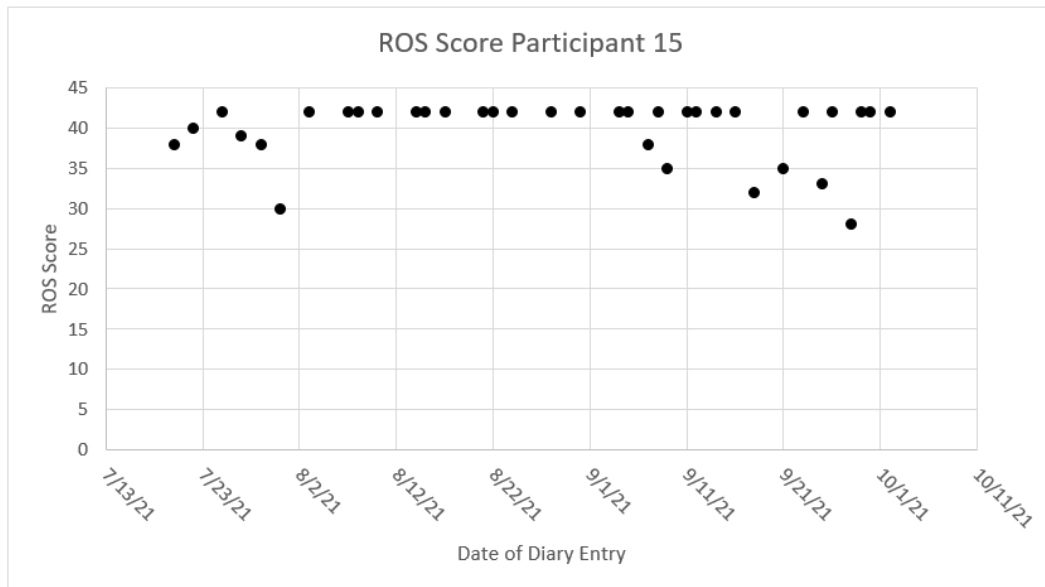
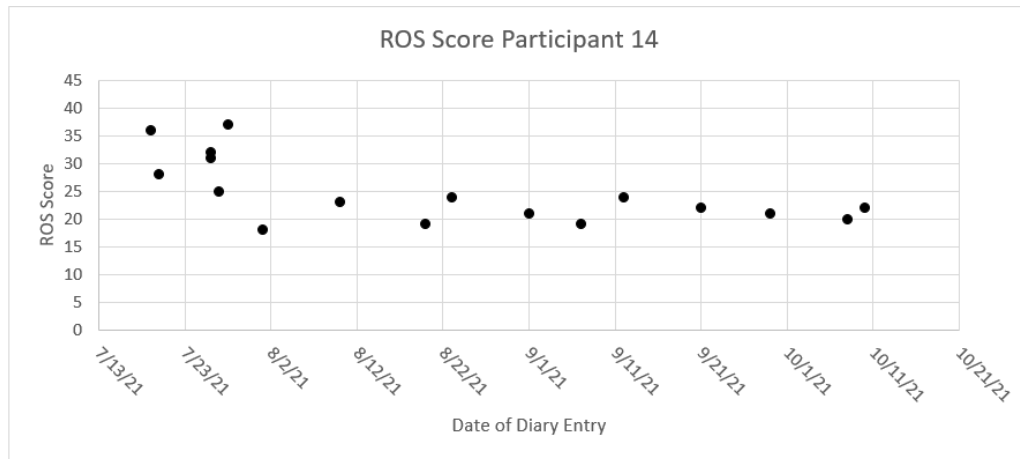


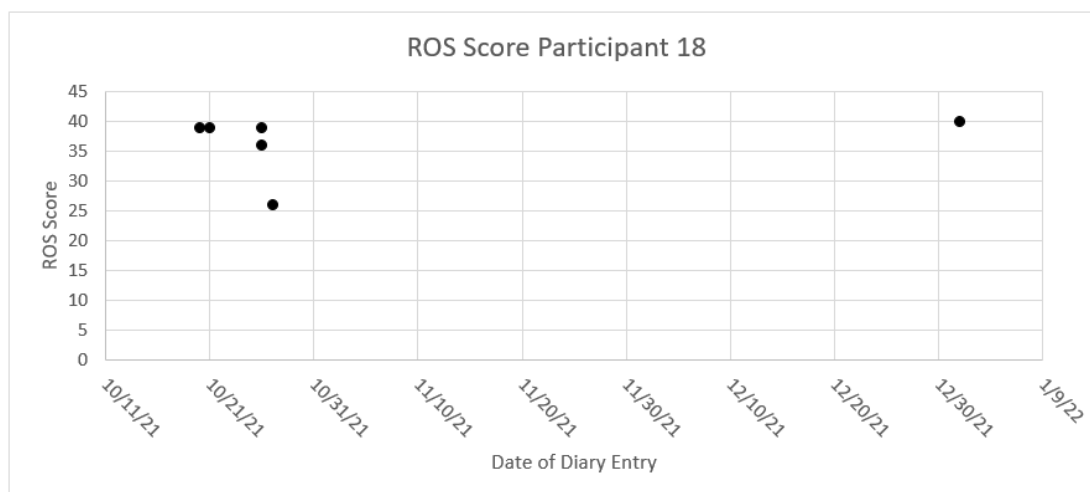
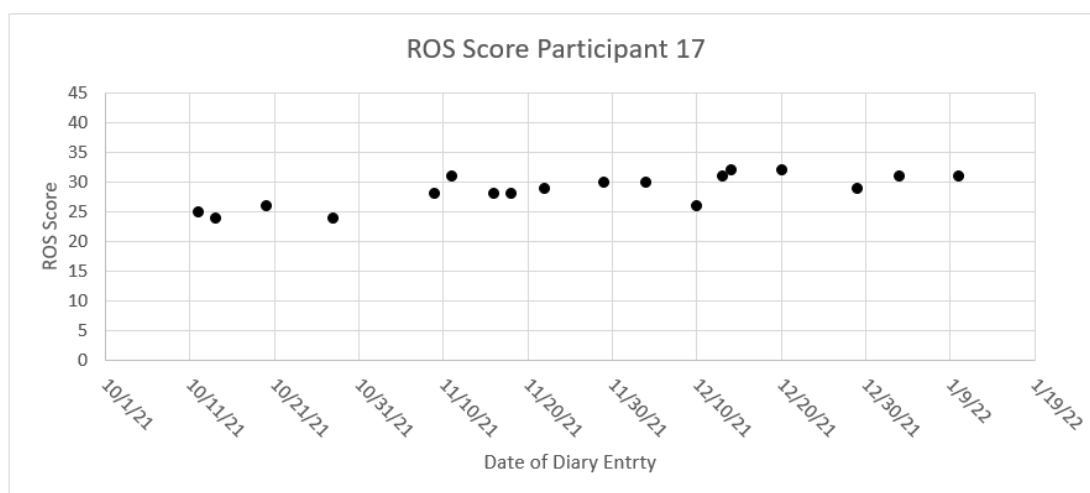
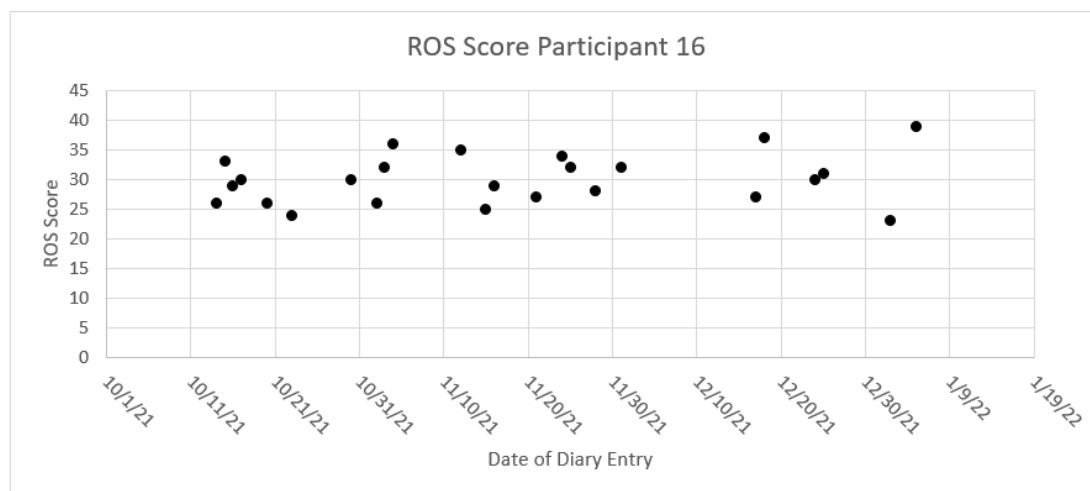


