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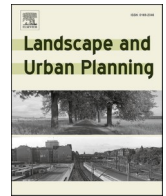
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## Research Paper




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

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## HIGHLIGHTS

- Dynamic blue space experiences were captured using solicited research diaries.
- Diaries provided novel insight into temporal trends in exposure outcomes.
- Inland blue space exposure can lead to positive restorative outcomes across time.
- Blue spaces can act as versatile public health resources.
- Maintenance of high-quality blue spaces is needed to ensure future health benefits.

## GRAPHICAL ABSTRACT

Inland Blue Space Visit Type	Exemplar Exposure Outcomes
 <b>Day Trips</b>	<ul style="list-style-type: none"> <li>• Nostalgia</li> <li>• Curiosity</li> </ul>
 <b>Getting Fresh Air</b>	<ul style="list-style-type: none"> <li>• Sense of Escapism</li> </ul>
 <b>Routine Visits</b>	<ul style="list-style-type: none"> <li>• Sense of Place</li> <li>• Recreational Opportunities</li> <li>• Social Interactions</li> </ul>
<p><i>Conclusion:</i> Diary entries captured the range of positive health outcomes gained from inland blue space exposure.</p>	

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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.

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## 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., 2019; McDougall et al., 2022; Börger et al., 2021; Haeflner 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 & 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.

## 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, van der Voordt and Dewulf, 2016](#)). Further information on non-respondents is available in the [supplementary information \(S3\)](#).

### 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 [supplementary information](#)).

The diary entry structure consisted of thirteen qualitative and quantitative questions (see [supplementary information](#)). 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.

### 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. 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 ([Fig. 1](#)). 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.

### 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 ([Fig. 2](#)). 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 ([Fig. 2](#), 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:  $p < 0.001$ ).

The ROS scores were significantly affected by the perceived impact of the weather conditions on the overall blue space experience. Diary

**Table 1**  
Demographic data per sample group.

Data Collection Phase	July-October	October-January	January-April	April-October
<b>N</b>	15	10	11	9
<b>Age Group (n, (%))</b>				
18–30	6 (40)	1 (10)	/	/
31–40	/	1 (10)	1 (9.1)	/
41–50	5 (33.3)	2 (20)	2 (18.2)	2 (22.2)
51–60	1 (6.6)	2 (20)	3 (27.3)	2 (22.2)
61–70	3 (20)	3 (30)	1 (9.1)	3 (33.3)
71–80	/	/	4 (36.4)	2 (22.2)
81–90	/	1 (10)	/	/
<b>Gender (n, (%))</b>				
Male	7 (46.6)	3(30)	5 (45)	3 (33.3)
Female	8 (53.3)	7(70)	6 (55)	6 (66.6)
<b>Ethnicity (n, (%))</b>				
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)	/	/	/
<b>Education (n, (%))</b>				
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)
<b>Employment Status (n, (%))</b>				
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)
<b>Location (n, (%))</b>				
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)
<b>Overall Life Satisfaction</b>				
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)	/	/	/
<b>Blue Space Activities Recorded By Participants (n)</b>				
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/	3	3	4	3
Wildlife Photography				

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 (Fig. 3,  $p < 0.001$ ).

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,  $p < 0.001$ ).

