Behaviour Change in The Brecon Beacons National Park: An Applied Collaborative Research Project to Investigate Cross-Context Behaviour Change and Behavioural Interventions in a UK National Park

Conor John, B.Sc., M.Sc.

Submitted in accordance with the requirements for the degree of

PhD in Psychology

March 31st 2021

School of Psychology

Cardiff University

70 Park Place

Cardiff

CF10 3AT

Statement 1

This thesis is being submitted in partial fulfilment of the requirements for the degree of PhD.

Statement 2

This work has not been submitted in substance for any other degree or award at this or any other university or place of learning, nor is it being submitted concurrently for any other degree or award (outside of any formal collaboration agreement between the University and a partner organisation)

Statement 3

I hereby give consent for my thesis, if accepted, to be available in the University's Open Access repository (or, where approved, to be available in the University's library and for inter-library loan), and for the title and summary to be made available to outside organisations, subject to the expiry of a University-approved bar on access if applicable.

Declaration

This thesis is the result of my own independent work, except where otherwise stated, and the views expressed are my own. Other sources are acknowledged by explicit references. The thesis has not been edited by a third party beyond what is permitted by Cardiff University's Use of Third Party Editors by Research Degree Students Procedure. be published without proper acknowledgement.

Signed **Conor John** (candidate)   Date 09/08/2022

Word Count: 62,000

Acknowledgements

I'd like to thank everyone that has supported me over the last 4 and a half years. The PhD has been a real journey. With the support of family, friends and supervisors, it's one I am proud to have completed.

My first thanks have to go to my wonderful partner, Emma. She has provided support and understanding that I did not think possible. I would not have been able to complete this without her. Thank you too to my good friends Maya, Ryan, the rest of the PhD cohort and my office buddy Emily, you provided laughs, support and well-needed breaks from it all.

Thank you to all the staff at the Brecon Beacons National Park Authority. A big thanks to Richard Tyler for helping to establish the research in the first place. And a huge thank you to James Lawrence. Without the support and help from James, this thesis would not have been possible, and I thank him for helping to ensure that the PhD research was always kept on track to try and make a positive difference in the National Park.

Finally, I'm incredibly grateful for the support offered by my supervisors: Professor Lorraine Whitmarsh, Dr Dimitrios Xenias and Professor Wouter Poortinga. The PhD has been full of highs and lows, and I cannot thank you enough for sticking with me through it all. To be at the end feels completely surreal. Without your support, I would not have gotten this far. I am glad that I had you as my supervisors, I don't think I would have coped with anyone else.

If this gets you a PhD, what hope is there for tertiary education?

– Participant 4 (Study Two)

Thesis Abstract

Large-scale individual behaviour change is critical for us to have a tangible impact on tackling the current climate and biodiversity crises. To elicit such extensive behaviour change, it is essential to break away from traditional intervention development, where interventions focus on a single target behaviour, and develop interventions that have a far-reaching impact beyond their target behaviour and contexts. Until now, little research has been done to explore the drivers behind behaviours in nature-based contexts (e.g., National Parks) or evaluate interventions for PEBs within these contexts (Ramkissoon et al., 2012; Unnava, Burnkrant, 2015).

Covering 1,344km^2, the Brecon Beacons National Park (BBNP) is one of three National Parks in Wales. The National Park attracts around 5 million visitors a year, which causes a variety of environmental issues within the BBNP (Brecon Beacons National Park Authority, 2014, 2015, 2017). The Brecon Beacons National Park Authority (BBNPA) are at the forefront of managing the National Park, to minimise the negative impacts of tourism on the area. Working in collaboration with the Brecon Beacons National Park Authority, the research outlined in this thesis explores PEB change in the BBNP and potential spillover effects between a home and national park context.

Chapter 1 introduces the collaborative partner for the thesis research, the Brecon Beacons National Park Authority, and outlines some of the interventions in place in nature-based contexts and the Brecon Beacons National Park. Chapter 2 introduces the concepts of behaviours, spillover and interventions. Three empirical chapters, Chapters 3-5, outline studies investigating behaviour change across national park and home contexts. Additionally, the chapters cover studies investigating interventions aimed at encouraging pro-environmental behaviours. Finally, the thesis concludes with a summary and conclusion; Chapter 6 discusses the implications of the research, for both academic research and practitioners in the areas of conservation, visitor management and nature-based tourism.

Table of Contents

List of Figures

List of Tables

Key Terms & Abbreviations

Abbreviation	Term	Definition/Overview
-	Accretion	Accretion is the deposition of material on a physical environment as a result of people's past behaviours or their interactions with the physical environment (Fan Ng, 2016).
-	Behavioural Residue	A different term used for accretion. Note: behavioural residue is very similar to the term "behavioural accretion", but in this thesis, the more up to date definition "accretion" will be used (Fan Ng, 2016; S. D. Gosling et al., 2002).
-	Brecon Beacons	The central region of the Brecon Beacons National Park, including Pen y Fan.
BBNP	Brecon Beacons National Park	The National Park located in mid-Wales and the area of study for this thesis (see Figures 1 and 2 for maps of the Brecon Beacons National Park).
BBNPA	Brecon Beacons National Park Authority	The organisation that manages the Brecon Beacons National Park.
EDB	Environmentally Damaging Behaviour	A behaviour which is detrimental or damaging to the natural environment.
ESB	Environmentally Significant Behaviours	Umbrella term for all EDBs and PEBs (Stern, 2000)
-	Home context	The home environment. Within this thesis, a home context also encapsulates the areas near the home, such as local parks, paths and roads.

IVE	Immersive Virtual Environment	"Digitally rendered spaces offering sensory-rich simulations that allow users to experience mediated events in the virtual world as they might in the physical world" (Ahn et al., 2016).
MVC	Mountain Visitor Centre	The Mountain Visitor Centre is ran by the Brecon Beacons National Park Authority. It is located in the Brecon Beacons, the central part, of the NP. It is one of the only buildings managed for the public by the BBNPA and has as a tourist information centre, café and shop.
-	Interpretation	Interpretation is a term used by National Park staff and communicators within nature-based settings all over the world. Broadly, interpretation is the process of providing visitors with an opportunity to connect with a place. National Parks interpret to the visitor when they communicate at visitor centres and on paths. Interpretation can also refer directly to signage, messaging and displays, leaflets and information boards at sites across the BBNP.
-	Nature-based Context	Referring to a nature-based environment. Within literature it often encapsulates a specific location or visit, such as a visit to a nature reserve. To fall into this category, an environment needs to be wholly nature-based.

| NEP | New Ecological Paradigm | A measure of environmental worldview or values created by Dunlap (2012). |

NP   National Park

National Parks are large areas of land that are protected by law for the benefit of the nation. They were originally established by the 1949 National Parks and Access to the Countryside Act. The Environment Act 1995 revised the original legislation and set out two statutory purposes for National Parks in England and Wales; to conserve and enhance the natural beauty, wildlife and cultural heritage and to promote opportunities for the understanding and enjoyment of the special qualities of National Parks by the public (New Forest National Park Authority, 2022).

Note: In the United States and elsewhere across the world, National Parks are managed differently to the UK and offer visitors a different experience to visits to the UK. To avoid confusion, any reference to a national park outside of the UK will also include reference to the country or explicitly state that the national park is not within the UK.

-            National Park Context

Referring to a national park specifically. This includes the outside environment within the national park and indoors; holiday homes or places that visitors will stay in. National Parks within the UK often include towns, domestic residences and agricultural land that would not qualify them to be categorised into 'nature-based context'. The Brecon Beacons National Park does include towns,

residences and agricultural land.

NRW	Natural Resources Wales	A Welsh Government sponsored body, which became operational from 1 April 2013, when it took over the management of the natural resources of Wales. It was formed from a merger of the Countryside Council for Wales, Environment Agency Wales, and the Forestry Commission Wales, and also assumes some other roles formerly taken by Welsh Government.
-	Oculus Quest	The Oculus Quest is a virtual reality headset, produced by Oculus. The headset was used for Study Five. The Oculus Quest is now discontinued and has been replaced with the Oculus Quest 2.
PEB	Pro-Environmental behaviour	A behaviour that is either beneficial to or reduces impact on the natural environment.
PONT	Pori Natur a Threftadaeth	PONT is an organisation that brings together and shares knowledge, expertise and practical skills on conservation and grazing across Wales. Their aim is to collaborate with those in the farming, conservation, local communities and other interest groups to help deliver practical grazing solutions that benefit

the various interests in an integrated manner (PONT, 2021).

–	Waterfalls Country	Waterfalls Country is an area in the Southwest of the Brecon Beacons National Park. It is speculated to have the greatest concentration of waterfalls, cascades, caves and gorges in the UK (Waterfall Country Wales, 2021).
VR	Virtual Reality	For this thesis, virtual reality is defined as any simulated environment, either computer generated or real-world (e.g., video/photos), that is presented within a virtual reality headset, which allows for full 360° or 180° viewing.

Maps of The Brecon Beacons National Park
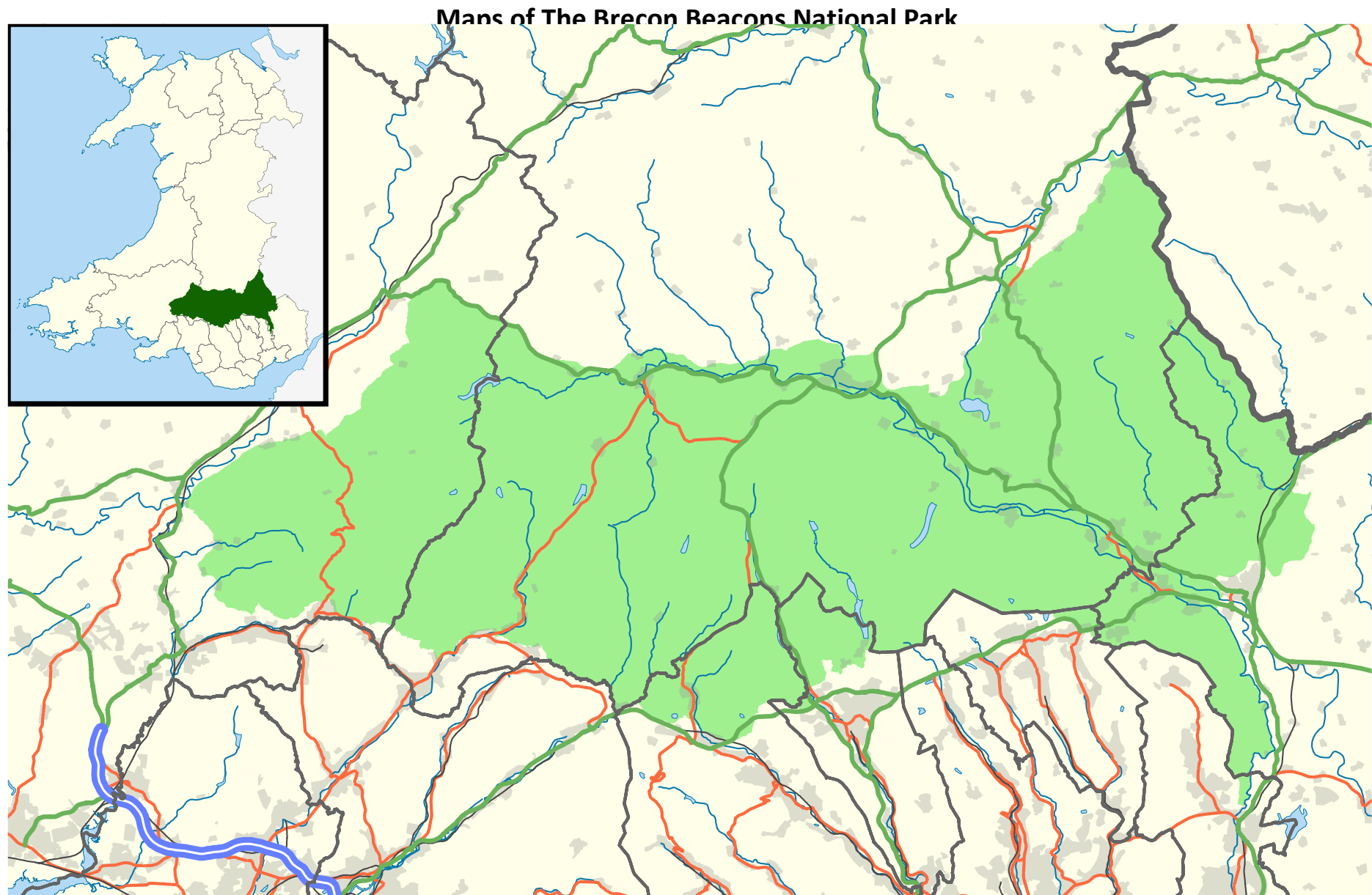
Figure 1 - Map of the Brecon Beacons National Park, showing its location within Wales (image used under creative commons - contains Ordnance Survey data © Crown copyright and database right).

Figure 2 - Map of the Brecon Beacons National Park, provided by the Brecon Beacons National Park Authority.

Presented Studies

An overview of the studies presented in this thesis

Chapter	Study Title	Linked to Research Question	Gaps in Current Literature & Practitioner Work	Purpose of the Study
Three	Study One	Question 1 - Do environmental behaviours and attitudes change across contexts, between home and the National Park? Question 2 – What are the main predictors for PEBs in the National Park and at home? Question 4 - Does behavioural spillover occur between a home and National Park context?	• Little research on cross-contextual behaviour change between a home and National Park context • Thus far, no research has explored National Park context-specific behaviours	• To test the feasibility of studying behaviours across contexts and to establish if the methodology for doing so is effective
Four	Study Two	Question 3 – Can interventions reduce instances of EDBs in the National Park?	• Next to no research has empirically tested the effectiveness of interventions to reduce dog fouling • Little research has explored behavioural mapping for EDBs in a nature-based context	• To investigate the effectiveness of behavioural mapping as a tool to measure behaviour • To test the effectiveness of a novel intervention to reduce dog fouling
	Study Three	Question 3 – Can interventions reduce instances of EDBs in the National Park? Question 4 - Does behavioural spillover occur between a home and National Park context?	• Research into interventions within nature-based contexts has not explored message framing to reduce littering • National Parks in the UK often resort to signage to act as an intervention to reduce EDBs, but no research has investigated the effectiveness of such interventions	• To investigate the effectiveness of different messages to reduce littering in a nature-based context • To add to the knowledge of practitioners and develop methodology that can be used by practitioners in the future

Five	Study Four	Question 2 – What are the main predictors for PEBs in the National Park and at home? Question 3 – Can interventions reduce instances of EDBs in the National Park? Question 4 - Does behavioural spillover occur between a home and National Park context?	• Little research has investigated the impact of pre-visit interventions	• To investigate the impact that exposure to different message frames pre-visit could have on behaviours during and after visits to the National Park
	Study Five	Question 3a – Can a virtual visit to the National Park lead to changes in environmental behaviours and attitudes?	• Research has only just began exploring the potential influence that visits to virtual nature can have on environmental attitudes and beliefs • Additionally, little research has tested the potential for Virtual Reality as a research tool	• To test the potential impact that virtual nature can have on environmental behaviours • Additionally, to explore the possibility of using virtual reality as an intervention and research tool within environmental psychology research

Previous Publications

The thesis includes elements from a published report, namely:

Chapter Two – Feasibility Study

Federal Agency for Nature Conservation, & Landau University. (2019). Green Ways – Perspectives of Environmental Psychology Research. In G. Reese, A. Römpke, A. W. Mues, & K. Bockmühl (Eds.), *Federal Agency for Nature Conservation*. Federal Agency for Nature Conservation. https://www.bfn.de/sites/default/files/BfN/service/Dokumente/skripten/skript529.pdf

1   Chapter One – Collaborative Foundations

1.1   Introduction

Governments across the world, have started recognising the impact that climate change is having on our planet. With declarations of climate emergencies and the signing of the Paris Agreement, there has been a large-scale shift by governments and organisations to focus on tackling the climate and biodiversity crises (Cimato & Mullan, 2010; Climate Change Committee, 2021; United Nations, 2021) The U.K. government, for example, has brought into legislation a target for all emissions to be at net zero by 2050 (Sataloff et al., 2020; U.K. Government, 2019). To meet this target, large-scale changes from government, businesses and also in the behaviour of citizens are required (Nash et al., 2017; UN Development Programme, 2016; United Nations Framework Convention on Climate Change, 2018). Individual behaviour change, when taken up on a large-scale, is essential for us to have a tangible impact on climate change; changes to our food consumption, material production and energy usage as individuals will have a direct on global emissions (Williamson et al., 2018).

To elicit such extensive behaviour change, it is essential to break away from traditional intervention development, where interventions focus on a single target behaviour, and develop interventions that have far-reaching impact beyond their target behaviour and contexts (Thøgersen & Crompton, 2009). Behavioural spillover, where the performance of one behaviour leads to change in another, is one mechanism through which behavioural consistency and positive change across contexts can be achieved through interventions (Maki et al., 2019; Truelove et al., 2014). However, this is not a simple phenomenon, as research has found that behaviours are often inconsistent across contexts, with individuals becoming less environmentally friendly as they move away from a home context (Barr et al., 2010; Nash et al., 2017). Understanding the mechanisms that drive spillover, and behavioural changes across contexts, is essential to develop successful wider-reaching interventions.

The context-specificity of behaviour change, with individuals behaving differently across contexts, is also important when considering human impacts on natural environments. As green spaces and natural habitats shrink, there is an ever-increasing number of people visiting National Parks (NPs) in the U.K. and elsewhere (Holroyd, 2018; Monbiot, 2018a, 2018b). The increasing visitor numbers are leading to increased pressure on NPs, and more incidents of environmentally

damaging behaviours (EDBs), like disturbance to wildlife, pollution and erosion (National Parks UK, 2018; Rowe, 2020).

NPs, although an American invention, have rapidly become ubiquitous around the world as a way to designate areas of the natural environment for conservation and recreation (Dasmann, 1972; Nash, 1970; Stevens, 2002). With 92% of land legally out-of-bounds for most of the general public, the UK's National Parks are becoming a honey-pot for tourists and tourism more broadly – as they offer some of the only legally accessible outdoor space for the UK public (Hayes, 2020).

In recent years, there has been an increasing pressure on NPs; the influence of social media and the COVID-19 pandemic have contributed to visitor numbers increasing drastically in NPs in the UK and abroad (Pouso et al., 2020; Prata et al., 2020; Sessions et al., 2016; Simmonds et al., 2018a; Sinclair et al., 2020; M. K. S. Smith et al., 2021; Souza et al., 2021). This increase in visitor numbers, and crucially in density, is causing issues for wildlife, ecosystems, habitat and local infrastructure (Abrams et al., 2020; Brecon Beacons National Park Authority, 2014, 2015; Buckley, 2004; Hamstead et al., 2018; Tratalos et al., 2021). Despite their global reach, there is a distinct lack of research that focuses on NPs in the field of environmental psychology and very few management plans for NPs that utilise behaviour change research or theory (Brecon Beacons National Park Authority, 2013, 2014; Cialdini, 2003; Pratt-heaton, 1999; Ramkissoon et al., 2012). Whilst management of NPs differs across the globe, the findings from studies into NPs and environmental behaviour change have the potential for far-reaching impact and applications (Ramkissoon et al., 2012).

The research presented in this thesis provides an important contribution to the environmental behaviour change literature. The thesis research is a collaborative project, between the Brecon Beacons National Park Authority and the author, an academic researcher. As one of the first collaborations between a UK NP and an environmental psychologist, the thesis offers valuable insights for both academics and practitioners. Additionally, the thesis explores the process of collaboration between an NGO and academic research institute – providing insights into how collaborative relationships can benefit both academics and practitioners, whilst also discussing shortfalls and pathways for future collaborative work.

The collaboration is the vessel for a series of exploratory studies, providing the foundations for investigations into cross-contextual behaviour change between home and NP contexts, and interventions aiming to encourage PEBs. The research brings together work spanning

environmental psychology, sustainable tourism, conservation management and behaviour change science. It investigates the use of academic research methods within an NGO and assesses the potential for academic theory to be utilised by practitioners. Finally, the thesis provides insights into interventions that may be of use for practitioners managing NPs, and similar areas for recreation and conservation.

The thesis includes three empirical chapters, and two literature review chapters. Chapter One explores the collaborative partner for the research, the Brecon Beacons National Park Authority. Chapter Two explores behaviour change theory and academic research in the field of environmental psychology more specifically. Additionally, Chapter Two discusses the theory of behavioural spillover, and the potential for this phenomenon to be explored within the context of a NP. Three empirical chapters - Chapters Three, Four and Five – showcase a variety of exploratory and experimental studies investigating spillover and behaviour change within a BBNP context. The thesis concludes with a discussion chapter that provides an overview of the findings and conclusions drawn from the research, and how they fit into the research landscape.