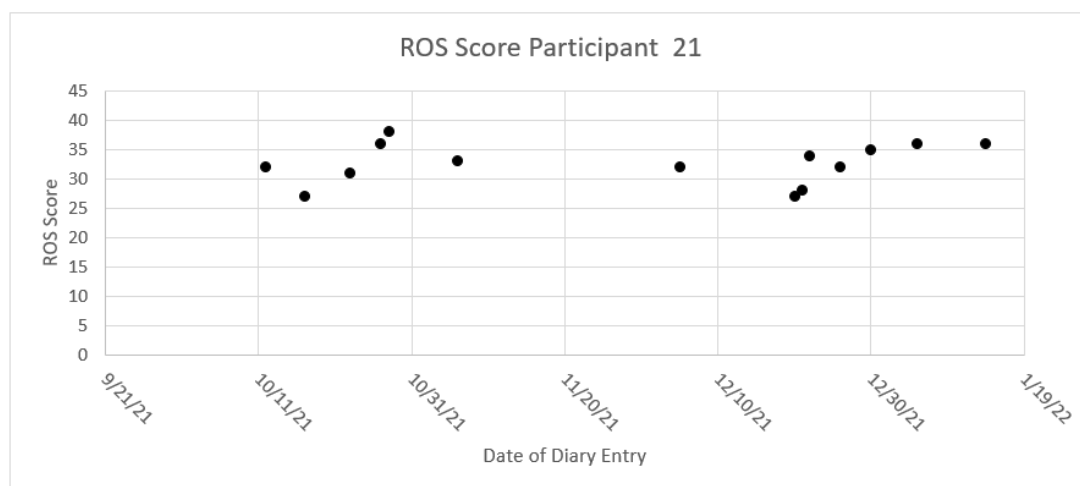
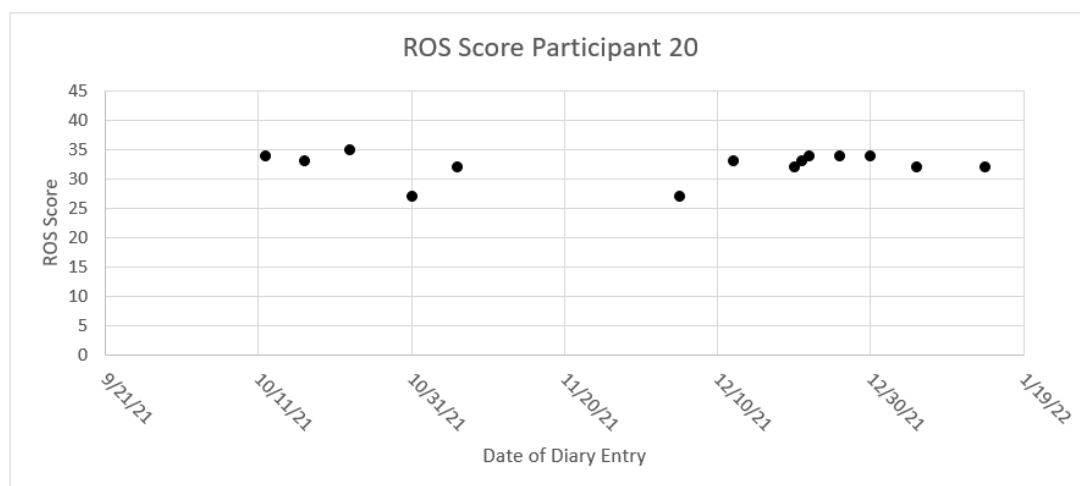
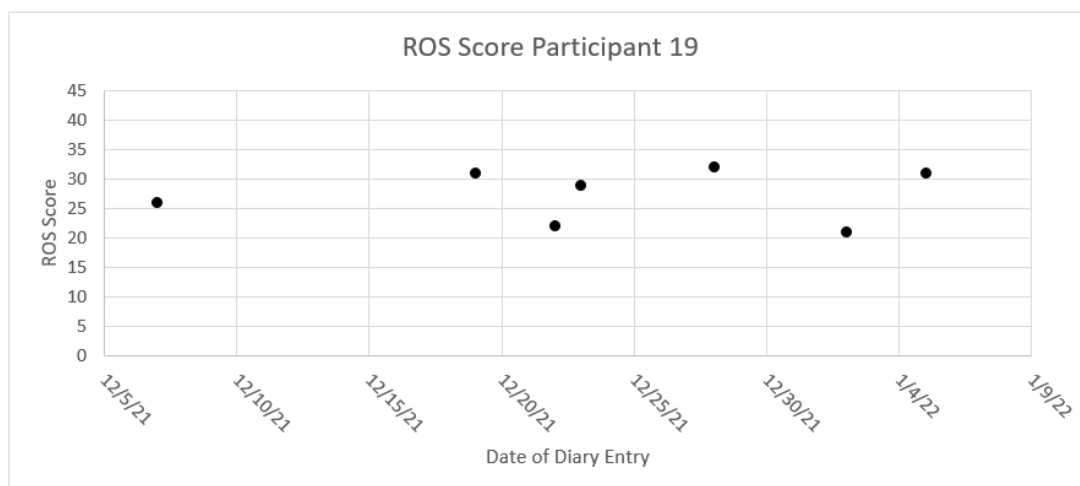


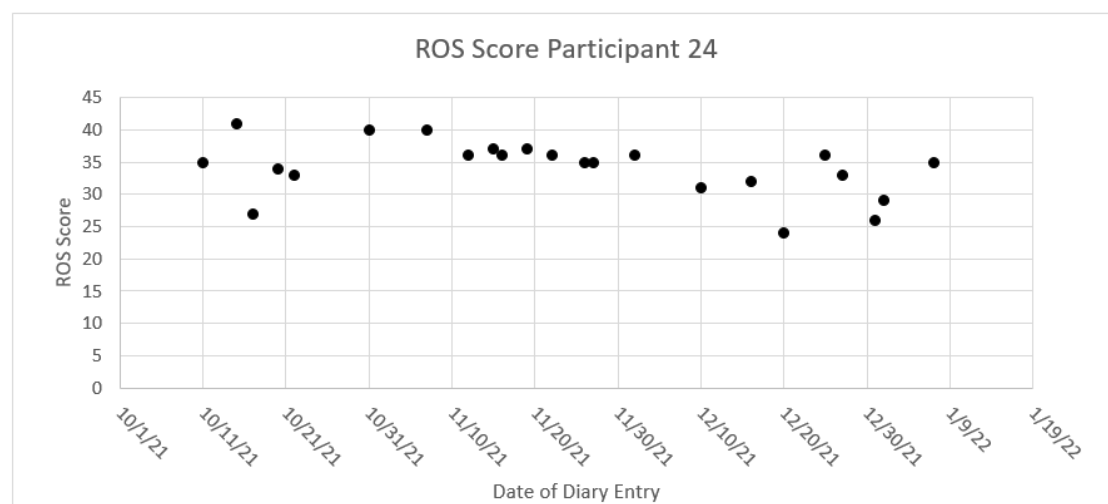
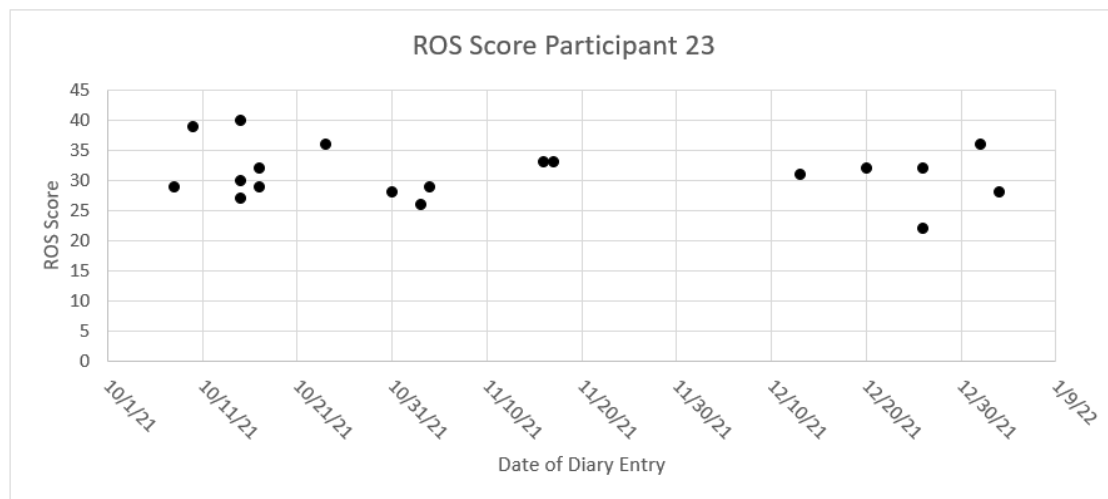
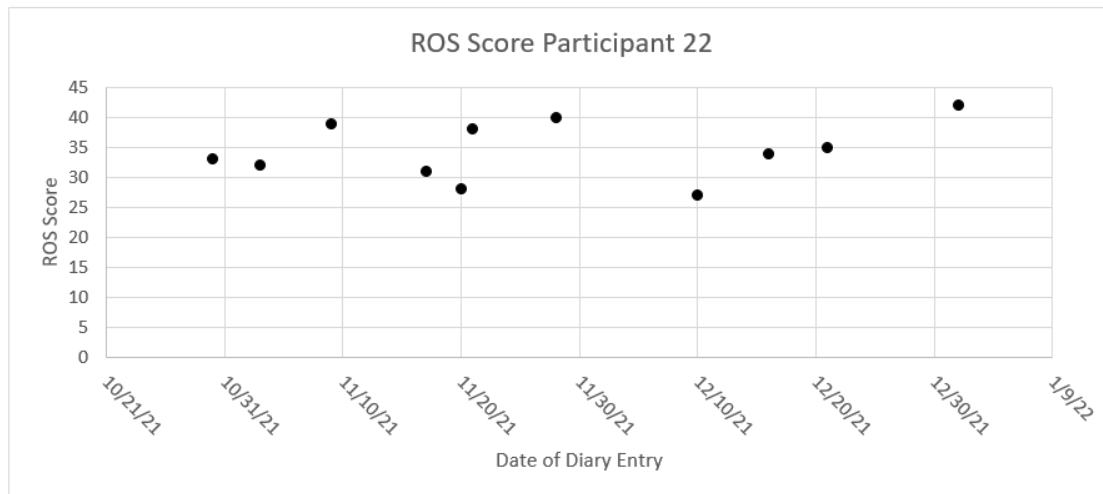