### 3.2. 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.

#### 3.2.1. 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.

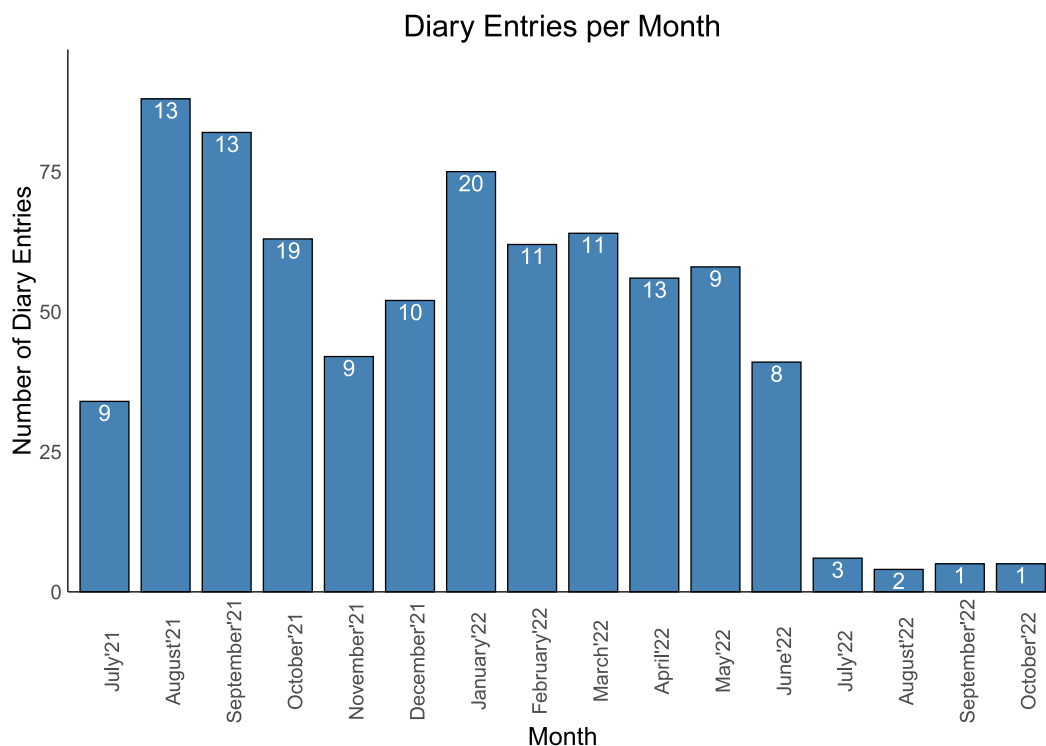
The erosion and degradation of riverbanks and green-space environments near waterways also had a strong negative impact on blue space experiences. After observing that parts of their local riverbank had collapsed, one participant noted; *“that ‘man’ is first class at decimating his environment through 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.

**3.2.1.1. 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.*

Diaries highlighted how these activities were not just restricted to exercise, as blue spaces also afforded individuals a chance to take part in





**Fig. 1.** 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.

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.

**3.2.1.2. 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.

### 3.2.2. 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.

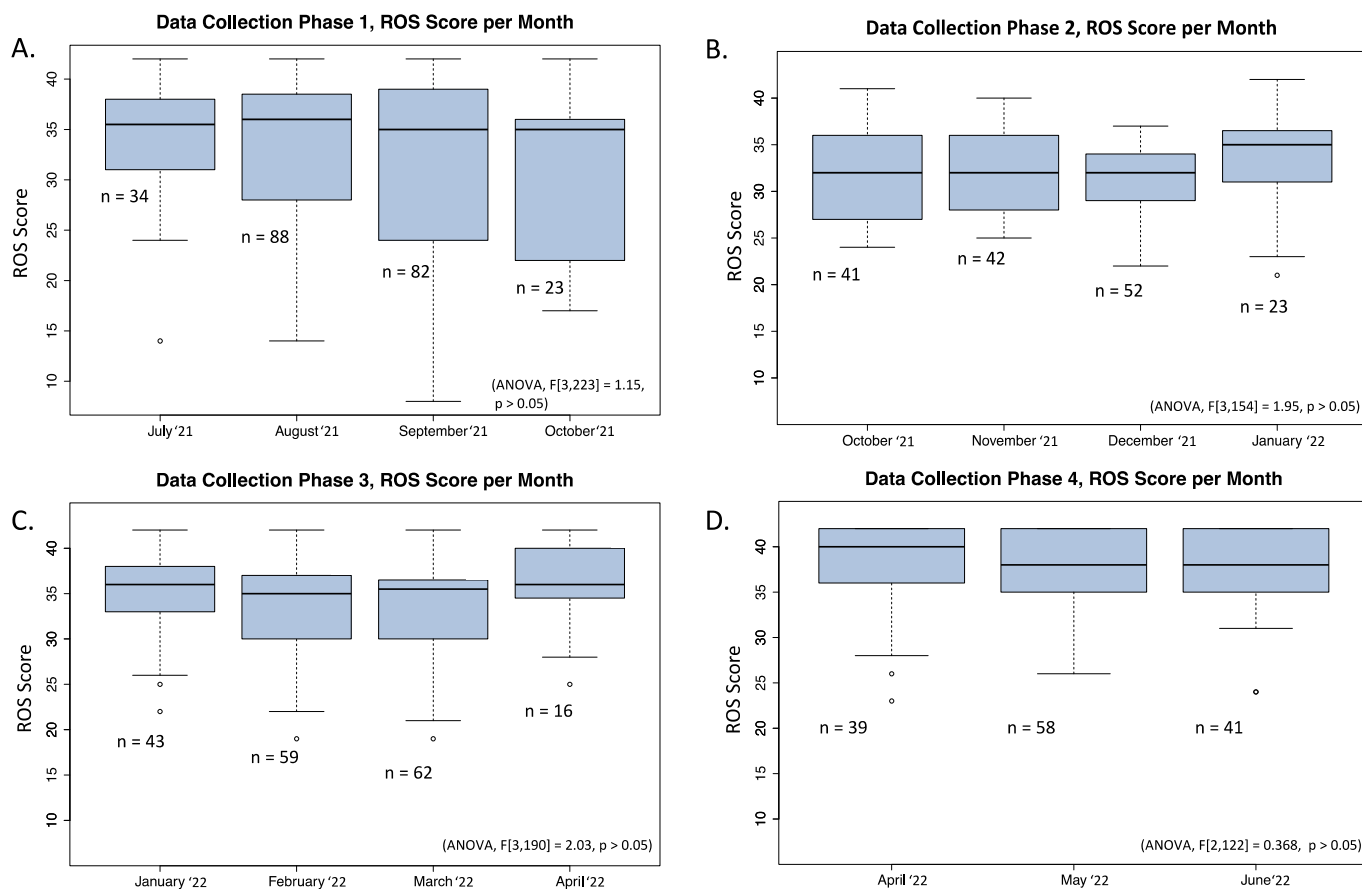
*“Diary question: What did you hear of interest?”*