Chapter One introduces the collaborative research partner, area and the research landscape. The chapter explores the context for the research, providing evidence to support the research questions and plan, which are presented at the end of Chapter Two.

The chapter discusses the collaborative partner for the thesis, The BBNPA, before giving an overview of the research questions for the thesis and considerations for the research. Chapter Two is split into 7 sections:

1.1 Introduction to the Thesis and Chapter One.

1.2 Discusses the research area and introduces the collaborative partner for this thesis, the Brecon Beacons National Park Authority. In addition, this section explores the environmental behaviours that have a negative impact on the National Park. It also discusses current interventions and research into interventions within nature-based contexts and NPs more specifically. Finally providing an overview and justification for research.

1.2   Research Area & Partner

1.2.1   The Brecon Beacons National Park

The Brecon Beacons National Park (BBNP), located in South Wales, covers 1,344km^2 and is one of three NPs in Wales and one of 15 in the U.K. (National Parks UK, 2021). The area was designated a NP in 1957, with the western half gaining European and Global Geopark status in 2005, with the creation of Fforest Fawr Geopark (Fforest Fawr Geopark, 2021) (see figures 1 and 2 on pages xxii and xxiii). The NP is an International Dark Sky Reserve, and Blaenavon, within the National Park, is a UNESCO World Heritage Site (International Dark-Sky Association, 2021; National Parks UK, 2021). With so much cultural, biological, and historical significance, the BBNP is a popular tourist destination.

The BBNP is estimated to host over 4 million visitors every year, 74% of which come to the NP for no more than a day, which is an "unusually high" number compared to other Welsh NPs (Brecon Beacons National Park Authority, 2015). Whilst the NP attracts tourists in their millions, it is also a permanent home to around 33,500 people who live within its boundaries (Statistics for Wales, 2017). Additionally, a vast amount of the BBNP is made up of agricultural land. With so much agriculture and a high population of people living within the BBNP, the term "living landscape" is used to characterise the NP (Brecon Beacons National Park Authority, 2021d). With high visitor numbers, cultural and scientific sites, agricultural significance, and a large population, managing the site to mediate the impacts of tourism, and meet the needs of every stakeholder, falls onto the BBNPA.

1.2.2   The Brecon Beacons National Park Authority

The BBNP is managed by the Brecon Beacons National Park Authority (BBNPA) who deal with the maintenance of paths, uniting of stakeholders and tourism impact within the BBNP (Brecon Beacons National Park Authority, 2021b). The BBNPA have produced a five-year management plan in which they outline their key targets and goals. Within the plan they highlight their six main themes; theme one "Managing Park Landscape to Maximise Conservation and Public Benefits" and theme two "Conserving and Enhancing Biodiversity". The plan also highlights that to achieve these two themes, there is a need to develop a deeper understanding of visitors to the

National Park. Furthermore the plan highlights the need to develop more effective interventions to change the behaviours of visitors to the Park too (Brecon Beacons National Park Authority, 2013)[1].

Additionally, the BBNPA are attempting to develop more effective and innovative ways to both manage and understand their visitors. For example, utilising and monitoring social media; social media posts featuring locations have been found to lead to increasing visitor numbers as well as working to manage visitors (Donahue et al., 2018; Hamstead et al., 2018). Cloud-based monitoring (using live traffic, car park and people counters) is also being developed and trialled within Waterfall Country in the NP (J. Lawrence[2], personal communications, July 2021).

The BBNPA have not previously worked with behaviour change scientists and are interested in establishing a knowledge exchange for behaviour change (J. Lawrence, personal communications, Jan 2018). Working collaboratively with the BBNPA, this research hopes to assist the organisation in developing understanding of, and interventions to tackle, some of the core issues they are interested in: visitor management, interpretation and behaviour change. Currently, the BBNPA do not carry out specific research relating to any of these areas and this research will be the first of its kind for the BBNPA.

This is not uncommon within the broader research landscape. Indeed collaborative projects at this scale lacking; whilst there are various studies that have used NPs as the basis for investigations into environmental behaviours – none of them have been long-term collaborative PhD research projects. To this degree, this thesis also explores the collaborative foundations of the research, uncovering the benefits and shortcomings of such work.

1.2.3   Main Issues for the Brecon Beacons National Park Authority

Despite protected status, the National Park's environment is affected by the impacts of tourism. Issues associated with visitors in the NP include: off-roading, littering, path erosion, disturbance to wildlife and pollution (Brecon Beacons National Park Authority, 2014, 2021a; National Parks UK, 2018). These environmentally damaging behaviours (EDBs) are not unique to the

---

[1] The research presented within this thesis does fall within the two themes outlined in the BBNPA's management plan. However, the fact that it does is purely coincidental. The research was not informed by the management plan or form a part of the BBNP's broader management strategy.
[2] James Lawrence is visitor management officer at the Brecon Beacons National Park Authority. He is also a co-supervisor for this PhD research.

National Park. However, they are distinctly different to EDBs typically performed in in a home or domestic context. Additionally, these are not behaviours that have been explored within literature.

Littering is one of the key issues that the NP faces (J. Lawrence, personal communications, January 2018). Littering, the act of disposing of waste without using a recycling or waste bin, is a problem within the UK as a whole (Unnava & Burnkrant, 2015). NPs have experienced heightened issues with littering due to the COVID-19 pandemic, as the number of visitors increased exponentially due to international travel restrictions (Johnson, 2021; Laviille, 2020; Pidd, 2021). However, litter within the National Park has not been explored in-depth. Excluding small-scale projects from community groups such as Llangattock Litter Pickers[3], there is a vast gap in research on the topic within the BBNP (Llangattock Community Council, 2021). What little research has been conducted on the impact of visitors in the BBNP has not focused on littering. Work investigated 'visitors and 'visitor pressure in the Brecon Beacons National Park' in the 90s, but did not mention litter at all, focusing almost exclusively on path erosion (Pratt-Heaton, 1999).

Path erosion is also a notable issue within the BBNP too; paths are widened as visitors stray off path, eroding the topsoil and leading to destruction of flora and fauna (Brecon Beacons National Park Authority, 2015; Pratt-Heaton, 1999) Repair costs to rebuild and fix paths within NPs are estimated at between £20 and £100 per meter (Lake District National Park, 2017). Repairs are completed on a need-by-need basis, and no research has been conducted to measure the scale of the issue within the National Park. Whilst no yearly costs are obtainable from the BBNPA, as an example, just one-kilometre long stretch on a popular route up Pen-y-Fan cost £12,100 to repair in 2017 (British Mountaineering Club, 2017). In addition to erosion, the widening of paths leads to increased disruption to wildlife; buffer zones like hedges and verges are destroyed, meaning wildlife is increasingly encroached on (Bates et al., 2020; Marzano & Dandy, 2012; Rodway-Dyer & Ellis, 2018).

Another of the main issues that the BBNPA are concerned about in relation to visitors, are dogs. Issues like livestock worrying, neosporosis (a parasite found in dog faeces which can lead to death and miscarriages in livestock) and disturbance to wildlife are all major concerns for the BBNPA (Brecon Beacons National Park Authority, 2018). The BBNPA are not the only NP or environmental organisation that have a focus on dog related issues, with organisations across the

---

[3]Research from Llangattock litter pickers is conducted by members of local community group and no documents, reports or findings have been published by the group.

UK spending a vast amount of resources, money and time to tackle the issue through campaigns (Brecon Beacons National Park Authority, 2018; Edwards & Knight, 2006; Hampshire County Council & Kennel Club, 2016; Jenkinson, 2007; Peak District National Park Authority, 2008). With 24.2% of NPs classed as agricultural land, much of this grazed by livestock, there is clear potential for large scale livestock worrying problem (Raven-Ellison, 2021). However, there is little evidence to support the premise that livestock worrying is as large a problem as the BBNPA believe. Research from the National Sheep Association surveyed only 233 farmers in one study and 89 in another; the organisation asked participants about sheep worrying from dogs (National Sheep Association, 2016, 2017). However, the surveys were methodologically flawed; the study had a very low sample size and used leading questions. Additionally, the studies were conducted by an organisation with conflicting interests in the topic. Research from Oxley et al. (2017) also failed to deliver strong evidence to suggest sheep worrying is a significant issue within the UK or any particular region.

Finally disturbance to wildlife is considered a widespread issue within the NP (Brecon Beacons National Park Authority, 2015). Indeed, the issue is perceived by stakeholders to be a key issue – it is outlined in the visitor management plan (Brecon Beacons National Park Authority, 2013). However, no research has been conducted by the BBNPA or collaborative partners to investigate the issue. There is also no research in the literature that has investigated visitor impact on species within the BBNP.

For all the issues outlined above, the BBNPA divide resources and staff time based almost entirely on anecdotal reports. Scientific studies conducted measuring the impact of visitors and the scale of issues have not been conducted since the nineties. These studies revealed that issues such as pollution to lakes, community objections to tourists and traffic management were significant at the time, but little to no research has been conducted in the years preceding these studies (Bennion & Appleby, 1999; Cullinane, 1997; Fitton, 1996).

The lack of research measuring the impact of tourists in the BBNP is surprising, given that NPs are increasingly becoming some of the most popular natural sites in the UK – a fact which has been reinforced during the COVID-19 pandemic (Johnson, 2021). UK NPs are being marketed as a great way to break free from modern living. Research highlights how beneficial to mental health and wellbeing interacting with the natural environment is, leading to an increasing numbers of visitors each year (Frumkin, 2001; C Maller et al., 2006; Reeves et al., 2021; Wyles et al., 2017). With rising numbers comes an increase in issues, and research shows that NP visitors are often not

aware of the impact they may have on the natural environment (Sterl, Brandenburg, & Arnberger, 2008). Currently, active communication with visitors is the main way that the BBNPA attempt to tackle these behaviours, as well as working with local police, councils, and landowners. However, this is not reducing the negative impact of visitors to acceptable levels (J. Lawrence, personal communications, Jan 2021). This highlights the need for the BBNPA to raise awareness and discover the factors that influence behaviour, so that areas can be better protected and the negative impacts can be reduced (Cohen, 1978; Sterl et al., 2008).

These issues are not unique to the BBNP, neither is the lack of research. Whilst resources and time are focused on specific issues, there is often a lack of empirical or objective evidence. Much of the BBNPAs strategy is aimed at tackling behaviours and issues that are defined only with anecdotal evidence. This approach is also used by similar organisations in the UK and abroad. There is a need for research into EDBs and PEBs in the Brecon Beacons National Park, which will help build a picture of the broader research landscape of behaviours in nature-based contexts. Finally, there has been no research to investigate the potential cross-contextual behaviour change of visitors to the BBNP. However, the BBNP offers a good opportunity to explore this and would help fill the research gap first highlighted Ramkissoon et al. (2012).

1.2.4   Current Approaches to Behaviour Change in the BBNP

This section will discuss the broad interventions and communications strategies currently in use within NPs and nature-based contexts in the UK. The section explores signage, physical/structural changes to the environment and the provision of tools. The section will outline the main intervention used by the BBNPA, signage. The focus on signage is because this is the main channel that the BBNPA use for communications (J. Lawrence, personal communications, February 2019). The section also highlights the need for further research, as well as the need for the development of interventions that are informed by science.

The BBNPA utilise a network of volunteers and staff to conduct active conservation, by both protecting and monitoring areas, as well as to communicate and engage with visitors and locals. However, the most well-established and utilised communication channel is signage and interpretation (J. Lawrence, personal communications, February 2019). This is predominantly

because signage and interpretation offer the chance to communicate with visitors in remote areas and in the absence of staff or volunteers.

Signage and interpretation[4] used within the BBNP is used to inform visitors of the history of a site, wildlife or walking routes. These, often, do not include any behaviour change messaging (J. Lawrence, personal communications, June 2018). However, some webpages, leaflets and signage include additional behaviour change messaging and fall into the category of "interventions". The messaging is broadly focused on being a responsible visitor; but none of these interventions have been tested using research. The interventions are often not based on psychological principles or behaviour change theory (J. Lawrence, personal communications, January 2018). The interpretation team[5] has used the work of Ham et al. (2009), *Promoting Persuasion in Protected Areas,* to help inform some interventions, but this is not applied to all interpretation and signage outputted by the BBNPA (J. Lawrence, personal communication, February 2018).

Signage is one of the easiest ways to communicate with visitors in the BBNP, but signage has been defaced or removed in the past (J. Lawrence, personal communications, March 2018). Signage in the BBNPA is also often placed in the most convenient location rather than the most appropriate. This is evident across the National Park. As shown in Figure 3 - a sheep worrying sign, aiming to encourage walkers to put their dog on the lead around livestock, has been placed on the vehicle gate, not the gate used by dog walkers. Additionally, there is a large focus on dog related behaviours, compared to other EDBs and PEBs (see Figure 3 for an example of signs used within the BBNP).

Throughout the BBNP various signs are used to encourage dog owners to put their dogs on a lead. These vary greatly in terms of message, design, and tone. One of the most well-used and widely deployed shows a dog with its lead in its mouth, with the words "don't get me shot". The sign is at odds with research that suggests that showing the target behaviour and creating a norm within images is the best way to promote behaviours, instead showing a dog off-lead (Cialdini et al., 2006). There is some interpretation that is used seasonally to encourage other PEBs aside from dog owner behaviours, but this is limited to specific locations.

---

[4]Interpretation is defined in the Key Terms and Abbreviations table at the beginning of the thesis.
[5]This team, within the BBNPA, is responsible for creating signage, leaflets, and information boards for visitors across the National Park.

Another additional issue with signage is a lack of consistency within the National Park. Natural Resources Wales own land within the BBNP and provide some on-site signage to promote PEBs and safety behaviours. The signage is not based on any kind of scientific research and features different messaging to the BBNPA. The lack of consistency between organisations that operate within the same NP is counterintuitive, as consistency in messages increases their effectiveness (Ham et al., 2009).

Other interventions are used within NPs to combat EDBs like erosion include physical infrastructure. Within the Cairngorms National Park, the erosion on Cairn Gorm required a path to be installed from the base to the summit, with a rope handrail used to discourage visitors from going off path and causing further erosion (see Figure 4 - Ropes used to encourage visitors to not stray off the built path on Cairn Gorm in the Cairngorms National Park Within the Brecon Beacons, similar physical barriers are used to discourage erosion on paths (see Figure 5 - Barrier with messaging to encourage visitors to use a different path due to path erosion, on Hay Bluff, Brecon Beacons National Parkand Figure 4 - Ropes used to encourage visitors to not stray off the built path on Cairn Gorm in the Cairngorms National Park

Within some areas of the BBNP, organisations have begun to use structural interventions, in the form of tools (e.g., litter pickers and bags), to tackle EDBs like littering. The Llangattock litter pickers are a community group who focus on collecting litter in the areas around Llangattock, in the South East of the BBNP (Llangattock Community Council, 2021; Llangattock Litter Pickers, 2021b, 2021a). The community group conduct weekly litter picks conducted by volunteers. The group have also deployed interventions in the National Park. They have installed #2minutebeachclean stations throughout Llangattock village, which provide individuals with bags and litter pickers to clean public areas in the town of Llangattock (The 2 Minute Foundation, 2021). Organisations and the creators of the litter-picking station report that provision of tools like this are effective at bringing about behaviour change and a reduction in litter. However at the time of writing there is no scientific research to support these claims[6].

There is a need to investigate interventions in nature-based contexts, not only to research which interventions will be most effective but also to further investigate how to objectively

---

[6] The author contacted the 2 Minute Foundation and suggested collaborating with the organisation on a research study, to test the effectiveness of these litter-pick stations. However, the organisation did not agree to collaborate on research. As the stations cost upwards of £500 to purchase, this intervention was not considered for testing in this thesis.

measure behaviours within nature-based contexts. This gap in research aligns with the gap in research exploring behavioural spillover and cross-context behaviour change in nature-based contexts, as mentioned previously. Overall, there is a clear lack of focus within the field of environmental psychology and behaviour change on nature-based contexts. This is stark, considering how important natural sites can be for improving health and wellbeing, as well as their potential for behaviour change.

Figure 3 - Signage used within the Brecon Beacons National Park to encourage responsible visitor behaviours. Note that most of the signs are focused on dog owner behaviours

Figure 5 - Barrier with messaging to encourage visitors to use a different path due to path erosion, on Hay Bluff, Brecon Beacons National Park
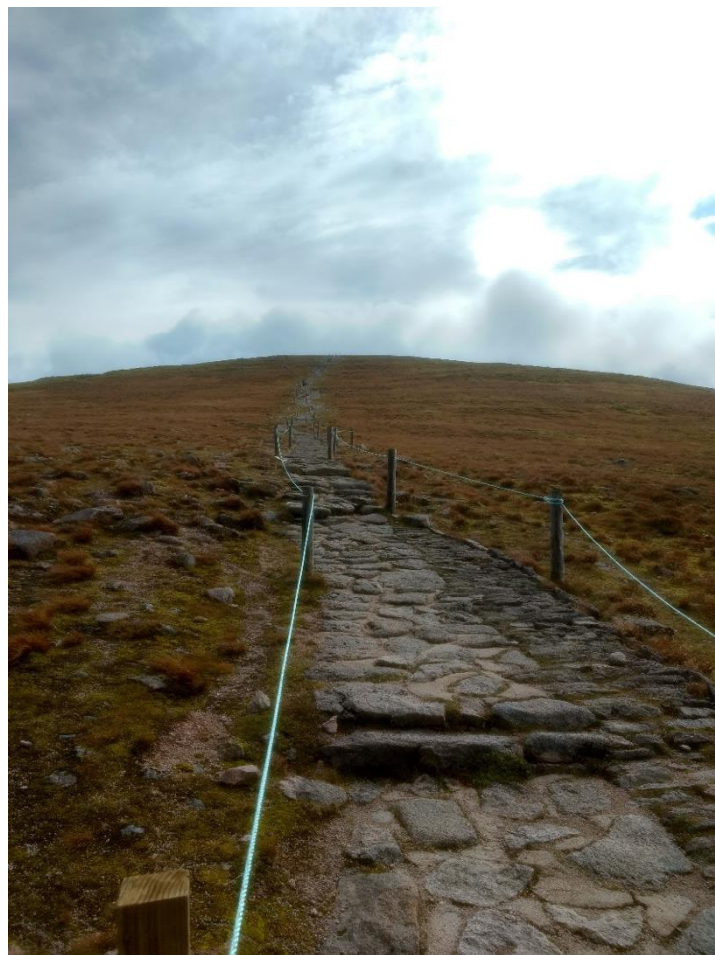
Figure 4 - Ropes used to encourage visitors to not stray off the built path on Cairn Gorm in the Cairngorms National Park

2   Chapter Two – Behaviours Across a Home and National Park Context

2.1   Introduction

Chapter One provided insights into the collaborative partner and the research area for this thesis research. The chapter provided insights into how the novel collaboration could provide a platform for investigations into behaviour change across contexts and interventions. Chapter Two offers an introduction to behaviour change and behavioural spillover, reviewing both theoretical and empirical literatures. The chapter also discusses behaviour change interventions and frameworks, and is divided into five main sections:

2.2 Defines environmental behaviours, outlining the differences between pro-environmental and EDBs. This section also discusses the antecedents of behaviours, and factors that mediate environmental behaviours.

2.3 Discusses behavioural spillover, focusing on positive and negative spillover, before discussing cross-context spillover and the factors that mediate spillover.

2.4 Discusses behaviour change interventions and frameworks, including two categories of behavioural interventions: structural and information strategies.

2.5 Summarises behaviour change and an overview of the topics discussed in the previous sections.

2.6 Provides an overview of the behaviours under investigation within this thesis research.

2.7 Outlines the research questions for the thesis research.

2.8 Discusses research and methodological considerations for the research.

2.9 Gives an overview of the research presented in the thesis.

2.2   Environmental Behaviours

A growing number of studies highlight that technological change alone will be insufficient to address climate change and other environmental problems; significant changes to public behaviour will also be essential (Williamson et al., 2018). Over three-quarters of greenhouse gases can be

attributed to households (United Nations, 2020), and most of the measures to reach the UK's net zero target require behaviour change by consumers (Committee on Climate Change, 2020). Climate change and EDBs can impact communities and biodiversity at a local level; flooding, pollution, wildfires and coastal erosion are just some examples of local impacts caused by global climate change (NASA, 2021; Intergovernmental Panel on Climate Change, 2019). In order to combat these issues, behaviour change interventions are required, as well as a deeper understanding of citizens' environmental behaviours (Dockerty et al., 2005; Doherty, 2018; Sheppard et al., 2011).

To do this, we must first define environmentally significant behaviours (ESBs) before exploring both pro-environmental behaviours (PEBs) and environmentally damaging behaviours (EDBs). Lastly, understanding behavioural antecedents is essential to develop effective behaviour change interventions (Alzubaidi et al., 2021).