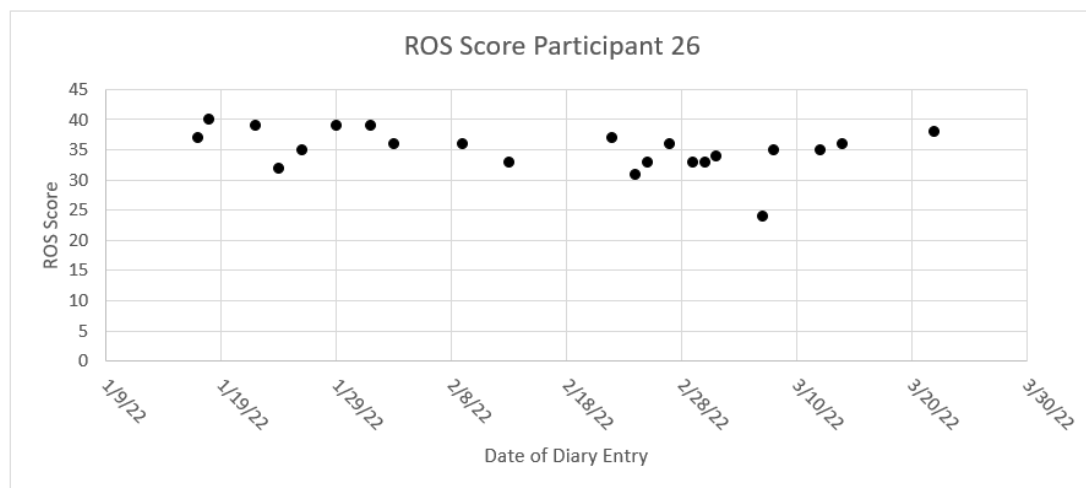
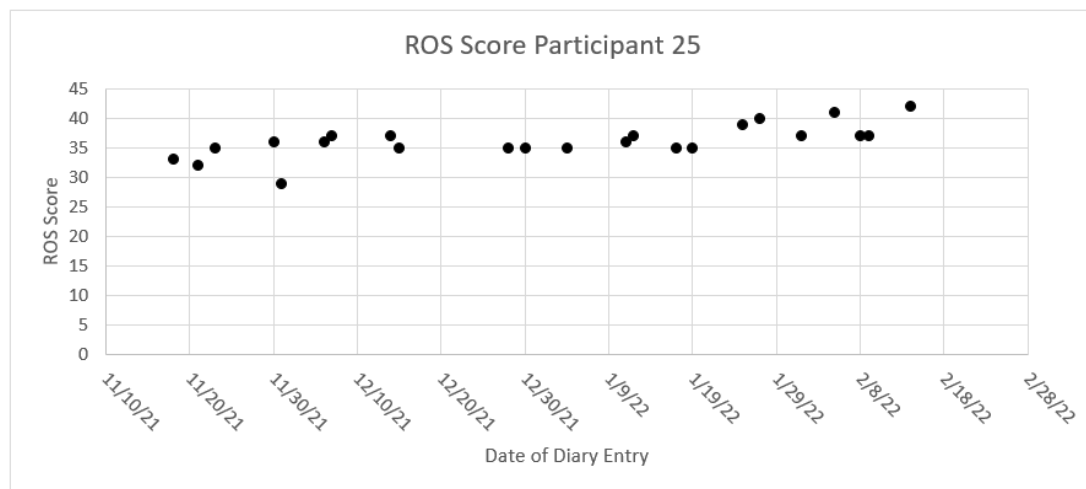


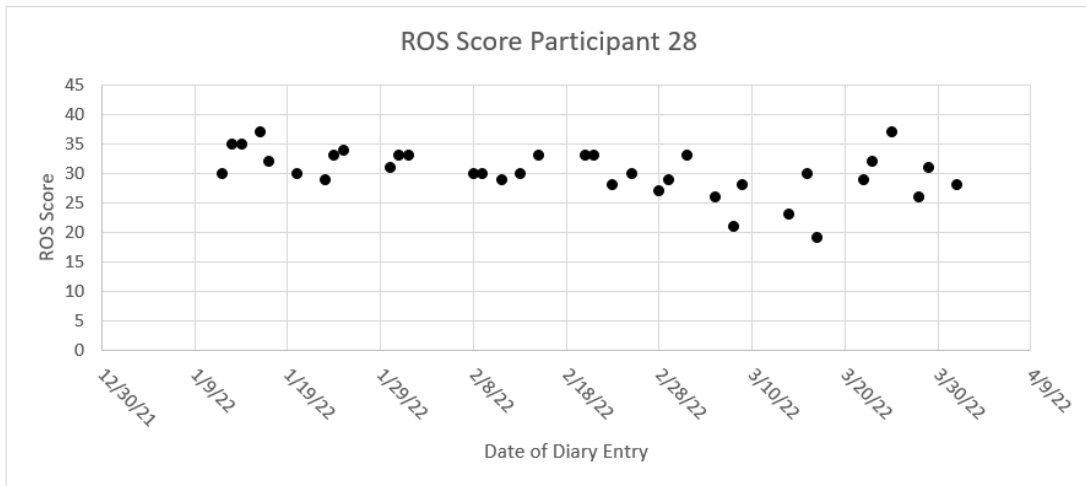
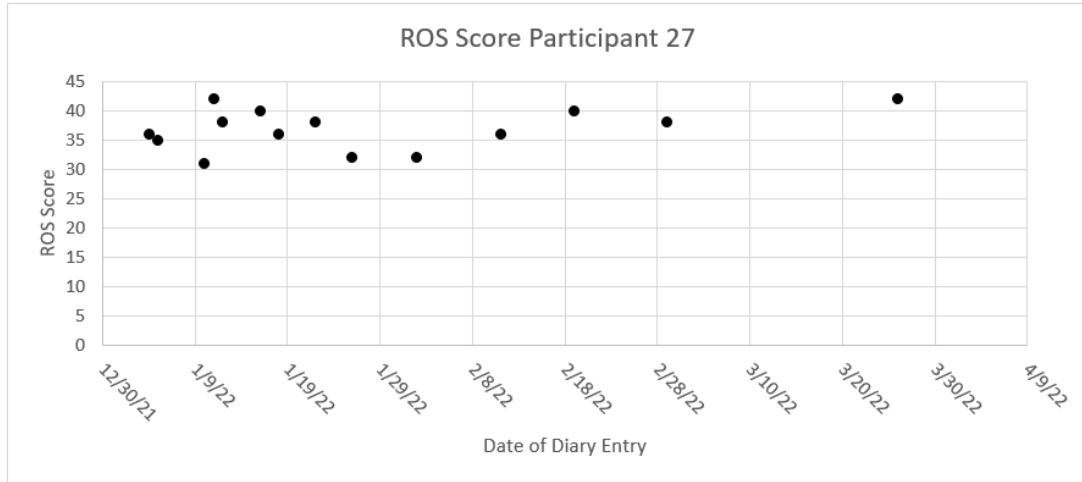


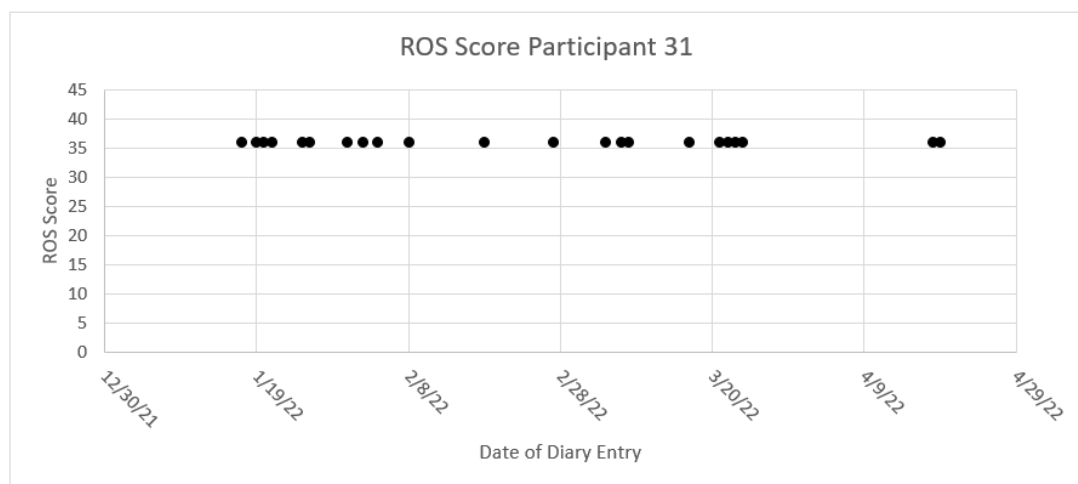
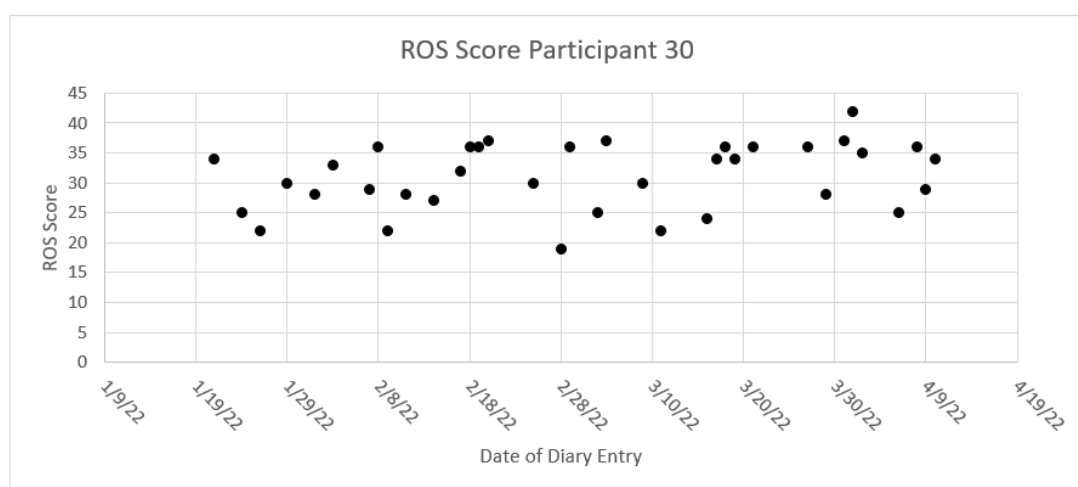
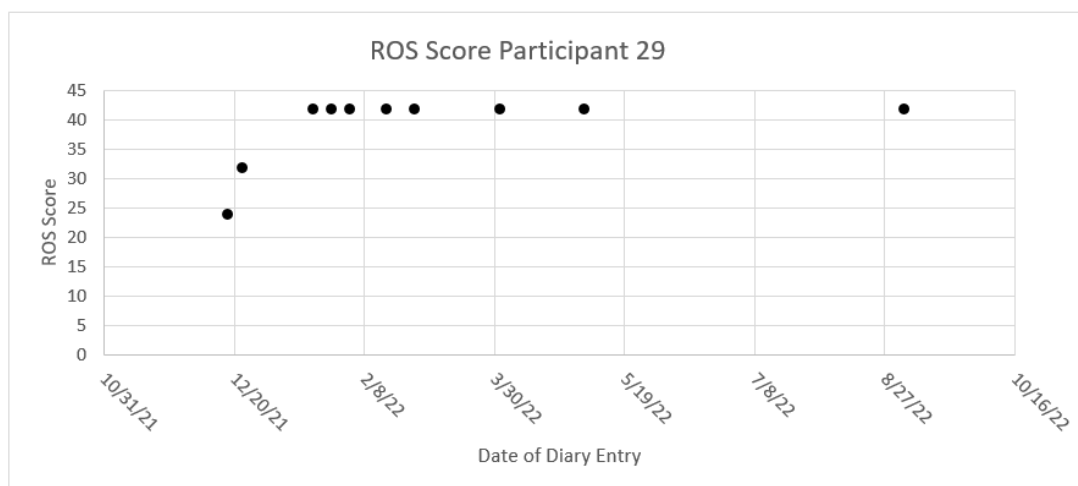