*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.

### 3.2.3. 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



**Fig. 2.** 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.

participant’s local area. This encouraged participants to spend longer periods of time at the blue space than they would for routine visits.

**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.

**3.2.3.2. 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.*

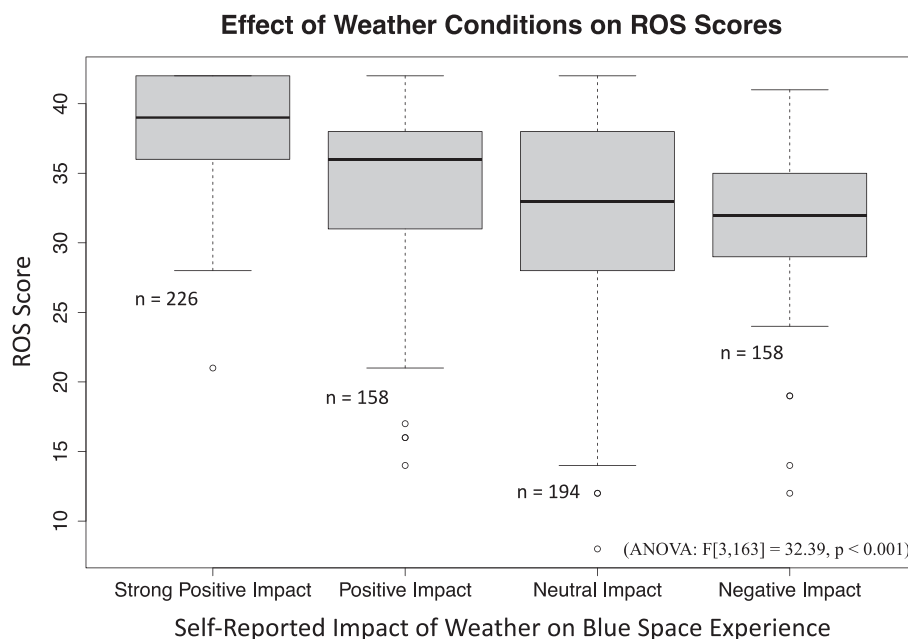
Often this information was obtained via interpretation boards at natural environments, however, insight was also gained from informal discussions with other blue space users, as well as attending organised events held by communities and businesses.