2.2.1   Environmentally Significant Behaviours

Environmentally significant behaviours are defined by 'impact' i.e., the extent to which a behaviour alters the environment (Stern, 2000a). ESBs can be further categorised into direct and indirect impact behaviours (Stern, 2000a). Direct impact behaviours include behaviours that directly or proximally cause environmental change (either positive or negative), examples include deforestation, household waste and recreational travel behaviours. Conversely, indirect impact behaviours affect the environmental indirectly, for example influencing public policy (Stern, 2000a). ESBs can thus be either positive (pro-environmental) or negative (environmentally damaging).

2.2.1.1   Pro-Environmental Behaviours

Definitions of PEBs are debated widely within the literature; from earlier definitions which focus on direct behaviours to the more contemporary definitions which also include indirect behaviours (Brundtland, 1987; Halpenny, 2010; Sivek & Hungerford, 1990). Within this thesis, Halpenny's (2010) definition will be used; PEBs are 'any action by an individual (or group) that promotes or results in the sustainable use of natural resources'.

2.2.1.2   Environmentally Damaging Behaviours

Academic research often focuses on PEBs, investigating interventions aiming to encourage PEBs or the frequency of performance of PEBs. However, for practitioners, tackling EDBs is of equal

importance. The Brecon Beacons National Park, the collaborative partner for this research[7], deal with a variety of EDBs. Examples of behaviours include sheep worrying[8], off-road biking and wild camping[9]. As such, this thesis requires a definition of EDBs; they are defined here as 'any action, by an individual or group that promotes or results in the unsustainable use of, or damage to, natural resources'.

2.2.1.3 Intent vs. Impact

The definitions outlined above for PEBs and EDBs are impact-orientated (Halpenny, 2010). The definitions imply that behaviours will lead to the promotion of or damage to the natural environment or result in the sustainable/unsustainable use of natural resources. However, when researching behaviours, it is not always possible to measure the impact of behaviours, nor the actual performance of behaviours. As such, previous research has often used measures of behavioural intent as a proxy for individuals' performance of behaviours.

An intent-orientated definition of environmentally significant behaviour is a behaviour that is undertaken with the intention to change (normally to benefit) the environment (Stern, 2000a). This definition differs from the more impact-orientated definitions mentioned above because intent is identified as an independent cause of behaviour, whilst it also notes that intent may not necessarily result in actual impact. For example, many people recycle with the *intention* of tackling climate change, but the *impact* of this behaviour on cutting emissions is minimal. Conversely, avoiding driving is often done for reasons (*intentions*) of cost, convenience or health, rather than environmental concern – but in terms of environmental *impact* is very significant for cutting emissions (Ivanova et al., 2020; Whitmarsh, 2009). Within this thesis, both environmental intentions and impacts will be considered using both self-report and observational measures of behaviour.

---

[7] The Brecon Beacons National Park Authority and the collaborative nature of this research are discussed in further detail in Chapter Two.
[8] Sheep worrying includes dogs attacking (i.e., biting) or chasing livestock in such a way that will cause injury or suffering (Eat Farm Now, 2021).
[9] Wild camping is the act of camping on land that is not designated as a campsite. This usually takes place in "wild" areas such as National Parks and natural areas.

2.2.2   Antecedents of Environmental Behaviours

When investigating ESBs it is important to also understand their antecedents, factors that predict the performance of behaviours. This section briefly explores four of the most prominent antecedents that have been explored in relation to environmental behaviours. As this thesis has a focus on NPs, this section will also note the gaps in research around factors that play a role in ESBs in NPs, and nature-based contexts more broadly. As such, the factors under investigation have been selected as they have received considerable support within the ESB literature. Conversely, research investigating PEBs in nature-based contexts has not focused on these factors. Whilst other factors have been found to mediate environmental behaviours, this thesis will focus on four psychological factors: identity, place attachment, connectedness to nature and norms.

There are other factors that predict ESBs; structural factors (e.g., provision of facilities), fiscal measures (e.g., cost), convenience (e.g., proximity to an individual) have all been found to shape ESBs to a greater extent than these four psychological factors. However, these four factors have been selected due to their mediating effect on spillover; spillover effects will be explored later in this chapter and within this thesis more broadly too (Lacasse, 2016; Maki et al., 2019; Ramli & Naja, 2012; Truelove et al., 2014; Van der Werff et al., 2014b; Whitmarsh et al., 2018). Additionally, manipulating psychological factors is rapidly becoming a popular way to elicit behavioural changes, as they are more cost-effective and easier to manipulate than other factors such as structural changes (Behavioural Insights Team, 2011, 2019; Dolan & Galizzi, 2015; Leggett, 2014; Shogren, 2012; Trelohan, 2020).

Identity – the label people use to describe themselves – has been highlighted as a key driver of environmental behaviour, with many research projects and a recent meta-analysis from Udall et al. (2021), concluding that identity plays a significant role in environmental behaviours (Carfora et al., 2017; Geiger et al., 2019; Whitmarsh et al., 2017). Identity has also been explored in relation to how it may mediate place attachment (Balundè et al., 2019; Devine-Wright & Howes, 2010).

Place attachment is another factor which has been extensively researched within the field and is defined as a set of feelings that emotionally and/or spiritually bind a person to a place (Tumanan & Lansangan, 2012). Its definition has been adapted over the years, with Halpenny (2010) defining it as "a bond with a particular place and characterised as having functional (place dependence), cognitive (place identity) and affective (place affect) aspects." This is in contrast to the earlier works of Vaske and Kobrin (2001), who deemed functional place dependence as a

separate aspect. A recent meta-analysis from Daryanto and Song (2021) supports previous research which suggests place attachment has a role to play in ESBs (Daryanto & Song, 2021; Gifford & Nilsson, 2014; Halpenny, 2010; Hernández Bernardo et al., 2010; Ramkissoon et al., 2012; Ramli & Naja, 2012). Conducting research in NPs may provide insight into how place attachment mediates behaviours in nature-based contexts, which has not been explored before (Ramkissoon et al., 2012).

A focus on nature-based contexts provides an opportunity to explore a factor which has been explored extensively in research, connectedness to nature. Connectedness to nature is defined as 'how people identify themselves as connecting to the natural environment and the relationships they have with nature' (Restall & Conrad, 2015). Connectedness to nature has been found to predict PEBs, with multiple meta-analyses supporting these findings (All et al., 2018; Balundė et al., 2019; E. Gosling & Williams, 2010; Mayer & Frantz, 2004; Whitburn et al., 2020).

Norms have also been extensively researched in relation to ESBs, with meta-analyses supporting extensive research which has found that norms have an influence on environmental behaviours (Cialdini et al., 2006; Schultz et al., 2007; Wan et al., 2017). Personal norms, as defined by Schwartz (1977), are self-expectations that are based on internalised values. Personal norms reflect commitment with internalised values and are experienced as feelings of personal obligation to engage in a certain behaviour. Whilst personal norms are focused on the individual sense of moral obligation, social norms cover subjective assumptions about how individuals feel they should behave and how they actually behave, and have also been found to be reliable predictors of PEBs (Abrahamse & Steg, 2013). There is a clear relationship between social and personal norms, with social norms becoming personal norms through internalisation, so understanding the effects of both is important (Schwartz, 1977). Furthermore, social norms are one of the only factors explored within research into interventions in a NP or nature-based context (Cialdini et al., 2006).

It is important to note that there are other factors that mediate and influence ESBs, and several behaviour change theories have been applied to explain behaviour change; the value-belief norm (VBN) theory, theory of planned behaviour (TPB) and transtheoretical model (TTM) have all been used to explain and predict ESBs (Whitmarsh et al., 2021). Additional factors that have been found to mediate ESBs include structural factors (e.g., income, location), which have been found to have a greater influence on behaviour than psychological factors, and social influence (Nolan et al., 2008; Whitmarsh et al., 2017; Whittle et al., 2019).

2.2.2.1 Identity

As mentioned above, a recent meta-analysis from Udall et al. (2021) found that self-identity plays a role in mediating environmental behaviours. The researchers explored the results from 104 studies, from 86 articles, which investigated identity and its influence on environmental behaviours – concluding that self-identity and group-identity (e.g., being a member of an environmental organisation) have a moderate association with environmental behaviours. This follows numerous studies which have found a relationship between identity and PEBs. Research has found that environmental identity can predict environmental behaviour and policy preferences (Brick & Lai, 2018). The authors utilised self-report measures to measure PEBs, with their own meta-analysis of four pre-registered studies finding that identity does influence PEBs and policy preferences (Brick & Lai, 2018). This work is preceded by other research finding that self-identity plays a role in the performance pro-environmental actions (Cook et al., 2002; Nigbur et al., 2010; Lorraine Whitmarsh & O'Neill, 2010).

Environmental self-identity (i.e. whether you see yourself as someone who is the type of person whose actions are environmentally-friendly) has also been found to have a relationship with obligation-based intrinsic motivation and PEB (Van der Werff et al., 2013). This research notes that the reason self-identity may influence PEB is due to obligation-based intrinsic motivation, being motivated out of a sense of obligation related to approval from oneself or others. The researchers suggest that future research should test if campaigns focused on environmental self-identity that attempt to strengthen the obligation-based intrinsic motivation, are effective in promoting PEBs, in the short as well as in the long term (Van der Werff, Steg, & Keizer, 2013).

As this thesis is focusing on visitors to a nature-based context, it is also important to highlight that identity has been found to play a significant role in the adoption of ecotourism attitudes and beliefs (Teeroovengadum, 2019). Encouraging a stronger environmental identity may be useful to increase participation in ecotourism activities. In addition, research also suggests that visits to nature may directly change or shape an individual's environmental identity (Otto & Pensini, 2017). Following the suggestions from Van der Werff et al. (2013), this thesis offers the potential to explore how interventions and visits, may lead to changes in the environmental identity of visitors in NPs, as well as how these changes may influence ESBs (both in NPs and other contexts).

2.2.2.2 Place Attachment

A recent meta-analysis from Daryanto and Song (2021) supported previous research which suggests place attachment mediates environmental behaviours. Analysing 130 effect sizes from 38 studies, Daryanto and Song (2021) not only focused on place attachment's relationship with PEBs, but also the difference between tourists' and residents' place attachment. The researchers found that place attachment has a greater effect on PEBs for tourists in a tourist site, than for residents in their place of residence. These findings are counter-intuitive, as tourists are generally considered to be less environmentally friendly than residents (Becken, 2007; Miao & Wei, 2013). More research needs to be conducted to investigate these findings and look for any other potential variables that may influence this relationship. This is one goal of this thesis, which will be investigating visitors' environmental behaviours and attitudes within a National Park.

Of further significance to this thesis, place attachment has been found to predict environmental behaviours in nature-based locations, with possible spillover of behaviours into other contexts (Vaske & Kobrin, 2001). Vaske and Kobrin (2001) found that a higher place attachment for a natural setting, in this case a local nature reserve, led to greater PEBs in everyday (domestic) life. This mediating role is further supported by Walker and Ryan (2008) who found participants who had greater levels of place attachment to a local wetland site, were more supportive of conservation in general. More recent research has also found that place attachment mediated behavioural intention of visitors to a nature-based location, with greater place attachment leading to higher intention to perform PEBs in general (Tonge et al., 2015)

Previous research has also considered place attachment in a NP context. Halpenny (2010) found that place attachment for a Canadian NP mediated place-dependent PEBs, as well as the potential for spillover effects to behaviours outside of the NP context. Furthermore, findings from Jorgensen and Stedman (2001) found that residents in a lake district were more willing to engage in behaviours that maintained or enhanced value in the area, if they had a higher sense of attachment to the place. Despite this body of work, Ramkissoon, Weiler, and Smith (2013) argue that research in the area of place attachment in national park contexts is lacking and fragmented, and that more research is needed to examine the relationship between PEBs in a NP context on general PEBs.

This thesis explores the relationship between place attachment and environmental behaviours, and the potential for cross-contextual behaviour change between a home and NP context. Additionally, the place attachment of visitors and residents is examined.

2.2.2.3 Connectedness to Nature

When exploring ESBs within a nature-based context, a factor which should be considered is connectedness to nature. Not only can connections to a place lead to an increase in pro-environmental behaviour, so too can a connection to nature (Whitburn et al., 2020). Also known as "relatedness to nature" or "nature relatedness", nature connectedness is a connection to nature that includes emotions, experiences and understanding of the human connection to all living things (Nisbet & Zelenski, 2013). Research has often investigated connectedness to nature in relation to health and wellbeing, with a greater connection generally being positively correlated with increased health and wellbeing (Cecily Maller et al., 2006; Martin et al., 2020a; Richardson et al., 2016; Wyles et al., 2017).

Research has also found that connectedness to nature has a positive relationship with PEBs (Gosling & Williams, 2010; Hughes et al., 2018; Martin et al., 2020; Whitburn et al., 2020). One study, for example, found that individuals with a higher connection to nature were more likely to perform native vegetation protection behaviours compared to those with lower connectedness to nature (Gosling & Williams, 2010). Furthermore, researchers exploring connectedness to nature in children found that increased performance of environmental behaviours, after a nature-based education session, was mediated by connectedness to nature (Otto & Pensini, 2017).

Two meta-analyses have been conducted to investigate whether connection to nature promotes PEBs. The first, from Mackay and Schmitt (2019) found that whilst there was evidence of publication bias in favour of studies reporting positive effects, this was only for experimental studies and not correlational studies. Controlling for this, the researchers conclude that there is strong evidence to suggest a strong association between connection to nature and PEBs (Mackay & Schmitt, 2019). A second meta-analysis from Whitburn et al. (2020) reviewed 37 papers, finding that deeper connections to nature may explain why some individuals behave more pro-environmentally than others. The results suggest that fostering a strong connection to nature may result in greater engagement in PEBs.

Connectedness to nature is influenced by time spent in nature-based contexts. Research from Wheaton et al. (2016) found that visitors to a nature-based tourism site in the United States had an increased connectedness to nature post-visit, with this connection decreasing after three months. This suggests that the positive effects resulting from connectedness to nature may not last over time.

This thesis aims to build on these findings, by exploring whether connectedness to nature changes due to visits to nature-based contexts. Additionally, it explores whether any changes to nature connectedness mediate environmental behaviours in both a NP and/or a home context.

2.2.2.4 Personal & Social Norms

Norms have been found to be a key driver of behaviours, from student binge-drinking to energy-saving behaviours, and attendance to cancer screening sessions to kerbside recycling (Bergquist et al., 2017; Bergquist & Nilsson, 2016; Nigbur et al., 2010; Perkins et al., 2010; Steadman et al., 2002). Both personal and social norms have been found to play a role in PEBs too, with research finding that personal norms can impact self-reported PEBs (Harland et al., 1999; Lind et al., 2015; Ruepert et al., 2016). Additionally, social norms have also been found to impact PEBs; country-level norms influence the norms of family and friends and their PEBs (Culiberg & Elgaaied-Gambier, 2016).

A meta-analysis from Geiger et al. (2019) explored factors related to recycling behaviours, and found that personal and social norms are positively related to recycling behaviours. The meta-analysis looked at 89 studies, concluding that these factors are better able to predict intention to recycle than self-reported recycling behaviour. Further meta-analyses also highlight the importance of norms, both personal and social, and their influence on environmental behaviours (Bamberg & Möser, 2007; Klöckner, 2013).

Norm-based messaging has also been applied within a nature-based context, with results from a seminal study finding that normative messaging was the most effective messaging to reduce theft of petrified wood from the Petrified Forest NP in Arizona (Cialdini, Demaine, Sagarin, & Barrett, 2006). Social norms messages are used by practitioners in the field of tourism in, and visitor management of, nature-based tourist sites. This is, in part, due to the aforementioned study conducted by Cialdini et al. (2006), which gained widespread attention from practitioners.

Within the UK, practitioners are using norms within interventions, but research into their effectiveness is lacking (J. Lawrence, personal communications, May 2018). Campaigns focusing on social norms have been used to encourage friendly interactions on shared paths in the South Downs National Park, for example, but no reviews or assessments of their effectiveness have been conducted (Behaviour Change, 2016; South Downs National Park Authority, 2016). This thesis will

explore the effectiveness of behaviour change interventions that utilise norms and attempt to provide clearer insights for practitioners.

2.3   Behavioural Spillover

Section 2.2 outlined environmental behaviours, covering the antecedents of behaviour and touching on how these are used to inform behaviour change interventions. However, behaviours do not occur in isolation, and the following section will explore the theories and drivers behind the phenomena of behavioural spillover.

Behavioural spillover can be broadly defined as the effects from a target behaviour that lead to further behavioural response(s) in other, associated behaviour(s) (Poortinga et al., 2013; Thøgersen, 2004). Further definitions highlight the fact that to constitute spillover, the behaviours must be different, sequential, share a motive and involve a common link (Nash et al., 2017). The effectiveness of behaviour change interventions is not only measured on whether the target behaviour occurs due to the intervention; there is growing interest in whether behavioural spillover occurs due to interventions too (Truelove et al., 2014).

The phenomenon was originally seen outside of environmental psychology, being identified in economics, but has now been studied in other fields and other areas, such as health and prosocial behaviours (Truelove et al., 2014). Spillover has also been recognised in consumer psychology, with researchers suggesting that far-reaching effects beyond the target behaviour of a 'prime' materialise as spillover (Meyers-Levy & Zhu, 2007). Spillover effects are bidirectional, with positive and negative spillover effects being explored in the literature. Positive behavioural spillover is when an *increase* in one positive behaviour leads to an *increase* in another positive behaviour (Nash et al., 2017). Conversely, negative spillover is when an *increase* in a positive behaviour leads to a *decrease* in a different positive behaviour or an *increase* in a negative behaviour (Truelove et al., 2014).

Spillover theory focuses on the interrelationships between behaviours and an identification of the catalysts that lead to extensive behaviour change (Nash et al., 2017). Within environmental psychology research, spillover has become a phenomenon of particular interest, due to its potential catalysing effects. Researchers have highlighted the importance of understanding the impact that interventions can have on broader societal behaviour change, through spillover, both towards or

away from sustainability (Wonneck & Hobson, 2017). Whilst behavioural spillover generally arises from deliberate and targeted interventions, spillover also has the potential to occur due to changes in awareness, policy changes and technological advances (Nash et al., 2017).

Both positive and negative spillover effects have been investigated in literature, with mixed and conflicted results (Truelove et al., 2014). There are also distinct divisions within the literature, with research tending to focus on one kind of spillover and specific mechanisms and theories. Research has tended to describe positive and negative spillover as separate phenomena, and it is unclear which type of spillover occurs more or less frequently (Nash et al., 2017).

Positive and negative spillover are often regarded in the literature as separate, and with different underlying mechanisms. However, Truelove et al (2014) suggest that more needs to be done to explore the net effects of interventions, so that interventions are not evaluated entirely on the occurrence of one type of spillover or the other, but rather consider both. Due to the nature of the current literature surrounding spillover, it is important to discuss both positive and negative spillover separately, before discussing the factors that mediate them both.

2.3.1   Positive Spillover

Research shows that environmental behaviours often occur in parallel (Barr et al., 2010; Thøgersen, 1999). Environmental behaviours often correlate in distinct clusters, for example, 'waste and recycling', 'transport' and 'purchasing behaviours' (Barr et al., 2005; Lynn, 2014). Behaviours are more consistent within these clusters, which suggests spillover may be more likely to occur within similar domains or contexts than between them (Thøgersen, 2004). Research into spillover in Danish consumers used loyalty card data to monitor consumers' organic product purchase history over 20 months. The researchers found a consistent increase in purchases across a range of organic food products from initial purchases of organic dairy products, demonstrating positive behavioural spillover (Juhl et al., 2017).

Outside of private and direct impact behaviours, research has found that positive spillover can also occur in public-sphere behaviours too, in the form of policy support (Thøgersen & Noblet, 2012a; Willis & Schor, 2012). Poortinga et al. (2013) found that after the implementation of a single-use plastic carrier bag charge for consumers in Wales, support for environmental policies significantly increased. Other research has also shown the extent to which positive spillover can

occur across behavioural clusters. The introduction of a vehicle congestion charging policy, for example, led to positive spillover not only within transport behaviours but also in resource and energy use behaviours (Kaida & Kaida, 2015).

Behavioural similarity may explain this positive spillover, to an extent. Research has found that people tend to group behaviours based on how similar they are (Gabe-Thomas et al., 2016; Littleford et al., 2014; Thøgersen, 2004). Thus, the chance of positive spillover increases as the similarity between behaviours increases (Margetts & Kashima, 2017; Thøgersen & Noblet, 2012b; Truelove et al., 2016)

Tying closely with similarity, consistency has also been suggested as one explanation as to why positive spillover occurs (Thøgersen, 2012). According to cognitive dissonance theory, individuals need to behave consistently and appear consistent to others (Bem, 1967; Cialdini, Trost, & Newsom, 1995). Cognitive dissonance is the state of having inconsistent thoughts or feelings. The theory suggests that individuals want to reduce this cognitive dissonance as much as possible (Festinger & Carlsmith, 1959). Researchers suggest this theory may help explain why individuals often avoid information about environmental problems, as they contradict or threaten our basic assumptions of quality of life and material needs (Kollmuss & Agyeman, 2002).