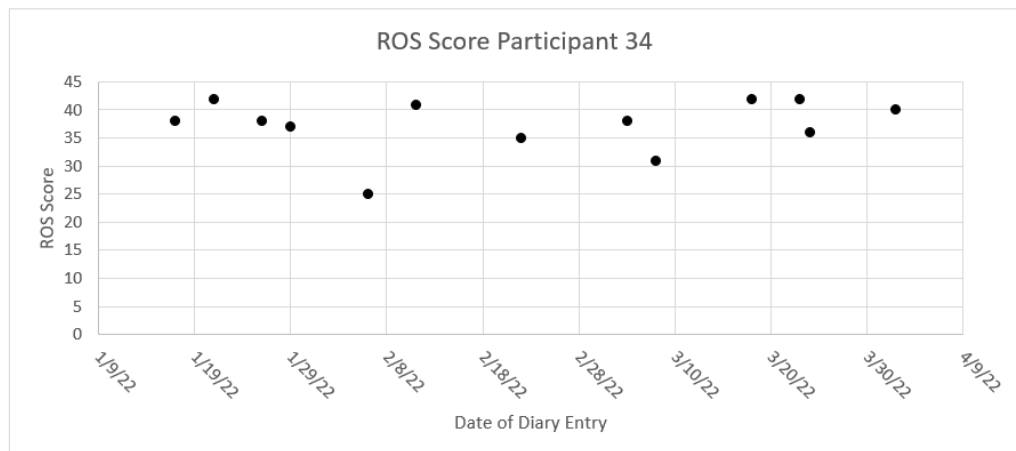
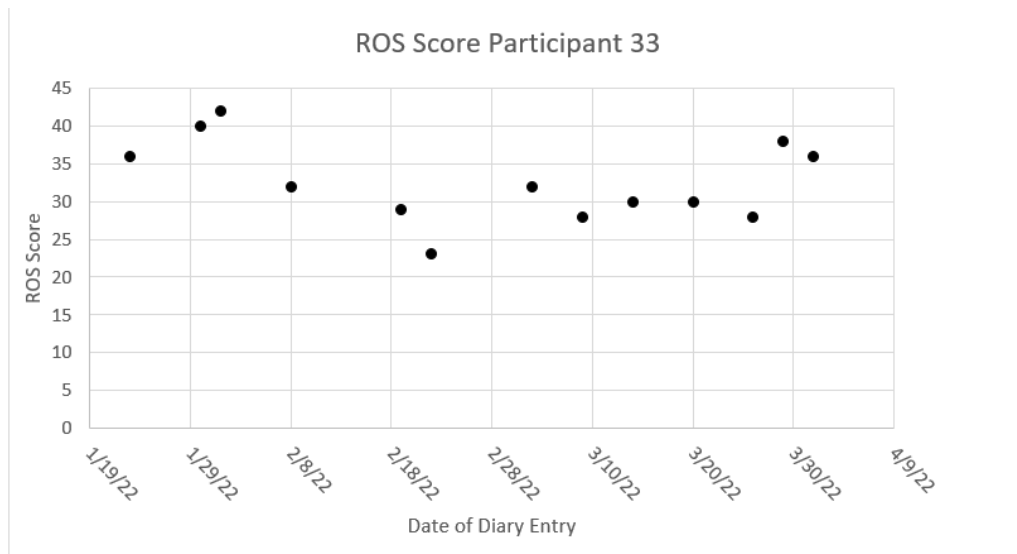
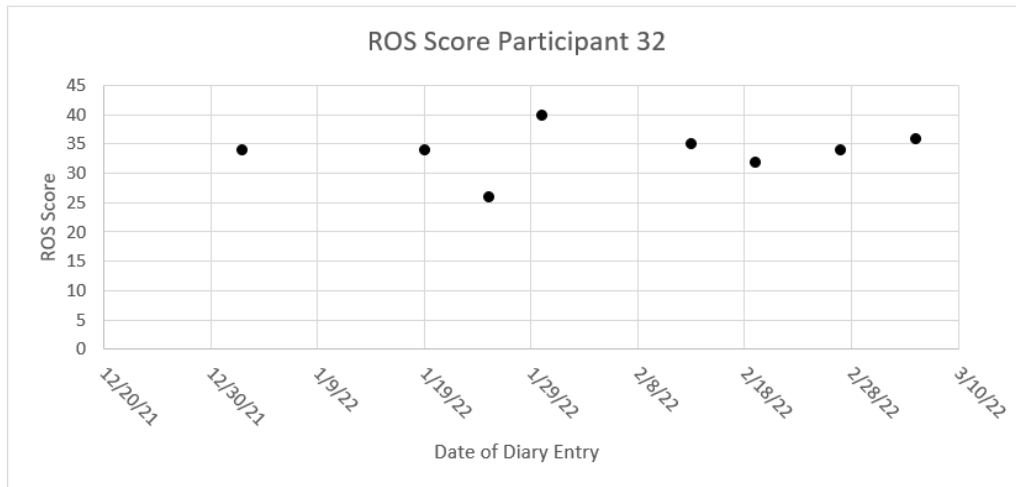


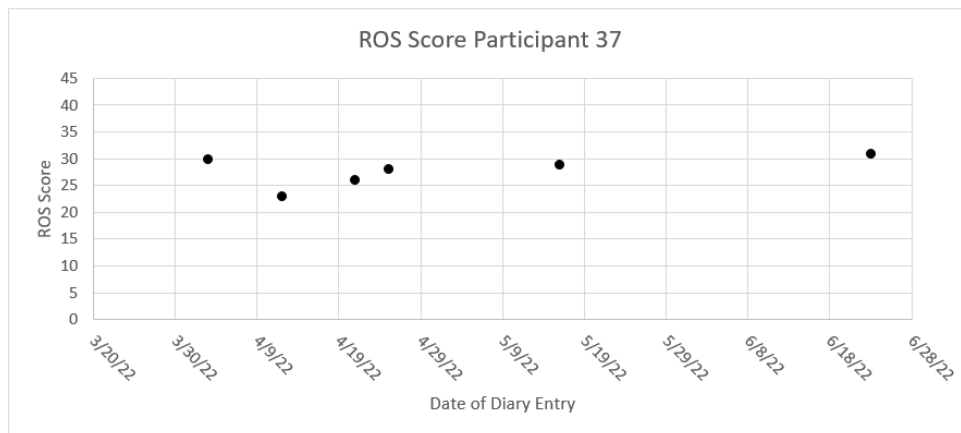
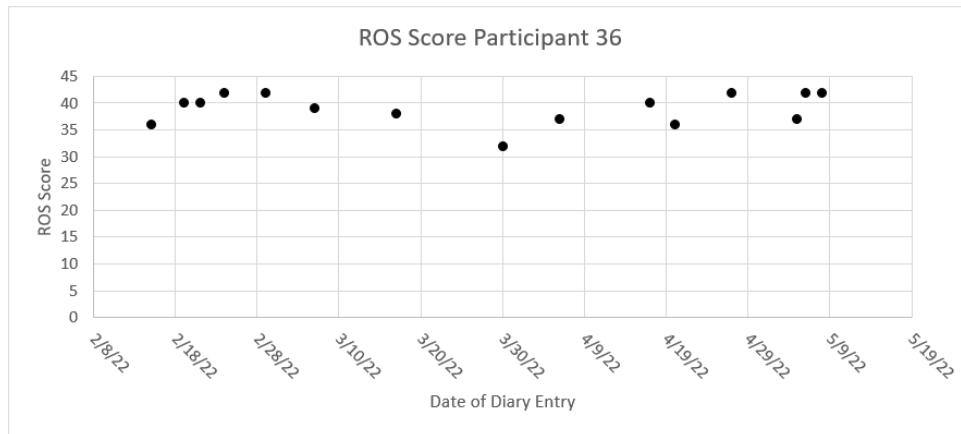
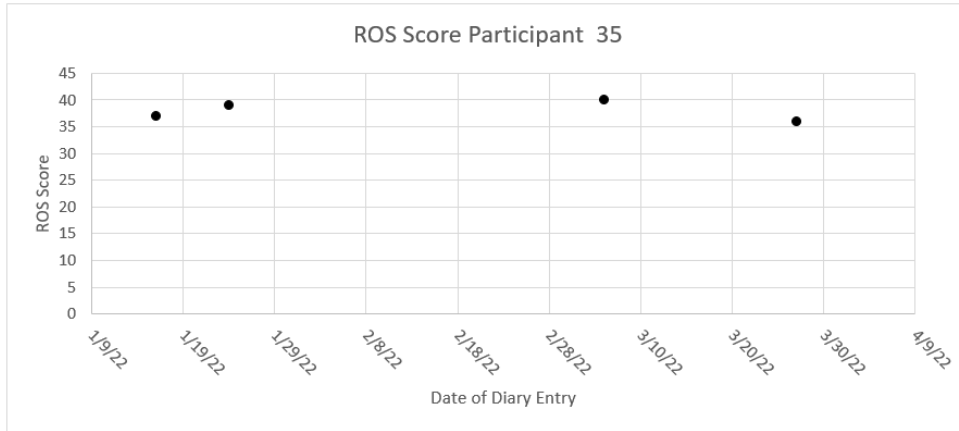