**3.3. 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.

**3.3.1. 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 (Fig. 4a). 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



**Fig. 3.** 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.

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.*

### 3.3.2. Participant 2. November-February

For participant 2 (Female, 81–90), the mode ROS score recorded throughout the diary was 35 (Fig. 4b). 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. 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) (Fig. 4c). 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 spring-time 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.*

### 3.3.4. 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 (Fig. 4d). 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



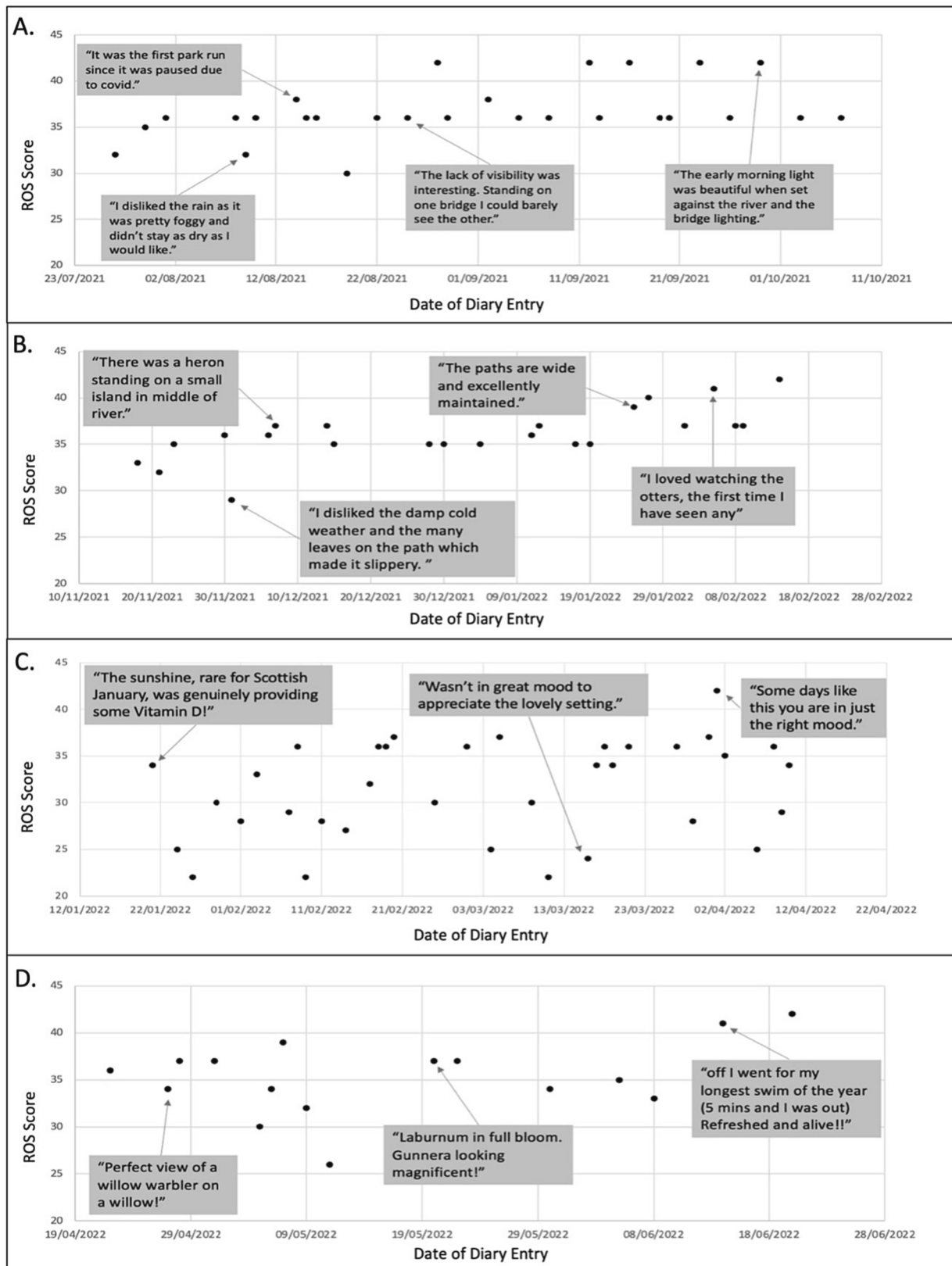


Fig. 4. ROS Scores from four diary participants who all took part over different months of the project. Each marker represents a diary entry and the ROS score the participant attributed to the blue space experience recorded within that entry. The four graphs have been annotated with notes from corresponding 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.

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.

#### 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 well-being 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, & 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, Matros, & Classen, 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, lead 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, Wheeler and Phoenix, 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 oversimplifying 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, Moran and Turner, 2019; Lengen, 2015; Fox, Marshall and Dankel, 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 lead to feelings of solastalgia for coastal blue space users as they re-negotiated their relationship with local environments (Jellard & 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).

## 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.

## Declaration of Competing Interest

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

## Data availability

Data will be made available on request.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.landurbplan.2023.104904>.

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