In addition to cognitive dissonance, Ramli and Naja (2011, 2012) further suggested that positive spillover is also driven by social identity. This ties into Thøgersen's (2012) work, which suggests that the impact and role of consistency on spillover could also be explained by identity, which he discusses in relation to self-perception theory. It has been suggested that self-perceptions change with behaviour, so the performance of one environmental behaviour may lead to an individual adopting more PEBs to act in accordance with their own self-perception or identity (Cook et al., 2002). As discussed earlier, identity has been found to be a significant predictor of PEBs, with researchers finding that an increased environmental identity can lead to increased PEBs.

In terms of behaviour change, whilst Poortinga et al. (2013) found an increase in environmental identity individuals as a result of those individuals taking their own bags to the supermarket, the researchers did not find any positive *behavioural* spillover. The researchers deemed that the extrinsic nature of the carrier bag charge meant spillover did not occur. However, extending exposure to a similar intervention led to increased environmental identities and also behavioural spillover in Kaida and Kaida's (2015) study. This suggests that whilst environmental

identities may change relatively quickly due to an intervention, the change in behaviour and subsequent positive spillover associated with this change may take longer to manifest.

Research has also found that cueing an enhanced sense of pro-environmental identity can lead to an increase in *intention* to perform PEBs (Cornelissen et al., 2008). This research, like others, measured behaviours for only a short duration of time post-intervention. The findings from Kaida and Kaida's (2015) study suggest that positive spillover may take longer to manifest in some instances if the spillover is due to identity shifts.

2.3.2   Negative Spillover

Negative spillover (or "spillunder") is essentially the antithesis of positive spillover; performing one PEB can make the performance of other PEBs less likely (or EDBs more likely). In comparison to positive spillover, less research that has been conducted to directly test for negative spillover (Truelove et al., 2014). However, there are a growing number of studies that have found negative spillover and offer explanations for this contrasting phenomenon. Research from a randomised-control trial from McCoy and Lyons (2017) for example, found that whilst overall energy consumption reduced in households where smart meters had been fitted, compared to control, there was also a significant reduction in investment in energy efficiency measures within the households. This unintended outcome is negative behavioural spillover.

Negative spillover effects may occur when one behaviour is deemed to be compensatory for another. Research from Catlin and Wang (2013) found that consumption of paper increased when a recycling bin was presented alongside a standard waste bin, compared to only a waste bin. This compensatory behaviour idea is closely tied to the idea of moral licensing. Moral licensing is essentially when an individual uses a good act to cover up a bad act or, vice versa, when an individual performs a bad act after performing a good act (Khalil & Feltovich, 2018). For example, people are more likely to cheat and steal after purchasing eco-friendly products (Mazar & Zhong, 2010). Moral licensing has been discussed in detail as one explanation as to why negative spillover occurs – a person justifies their EDB because they had previously, or are going to, perform a PEB (Khalil & Feltovich, 2018; Sörqvist & Langeborg, 2019; Truelove et al., 2016). Moral licensing, alongside rebound effects and contribution ethic, have been explored within the literature as key

mechanisms for negative spillover. However, it is beyond the scope of this thesis to explore negative spillover in detail.

2.3.3   Cross-context Behavioural Spillover

Whilst positive behavioural spillover has generally been investigated within one context, research has also found that spillover can manifest not only across behaviours, but across contexts too. Cross-context spillover occurs when a behaviour spreads from context A to context B. Studies have shown that behaviours can be consistent between home and work, for example (Tudor, Barr & Gilg, 2007). Tudor et al. (2007) found that behavioural spillover occurred between the home and work, with employees who practised recycling at home being more likely to practise similar behaviours at work. This spillover was mediated by the underlying attitudes and beliefs of the staff towards the environment and, generally, those with "pro-environmental views" were more likely to exhibit spillover. Further research on spillover has looked at energy use behaviours between home and work settings. Littleford, Ryley, and Firth (2014) found that spillover did not occur across settings, but that there was a weak relationship across settings between behaviours that shared characteristics (such as equipment used). Previously mentioned work from Ramli and Naja (2011, 2012) focused on contextual spillover, proposing that positive contextual spillover is driven by identity and cognitive dissonance. They suggest that identity is involved in adjusting attitudes in line with the behaviour in context A, and cognitive dissonance is involved in acting consequently in context B (Ramli & Naja, 2011, 2012).

Contextual spillover has also been found in recycling behaviours from workplace to home, in Malaysian, Taiwanese, UK and Swedish samples (Andersson et al., 2012; Lee et al., 1995; Nik Ramli & Wahid, 2012; Ramli & Naja, 2011; Tudor et al., 2007). The studies all utilised similar methods to research from Andersson et al. (2012). The researchers used self-report measures to investigate whether recycling behaviours at work spilled over to a home context, finding that the implementation of a new recycling scheme at work involving separating recycling properly led to changes in recycling behaviours at home too (Andersson et al., 2012).

Whilst cross-context spillover between home and work has been explored, research into spillover across other contexts has also been carried out. For example, research into behavioural consistency has found that behaviours from home may not transfer to a holiday context. Barr,

Shaw, Coles and Prillwitz (2010) found that individuals reduce their PEBs on holiday, justifying this through moral licensing, because they are environmentally conscious at home. Other research supports the notion that the environment is not considered in a holiday context (Becken, 2007; Hares et al., 2010).

Additional research from Whitmarsh et al. (2018) further investigated cross-contextual spillover, across home, workplace and holiday contexts. The researchers found that individual (e.g., pro-environmental identity) and contextual factors (e.g., facilities) are mediators of PEBs across contexts, although the importance of these factors changes depending on the context. The researchers suggest this may be due to the different context-specific requirements, skills and equipment (e.g., recycling is easy to do in many places as it requires only a receptacle, but there may be more variability for a more complex behaviour like energy usage which requires access to a thermostat or heating controls) (Whitmarsh et al., 2018). Other individual factors like environmental attachment have also been found to have moderating effects on spillover of PEBs from home to tourist contexts (Xu et al., 2020).

Nilsson, Bergquist and Schultz (2016) suggest that this disparity between home and holiday contexts may not be showing negative spillover effects but in fact may reflect the fact that certain contexts decrease PEBs in general. In a meta-analysis of licensing effects, Blanken van de Ven and Zeelenberg (2015) found that context was not a moderator of spillover and did not moderate the effects of licensing. However, the blatancy[10] vs. ambiguity[11] of behaviour, which has been proposed as a moderator for cross-context behaviour change too, was not tested in the meta-analysis (Effron & Monin, 2010). In their review Nilsson, Bergquist and Schultz (2016) highlight that research investigating the potential for promoting spillover in public settings has also been neglected, with research generally exploring work to home contexts. Furthermore, Ramkissoon, Weiler and Smith (2012) argue that more research needs to be conducted to investigate the potential for behavioural spillover between nature-based contexts, such as NPs, and more general contexts, such as the home, as literature exploring spillover within nature-based contexts and between nature-based contexts and other contexts is lacking.

Despite this lack of research investigating behavioural spillover between home and nature-based or tourism contexts, there is a considerable literature on sustainable tourism (Barr, Shaw,

---

[10]A blatant behaviour would be a behaviour that clearly represents a moral violation.
[11]An ambiguous behaviour would be a behaviour that could, but need not, represent a moral violation.

Coles and Prillwitz, 2010). In fact, the field of responsible tourism has made great attempts to monitor the impact of tourists and their behaviours on the natural world for some time. Prominent research from Herman (1992) highlighted in the early 90s the exploitation of NPs in the US through tourism and development, for example. Herman (1992) argued that "overuse threatens both the natural and social environments of the parks." Indeed, here in the UK, work has attempted to investigate the impact of tourism across UK NPs, and has highlighted common issues: littering, path erosion and widening, disruption to wildlife and negative reactions from host communities (Brecon Beacons National Park Authority, 2014, 2017, 2021a; Pratt-Heaton, 1999; T. A. Smith & Dunkley, 2018; UNEP-WTO, 2005). However, very few studies have investigated the behaviour change aspect of environmental behaviours within NPs (Jurowski, Uysal, & Williams, 1997; National Parks, 2016). Whilst the work of NP management teams and researchers is varied, there is great potential for the negative impact of tourism to be better understood and possibly decreased, if a more thorough understanding of the links between home and nature-based contexts is achieved. In their review of place attachment and its influence on pro-environmental behaviour, Ramkissoon, Weiler and Smith (2011) discuss the need for research to be conducted in nature-based contexts, specifically NPs, to investigate the spillover effects of general contexts (e.g., a home context). However, over a decade later, the research is still lacking.

Previous work that has collected data in nature-based contexts did so incidentally, rather than to investigate nature-based contexts. Indeed, research that has coincidentally used nature-based contexts as the focus of research has classed them as holiday contexts. For example the work from Xu et al. (2020) collected data in a nature-reserve, forest park and scenic area. However, data was also collected in a holiday resort and at a cultural attraction, and these were all analysed as one 'tourism/holiday' context. Intervention work from Cialdini, Demaine, Sagarin and Barrett (2006) did look at behaviour change within a nature-based context but did not look at anything other than impact onsite, with no investigation into any cross-context behaviour change. This further highlights the need for research explicitly investigating the cross-context behaviour change between nature-based and home contexts.

The research mentioned above covers a variety of contexts: home, work and holiday. However, little research has looked at spillover between these contexts and transient contexts (i.e., during travel, commuting etc) or nature-based contexts (i.e., NPs, nature reserves etc). Nature-based contexts can be defined as: any contexts when a person is in a natural or modified-natural

(e.g., farmland) ecosystem (Ramkissoon et al., 2012). Ramkissoon et al. (2012) highlight the necessity to explore the relationship between behaviours in a nature-based context (and specifically, within NPs) and a home context. The authors propose "visitors' pro-environmental behavioural intention in NPs positively influences their general pro-environmental behavioural intention" (Ramkissoon et al., 2012, p. 22).

The review from Ardoin et al. (2015), whilst not explicitly mentioning spillover, did mention the fact that some studies looked at behaviours beyond a nature-based tourism context. For example, research found that visitors who went on a whale-watching trip said that they intended to pick up litter that was harmful to wildlife when they returned home. However, the researchers did not compare these results with control, so no inferences can be made (Stamation et al., 2008). More in-depth work from Hughes, Packer and Ballantyne (2011) did investigate post-visit behaviours at Mon Repos Turtle Rookery, an educational centre focused on teaching people about turtles. The researchers found that environmental behaviours at home increased, however this research used post-visit educational messages as an intervention, which means that spillover is not measurable, as the intervention took place in a home context, post-visit (Hughes et al., 2011). This is mirrored in many studies, with none truly investigating spillover effects between home and nature-based contexts or the spillover effects of interventions in a nature-based context either.

2.3.4   Factors Mediating Spillover

Understanding the factors that contribute to spillover is essential to develop interventions that have lasting, effective and far-reaching impact. Many of the factors that mediate behaviour change also mediate spillover. This section will briefly outline some studies that have focused on behavioural spillover mediators, focusing on framing, identity, knowledge, and awareness.

2.3.4.1   Value framing

Framing of pro-environmental messages has been found to affect positive spillover across behaviours. Evans et al. (2013) found that when reading about self-transcendent reasons for car-sharing, individuals were more likely to recycle than those who read self-interest framed messages. Other framing studies have found that environmental framing was more associated with pro-environmental intentions than monetary framing (Steinhorst & Matthies, 2016). Researchers also found that when completing a recycling task under a normative goal-frame, individuals were more

likely to report higher feelings of obligations towards energy conservation and pro-environmental policy acceptance, compared to those who conducted the task under a gain frame (Steinhorst et al., 2015).

There is a distinct lack of work that has investigated the impact of framing on spillover (Hamann & Reese, 2020). Conversely, there is a significant amount of work that highlights how important message framing is for conservation (Ham & Hughes, 2010; Kidd et al., 2019; Kusmanoff et al., 2020). Building on this research, this thesis will explore the potential influences that framing may have on behavioural spillover.

2.3.4.2 Knowledge & Awareness

Environmental knowledge can be defined as a general knowledge of facts, concepts, and relationships concerning the natural environment and its major ecosystems (Fryxell & Lo, 2015). In order to change behaviour, one of the most common tactics is to increase environmental knowledge through information provision, as giving people information about environmental problems helps them tackle the problems better (Abrahamse & Matthies, 2012). This necessity for knowledge has been shown in various studies that have highlighted that an increased knowledge leads to increased likelihood to partake in environmental behaviours (Chan, 1998; Mostafa, 2007; Perron et al., 2006). This is reflected in research that found that consumers with an existing knowledge of ecological product labels, were more likely to purchase new ecologically-labelled brands (Thøgersen et al., 2010). Interventions themselves are not the only way to improve individuals' knowledge; research has found that the act of engaging in PEBs itself may improve people's knowledge and expertise, and assist with awareness of other behaviours too (Thøgersen, 1999). Consequently, this thesis will investigate the impact that knowledge and awareness may have on spillover, through the testing of interventions that provide information.

2.3.4.3 Identity

As discussed in section 2.2.2.1, identity has been found to predict general environmental behaviours, but it has also been found to mediate spillover. In one study for example, an increase in pro-environmental identity from engaging in recycling behaviours at work led to positive spillover in the form of increased recycling at home (Andersson et al., 2012). Other research has discussed the idea that performing an environmental action leads to individuals identifying themselves as 'green' and this increases the likelihood they will engage in more PEBs (Whitmarsh & O'Neill, 2010). This is

supported through cueing studies, in which individuals who were cued with an increased sense of green identity increased intentions to behave environmentally (Cornelissen et al., 2008; Van der Werff et al., 2014b, 2014a).

Work from Verfuerth, Jones, Gregory-Smith and Oates (2019) found that cross-context spillover was mediated by identity. Specifically, the research found that identity threat is a limiter of positive contextual spillover. The researchers developed a new menu system for a workplace, with a reduction in meat-based food options of 70%. Participants felt that the intervention, with its sustainable food choices and messaging, threatened their self-image. This highlights the need for interventions to align more with broad identities to minimise the chance of threats to identity (Verfuerth et al., 2019).

2.4 Behaviour Change Interventions & Frameworks

Behaviour change interventions can be defined as "coordinated sets of activities designed to change specified behaviour patterns" (Michie et al., 2011). Recently, governments have identified the necessity to combat anthropogenic climate change and are paying particular interest in behaviour change interventions for the good of the environment (Abrahamse et al., 2005; Behavioural Insights Team, 2019; Dietz et al., 2009; Steinhorst & Matthies, 2016; United Nations Framework Convention on Climate Change, 2018; Behavioural Insights Team, 2019). Behaviour change is essential in order to tackle anthropogenic climate change, but research has also highlighted the necessity for behaviour change interventions at the societal level in health, environment, education and other areas (Barr, Coles & Shaw, 2008; Halkiopoulos, 2018; Hume et al., 2018; Michie, Fixsen, Grimshaw, & Eccles, 2009). This section will further discuss behaviour change interventions and theories, reviewing literature across a variety of disciplines and fields.

Within the literature regarding environmental behaviours, there has been a focus on investigating behaviours within a home context, which aligns with the fact that household emissions are the highest contributor to greenhouse gases emissions within the UK (Office for National Statistics, 2018). However, as this thesis will be exploring contextual behaviour change, this section will also discuss research conducted in workplace, holiday, and nature-based contexts.

There is much debate around the best framework for behaviour change, and there are many ways to classify interventions (Michie et al., 2011). Binary frameworks offer two clear, broad intervention classifications. The upstream and downstream framework, for example, states that interventions can be used to persuade the individual to adopt recommended behaviours ('downstream') or to establish changes in the structural determinants of behaviour ('upstream') (Khajeh et al., 2015). Similarly, Steg and Vlek (2009) argue that interventions can be classed as either informational strategies (e.g., information, persuasion, social support and role models, public participation) or structural strategies (e.g., availability of products and services, legal regulation, financial strategies). This binary approach is not unique. Geller et al. (2016) argue that behavioural interventions can be categorised into two main classes: activator and consequence interventions. Activator interventions include information, prompts, goal setting, modelling and behavioural commitment, whilst consequence strategies include rewards and feedback (Geller et al., 2016).

Other frameworks exist that utilise more in-depth classification methods. A systematic review of behaviour change frameworks was conducted by Michie et al. (2011), in an attempt to create a unifying and singular framework. The authors developed 'the behaviour change wheel' (BCW), which includes nine intervention classifications (modelling, enablement, training, coercion, incentivisation, persuasion, education, restrictions and, environmental restructuring). As well as seven policy classifications that encapsulate these (guidelines, environmental/social planning, communication/marketing, legislation, service provision, regulation and, fiscal measures). The behaviour change wheel has been utilised to create successful interventions primarily for health (Michie et al., 2011; Michie et al., 2014).

Within this thesis the categories suggested by Steg and Vlek (2009) will be used as the framework for intervention development. These classifications – information strategies and structural strategies – are simple and are also easy to explain to practitioners. Interventions developed within this research are not going to be developed in isolation by academics, so providing clear and accessible classifications is essential to ensure that practitioners are able to understand concepts quickly. The BCW, whilst priding itself on being synthesised from 19 different behaviour change frameworks, requires the use of a book to understand how to use it (Michie et al., 2014). Whilst undoubtedly a thorough and well-informed framework, the BCW is arguably too complex to be easily used by non-specialists. Moreover, some intervention categories in the BCW framework are less relevant to NP authorities than to other actors, such as governments (e.g.,

regulation, fiscal measures). NP authorities, within the UK, are restricted as to where and when they can charge visitors. Whilst it would be possible to implement some fiscal measures within specific locations (e.g., at visitor centres), it is not possible to implement these measures to all visitors to a NP.

The following section will explore one of the categories from Steg and Vlek's (2009) work, information strategies. The section will discuss the specific techniques that fall into this category and studies that showcase the use of informational interventions for environmental behaviour change in home and nature-based contexts. This thesis will predominantly focus on information strategies, rather than structural strategies. This focus is due to the financial costs associated with structural changes. Structural changes require large-scale planning (e.g., shutting off roads for motorised traffic) and larger costs than information strategies (e.g., providing bins). Whilst these strategies may be effective, the implementation of them would require more time and budget than this doctoral research would allow.

Following information strategies, persuasive technology and social media are discussed. These are emerging tools in behaviour change, and whilst they include practical implementation of information strategies, persuasive technology and social media can be defined as a category on their own (Steg et al., 2013, p.244 - 254). Persuasive technology is a 'step-up' from traditional modes of information provision, traversing barriers faced by traditional routes like billboards, leaflets and TV campaigns by offering numerous advantages over them. Persuasive technology and social media offer the ability to: adapt interventions based on current affairs and individual preferences, scale interventions up for widescale distribution (i.e., national campaigns) or down for individuals (i.e., personalised wearables) and also offer the potential for ambient persuasion, where individuals are not consciously attending to an intervention (Creaser et al., 2021; Düking et al., 2020; Ham et al., 2009; Kort et al., 2008). Persuasive technology comes in various forms, and this section will discuss one of the more recent tools to be utilised for behaviour change, virtual reality. Virtual reality offers the chance for immersion in hypothetical environments and real-world locations, using the latest in video, 3D images and immersive displays, and has been found to be an effective tool for behaviour change (C. Ferguson et al., 2015; M. Slater et al., 2013; Taufik et al., 2021; Vankov Id et al., 2021; Zaalberg & Midden, 2013; Zimmermann et al., 2021). The final section discusses combined intervention approaches, highlighting the need for further research that

explores interventions in isolation and the merits of combining behavioural interventions for behaviour change.

2.4.1 Information Strategies

Information strategies aim to change knowledge, attitudes, and norms. Interventions of this type include techniques such as provision of information, feedback, goal setting and commitment (Steg & Vlek, 2009). This section will outline the research looking into the most common information strategies explored in literature: information provision and norms.

2.4.1.1 Provision of Information

Two different types of information can be provided: information about environmental issues (issue information) and information about how individuals can tackle environmental issues (procedural information). Information provision is based on the knowledge-deficit model, working on the assumption that individuals do not know about an environmental problem or that if they do, they do not know what to do about it (Schultz, 2002). Research has found that participants who were provided with information in the form of guidelines for purchasing climate-friendly foods (e.g., locally grown vegetables vs. imported vegetables), made more pro-environmental choices compared to those participants in a control condition (Schmidt, 2021).