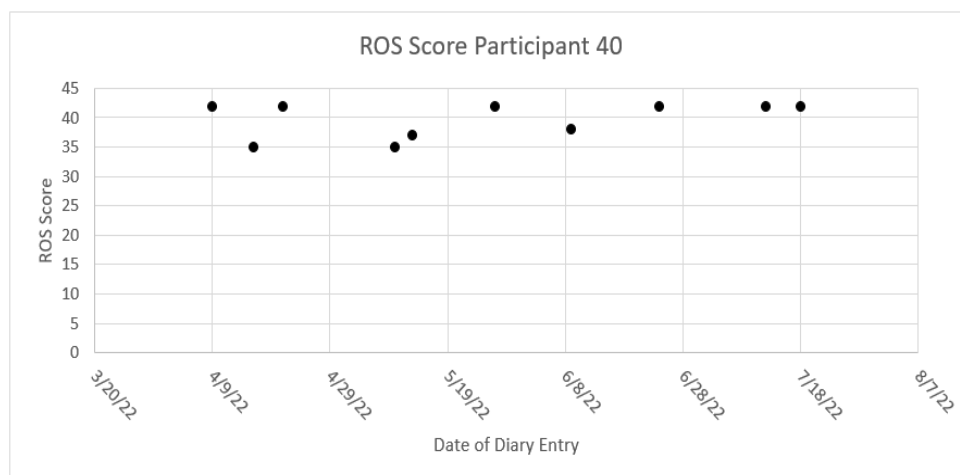
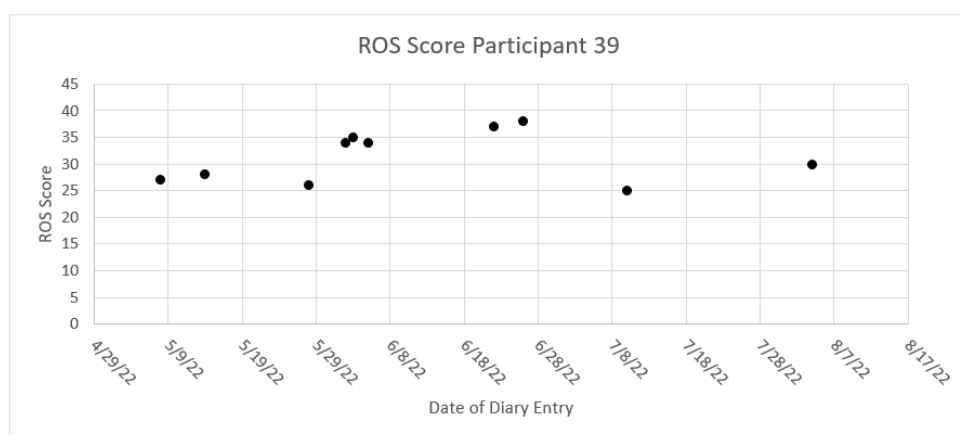
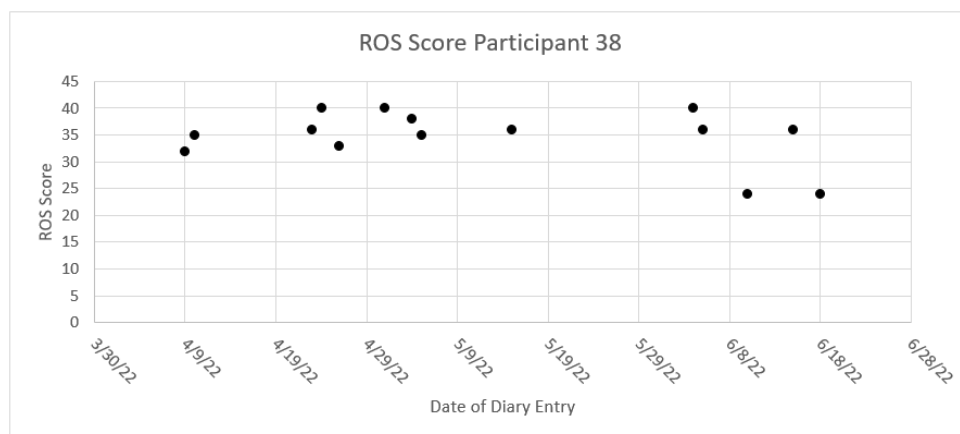


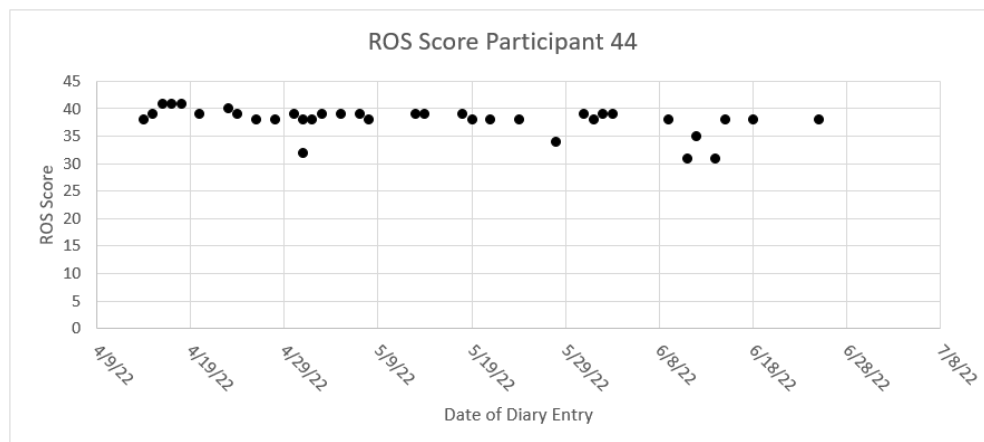
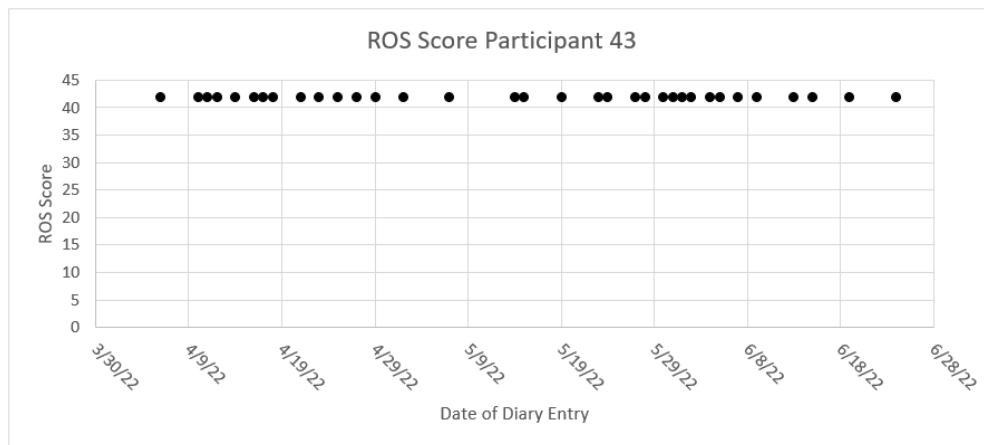
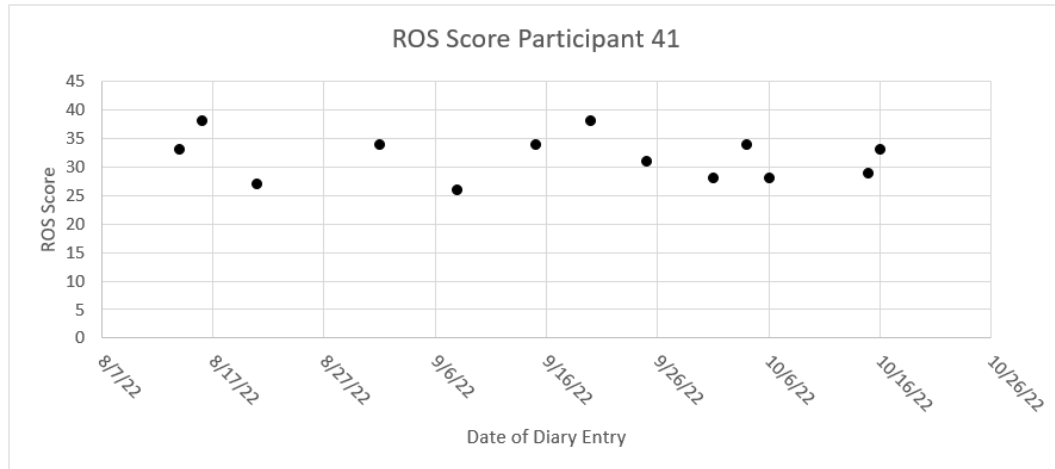


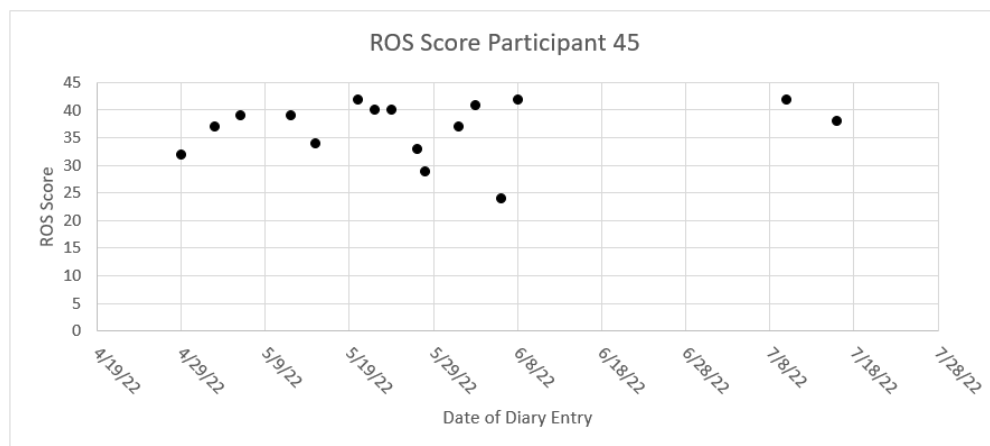












Appendix 5: Example of Scientific Communication Arising from Chapter 3

12/06/2025, 20:01

I've read hundreds of diary entries to quantify the restorative power of Scotland's lochs and rivers

THE CONVERSATION

Academic rigour, journalistic flair

I've read hundreds of diary entries to quantify the restorative power of Scotland's lochs and rivers

Published: September 2, 2024 12:52pm BST

Megan Grace

PhD Candidate, Biological and Environmental Sciences, University of Stirling



Henry Allen, CC BY-NC-ND

In October 2021, a man recreated a walk he first completed 62 years ago by climbing just under 3,000 feet to reach the summit of Beinn Damh on the north-west coast of Scotland. The steep ridge walk provided unobstructed views across Loch Damh and Loch Torridon. The combination of dramatic vistas and poignant nostalgia left him feeling energised and restored.