However, research suggests that information provision alone is not the best intervention (Jepson et al., 2010; Whitmarsh et al., 2021). Information provision may actually be less effective than other types of interventions, and may only raise awareness rather than change behaviours (Abrahamse & Matthies, 2012; Staats et al., 1996). Staats, Wit and Midden (1996) studied the impact of a mass-media campaign aiming to increase public awareness about the greenhouse effect. The campaign used both kinds of information provision, informing people about the greenhouse effect, its consequences, as well as potential ways to combat the problems associated with it. The media campaign was distributed on billboards, TV adverts and national newspapers and outlined what you could do as an individual, rather than what collective efforts could be made. The researchers found that whilst awareness and knowledge increased after the campaign, it did not have an impact on behaviour. The research also found that individuals were concerned about the behaviours of other parties, as they believed that their individual behaviours were irrelevant if others were not changing their behaviours too. This work supports the previously mentioned

theory that social norms play a role in behaviour, and further research has been conducted to investigate how norms can be used in information interventions. Additionally, the work highlights the need for combined approaches, which is covered later in this chapter.

2.4.1.2   Norms

As the aforementioned research from Staats et al. (1996) highlights, individuals' behaviours are influenced by their beliefs about others' behaviour, or social norms. There are two main types of social norms that are explored within the literature, injunctive norms and descriptive norms. The former is the perception of which behaviours are typically approved or disapproved, whilst the latter are the perceptions of which behaviours are typically performed (Cialdini, 2003). These are different to personal norms, which are rules or standards for one's own behaviour, which have also been found to influence behaviour (Nigbur et al., 2010).

Research has found that social norms can be used effectively in behavioural interventions. Perkins, Linkenbach, Lewis and Neighbors (2010) found that providing normative information can lead to a reduction in drink driving, for example. The same kind of influence can be seen on PEBs too (Silvi & Padilla, 2021). Research from Schultz, Nolan, Cialdini, Goldstein, and Griskevicius (2007) found that individuals who learned most of their neighbours were performing energy conservation behaviours, subsequently used less energy themselves. Jachimowicz, Hauser, O'Brien, Sherman and Galinsky (2018) also found that normative beliefs predicted energy conservation. The researchers analysed the results from 211 randomised control trials in the USA, that revealed energy usage for households across 27 states, and combined these with results from a survey conducted on individuals in those states that focused on personal and normative beliefs. The authors conclude that normative beliefs play a critical role in promoting energy conservation (Jachimowicz et al., 2018). Additionally, interventions that utilise social norms messages have also been found to be effective at changing behaviours (as noted earlier, e.g., in the Petrified Forest NP study; Cialdini et al., 2006) – with research finding that whilst norms may increase performance of PEBs they may also increase feelings of guilt (Trelohan, 2020).

2.4.2   Persuasive Technology & Social Media

The use of technology to convey persuasive messaging is commonplace; billboards, TV advertisements and, more recently, social media, are all used as platforms for companies to

persuade individuals to purchase their service or goods. Consumerism aside, there is emerging research that shows the potential for persuasive technology to be used within behaviour change. For example, research has found that social media can be utilised to encourage PEBs within nature-based tourism; researchers suggest using social media as a management tool, to promote PEBs, control visitor numbers to sites, and better understand visitors' nature-based tourism experiences (Tenkanen et al., 2017; Walden-Schreiner et al., 2018; Wheaton et al., 2016). Research from Tenkanen et al. (2017) investigated social media data and how it correlates to visitor numbers, finding that increased posts to social media about natural sites was followed by increased visitor numbers to those sites. The researchers suggest these findings and information could be used to help inform management plans, by understanding audiences and providing tailored information to them.

Further research also found that increasing popularity of a location on social media (i.e. an increase in photos of a site being posted with information about the location) often leads to an increase in visitation (Donahue et al., 2018; Hausmann et al., 2018; Simmonds et al., 2018b). This increase in visitors can be highly damaging at a local level, with natural sites such as the Borrego Springs 'super bloom', and the 'fire falls' in Yosemite NP experiencing unprecedented attention and damage due to increased visitation (Gammon, 2019, 2020; Pollack, 2019). Social media, for some, is perceived as one of the key drivers for over-tourism and organisations such as Leave No Trace, are starting to develop guidelines for visitors to combat the issue, like avoiding the use of Geotags (information that shows other social media users the location a photo was taken) on photos posted to social media (Leave No Trace, 2018).

Technological advancements and increased media coverage of the environment have also led to innovative and unexpected behaviour change too. Wildlife programs like Blue Planet, have led to a dramatic shift in public opinion, with plastic straws becoming unpopular with the public. This change, dubbed 'The Blue Planet Effect', showcases that behaviours and attitudes can be changed by mainstream media (Gell, 2019). Moreover, research has found virtual interactions with nature can lead to changes in wellbeing as well as behaviour (BBC, 2020a, 2020b; Gordon, 2020; Yeo et al., 2020).

2.4.2.1   Virtual Reality

Virtual reality (VR) is an environment which is presented through an electronic device and creates a sense of immersion and presence. It is rapidly being accepted as a new media form and

recognised by the mainstream media industry (Felix & Paul Studios, 2019; Scatter, 2017). VR is also being embraced outside of media and has been used across a variety of sectors and fields for various tasks, such as training, therapy, education, and behaviour change (Chang, 2016; Herbelin et al., 2002; Huygelier et al., 2019; Tanja-Dijkstra et al., 2018). In general, VR is experienced with VR headsets, which allow users to immerse themselves in an environment with full 360-degree video and audio. Additionally, VR often allows for movement within environments and interaction using controllers. VR can involve immersion in computer generated landscapes and settings, but VR headsets also offer users the chance to experience real-world locations and settings, with the use of 360° videos and photos. Steure's review (1993) attempted to provide a definition for virtual reality, but the multiple definitions used in recent research have made the field confused and complicated (Kardong-Edgren et al., 2019). This research will use an adaptation of the definition from the Healthcare Simulation Dictionary, which is one of the most recent and developed definitions (Kardong-Edgren et al., 2019; Lopreiato et al., 2021). Within this thesis VR is defined as any simulated environment, either computer generated or real-world (e.g., video/photos), that is presented within a virtual reality headset, which allows for full 360° or 180° viewing.

VR's adoption as a commonplace research tool and consumer product has been discussed extensively within literature. Researchers 20 years ago, when VR was very much in its infancy, discussed the potential impact that VR nature would have on our valuing of nature and the preservation of nature (Levi & Kocher, 1999). The authors looked at the extent to which VR nature would influence an individual's perceptions of the natural world. Interestingly the researchers concluded that "widespread use of virtual nature could reduce support for the preservation of local natural environments, and these environments play a key role in the global ecology" (Levi & Kocher, 1999, p. 9). However, this negative prediction is at odds with the contemporary perspectives on virtual nature, which see the potential for it as a force for good (Gordon, 2020; Scates et al., 2020).

The use of visual stimuli as a behaviour change method is not a novel idea. Early studies, conducted before the rise of VR, found that visualisations of nature could have a positive impact on behaviour and attention (ref). Photo-realistic rendered landscapes and photos were found to be more effective at engaging participants in discussions around climate change and energy systems than charts/graphs and non-photo-realistic images (Sheppard, 2005). The author also suggests that local landscapes are more effective at eliciting positive affective responses than unfamiliar

landscapes. Research into the effectiveness of VR as a research tool is expanding, with researchers finding that immersive virtual natural environments, for example, can be useful as a tool for restoration (Yu et al., 2018). Crossan and Salmoni (2019) found that simulated walks in nature, involving a large 180° display, increased the attention of individuals compared to the same participants in a control condition. Additionally, large projects like "Virtual Nature", which aims to investigate the effectiveness of VR in boosting wellbeing, have started a new direction in VR research within environmental psychology (Virtual Nature, 2018).

Despite recent advancements in the technology and uptake within research, VR as a tool for behaviour change is still a relatively new area. VR has been found to be effective as a behaviour change tool, with researchers studying the effect of "embodiment" tasks within immersive virtual environment (IVE) (Ahn et al., 2016; Platoni, 2015). IVEs are defined by these authors as "digitally rendered spaces offering sensory-rich simulations that allow users to experience mediated events in the virtual world as they might in the physical world, to enhance feelings of interconnectedness and involvement with nature" (Ahn et al., 2016, p. 400). In one study, participants crawled around on all fours and "acted" as a cow within an IVE, where they could see a reflection of a cow avatar that represented them. They experienced this for a few minutes and before being told that they are being sent to a slaughterhouse and were told to wait in a field whilst the sound of a truck engine grew closer and the floor began to shake, the IVE ended at this point. Those participants that took part in the IVE showed greater interconnection between the self and nature compared to those who had just watched a video. VR led to greater perceptions of environmental risk and involvement with nature, which persisted for one week (Ahn et al., 2016).

A further study that utilised IVEs and VR found that PEBs could also be influenced. The researchers compared the impact on paper conservation behaviours of experiencing either an IVE in which participants cut down a virtual tree, a video depicting the tree-cutting process and, a print description of the tree-cutting process. After being exposed to one of the three conditions, participants were then asked to clean up a spilled cup of water, and the number of paper napkins they used was an indicator of pro-environmental behaviour. The researchers found that those in the VR condition used significantly less paper to wipe up the spilled water (Ahn, Bailenson, & Park, 2014).

Whilst these studies utilise VR and IVEs, the focus is on the impacts of embodiment and interacting with the environment in the virtual world. However, when using 360° video within VR,

interaction is limited, and the immersion comes from being in a "real" landscape rather than a computer generated one. Use of 360° video and VR provides a potentially beneficial and novel methodology.

Traditional studies investigating visitor behaviour and cross-context behaviour rely on field-studies and visitor surveys. This leads to methodological constraints; the seasonality of visitors to sites and the time-intensive nature of in-person field surveys. Developing methods that utilise VR nature within a lab study could combat these constraints, whilst also offering the potential to test interventions that are in-situ in VR nature experiences. This thesis will investigate the potential for VR as a behaviour change tool, with a laboratory study outlined in Chapter Five offering some insight into its potential.

2.4.3   Combined Approaches

Whilst various individual strategies have been investigated, the conclusion of many studies is that interventions that include multiple strategies (including informational and structural) tend to be most effective (Watson et al., 2021). In a review, Abrahamse, Steg, Vlek and Rothengatter (2005) looked at interventions aimed at household energy conservation, focusing on papers that investigated behaviour change over time and underlying behavioural determinants. The review concluded that a combination of interventions is often the best way to change behaviour, a conclusion which has been established in a number of intervention studies and reviews (Lanzini & Thøgersen, 2014; Steg & Vlek, 2009). On the other hand, there are studies which find combining interventions do not necessarily provide additive effects: Bamberg (2002) compared monetary incentives with implementation intentions (creating a personal goal to perform a behaviour) to encourage the purchasing of organic food and found no additional benefit when the two intervention types were combined. Moreover, Abrahamse et al. (2005) highlight that many intervention studies do not test interventions in isolation, meaning that it is difficult to establish if a combination is additionally beneficial over and above the interventions separately. This is an important issue, as a combination of interventions may well be more costly and time-consuming to implement. This suggests that any interventions should be tested in isolation, as well as in combination, to provide more insight on their effectiveness. Consequently, the work in this thesis

will investigate, wherever possible and applicable, interventions in isolation before testing a combination.

2.5   Overview of Behaviour Change

Chapter Two has highlighted three notable gaps in research: research into environmental behaviour change in natural tourist contexts (e.g., NPs); contextual spillover across home and nature-based contexts; and the application of novel behaviour change tools (e.g., VR) to promote PEBs. Extensive work has uncovered the influences on PEBs, including structural factors and individual factors such as identity, place attachment, connectedness to nature and norms (Cialdini et al., 2006; Daryanto & Song, 2021; Geiger et al., 2019; Mayer & Frantz, 2004; Udall et al., 2021; Whitburn et al., 2020). Whilst work investigating behaviour change interventions has offered insights into how behaviours can be changed in domestic and workplace settings, there have been very few studies that have attempted to change behaviour in a nature-based context (Almosa et al., 2017; Cialdini et al., 2006; Ramkissoon et al., 2012; Unnava & Burnkrant, 2015). Additionally, research has investigated behaviour change between a home context and other contexts like work and holiday; but there remains scant literature which has investigated behaviour change between nature-based contexts and a home context (Ramkissoon et al., 2012; Verfuerth et al., 2019; Wang & Xu, 2015; Whitmarsh et al., 2018; Xu et al., 2020). Finally, while informational approaches have been widely used to promote PEBs, there is a need to explore how novel tools like social media and VR can be applied in isolation and combination with other approaches.

This thesis will draw on the findings from previous work, presenting a series of research studies conducted in collaboration with the BBNPA, practitioners in the field of land management and visitor management (see Chapter 2). The studies each attempt to fill the gaps in literature, by providing new insights into behaviours across a nature-based context and a home context. Furthermore, several intervention studies attempt to uncover the most effective methods to encourage behaviour change in a nature-based context.

2.6   Behaviours Under Investigation

The following section will outline the behaviours under investigation in this thesis. To investigate behaviour change across contexts, research needs to focus on a variety of behaviours in both home and NP contexts. Typically research into PEBs and spillover have focused on home context behaviours, with some cross-contextual research investigating workplace and holiday behaviours (Barr et al., 2010; Verfuerth et al., 2019; Whitmarsh et al., 2018). Additionally, research into EDBs in a nature-based and NP contexts is limited; the few studies conducted have has focused on niche behaviours, like theft of petrified wood (Cialdini, 2003; Ramkissoon et al., 2012). Given the widespread issues in the BBNP, there is a necessity to explore EDBs, like littering and disturbance to wildlife, too. Thus, whilst most research conducted has focused on encouraging PEBs, this work will also explore interventions to discourage EDBs, and the mediators that influence performance of EDBs.

Finally, whilst research has investigated cross-context behaviour change between home, holiday and work contexts, there is little research exploring how behaviours change between home and nature-based or NP contexts (Ramkissoon et al., 2012, 2013). Therefore this work will investigate behaviours in both a home and a NP context.

2.6.1   Home Behaviours

Much work has investigated the behaviour of individuals in a home context, focusing on domestic behaviours; energy and water consumption, recycling, food waste and shopping have all been explored within the literature (Lanzini & Thøgersen, 2014; Martiskainen & Ellis, 2011; Stoeva & Alriksson, 2017; Young et al., 2017).

It is possible to use self-report measures to measure these domestic behaviours. This offers the chance to explore cross-context behaviour change, as items can be applied to different contexts at multiple time points (Kormos & Gifford, 2014). The studies outlined in this thesis will use self-report measures to explore environmental behaviours. The studies will use a selection of self-report behavioural items used in the CASPI surveys conducted by Whitmarsh et al. (2017) (see Table *1* for the behaviours under investigation).

Table 1 - Self-Report Behaviours Proposed for Investigation

Behavioural Domain	Self-Report Item
National Park Behaviours[a]	When walking, I kept to designated paths and trails
	Avoided littering (throwing rubbish on the street/path)
Domestic & Everyday Behaviours	Recycled my waste (e.g., glass)
	Turned off the tap when brushing teeth
	Used reusable water bottles instead of single-use bottles
	Turned off lights when not in use
Consumption Behaviours	Eaten organic, locally-grown or in season food
	Took short showers (less than 3 minutes long) or infrequent baths
	Bought products with less packaging
	Avoided eating meat
Other Behaviours	Encouraged other people to save energy

[a]Two new behaviours/items, all others are from the CASPI survey (L Whitmarsh et al., 2017).

Additionally, Studies Two, Three and Five also utilise objective measures of environmental behaviours. Studies Two and Three tests the feasibility of behavioural mapping of littering on a site in the BBNP. The studies explore the effectiveness of an interventions and trials the methodology as a tool for practitioners. Study Five is a laboratory study and utilises a technique similar to that used by Evans et al. (2013); a filler task which requires participants to dispose of paper in their choice of a general rubbish bin (which is in close proximity) or a recycling bin (which is more distant). These measures were used to explore the potential for more ecologically valid measures of PEBs, and are discussed greater detail in their respective chapters.

2.6.2   National Park Behaviours

There are a variety of EDBs that cause issues within the NP; disturbance to wildlife, erosion, and pollution are a problem for the BBNPA and the environment (Brecon Beacons National Park Authority, 2015). However, these behaviours are not easy to monitor within the parameters of environmental psychology. Monitoring erosion, for example, can be conducted using drones, but this is beyond the scope and budget of this research (Appeaning Addo et al., 2018; Hemmelder et al., 2018; Pucino et al., 2021).

Conversely, one of the biggest issues facing the NP is litter, which in comparison to other issues is relatively easy to objectively measure. The BBNPA have identified littering as one the key target behaviours they want to tackle regarding visitor management and behaviour change (J. Lawrence, personal communications, March 2018).

What constitutes littering is debatable and the UK government have only defined "litter" rather than the act of littering. They define litter as "most commonly assumed to include materials often associated with smoking, eating and drinking; or are improperly discarded and left by members of the public" (Priestley, 2017). For this research, the target behaviour "littering" will be defined as "improperly discarding of materials associated with smoking, eating and drinking". Anecdotally, aside from fly-tipping that occurs within the National Park, it is mainly food and drink items that are littered by visitors. As the NP does not have many bins on sites, the target behaviour is not "to use a bin". The behaviour under study here is "littering" and the target behaviour is to "not litter".

 From a research standpoint, the NP offers a unique chance to explore litter behaviour outside of a home or urban context. Much research has looked into ways to tackle littering and other waste behaviours within urban centres and roadsides, but fewer studies have been conducted in nature-based contexts (Cialdini, 2003; Guagnano, Stern, & Dietz, 1995b; Keep Wales Tidy, 2021). This behaviour can be monitored objectively, by measuring the amount of litter on a site.

Additionally, self-report measures can also be used to measure environmental behaviours within a nature-based context. In addition to the CASPI items, two new self-report behaviours will be used to measure two behaviours relevant to the NP context, see Table *1* for the proposed behaviours under investigation.

One important behaviour that is not being researched, is disturbance to wildlife. Whilst this is an issue that is reportedly increasing within the NP, although research within the BBNP is lacking, conducting research into this would be outside the scope of the research and requires the knowledge and research skills of, or collaboration with, an ecologist (Geffroy et al., 2015).

2.6.3   Justification for Research

A collaborative research project that aims to investigate novel interventions within a UK NP is unprecedented. This thesis provides an opportunity to not only explore interventions, but also to test collaborative research between a UK National Park Authority and academic researcher. This work is novel, as little collaborative research has taken place of this nature (Esfandiar et al., 2022; Ramkissoon et al., 2012).

Additionally, to combat the issues that UK NPs, and the BBNP more specifically, face, there is a clear need for research investigating the impact that visitors have on the BBNP. Furthermore, the lack of interventions developed with behaviour change theory in mind provides the chance to develop and test communications and interventions for use within the BBNP. As the BBNPA do not currently have the time or resources to investigate visitor impact in-depth or test interventions, the collaborative research outlined in this thesis aims to provide them with insights they cannot gain on their own. The benefits of encouraging PEBs and discouraging EDBs in the NP are also clear. The negative impact that visitors have on the NP mean that behaviour change could be a useful tool for the BBNPA to manage and reduce the impact that visitors have in the NP.

Additionally, the collaborative relationship and novelty of the UK NP context provides a unique opportunity to conduct research that aims to fill gaps within the academic research field of cross-contextual behaviour change. As previously mentioned, research investigating the cross-context behaviour change between home and NP contexts is lacking. By combining intervention and impact studies with cross-context surveys on behaviour change, the research outcomes aim to provide impact on the ground in addition to advancement of knowledge in relation to cross-context behaviour change and spillover.

With the advancements in technology, there is potential to trial new and novel methodologies to test the effectiveness of interventions. Data collection will rely heavily on seasonality, and interventions will need to be tested in-situ. Developing studies that can be

conducted outside of peak visitor seasons and without the need for field studies is essential. As discussed in detail in Chapter Two, Section 2.4.2.1, VR nature has been used to test the effectiveness of interventions. As such, the thesis research will also look at the viability of VR nature as a methodology to test the effectiveness of interventions.

Finally, there is a need to explore a wider range of behaviours within a NP context, to allow for deeper investigations and comparisons between home and NP contexts, but also to ensure that EDBs are explored too. The proceeding section, 2.67, outlines the research questions under investigation in this thesis.

2.7   Research Questions

Chapters One and Two highlight clear gaps in academic research, and a lack of research from practitioners and organisations responsible for conserving and protecting the natural world. The necessity for investigations into cross-contextual behavioural spillover, as well as general behavioural research in nature-based contexts is clear. Also clear is the need to explore collaboration between NGOs and academics. The work outlined in this thesis provides insights into how collaborative work can

This collaboration provides a platform for the BBNPA to investigate those issues that have the most detrimental impact on the environment, and to find innovative and effective methods to measure behaviour which can be used to combat EDBs and encourage PEBs. Additionally, despite the wide variety of perceived issues within the NP, and the active implementation of interventions such as signage (as outlined in the preceding sections), these have never been systematically reviewed or evaluated. This means that the BBNPA are unable to effectively review their own interventions internally, which in turn may be holding back progress and inadvertently be decreasing performance of PEBs by visitors.