Later that same year, a woman documented regular walks along the banks of the fast-flowing river Thurso, near Inverness, in search of otters. Over the winter months, sightings of wildlife on the riverbanks alongside cheerful exchanges with other walkers strengthened her connection with her local community.

In the spring of 2022, another man recorded the joy of swimming in a loch at the bottom of his garden in central Scotland: "Water was warm and enticing – took me five minutes to get waist deep – then... off I went for my longest swim of the year (5 mins and I was out). Refreshed and alive!!"

<https://theconversation.com/ive-read-hundreds-of-diary-entries-to-quantify-the-restorative-power-of-scotlands-lochs-and-rivers-235275>

1/3



A view of the Ling Hut and outline of the Torridon hills, near Beinn Damh. Henry Allen

All three of these people took part in my [environmental research project](#) investigating whether Scottish freshwater environments can provide positive mental health outcomes over time. In total, 45 participants from across Scotland took part, with over 700 diary entries recorded between July 2021 and October 2022. Four groups of Scottish adults completed a three-month-long diary at different intervals during this timeframe.

Completed diaries captured firsthand accounts of the benefits of freshwater interactions and created a large database of freshwater experiences: from sailing and swimming to sketching by the water's edge.

This study was one of the first to use diaries to study our relationship with blue spaces. By analysing these personal stories, experiences and emotions, my diary study adds to the growing body of research quantifying the [health benefits](#) of spending time in nature.

There were some challenges. Transcribing diary entries was time-consuming and deciphering handwriting was tricky at times. One note about watching young people partying next to a riverside path intrigued me: "the ducks weren't overly alarmed, just retreated as the ravers headed towards them backwards." Months later, during a discussion with a fellow PhD student, I realised they had been rowing, not raving.



calm water with rocks on either side, looking out to loch, blue cloudy sky

The river meeting the sea at west Kilbride. Jacqueline Kennedy, CC BY-NC-ND

Overall, my results highlight the potential for lakes and rivers to improve people's physical and mental wellbeing. Diary entries revealed that participants held a strong appreciation of Scotland's freshwater environments and consistently felt they gained restorative health benefits such as calmness and improved concentration levels.

Feeling fresh air and the meditative flow of the water led to a sense of escapism from everyday concerns for many participants. Interestingly, despite the timing of the project coinciding with ever-changing public health policies, COVID was only mentioned in two diary entries. Other research has found that the pandemic led to an increased appreciation of inland waterways.

A kingfisher spotted near the Scottish town of Bathgate during the diary study. Jim Easton

Many participants had an emotional connection to the freshwater environments that they regularly visited. This helped to create a sense of belonging. However, this emotional attachment also meant that diarists could be adversely affected by environmental change.

Litter, agricultural pollution and timber harvesting regularly contributed to negative freshwater experiences. Investment in the maintenance and upkeep of freshwater environments therefore has the potential to have far-reaching benefits, both in terms of public health outcomes as well as biodiversity levels.

The process of journalling also proved to enhance the restorative effect of visiting Scotland's inland waters, as one person wrote: "this diary has been really helpful charting my progress and patterns, that I may even carry it on myself!"

Swimming, sailing, even just building a sandcastle - the ocean benefits our physical and mental wellbeing. Curious about how a strong coastal connection helps drive marine conservation, scientists are diving in to investigate the power of blue health.

This article is part of a series, Vitamin Sea, exploring how the ocean can be enhanced by our interaction with it.

Appendix 6: Chapter 4 Additional Information

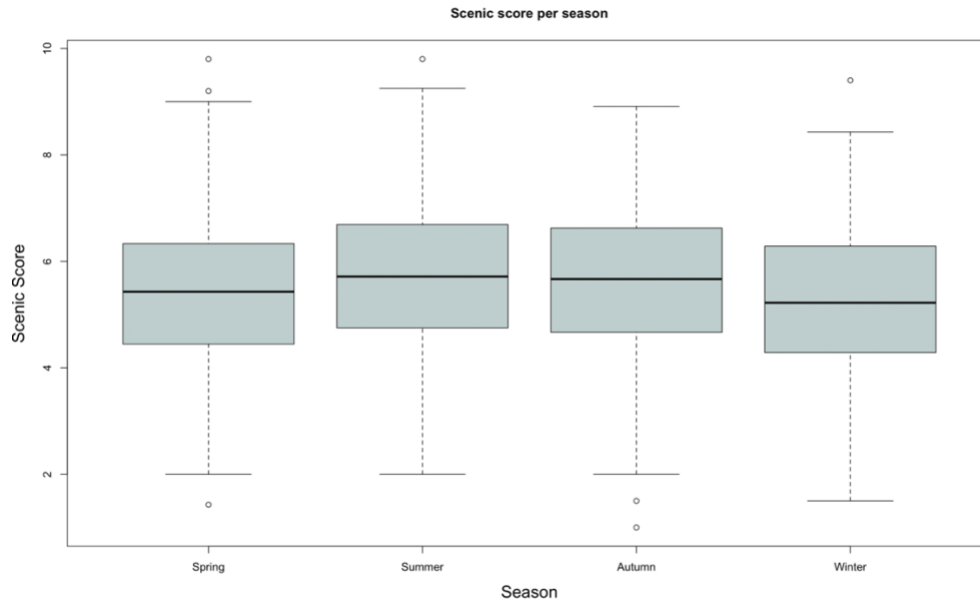


Figure A1: Variation of scenic scores depending on the season within which each photo in the Scenic-or-Not dataset was taken. Seasons are relevant for the Northern Hemisphere and were classified according to Met Office guidelines. Centre horizontal dash box and whiskers represent median, interquartile range and upper and lower limits, respectively.

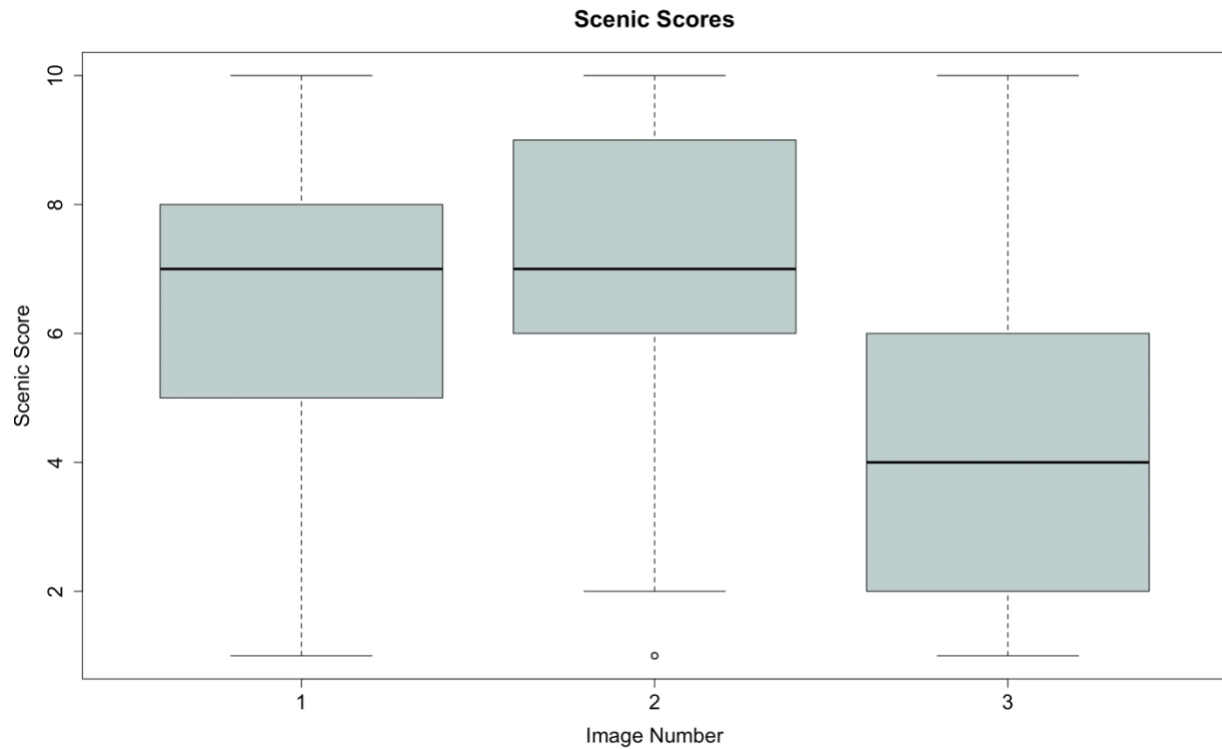


Figure A2: Scenic score for each image included in the online survey. Centre horizontal dash, box and whiskers represent median, interquartile range and upper and lower limits, respectively.

Table A1: Key demographics and relevant background information of survey respondents.

Variable	Category	Number/Frequency	%
Age	18-24	122	12.0
	25-34	196	19.3
	35-44	179	17.6
	45-54	193	19.0
	55-64	235	23.1
	65-74	65	6.4
	75 years or older	23	2.3
	Prefer not to say	2	0.2
Gender	Male	467	46.0
	Female	535	52.7
	Other	13	1.3

Location	Rural	218	21.5
	Urban	303	29.8
	Suburban	486	47.9
	Other	8	0.8
Frequency of taking part in outdoor activities	Never	34	3.3
	Less than once a month	65	6.4
	Once a month	34	3.4
	A few times a month	133	13.1
	Once a week	153	15.1
	Several times a week	395	38.9
	Everyday	201	19.8

Table A2: Demographics of the focus group participants.

Demographic Variable	Category	Frequency	Percentage
Age	18-24	1	5%
	25-34	2	10%
	35-44	0	0
	45-54	2	10%
	55-64	6	30%
	65-74	8	40%
	75 years or older	1	5%
Gender	Male	12	60%
	Female	8	40%
Location	Rural	17	85%
	Suburban	1	5%
	Urban	2	10%

Table A3: Demographic variables of each focus group.

Group Number	Number of Participants	Key Demographic Variables
1	6	Predominant Age Ranges – 45-54, 33.3%; 55-64, 33.3%. Gender – 50% Female Location – 83.3% Rural
2	4	Predominant Age Range – 55-64, 75% Gender – 75% Male Location – 100% Rural
3	6	Predominant Age Range – 65-74, 66.67% Gender – 83.3% Male Location – 83.3% Rural
4	4	Predominant Age Range – 65-74, 75% Gender – 50% Male Location – 100% Rural

Table A4: Scenic-or-Not images used as discussion tools in the focus groups alongside associated scenic ratings and key comments from each focus group.

Image	Group Scenic Rating (1 st = Most Scenic, 15 th = Least Scenic)	Key comments on Photo
A 	Group 1 – 1st Group 2 – 1st Group 3 – 1st Group 4 – 1st	“That looks like the yeah the apex of scenicness” -Participant 1, Group 1, Male, 55-64 “That would be nice whatever time of year.” - Participant 2, Group 3, Male, 65-74 years
B 	Group 1 – 3rd Group 2 – 2nd Group 3 – 2nd Group 4 – 2nd	“This is a bit contrived with the chair” - Participant 3, Group 2, Male, 55-64
C 	Group 1 – 4th Group 2 – 4th Group 3 – 3rd Group 4 – 7th	“It's not a bit you would go and visit unless you were dying or getting married.” - Participant 4, Group 2, Male, 55-64 “That looks like ‘The Holiday’ [the Christmas film]” - Participant 6, Group 1, Female, 18-24
D 	Group 1 – 2nd Group 2 – 6th Group 3 – 6th Group 4 – 7th	“I’d like to draw this one, but I don’t see any river” - Participant 7, Group 1, Female, 55-64

	Group 1 – 5th Group 2 – 5th Group 3 – 7th Group 4 – 4th	“I like a bit of hawthorn trees” - Participant 8, Group 1, Female, 45-54 “Manufactured, Its very Victorian, its there’s a new town to the side of this and a golf course and a tesco shopping trolley” - Participant 4, Group 2, Male, 55-64
	Group 1 – 6th Group 2 – 9th Group 3 – 4th Group 4 – 9th	“I like the sunset of that one” - Participant 9, Group 1, Male, 25-34 “It's nice, I think it suggests there’s loads of other housing. I think you might be walking through endless houses at the end of the river that might just be a snapshot” - Participant 10, Group 3, Male, 65-74
	Group 1 – 9th Group 2 – 8th Group 3 – 5th Group 4 – 3rd	“I like it cause there’s trees and there’s grass and stuff, yeah.” - Participant 11, Group 4, Male, 65-74 “That’s a bit sad but scenic” - Participant 8, Group 1, Female, 45-54
	Group 1 – 8th Group 2 – 11th Group 3 – 8th Group 4 – 10th	“It's not near water, it's not near bridges, but it's it's peaceful isn't it, even though its modern forestry.” - Participant 4, Group 2, Male, 55-64
	Group 1 – 13th Group 2 – 7th Group 3 – 12th Group 4 – 15th	“The only thing I don't like about it are the pylons” - Participant 12, Group 4, Female, 65-74 “There’s nothing wrong with that it looks like Kent its Romney Marsh, Scots float or somewhere.” - Participant 3, Group 2, Male, 55-64

 cc by sa 2.0 - A public footpath, viewed... by Robert Edwards - geograph.org.uk/p/1020094	Group 1 – 11th Group 2 – 12th Group 3 – 9th Group 4 – 5th	“That’s just boggy” - Participant 5, Group 2, Female, 55-64 “It’s alright scenically but it’s not really water” - Participant 13, Group 3, Male, 55-64
 cc by sa 2.0 - West Stockwith by Richard Cuth - geograph.org.uk/p/1060794	Group 1 – 7th Group 2 – 3rd Group 3 – 10th Group 4 – 8th	“It’s one of those places you'd like to explore around.” - Participant 5, Group 2, Female, 55-64 “I think on a sunny day, in the sunshine that would lift that picture” - Participant 8, Group 1, Female, 45-54
 cc by sa 2.0 - North Elm Farm by Paul Hensley - geograph.org.uk/p/1041041	Group 1 – 10th Group 2 – 10th Group 3 – 11th Group 4 – 10th	“I don’t think that ones very scenic... And not a lot around it.” - Participant 14, Group 3, Male, 75 years or older
 cc by sa 2.0 - Bishops of the River Trent by Alan Murray Ball - geograph.org.uk/p/433389	Group 1 – 14th Group 2 – 14th Group 3 – 14th Group 4 – 14th	“I’d say no to that one actually, but I quite like the brick one [referring to Image O]” - Participant 1, Group 1, Male, 55-64

 cc-by-sa/2.0 Library, University of East London - geograph.org.uk/1154700	Group 1 – 15th Group 2 – 15th Group 3 – 13th Group 4 – 13th	“I think it’s the third bottom one because it’s a nice piece of architecture” - Participant 15, Group 3, Female, 65-74 “I find buildings beautiful, aesthetically wonderful” - Participant 16, Group 4, Male, 75 years or older
 cc-by-sa/2.0 Former Tobacco Bonded - by Roger Davies - geograph.org.uk/897063	Group 1 – 12th Group 2 – 13th Group 3 – 15th Group 4 – 12th	“This looks more like a scene from one of these detective shows” - Participant 1, Group 1, Male, 55-64 “Quite charming really... well, it’s got more industrial heritage that’s my bias” - Participant 3, Group 2, Male, 55-64

Appendix 7: Questionnaire Structure

Electronic Consent

Please select your choice below. Clicking on the "Agree" button indicates that: You have read and understood the background information provided. You are 18 years of age or older.

You voluntarily agree to participate

- ☐ Agree
- ☐ Disagree

End of Block: Default Question Block

Start of Block:

Do you currently live in Scotland?

- ☐ Yes
- ☐ No

End of Block:

Start of Block: Background Information

How would you describe your gender?

- ☐ Male
- ☐ Female
- ☐ Prefer to self describe as... (Please Specify)

What is your age:

- ☐ Prefer not to say
- ☐ 18-24 years old
- ☐ 25-34 years old
- ☐ 35-44 years old
- ☐ 45-54 years old
- ☐ 55-64 years old
- ☐ 65-74 years old
- ☐ 75 years or older
- ☐ Prefer not to say

Please state whether you consider yourself to live in an urban, suburban or rural location.

- ☐ Urban
- ☐ Suburban
- ☐ Rural
- ☐ Other, please specify.. _____
- ☐ Prefer not to say
-

On average how often do you take part in outdoor activities (e.g. walking, cycling, running, gardening and other outdoor hobbies).

- ☐ Never
- ☐ Less than once a month.
- ☐ Once a month.
- ☐ A few times a month.
- ☐ Once a week.
- ☐ Several times a week.
- ☐ Everyday

End of Block: Background Information

Start of Block: Scenic Photographs

For each photograph shown below, please indicate **on a scale of 1 to 10** how scenic you consider the environment to be. *With 1 being 'Not Scenic' and 10 being 'Very Scenic'.*



Out of these three photos, please select your **favourite** photograph.



Considering the same three photos, please select your **least favourite** photograph.



What key words would you use to describe the landscape shown in the above photograph? (Please state up to 5 words)

☐ Key Word 1 _____

☐ Key Word 2 _____

☐ Key Word 3 _____

☐ Key Word 4 _____

☐ Key Word 5 _____

Considering the photograph, please mark the extent to which you agree with the following statements.



The weather conditions shown in the photograph are pleasant.

- ☐ Strongly Disagree
 - ☐ Disagree
 - ☐ Indifferent
 - ☐ Agree
 - ☐ Strongly Agree
-

The grass and trees shown are aesthetically pleasing.

- ☐ Strongly Disagree
 - ☐ Disagree
 - ☐ Indifferent
 - ☐ Agree
 - ☐ Strongly Agree
-

This is the kind of environment I would use for recreational purposes.

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Indifferent
- ☐ Agree
- ☐ Strongly Agree



What key words would you use to describe the landscape shown in the above photograph?
(Please state up to 5 words)

- ☐ Key Word 1 _____
 - ☐ Key Word 2 _____
 - ☐ Key Word 3 _____
 - ☐ Key Word 4 _____
 - ☐ Key Word 5 _____
-
-

Considering the photograph, please mark the extent to which you agree with the following statements.



The weather conditions shown in the photograph are pleasant.

- ☐ Strongly Disagree
 - ☐ Disagree
 - ☐ Indifferent
 - ☐ Agree
 - ☐ Strongly Agree
-

The grass and trees shown are aesthetically pleasing.

- ☐ Strongly Disagree
 - ☐ Disagree
 - ☐ Indifferent
 - ☐ Agree
 - ☐ Strongly Agree
-

This is the kind of environment I would use for recreational purposes.

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Indifferent
- ☐ Agree
- ☐ Strongly Agree



What key words would you use to describe the landscape shown in the above photograph?
(Please state up to 5 words)

- ☐ Key Word 1 _____
 - ☐ Key Word 2 _____
 - ☐ Key Word 3 _____
 - ☐ Key Word 4 _____
 - ☐ Key Word 5 _____
-

Considering the photograph, please mark the extent to which you agree with the following statements.



The weather conditions shown in the photograph are pleasant.