Combining the needs of practitioners and to fill in academic research gaps, five research questions are presented. The research questions outlined below address gaps in academic and practitioner research:

2.7.1 Question 1 – Do PEBs and attitudes change across contexts, between home and the National Park?

Previous research has shown that behaviours and attitudes change across contexts; home/work, home/holiday contexts have been investigated, but there is a clear lack of research looking at behaviours across home and nature-based contexts

2.7.2 Question 2 – What are the main predictors for PEBs (PEBs) in the National Park and at home?

Whilst previous research has found that a mixture of predictors and contextual factors influence behaviour, finding out what predictors are shared, if any are, between home and park is important.

2.7.3 Question 3 – Can interventions reduce instances of EDBs (EDBs) in the National Park?

Current measures of behaviour utilised by the BBNPA are almost entirely anecdotal and there is a need to find out how behaviours can be better measured and reported. Additionally, the BBNPA have not explored which interventions are most effective at changing behaviour.

2.7.3.1 Question 3a – Can a virtual visit to the National Park lead to changes in PEBs and attitudes?

The benefits to wellbeing and PEB and attitudes from interactions with "virtual" nature has been explored in literature, however the impact of virtual nature on environmental behaviours and attitudes have not been explored in-depth. The potential for VR nature to be adopted as a methodology within the field of environmental psychology has also not been explored fully.

2.7.4 Question 4 - Does behavioural spillover occur between a home and National Park context?

As highlighted by Ramkissoon et al. (2012), little research has been conducted to understand if spillover occurs between home and NP contexts. Despite being a decade old, the conclusions of this research remain relevant today.

2.8   Research & Methodological Considerations

Developing and implementing research to answer the five research questions outlined above requires careful consideration of methodologies. Outlined below are some of the main considerations – including the use of self-report measures and techniques to measure cross-context behaviour change.

One of the main barriers faced by this research is conducting research in the field and with visitors. The seasonality of visitor numbers means that research will only be feasible during tourist season, from May to September. This means that time is critical, as visitors need to be able to complete research tasks (e.g., surveys) quickly so that it does not disturb their visit and methods need to be developed quickly in time for tourist seasons. Consequently, the approach in this thesis will be to use a predominantly quantitative approach, as qualitative methods, generally, are more time-consuming (McGrath et al., 2019). However, given the potential for greater data gained from qualitative measures, the addition of open-ended, qualitative questions will be adopted wherever possible to provide supplementary insights.

There is ongoing debate around the most appropriate and effective methodology to adopt when investigating ESBs. Mixed-methods approaches allow for a balanced investigation into behaviours, capitalising on the strengths of both qualitative and quantitative approaches (Johnson et al., 2007; Tashakkori & Teddlie, 2003). The in-depth and philosophical debates around this topic are beyond the scope of this thesis; these debates are outlined extensively within the literature already (Johnson & Onwuegbuzie, 2004). As time is a key factor for this thesis, a quantitative approach is necessary.

Despite offering the most reliable measures of behaviour, the use of objective measures of behaviours (e.g., smart meters, water consumption gauges etc) is difficult for this type of research; visitors would need to be in contact with researchers prior to the visit, and the tools (e.g., a water consumption gauge or smart meter etc) would need to be installed both at home and at the location where visitors were staying (if they are overnight visitors). Such methods are far beyond the capabilities and budget of the research. As such, this thesis will utilise self-report measures of behaviour. The reliability of self-report measures is debated within the field, but again, discussion around this subject is beyond the scope of this thesis (Bleys et al., 2018; Collado et al., 2020; Kormos & Gifford, 2014; Stirratt et al., 2015; Winkel et al., 2009). Despite the ongoing debate, they

are still widely accepted and used within the field, and have been found to be effective and reliable tools to measure behaviour (Collado et al., 2020; N. Nash et al., 2017). To combat the potential pitfalls of relying on self-report measures, the research presented in this research utilises, wherever possible, extensively used, well-established and reliable self-report measures from the literature.

Finally, research outlined in this thesis will use behavioural intent as a measure of behaviour. The validity in the use of behavioural intention and self-report measures to investigate EDBs and how/why individuals decide to perform behaviours that have a negative impact, is debated (Collado et al., 2020). However, the intricacies of how intent relates to performance of both ESBs is beyond the scope of this research (Sörqvist & Langeborg, 2019). Additionally, both self-report and behavioural intention have been utilised in a wide variety of research projects within the literature. With these factors considered, the final element to consider is the behaviours under investigation.

2.9   Presented Research

With careful consideration of the methodological barriers, practitioner needs and research limits, a series of studies were conducted and are presented in the chapters that follow. Each study presented is focused on answering at least one of the research questions outlined in section 2.7 (see Table 2 for an overview of the studies presented in this thesis, including which research questions they attempt to answer and which gaps in research they address. This table can also be found on Page xxiv for ease of reference).

Table 2 – An Overview of the Studies Presented in this Thesis. Note: This table is also available at the beginning of the thesis on Page xxiv.

Chapter	Study Title	Linked to Research Question	Gaps in Current Literature & Practitioner Work	Purpose of the Study
Three	Study One	Question 1 - Do environmental behaviours and attitudes change across contexts, between home and the National Park? Question 2 – What are the main predictors for PEBs in the National Park and at home? Question 4 - Does behavioural spillover occur between a home and National Park context?	• Little research on cross-contextual behaviour change between a home and National Park context • Thus far, no research has explored National Park context-specific behaviours	• To test the feasibility of studying behaviours across contexts and to establish if the methodology for doing so is effective
Four	Study Two	Question 3 – Can interventions reduce instances of EDBs in the National Park?	• Next to no research has empirically tested the effectiveness of interventions to reduce dog fouling • Little research has explored behavioural mapping for EDBs in a nature-based context	• To investigate the effectiveness of behavioural mapping as a tool to measure behaviour • To test the effectiveness of a novel intervention to reduce dog fouling
	Study Three	Question 3 – Can interventions reduce instances of EDBs in the National Park? Question 4 - Does behavioural spillover occur between a home and National Park context?	• Research into interventions within nature-based contexts has not explored message framing to reduce littering • National Parks in the UK often resort to signage to act as an intervention to reduce EDBs, but no research has investigated the effectiveness of such interventions	• To investigate the effectiveness of different messages to reduce littering in a nature-based context • To add to the knowledge of practitioners and develop methodology that can be used by practitioners in the future
Five	Study Four	Question 2 – What are the main predictors for PEBs in the National Park and at home? Question 3 – Can interventions reduce instances of EDBs in the National Park? Question 4 - Does behavioural spillover occur between a home and National Park context?	• Little research has investigated the impact of pre-visit interventions	• To investigate the impact that exposure to different message frames pre-visit could have on behaviours during and after visits to the National Park
	Study Five	Question 3a – Can a virtual visit to the National Park lead to changes in environmental behaviours and attitudes?	• Research has only just began exploring the potential influence that visits to virtual nature can have on environmental attitudes and beliefs • Additionally, little research has tested the potential for Virtual Reality as a research tool	• To test the potential impact that virtual nature can have on environmental behaviours • Additionally, to explore the possibility of using virtual reality as an intervention and research tool within environmental psychology research

3   Chapter Three – Behaviours Across a Home and National Park Context

3.1   Introduction

As outlined in Chapters One and Two, little research has looked into the relationship between PEBs in a national-park context and PEBs in a home context (Nilsson et al., 2016; Ramkissoon et al., 2012). Currently the BBNPA do not measure or investigate behaviours in any structured way and there is little insight into how behaviours in a NP context differ, if at all, from behaviours in a home context. As such, the pilot study outlined in this chapter is an exploratory study to investigate environmental behaviours across a national park and home context.

Within academia, research investigating behaviour change in nature-based contexts is limited and there has been little research into cross-contextual behaviour change between home and national park contexts (Ramkissoon et al., 2012). The BBNPA focus predominantly on tackling EDBs (e.g., dog fouling, littering and disturbance to wildlife) rather than measuring or encouraging PEBs. Additionally, the BBNPA rely on anecdotal evidence to gauge the frequency and scale of behaviours, as outlined in Chapter Two.

This aligns with research on behaviours in national parks and nature-based contexts, which tend to focus on interventions that can change behaviours within those contexts individually, and do not explore the contextual behaviour changes that may occur (Ramkissoon et al., 2012). Research into behaviour change across contexts also tends to focus on home and workplace contexts or home and holiday contexts, not NPs or nature-based contexts (Littleford et al., 2014; Verfuerth et al., 2019; Whitmarsh et al., 2018; Xu et al., 2020).

One of the main aims of this thesis is to develop new and effects ways to measure behaviours across a home and nature-based context, as well as ways to measure behaviours within a nature-based context. Before developing any new measures, it is important to explore factors that shape existing behaviours and how visiting national park contexts shape pro-environmental intentions. Study One uses self-report measures to explore visitors' environmental behaviours and attitudes both at home and within the NP.

3.2 Study One – Exploring Behaviours Across Contexts

3.2.1 Overview

Working to fill the gap in research discussed in-depth in Chapters 1 and 2, an exploratory study was conducted to investigate cross-context environmental behaviour and attitude change, between a home and a NP context. The study used self-report measures to investigate individuals' environmental behaviours and attitudes at home, within the Brecon Beacons National Park, and behavioural intentions for home after their trip.

3.2.2 Hypotheses

Behaviours are more likely to correlate within contexts as behaviours have been found to be more consistent within, rather than between, contexts (Whitmarsh et al., 2018). H_1 hypothesises that behaviours will correlate within contexts to a greater extent than between contexts.

The second hypothesis, H_2, predicts that performance of PEBs will increase post-visit (measured using behavioural intention). Findings from previous research has suggested that visits to nature-based contexts can lead to increased performance of, and intention to perform, PEBs (Dearden et al., 2007; K. Hughes et al., 2011).

H_3 hypothesises that behavioural consistency will be predicted by green identity, new ecological paradigm, PBC, and nature relatedness scale scores. Several factors have been found to predict behavioural consistency and PEBs. High green identity, higher connection to nature, higher perceived behavioural control (PBC), and a high New Ecological Paradigm score (i.e., more pro-environmental worldview) have been found to predict and correlate with behavioural consistency and performance of PEBs (Chen, 2015; Walker & Ryan, 2008; Whitmarsh & O'Neill, 2010).

H_4 predicts that nature relatedness will increase post-visit to the Brecon Beacons National Park. Previous research found that visits to nature-based contexts can lead to an increase in connection to nature (Wheaton et al., 2016).

Finally, exploratory analysis was conducted to examine perceptions of responsibility for protecting the BBNP and how this related to PEBs. Change in predictors of PEB (identity, values, connectedness) following the NP visit were also examined, as was the difference in perceived behavioural control across contexts.

3.2.3   Ethics & Risk Assessment

Ethical approval was granted by Cardiff University Ethics Committee; EC.18.03.13.5275. As data collection took place offsite from the university, a risk assessment was also required.

3.2.4   Methods

3.2.4.1   Participants & Recruitment

Participants were recruited via opportunity sampling, through online and on-site recruitment channels. In total, 107 participants completed part one of the study, with 53 of the same participants completing part two (see Table 3 for participant demographics).

On-site recruitment for part one took place between May 2018 and October 2018. In total, 70 participants were recruited on-site within the Brecon Beacons National Park. Sites across the BBNP were chosen based on specific criteria outlined below. On-site participants completed part one of the study when they were in the Brecon Beacons National Park, retrospectively answering questions about behaviours at home.

Online participants were recruited through the 'Walking the Brecon Beacons' Facebook group (*Walking the Brecon Beacons*, 2021) This group had over 17,000 members at the time of recruitment (October 2018) and is a popular page for people to visit before they visit the Brecon Beacons National Park. The administrators of the page granted permission to advertise part one of the study and the advertisement was first posted in June 2018 and was "bumped" (i.e., put to the top of the page) frequently on the group until the latter half of September 2018.

Online recruitment was also conducted through Brecon Beacons Holiday Cottages, a lettings agency based in the NP (Brecon Beacons Holiday Cottages, 2021). This channel was established later in the data collection period and ran between August and September 2018. Customers who had booked a trip before 22nd September 2018 were invited in their booking confirmation email to take part in the study.

In total, 37 participants were recruited through online recruitment channels. The only selection criteria for participants who were recruited online was that their trip to the BBNP had to be completed before 22nd September 2018. Recruitment for the study ceased on 22nd September 2018 as this was the end of the peak season for the National Park.

All participants recruited online were asked to complete part one at least one week prior to arriving at the Brecon Beacons National Park. Participants were asked when they would be leaving the Brecon Beacons National Park, so that part two could be sent to them after this date. Part two of the study was sent to participants via email the day after they left the BBNP (see Figure 6 for a timeline of the study).
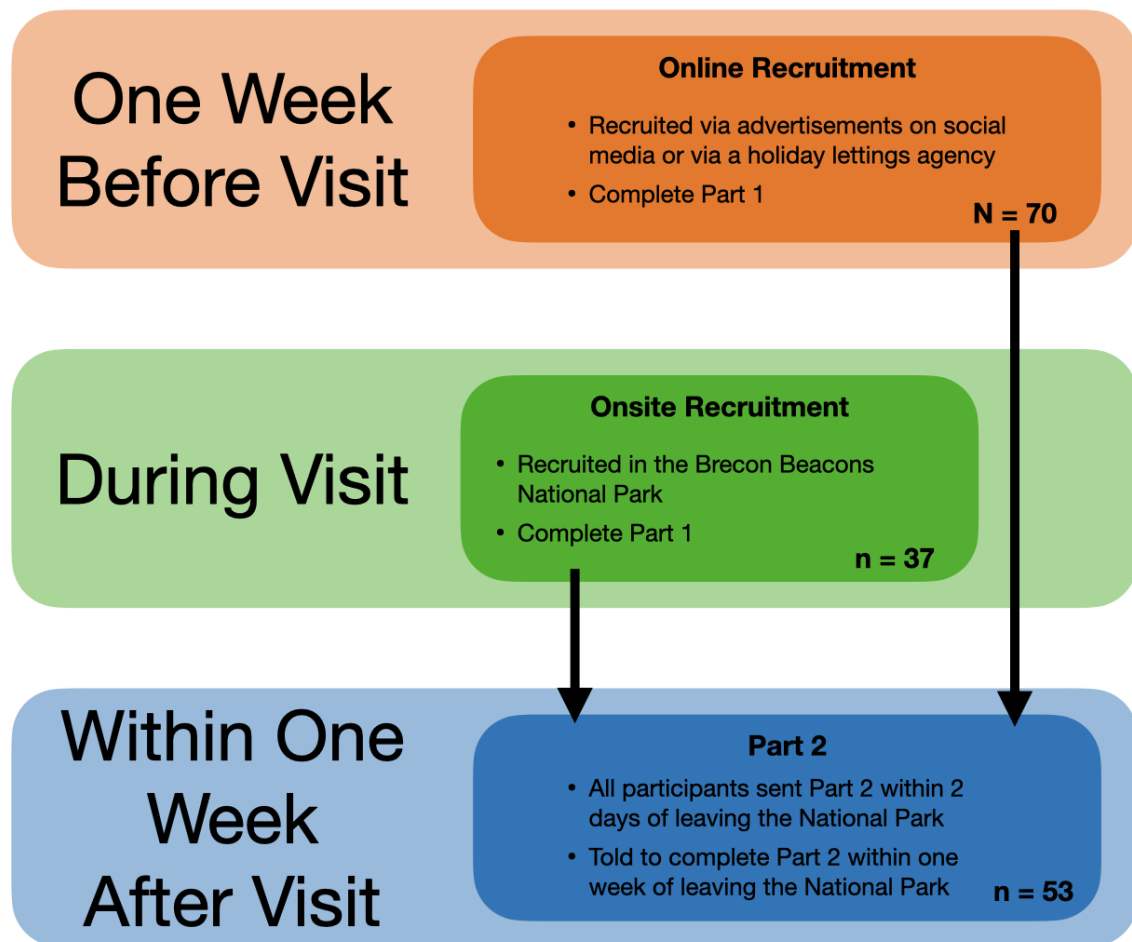
Figure 6 – Study One - Timeline for the Study

Table 3 – Study One - Participant demographics (continued on next page)

	Factor	Part One	%	Part Two	%
Sex	Female	62	57.9	30	56.6
	Male	45	42.1	23	43.4
Recruitment Channel	Online	70	65.4	29	54.7
	Onsite	37	34.6	24	45.3
Age	18-24	9	8.4	2	3.8
	25-34	26	24.3	14	26.4
	35-44	21	19.6	9	17.0
	45-54	13	12.1	6	11.3
	55-54	25	23.4	14	26.4
	65+	13	12.1	8	15.1
Residence	United Kingdom	102	95.3	50	94.3
	Rest of Europe	4	3.7	2	3.8
	Outside of Europe	1	.9	1	1.9

Factor	Part One	%	Part Two	%

Home residence	Urban	28	26.2	13	24.5
	Suburban	34	31.8	21	39.6
	Rural	45	42.1	19	35.8
Visit Type	Day Visitor	.	.	18	34.0
	Short Stay (1 or 2 visits)	.	.	9	17.0
	Medium (3 or 4 nights)	.	.	14	26.4
	Long Stay (5+ nights)	.	.	10	18.9
	Resident	.	.	2	3.8
Number of visits in previous two years	This is my first visit	.	.	18	34.0
	Once before	.	.	12	22.6
	2 - 3 times	.	.	12	22.6
	4 - 5 times	.	.	2	3.8
	6+ times	.	.	7	13.2
	Did not answer/prefer not to answer	.	.	2	3.8

Note. Questions asking about visit type and number of visits in the last two years were only used in part two.

3.2.4.2   Site Selection

In total, four sites were chosen for questionnaire distribution, based on footfall/visitor numbers, convenience of the location for collecting data, safety of the researcher(s) and weather conditions on data collection days. Unfortunately, the BBNPA only have visitor data for some sites, so the footfall of sites was determined based on BBNPA staff knowledge of sites. The four sites were: Gwaun Hepste Car Park, Pont Ar Daf Car Park, Pen Y Fan Summit and Hay Bluff Car Park (see Figure 7 for a map of the sites).
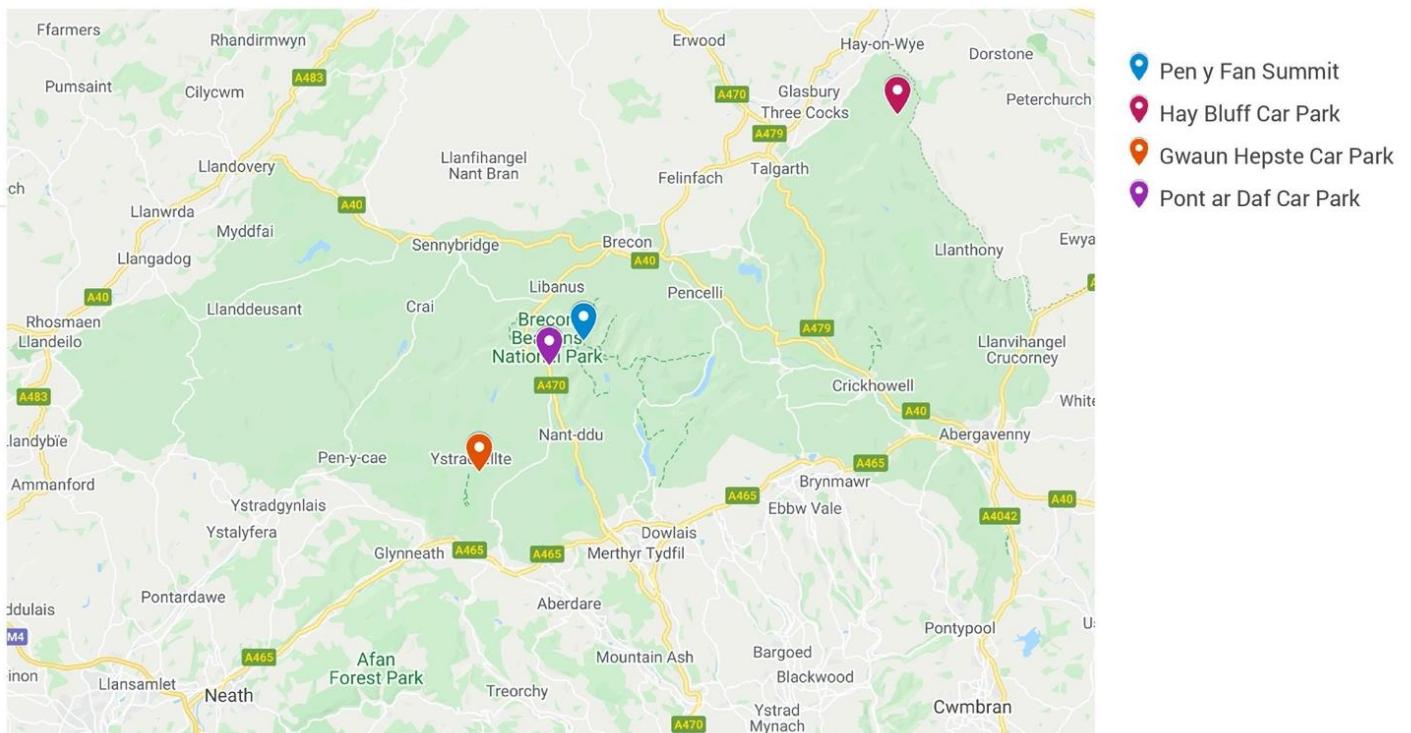
Figure 7 - Study One - Map of Recruitment Sites

3.2.4.3   Design

A within-subjects design was used, with measurements across two time points. Part one (time 1) contained questions relating to environmental behaviours, attitudes and beliefs within a home context. Part two (time 2) contained similar measures but for behaviours and attitudes in a NP context as well as behavioural intentions for home.

3.2.4.4   Materials & Apparatus

Both part one and two were developed as Qualtrics (2020a) online surveys. Part one of the survey was distributed on-site via the Qualtrics offline app (Qualtrics, 2020b), on an Apple iPad (2017 model). Part one for online participants was accessed either by the advertisement on social

media or via the advertisement within the Brecon Beacons Holiday Cottages booking confirmation emails. Email addresses were requested from participants in part one of the study. Part two of the survey was sent via email to participants.

3.2.4.5 Survey Part One

Visit Eligibility Filter. This question required participants to answer questions about their visit; if their visit took place before 22nd September 2018. If their trip was not going to be completed before 22nd September 2018 participants were not eligible to take part.

Demographics. General demographic data was collected; sex, age, location of home residence, nationality and type of home area (urban, suburban or rural). Dog ownership was also included, as the BBNPA deal with many dog related issues. It was deemed important to discover whether visitors owned/brought dogs on their visits or not. Email addresses were also requested, so that participants could be sent Part two. Email addresses were also used to link answers from part one and part two together.

Responsibility. Three questions were used to investigate attitudes towards conservation and protection of the BBNP. Two questions were open-ended:

- What do you think makes a responsible visitor to the Brecon Beacons National Park?
- Who do you think is most responsible for preserving and protecting the Brecon Beacons National Park?

The third and final question asked participants to rank who they believed was "most responsible for protecting and conserving the Brecon Beacons National Park". The question required participants to rank from 1 (indicating who they believed was most responsible) and 7 (who they believed was least responsible), from a list of 7 organisations/groups: BBNPA, Visitors, Landowners, Local Residents, Local Councils, Natural Resources Wales and Welsh Government.

Past Behaviours at Home. Participants were asked how often they had performed 15 behaviours at home during the previous week on a five-point Likert scale: always, most of the time, about half the time, occasionally and never. The 15 behaviours used in the questionnaire can be viewed in Table 4 The justification for investigating these behaviours is outlined in Chapter Two.

Table 4 – Study One – Behaviours Under Investigation

Behavioural Domain	Behaviour (Past)	Behaviour (Intention)
National Park Behaviours	When walking, I kept to designated paths and trails	When walking, I will keep to designated paths and trails
	Avoided littering (throwing rubbish on the street/path)	Avoid littering (throwing rubbish on the street/path)
Home & Everyday Behaviours	Recycled my waste (e.g. glass)	Recycle my waste (e.g. glass)
	Turned off the tap when brushing teeth	Turn off the tap when brushing my teeth
	Used my own bags at the shops	Use your own bags at the shops
	Used reusable water bottles instead of single-use bottles	Use reusable drinks bottles instead of single-use bottles
	Turned off lights when not in use	Turn off lights when not in use
Consumption Behaviours	Purchased environmentally friendly products	Purchase environmentally friendly products
	Eaten organic, locally-grown or in season food	Eat organic, locally-grown or in season food
	Conserved water	Conserve water
	Taken short showers (less than 3 minutes long) or infrequent baths	Take short showers (less than 3 minutes long) or infrequent baths
	Bought products with less packaging	Buy products with less packaging
	Avoided eating meat	Avoid eating meat
	Avoided wasting food (e.g. by using leftovers)	Avoid wasting food (e.g. by using leftovers)
Other Behaviours	Encouraged other people to save energy	Encourage other people to save energy

Perceived Behavioural Control. Participants responded on a five-point Likert scale (5 = extremely easy, 1 = extremely difficult) to the question "In your home area, how easy do you find it to be environmentally friendly?". This was used as a measure of perceived behavioural control (PBC). This was added as an exploratory measure, to explore if perceived behavioural control differed across contexts and if it mediated behaviours.

New Ecological Paradigm. The revised New Ecological Paradigm (NEP) is used widely in research and is probably the most widely used measure of environmental values or attitudes, worldwide (Dunlap, 2012). An adapted 6-item version of the New Ecological Paradigm from Dunlap (2012) was used for the study, as previous research has found that nine items, of the normally 15-item scale, are commonly misinterpreted by participants (Whitmarsh & O'Neill, 2010). Participants answered on a five-point Likert scale (5 = strongly agree to 1 = strongly disagree), indicating how much they agreed or disagreed with the statements: 'When humans interfere with nature, it often produces disastrous consequences', 'The balance of nature is strong enough to cope with the impacts of modern industrial nations' (reverse coded), 'the balance of nature is very delicate and easily upset', 'humans are severely abusing the environment', 'the so-called 'ecological crisis' facing humankind has been greatly exaggerated' (reverse coded), 'if things continue on their present course, we will soon experience a major ecological catastrophe'. An internal reliability analysis showed strong reliability for the NEP scale (α = .76).

Place Identity. The place identity scale was developed by Halpenny (2010) in order to measure an individual's cognitive assessment of a place. Five items were used to measure place identity and were adapted from Halpenny's (2010) scale (see Table 5 for the adapted items), with participants answering on a five-point Likert scale (5 = strongly agree, 1 = strongly disagree).

An internal reliability analysis showed strong reliability for the Place Identity scale (for a home context; α = .84).

Table 5 – Study One - Adapted Place Identity Items

Original Items (Halpenny, 2010)	Adapted Items for Home & Local Area	Adapted Items for Brecon Beacons National Park
Point Pelee National Park means a great deal to me	My local area means a great deal to me	The Brecon Beacons National Park means a great deal to me
I identify strongly with Point Pelee National Park	I identify strongly with my local area	I identify strongly with the Brecon Beacons National Park
Visiting Point Pelee National Park says a lot about who I am	Living in my local area says a lot about who I am	Visiting the Brecon Beacons National Park says a lot about who I am
I feel I can really be myself in Point Pelee National Park	I feel like I can really be myself in my local area	I feel like I can really be myself in the Brecon Beacons National Park
When I visit Point Pelee National Park, others see me the way I want them to see me	When I am in my local area, others see me the way I want them to see me	When I visit the Brecon Beacons National Park, others see me the way I want them to see me

Nature-Relatedness 6-Item Scale. The Nature-Relatedness 6-item scale (NR-6) from Nisbet and Zelenski (2013) was developed as a brief measure to capture relatedness to nature and includes six-items scored on a five-point Likert scale (5 = strongly agree to 1 = strongly disagree). Items include: 'my ideal holiday spot would be a remote wilderness area', 'I always think about how my actions affect the environment', 'my connection to nature and the environment is a part of my spirituality', 'I take notice of wildlife wherever I am', 'my relationship to nature is an important part of who I am' and 'I feel very connected to all living things and the earth'. Internal reliability analysis showed an acceptable level of reliability (α = .78).

Green Identity. The green identity scale used was adapted from a six-item scale from Whitmarsh, Capstick and Nash (2017). Items are scored on a seven-point Likert scale (7 = strongly agree, to 1 = strongly disagree) Five of the six items were used from the previous study: 'I would describe myself as an 'environmentalist'', 'I would not want anyone to think of me as someone who is concerned about reducing waste' (reverse coded), 'I would not want my family or friends to think of me as someone who is concerned about environmental issues' (reverse coded), 'I am the type of person who tries not to be wasteful', and 'I would be embarrassed to be considered a 'waste-conscious' person' (reverse coded). The item 'Taking action to protect the environment is an important part of who I am' was removed, as environmental action was not under investigation in this study. An internal reliability analysis showed good reliabilities for the green identity scale (α = .83)

Trip Information. Participants were required to supply the date they intended to leave the BBNP, so that part two could be emailed to them after they left.

3.2.4.6   Survey Part Two

Visit Information. Participants were asked about their visit to the Brecon Beacons National Park: length of stay (day visitor, short stay, long stay or resident), location of the majority of the stay (west, central or east), number of people in their group, whether they had visited the BBNP prior this trip (if yes: how many times previously in the last two years) and finally whether they took dogs on their trip.

Behaviours in the BBNP. Participants were asked about their behaviours during their stay in the BBNP and the same items were used as in part one of the study (see Table 4 for the behaviours).

Perceived Behavioural Control. Participants were asked "in the Brecon Beacons National Park, how easy do you find it to be environmentally friendly?". The item was answered on a five-point Likert scale (5 = extremely easy, 1 = extremely difficult) and was used as a measure for perceived behavioural control.

Place Identity. An adapted place identity scale, originally from Halpenny (2010), was used in part two, however it was adapted to include "the Brecon Beacons National Park" (see Table 5for the adapted items). Internal reliability analysis revealed the scale showed strong internal reliability when adapted for a NP context (α = .76).

Nature-Relatedness 6-Item Scale. The NR-6 was measured again and used the same items as part one. Internal reliability analysis showed an acceptable level of reliability (α = .79).

Green Identity. The Green Identity scale contained the same items as part one. Internal reliability analysis showed an acceptable level of reliability (α = .82).

Behavioural Intention. Participants were asked to rate the likelihood, on a five-point Likert scale (5 = extremely likely to 1= extremely unlikely), of them performing the 15 PEBs at home or in their local area in the future (see Table 4 for the behaviours).

Demographics. Two final items asked participants "what is your highest level of education?" and "what is your personal income (before tax)?". This was collected on an exploratory basis to see if these factors played a role in behaviours, attitudes, and beliefs.

3.2.5   Results

Analysis was conducted using SPSS Version 25.

3.2.5.1   Behaviours in a Home Context

A Pearson product-moment correlation coefficient was computed to assess the relationship between behaviours in a home context; the results of this can be viewed in the correlation matrix (see Table 6 for descriptives and Table 7 – Study One - Correlation Matrix for Behaviours in a Home Context (significant correlations in **bold** and negative correlations in red)for the correlation matrix).

Waste and consumption behaviours correlated more with other PEBs than did food, water or walking behaviours. "Bought products with less packaging" correlated with nine other

behaviours: "recycled my waste (e.g. glass)", "conserved water", "used reusable water bottles instead of single-use bottles", "purchased environmentally friendly products", "encouraged other people to save energy", "eaten organic, locally-grown or in season food", "taken short showers (less than 3 minutes long) or infrequent baths", "avoided wasting food (e.g. by using leftovers)" and "turned off lights when not in use". "Avoiding wasting food" and "purchasing environmentally-friendly products" each correlated with seven other behaviours.

The strongest correlations were between shopping behaviours 'bought products with less packaging' with "purchased environmentally friendly products' ($r = .433$, $n = 105$, $p < .001$) and 'purchased environmentally friendly products' with 'eaten organic, locally-grown or in season food' ($r = .412$, $n = 105$, $p < .001$).

Table 6 – Study One - Descriptives for Behaviours in a Home context and National Park Context

Behaviour	Home context			National Park Context		
	N	Mean Frequency* (descending)	SD	N	Mean Frequency* (descending)	SD
Avoided littering (throwing rubbish on the street/path).	107	4.93	0.54	53	4.92	0.55
Recycled my waste (e.g. glass).	106	4.72	0.51	52	4.60	0.82
Turned off lights when not in use.	107	4.49	0.65	49	4.55	0.58
Used my own bags at the shops.	106	4.43	0.84	49	4.51	0.794
Avoided wasting food (e.g. by using leftovers).	107	4.23	0.76	49	4.35	0.78
Turned off the tap when brushing teeth.	107	4.14	1.19	48	4.27	1.18
When walking, I kept to designated paths and trails.	107	4.11	0.74	53	4.28	0.74
Used reusable water bottles instead of single-use bottles.	104	4.07	0.87	52	4.35	0.81
Conserved water.	107	4.06	0.89	50	3.94	0.74
Purchased environmentally friendly products.	105	3.42	0.81	48	3.15	0.85
Bought products with less packaging.	106	3.30	0.90	47	3.32	0.98
Eaten organic, locally-grown or in season food.	107	3.17	0.93	52	3.17	0.92
Encouraged other people to save energy.	106	3.13	1.16	40	3.33	1.33
Taken short showers (less than 3 minutes long) or infrequent baths.	105	3.09	1.23	47	3.13	1.21
Avoided eating meat.	105	2.20	1.33	48	2.17	1.43

*Mean Frequency – 5 = always, 1 = never)

Table 7 – Study One - Correlation Matrix for Behaviours in a Home Context (significant correlations in **bold** and negative correlations in red)

Behaviour	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 - When walking, I kept to designated paths and trails.	-													
2 - Avoided littering (throwing rubbish on the street/path).	**.207***	-												
3 - Recycled my waste (e.g. glass).	.042	.059	-											
4 - Conserved water.	-.081	.087	.155	-										
5 - Used reusable water bottles instead of single-use bottles.	.076	.172	**.367****	**.246***	-									
6 - Used my own bags at the shops.	.098	-.094	**.222***	.023	**.342****	-								
7 - Purchased environmentally friendly products.	-.114	-.101	**.292****	**.239***	.188	**.229***	-							
8 - Avoided eating meat.	-.142	-.032	-.056	.099	-.069	-.070	.062	-						
9 - Encouraged other people to save energy.	-.171	-.044	.188	.086	-.047	.023	**.337****	.185	-					
10 - Turned off the tap when brushing teeth.	-.104	-.101	.082	**.270****	.084	**.243***	.039	.187	.151	-				
11 - Eaten organic, locally-grown or in season food.	-.151	-.050	**.262****	.046	**.270****	.075	**.412****	-.026	**.192***	-.108	-			
12 - Bought products with less packaging.	-.122	.047	**.310****	**.312****	**.284****	.145	**.443****	-.011	**.355****	.135	**.365****	-		

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14
13 - Taken short showers (less than 3 minutes long) or infrequent baths.	.063	.067	.112	**.232***	.077	.005	.154	.173	.128	.103	**.204***	**.291****	-	
14 - Avoided wasting food (e.g. by using leftovers).	-.097	.134	.157	.078	**.210***	.071	**.246***	.096	**.214***	**.215***	**.212***	**.396****	**.195***	-
15 - Turned off lights when not in use.	.081	**.210***	.041	.083	.029	-.072	-.072	.064	.077	**.254****	-.012	**.331****	.104	**.341****

* *p* < 0.05 (2-tailed)

** *p* < 0.001 (2-tailed)

Factor Analysis. To determine if these correlations were signalling the presence of behavioural clusters, an exploratory factor analysis was conducted. The 15 behaviour items were subjected to a principal components analysis (PCA). Prior to performing the PCA, the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of coefficients of .3 and above. The Kaiser-Meyer-Olkin value was .662, just exceeding the recommended value of .6 (Kaiser, 1970) and Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix (Bartlett, 1954).

PCA for the part one behaviour items revealed the presence of five components with eigenvalues exceeding 1, explaining 20.8%, 10.9%, 10.6%, 8.7% and 7.2% of the variance, respectively. An inspection of the scree plot (see Appendix A) revealed a clear break after the third component. Using Cattell's (1966) scree test, it was decided to retain three components for further investigation. This was further supported by the results of Parallel Analysis, conducted using Monte Carlo PCA for Parallel Analysis (version 2.3; Ed & Psych Associates). This showed only three components with eigenvalues exceeding corresponding criterion values for a randomly generated data matrix of the same size (15 variables x 105 respondents).

The three-component solution explained a total variance of 42.4% of the variance, with Component 1 contributing 20.9%, Component 3 contributing 10.9% and Component 3 contributing 10.6%. To aid the interpretation of these three components, oblimin rotation was performed. Oblimin rotation is also more appropriate when you are not assuming the factors are orthogonal *i.e. related), in fact we are assuming they are related. The rotated solution revealed a complex structure with all three components showing several strong loadings and some shared loading of variables across components (Thurstone, 1947). However, all shared variables loaded substantially more on one component. There was a weak negative correlation between component 1 and 2 (r = .-152) and component 1 and 3 (r = -.109) and there was a very weak positive correlation between components 2 and 3 (r = .028).

The interpretation of these results suggest that behaviours may have emerging clusters (see Table 8 for Component Matrix). Component one seems to include everyday behaviours, whilst component three seems to include behaviours linked to home frugality. Component two is less clear, with behaviours not clearly related in a behavioural cluster.

Table 8 – Study One - Forced Principal Components Analysis for 3 Components with Oblimin Rotation for Pro-Environmental Behaviours at Home

Item	Component			Communalities
	1	2	3	
When walking, I kept to designated paths and trails.	0.778			0.434
Avoided littering (throwing rubbish on the street/path).	0.645		-0.391	0.434
Recycled my waste (e.g. glass).	0.573			0.436
Conserved water.	0.540	-0.379		0.240
Used reusable water bottles instead of single-use bottles.	0.537		-0.318	0.570
Used my own bags at the shops.	0.477	0.309	-0.322	0.291
Purchased environmentally friendly products.	0.452			0.594
Avoided eating meat.	0.421			0.347
Encouraged other people to save energy.		0.560		0.427
Turned off the tap when brushing teeth.	0.499	-0.501		0.290
Eaten organic, locally-grown or in season food.	0.321	-0.434		0.458
Bought products with less packaging.	0.331	0.395		0.609
Taken short showers (less than 3 minutes long) or infrequent baths.			0.653	0.230
Avoided wasting food (e.g. by using leftovers).		0.413	0.568	0.427
Turned off lights when not in use.		-0.339	0.545	0.579

3.2.5.2   Behaviours in the Brecon Beacons National Park Context

Behaviours in the NP context were compared using a Pearson's product-moment correlation coefficient (see Table 6 – Study One - Descriptives for Behaviours in a Home context and National Park Context for descriptives and Table 9 for the correlation matrix). "Avoided wasting food (e.g. by using leftovers)" positively correlated with the most behaviours, eight in total. "Bought products with less packaging" correlated with seven other behaviours. The strongest positive correlation was between "encouraged other people to save energy" and "purchased environmentally friendly products" ($r = .507$, $n = 40$, $p < .01$) with the second strongest positive correlation being between water consumption behaviours "conserved water" and "taken short showers" ($r = .458$, $n = 47$, $p < .01$).

Table 9 – Study One - Correlation Matrix for Behaviours in a National Park Context (significant correlations in **bold**, negative correlations in red)

Behaviour	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 - When walking, I kept to designated paths and trails.	-													
2 - Avoided littering (throwing rubbish on the street/path).	.053	-												
3 - Recycled my waste (e.g. glass).	-.030	-.069	-											
4 - Conserved water.	-.042	-.207	.095	-										
5 - Used reusable water bottles instead of single-use bottles.	.122	-.114	.236	-.045	-									
6 - Used my own bags at the shops.	.012	.094	**.334***	.113	.075	-								
7 - Purchased environmentally friendly products.	-.099	.025	.204	.201	.028	.038	-							
8 - Avoided eating meat.	-.083	-.086	.114	.020	.029	.120	.176	-						
9 - Encouraged other people to save energy.	-.149	-.205	.091	**.352***	-.043	-.006	**.507****	.104	-					
10 - Turned off the tap when brushing teeth.	.215	-.091	**.367***	**.440****	-.048	.123	.086	.101	.139	-				
11 - Eaten organic, locally-grown or in season food.	-.074	.027	.015	-.020	.071	.045	**.300***	.175	.127	.133	-			
12 - Bought products with less packaging.	**.378****	.049	.196	**.371***	.004	**.383***	**.393****	.180	**.374***	.053	.242	-		

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
13 - Taken short showers (less than 3 minutes long) or infrequent baths.	.080	-.108	.393**	.458**	.159	.186	.331*	-.064	.208	.286	.178	.285	-		
14 - Avoided wasting food (e.g. by using leftovers).	-.125	-.122	.128	.320*	.342*	.098	.178	-.107	-.016	.203	.157	.113	.185	-	
15 - Turned off lights when not in use.	-.059	.139	.195	.183	.006	.083	-.019	.033	.109	.357*	-.101	.127	-.101	.116	

* $p < 0.05$ (2-tailed)
** $p < 0.01$ (2-tailed)

Factor Analysis. The suitability for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of coefficients of and above .3. The Kaiser-Meyer-Olkin value was .519, which is lower than the suggested minimum value of .6 required for a good factor analysis (Tabachnick & Fidell, 2013). The Bartlett's Test of Sphericity was not significant (Sig. = .254) which again, does not fit with the assumptions required to run a factor analysis. This suggested that this data was not suitable for factor analysis.