- ☐ Strongly Disagree
 - ☐ Disagree
 - ☐ Indifferent
 - ☐ Agree
 - ☐ Strongly Agree
-

The grass and trees shown are aesthetically pleasing.

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Indifferent
- ☐ Agree
- ☐ Strongly Agree

This is the kind of environment I would use for recreational purposes.

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Indifferent
- ☐ Agree
- ☐ Strongly Agree

End of Block: Block 5

Start of Block: Block 6

What factor would most encourage you to visit a freshwater area?

- ☐ 1) Sunny and warm weather conditions
 - ☐ 2) High levels of biodiversity of the trees and plants surrounding the river
 - ☐ 3) If it was located within a rural area, with no houses or buildings nearby
 - ☐ 4) Other, please specify...
-

Appendix 8: Semi-structured Interview Schedule

Underlined questions are classified as topic questions to guide the course of the interview. The questions written in smaller font underneath each topic question were used as probing questions if required. Additional impromptu questions were used during the interview based on the topics and information that were pertinent to each individual.

Introductory Question: What was one of your key memories of using freshwater areas during the COVID-19 pandemic?

What made it a stand-out experience?

Is that something you do on a regular basis?

Do you consider visiting freshwater areas to be a covid safe activity?

Is there any activity currently you can think of that you'd not consider to be covid safe?

How do you currently visit blue space environments, do you use a car, public transport etc?

If you could have your choice, what would be your preferred method of visiting blue spaces?

Has this adapted since the onset of the pandemic?

Do you think the way other people use and behave in blue spaces has altered since the start of the pandemic?

Have you noticed any trends in the way others behave?

Thinking about freshwater areas in general, do you think visiting these areas is important for your mental health and wellbeing?

Do you think the benefits of freshwater areas are similar to other natural environments or different?

Before the pandemic did you visit blue spaces for relaxation or stress-relief?

At any point during the pandemic, for example in lockdown or during different restrictions, did you decide to visit blue spaces to provide any wellbeing benefits?

Have you become more aware of the mental health and wellbeing benefits of freshwater areas since the start of the pandemic?

Do you think the way in which you use freshwater environments changed over the course of the pandemic?

What was your main reason for visiting blue spaces before the pandemic? Exercise etc

Has your main reason for visiting changed over the course of the pandemic?

Do you still visit these areas as regularly, and when you visit do you spend the same amount of time at the blue space?

What do you think governing bodies could do better to encourage people to access blue spaces?

Do you think specific policies should be in place to encourage CEV individuals to access blue spaces?

If required, would you be happy to return to social distancing and mask wearing?

Do you think there are any changes to public transport which could be made to improve access to blue spaces?

Appendix 9: Flooding Questionnaire Structure

Electronic Consent

Please select your choice below. Clicking on the "Agree" button indicates that:

1. You have read and understood the background information provided.
2. You are 18 years of age or older.
3. You voluntarily agree to participate

- ☐ Agree (1)
- ☐ Disagree (2)

Start of Block: Screening Questions

Do you currently live in Scotland?

- ☐ Yes (1)
- ☐ No (2)

Please select your age from the following list:

- ☐ Under 18 (9)
- ☐ 18-24 (10)
- ☐ 25-34 (12)
- ☐ 35-44 (13)
- ☐ 45-54 (14)
- ☐ 55-64 (15)
- ☐ 65-74 (16)
- ☐ 75+ (17)

Over the last **2 weeks**, how often have you been bothered by the following problems, when thinking about **climate change and other global environmental conditions**?

For example - global warming, flooding, ecological degradation, resource depletion, species extinction, ozone hole, pollution of the oceans, deforestation.

	0 - not at all (1)	1 - several of the days (2)	2 - over half the days (3)	3 - nearly every day (4)
Feeling nervous anxious or on-edge (1)	☐	☐	☐	☐
Not being able to stop or control worrying (2)	☐	☐	☐	☐
Feeling afraid (3)	☐	☐	☐	☐
Unable to stop thinking about future climate change and other global environmental problems (4)	☐	☐	☐	☐
Unable to stop thinking about past events related to climate change (5)	☐	☐	☐	☐
Unable to stop thinking about losses to the environment (6)	☐	☐	☐	☐
Difficulty sleeping (7)	☐	☐	☐	☐
Difficulty enjoying social situations with family and friends (8)	☐	☐	☐	☐
Difficulty working and/or studying (9)	☐	☐	☐	☐
Feeling anxious about the impact of your personal behaviours on the earth (10)	☐	☐	☐	☐
Feeling anxious about your personal responsibility to help address environmental problems (11)	☐	☐	☐	☐
Feeling anxious that your personal behaviours will do little to help fix the problem (12)	☐	☐	☐	☐

Considering the following **climate-change related factors**, please drag and drop the statements to show the extent to which you believe each to be a potential threat to yourself and your household.

1 = highest perceived risk

4 = lowest perceived risk

- _____ Sea-level rise (1)
- _____ Increased frequency of flooding incidents (2)
- _____ Increased frequency of storms (3)
- _____ Increased frequency of droughts (4)

What is the nearest freshwater feature to your current address?

- ☐ Lake (1)
- ☐ River (2)
- ☐ Canal (3)
- ☐ Stream (4)
- ☐ Pond (5)
- ☐ Wetland (6)
- ☐ Other, please specify (8) _____

What do you perceive to be the **greatest threat** to **your nearest freshwater area**?

- ☐ Point source pollution (e.g. instances where pollutants enter directly into the water such as from end-of-pipe discharges due to industry and wastewater treatment)
- ☐ Diffuse source pollution (e.g. runoff of pollutants from agricultural areas, forestry activities, roads, houses and commercial areas)
- ☐ Land erosion
- ☐ Hard engineering flood management strategies – such as dams, reservoirs and straightening rivers.
- ☐ Other - please specify _____

Please mark the extent to which you agree with the following statements.

	Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree
Visiting freshwater areas has a positive impact on my health and wellbeing .	☐	☐	☐	☐	☐
Freshwater areas have a positive impact on the local community .	☐	☐	☐	☐	☐
High levels of rainfall whilst visiting freshwater areas reduces my enjoyment of these environments .	☐	☐	☐	☐	☐
Observing fast flowing water reduces my enjoyment of visiting freshwater areas.	☐	☐	☐	☐	☐
The sound of fast flowing water reduces my enjoyment of visiting freshwater areas.	☐	☐	☐	☐	☐
The health and wellbeing benefits gained from visiting freshwater areas outweigh the disbenefits of freshwater flooding .	☐	☐	☐	☐	☐

Please specify up to three places (towns/cities/villages) in Scotland which you perceive to be at the greatest risk of flooding?

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Are you aware of the **Scottish Flood Forecast** provided by **SEPA** (Scottish Environmental Protection Agency)?

- ☐ Yes
- ☐ No
- ☐ Unsure

To what extent do you agree with the following statements:

	Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree
I would avoid visiting areas that I perceive to be susceptible to flooding on a given day. (1)	☐	☐	☐	☐	☐
I would avoid visiting an area if it was issued a 'low flood risk' alert by SEPA (2)	☐	☐	☐	☐	☐
I would avoid visiting an area if it was issued a 'medium flood risk' alert by SEPA (3)	☐	☐	☐	☐	☐
I would avoid visiting an area if it was issued a 'high flood risk' alert by SEPA (4)	☐	☐	☐	☐	☐

While living at your current address, have you been affected by a flooding event occurring in your local community?

- ☐ Yes (1)
- ☐ No (2)

Skip To: End of Block if While living at your current address, have you been affected by a flooding event occurring in you... = No

For how long after the flooding event did you experience the following physical health impacts:

	Never	During the flooding event	Up to 1 week after	Up to 1 month after	Up to 3 months after	Over 3 months
Restricted ability to exercise within the local community.	☐	☐	☐	☐	☐	☐
Respiratory infection.	☐	☐	☐	☐	☐	☐
Gastrointestinal infection.	☐	☐	☐	☐	☐	☐
Any other physical health impact. (Please specify)	☐	☐	☐	☐	☐	☐

For how long after the flooding incident did you experience the following mental health impacts:

	Never	During the flooding event	Up to 1 week after	Up to 3 months after	Over 3 months
Increased stress	☐	☐	☐	☐	☐
Lower levels of life satisfaction	☐	☐	☐	☐	☐
Increased levels of anxiety	☐	☐	☐	☐	☐

Considering the following factors, please indicate if you think your local community experienced them in the aftermath of the flooding event:

	Yes	No
Increased sense of community	☐	☐
Widening of economic disparities within community	☐	☐
Negative economic impact on community	☐	☐
Appropriate support from government bodies	☐	☐
Appropriate support from council	☐	☐

If you have any additional comments related to your previous experience of flooding events, please feel free to share.

How would you describe your gender identity?

- ☐ Man
- ☐ Woman
- ☐ Non-binary
- ☐ In another way (specify if you wish)

☐ Prefer not to say

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Please select your employment status from the following list:

- ☐ Full-time Employment (including self-employed)
- ☐ Part-time Employment (including self-employed)
- ☐ Retired
- ☐ Unemployed
- ☐ Stay-at-home Parent or Carer
- ☐ Other

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How long have you lived in your current address for?

- ☐ Up to 6 months
- ☐ Between 6 months and 1 year
- ☐ Between 1 to 2 years
- ☐ Over 2 years

What is your current post-code for your home address?

Do you identify as having a disability?

- ☐ Yes
- ☐ No
- ☐ Prefer not to say

End of Block: Background Info

Appendix 10: Flooding Semi-Structured Interview Guide

Can you tell me about your experience of flooding events while living in this area?

Can you talk me through the flood recovery process?

Have you had to relocate?

Have you received any help from the council or anyone else?

How long did it take you to feel as if you were back to normal?

Did you have any contact with SEPA or local council members during the flooding event?

Were you aware of the flood risk before moving to this area?

In the aftermath of a flooding incident, would you avoid visiting the freshwater area?

How do you think flooding events impact the local community?

When you visit the freshwater area under normal weather conditions, do you feel it is an enjoyable experience?

- How does this compare to when you visit during more extreme weather conditions?

Does the way that you use the riverside environment change over the seasons?