3.2.5.3 National Park and Home Behaviours

Descriptives were calculated and mean average response to the questions "how often did you perform X behaviour at home/in the Brecon Beacons National Park?" were plotted into a bar graph (see Figure 8 for bar graph and Table 6 for descriptives).

A series of paired-samples t-tests, with a Bonferroni correction for multiple analyses, were conducted to uncover if there were any significant difference for performance in behaviour across a home and NP context (see Table 10 for the results of the t-tests). The t-tests revealed that performance of behaviours was significantly different across contexts for one behaviour. Participants reported purchasing environmentally friendly products significantly more at home (M = 3.64 , SD = 0.74) compared to in the BBNP (M = 3.17 , SD = 0.84), t(46) = 4.29, p < 0.01.

Across contexts, some behaviours were more highly correlated than others. Most performed in both contexts was 'avoiding littering' (at home M = 5.00, in the BBNP M = 4.92). The least performed behaviour was 'avoided eating meat' (at home M = 2.31, in the BBNP M = 2.17). Across contexts there was little variation in commonality of behaviours.

A Pearson product-moment correlation coefficient was computed to assess the relationship between behaviours in the home context and the NP context. The analysis revealed many positive correlations between behaviours in a home and NP context (see Table 11 for the correlation matrix).

All but two of the behaviours – "recycled my waste" and "avoided wasting food" – correlated across home and NP contexts. It is apparent that some behaviours are more correlated with a wider variety of PEBs than others. "Taking your own bag to the shops", in a home context, correlates with "keeping to paths", "recycling waste", "conserving water", "using your own bags at the shops", "turning off the tap when brushing teeth" and "avoiding food waste" in a NP context.

This contrasts with the within-context correlations, for which buying products with less packaging correlated most with other behaviours.

When looking at behaviours in a NP context correlating with behaviours in a home context, "conserving water" correlates with the most behaviours, six in total: "conserving water", "using your own bags at the shops", "turning off the tap when brushing teeth", "buying products with less packaging" and "taking short showers".

In general, the strongest relationships observed are between the same behaviour in each context, with "avoided eating meat" showing the strongest positive correlation across contexts ($r = .937$, $n = 48$, $p = .000$). "Turning off the tap when brushing teeth" also shows a very strong positive relationship across contexts ($r = .847$, $n = 48$, $p > .01$). The results confirm hypothesis H_1. Overall, behaviours correlated within contexts to a greater extent than between contexts (when excluding the same behaviours across contexts).

Table 10 – Study One - Paired-samples T-tests Conducted to Investigate Performance of Behaviours Between a Home and NP context (continued on next page, significant values in **bold**)

Behaviour	Context	*M*	N	*SD*	Paired Samples T-Test		
					t	df	Sig.
When walking, I kept to designated paths and trails.	Home	4.15	53	0.72	-1.309	52	0.196
	BBNP.	4.28	53	0.74			
Avoided littering (throwing rubbish on the street/path).	Home	5.00	53	0.00	1.000	52	0.322
	BBNP	4.92	53	0.55			
Conserved water.	Home	4.14	50	0.78	1.871	49	0.067
	BBNP	3.94	50	0.74			
Used reusable water bottles instead of single-use bottles.	Home	4.33	51	0.74	-0.163	50	0.871
	BBNP	4.35	51	0.82			
Used my own bags at the shops	Home	4.65	49	0.48	1.265	48	0.212
	BBNP	4.51	49	0.79			
Purchased environmentally friendly products.	Home	3.64	47	0.74	4.293	46	**0.000****
	BBNP	3.17	47	0.84			
Avoided eating meat.	Home	2.31	48	1.42	2.001	47	0.051
	BBNP	2.17	48	1.43			
Encouraged other people to save energy.	Home	3.38	39	1.18	0.374	38	0.711
	BBNP	3.31	39	1.34			

Behaviour	Context	M	N	SD	Paired Samples T-Test		
					t	df	Sig.
Turned off the tap when brushing teeth.	Home	4.19	48	1.16	-0.893	47	0.377
	BBNP	4.27	48	1.18			
Eaten organic, locally-grown or in season food.	Home	3.27	52	0.79	0.697	51	0.489
	BBNP	3.17	52	0.92			
Bought products with less packaging	Home	3.45	47	0.85	0.799	46	0.429
	BBNP	3.32	47	0.98			
Taken short showers (less than 3 minutes long) or infrequent baths.	Home	2.91	46	1.03	-1.244	45	0.220
	BBNP	3.11	46	1.22			
Avoided wasting food (e.g. by using leftovers).	Home	4.29	49	0.82	-0.596	48	0.554
	BBNP	4.35	49	0.78			
Turned off lights when not in use.	Home	4.57	49	0.58	0.299	48	0.766
	BBNP	4.55	49	0.58			

**$p < .005$
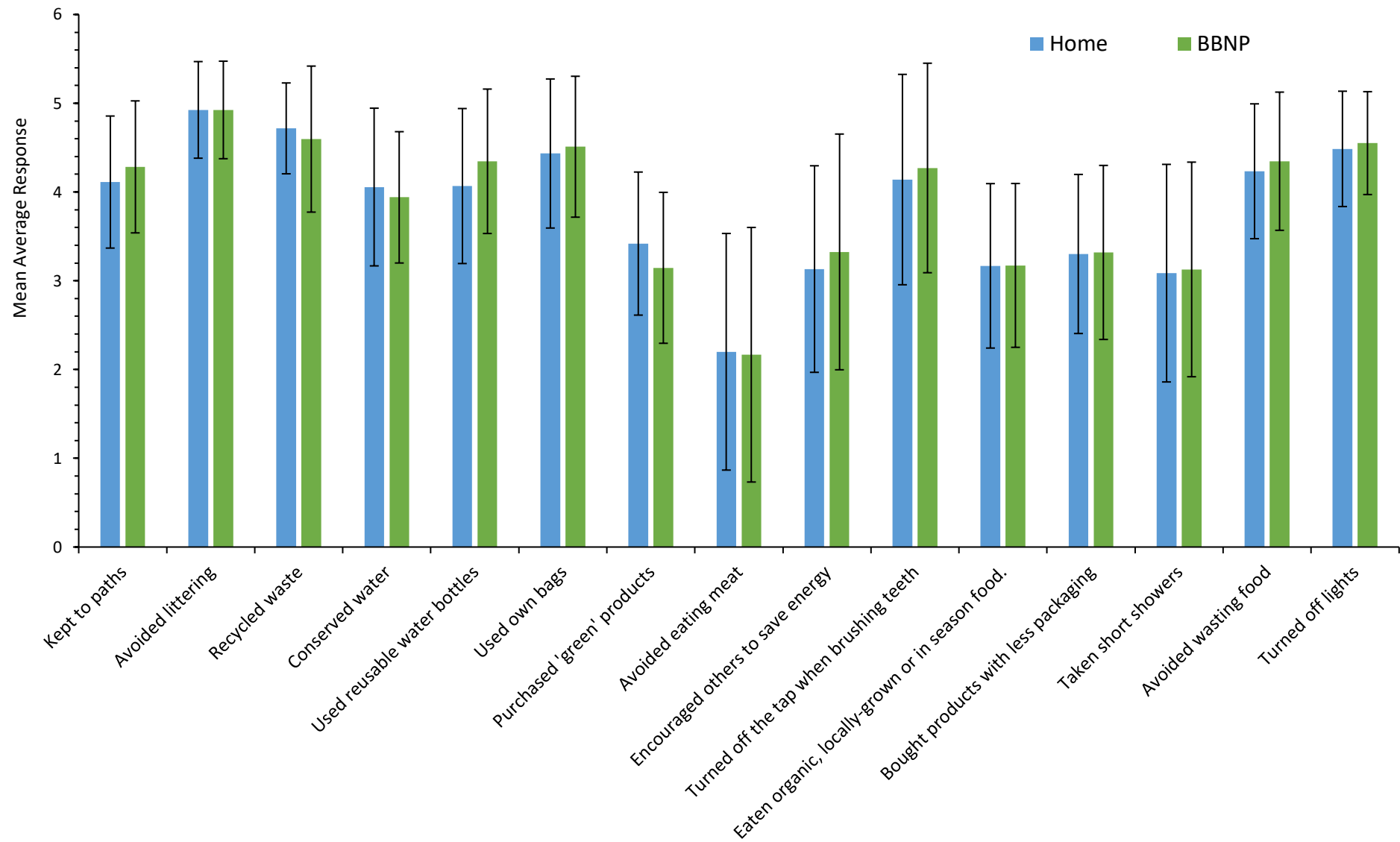
Figure 8 – Study One - Mean Average Response to "how often do you perform x behaviour at home" and "in the Brecon Beacons National Park". A higher score indicates behaviour is performed more frequently. Error bars represent *SD* .

Table 11 – Study One - Correlation Matrix Comparing Behaviours Between a Home and NP Context (significant correlations in **bold**, negative correlations in red)

Behaviour in a Home context	Behaviour in a Brecon Beacons National Park Context														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 - When walking, I kept to designated paths and trails.	**.495****	0.029	-0.072	0.244	0.201	0.107	-0.203	-0.182	0.001	-0.046	-0.158	-0.184	0.108	-0.064	-0.02
2 - Avoided littering (throwing rubbish on the street/path).	.b	.b	.b	.b	.b	.b	.b	.b	.b	.b	.b	.b	.b	.b	.b
3 - Recycled my waste (e.g. glass).	0.08	-0.051	0.264	-0.031	0.045	**.322***	-0.084	-0.178	-0.075	0.088	0.173	-0.023	0.147	0.225	0.033
4 - Conserved water.	0.057	-0.15	0.235	**.508****	0.242	0.269	0.155	0.041	0.065	**.296***	-0.032	0.141	0.231	**.342***	0.234
5 - Used reusable water bottles instead of single-use bottles.	0	0.064	0.177	-0.027	**.396****	**.327***	-0.013	-0.123	-0.064	0.002	0.262	-0.038	0.058	**.362***	0.008
6 - Used my own bags at the shops.	**.276***	0.193	**.284***	**.295***	0.162	**.310***	-0.035	-0.228	-0.07	**.429****	0.042	0.07	0.191	**.328***	0.252
7 - Purchased environmentally friendly products.	0.044	0.105	-0.104	0.238	0.031	0.018	**.558****	-0.044	0.159	0.15	0.204	0.182	0.062	**.308***	-0.012
8 - Avoided eating meat.	-0.029	-0.071	0.085	0	-0.027	0.092	0.115	**.937****	0.127	0.125	0.235	0.175	-0.039	-0.126	0.085
9 - Encouraged other people to save energy.	-0.237	-0.209	-0.082	**.343***	0.069	-0.071	0.159	0.162	**.487****	0.16	0.02	**.312***	0.122	0.06	0.051
10 - Turned off the tap when brushing teeth.	0.106	-0.097	0.115	**.382****	-0.06	0.136	-0.024	0.198	0.18	**.847****	-0.001	0.141	0.072	0.156	0.252
11 - Eaten organic, locally-grown or in season food.	-0.041	0.05	-0.016	-0.278	-0.096	0.18	0.243	-0.143	-0.037	0.027	**.336***	-0.24	0.137	0.169	-0.057

12 - Bought products with less packaging.	-0.2	-0.094	0.135	**.363****	0.058	0.102	0.258	-0.114	0.15	0.198	0.13	**.293***	0.261	**.320***	0.184
13 - Taken short showers (less than 3 minutes long) or infrequent baths.	-0.043	-0.139	0.244	**.428****	0.141	0.153	0.061	-0.023	0.034	0.026	0.109	0.19	**.559****	0.222	-0.016
14 - Avoided wasting food (e.g. by using leftovers).	-0.058	-0.118	0.118	0.201	0.193	0.17	0.083	-0.069	0.142	**.288***	0.244	0.174	**.336***	**.595****	0.201
15 - Turned off lights when not in use.	-0.048	-0.098	0.273	0.139	0.223	0.123	-0.047	0.214	-0.026	0.263	-0.163	0.184	-0.107	0.23	**.658****

.[b] cannot be computed because at least one of the variables is constant.

* $p < 0.05$ (2-tailed)

** $p < 0.01$ (2-tailed)

3.2.5.4 Behavioural Intention

A series of paired-samples t-tests were used to compare behavioural intention for home, post-visit, with past behaviours at home, pre-visit (see Table 12 for results of the paired-samples t-tests). Of the 15 behaviours, participants' intentions post-visit were significantly higher than self-reported behaviours pre-visit for eight of the behaviours. Intentions were significantly higher post-visit compared with pre-visit self-reported performance for: use reusable water bottles, use my own bags at the shops, purchase environmentally friendly products, avoid eating meat, encourage other people to save energy, eat organic or locally-grown food, buy products with less packaging, take short showers or infrequent baths and avoid wasting food. The results mean that hypothesis H_2 can be partially accepted, as participants' intentions to perform behaviours post-visit were greater than their self-reported behaviours pre-visit.

Table 12 - Study One - Results from a Series of Paired-samples t-tests Comparing Behaviours at Home pre-visit with Behavioural Intentions post-visit (continued next page)

Behaviour	Pre-visit			Post-visit			T-test		
	Mean	N	SD	Mean	N	SD	t	df	Sig (2-tailed)
When walking, I keep (kept) to designated paths and trails	5.00	52	.000	4.27	52	.819	-.819	51	.416
Avoid(ed) littering (throwing rubbish on the street/path)	5.00	52	.000	4.90	52	.569	1.218	51	.229
Recycle(d) my waste (e.g. glass)	4.85	52	.415	4.96	52	.194	-1.948	51	.057
Conserve(d) water	4.17	52	.785	4.39	52	.661	-1.906	51	.062
Use(d) reusable water bottles instead of single-use bottles	4.34	50	.745	4.58	50	.538	-2.585	49	**.013***
Use(d) my own bags at the shops	4.65	52	.480	4.73	52	.490	-.942	51	.351
Purchase(d) environmentally friendly products	3.57	51	.781	4.12	51	.683	-4.350	50	**.000****
Avoid(ed) eating meat	2.33	52	1.368	2.79	52	1.588	-2.822	51	**.007****
Encourage(d) other people to save energy	3.24	51	1.193	3.80	51	1.060	-3.124	50	**.003***

Behaviour	Pre-visit			Post-visit			T-test		
	Mean	N	SD	Mean	N	SD	t	df	Sig (2-tailed)
Turn(ed) off the tap when brushing teeth	4.25	52	1.118	4.37	52	1.010	-1.030	51	.308
Eat (eaten) organic, locally-grown or in season food	3.25	52	.764	4.08	52	.589	-7.153	51	**.000****
Buy (bought) products with less packaging	3.42	52	.848	4.14	52	.658	-5.746	51	**.000****
Take(n) short showers (less than 3 minutes long) or infrequent baths	2.98	52	1.038	3.69	52	1.058	-5.609	51	**.000****
Avoid(ed) wasting food (e.g. by using leftovers)	4.27	48	.818	4.63	48	.489	-3.861	47	**.000****
Turn(ed) off lights when not in use	4.60	52	.569	4.56	52	.725	.362	51	.719

*p < .05
**p < .005

3.2.5.5   Responsibility

Participants were asked "Who do you believe is most responsible for protecting and conserving the National Park?". Participants were required to rank from 1 (the most responsible) to 7 (least responsible). Frequency for first place and last place rankings can be seen in Figure 9. Overall, the BBNPA were ranked most frequently as most responsible. Local residents were most

Who do you think is most respnsible for protecting and conserving the Brecon Beacons National Park?
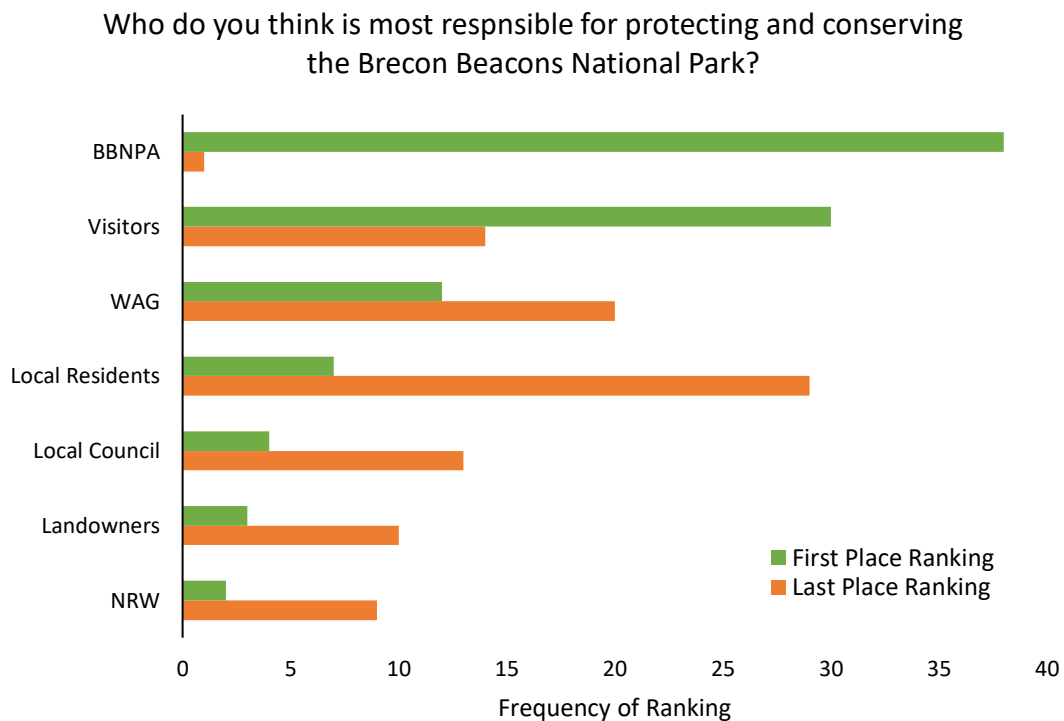
frequently ranked as least responsible.

Figure 9 – Study One – Frequency of First Place and Last Place Rankings

3.2.5.6   Responsibility and Behaviours

A series of independent samples t-tests were conducted to explore whether there was a difference in behaviours in a NP context between participants that ranked visitors as most responsible for protecting and conserving the NP and participants who did not rank visitors as the most responsible. No significant differences were found. An independent samples t-test also found no significant difference in PEBs between those that ranked visitors top in the responsibility and those that did not (see Table 13 for t-test results).

Table 13 - Study One - T-test Results for Responsibility Ranking Question (continued next page).

Behaviour	Visitors Ranked Most Responsible			Visitors Not Ranked Most Responsible			Levene's Test Sig.	*t*	df	*p*
	n	*M*	*SD*	*n*	*M*	*SD*				
When walking, I kept to designated paths and trails.	32	4.34	0.787	17	4.12	0.697	0.192	-0.994	47	0.325
Avoided littering (throwing rubbish on the street/path).	32	5.00	0.000	17	4.76	0.970	0.005	-1.000	16	0.332
Recycled my waste (e.g. glass).	32	4.69	0.592	16	4.56	1.031	0.253	-0.535	46	0.595
Conserved water.	30	3.83	0.791	17	4.06	0.659	0.586	0.994	45	0.325
Used reusable water bottles instead of single-use bottles.	32	4.22	0.906	16	4.56	0.629	0.188	1.359	46	0.181
Used my own bags at the shops.	30	4.60	0.724	15	4.33	0.976	0.114	-1.035	43	0.306
Purchased environmentally friendly products.	29	3.00	0.845	15	3.47	0.743	0.719	1.806	42	0.078

Behaviour	Visitors Ranked Most Responsible			Visitors Not Ranked Most Responsible			Levene's Test Sig.	t	df	p
	n	M	SD	n	M	SD				
Avoided eating meat	29	2.10	1.398	15	2.13	1.506	0.616	0.066	42	0.948
Encouraged other people to save energy	23	3.13	1.486	14	3.79	0.893	0.001	1.675	35	0.103
Turned off the tap when brushing teeth	30	4.23	1.357	15	4.53	0.516	0.025	1.067	41.095	0.292
Eaten organic, locally-grown or in season food	31	3.10	0.978	17	3.18	0.883	0.337	0.279	46	0.781
Bought products with less packaging	28	3.18	1.124	15	3.53	0.743	0.124	1.098	41	0.279
Taken short showers (less than 3 minutes long) or infrequent baths	29	3.10	1.263	14	3.14	1.099	0.959	0.100	41	0.921
Avoided wasting food (e.g. by using leftovers)	30	4.27	0.785	15	4.40	0.828	0.976	0.528	43	0.601
Turned off lights when not in use	29	4.59	0.568	16	4.63	0.500	0.461	0.820	43	0.228

3.2.5.7   Responsibility Thematic Analysis

In part one, participants were asked "what makes a responsible visitor to the Brecon Beacons?". A thematic analysis was conducted on the answers using NVivo (QSR International Pty Ltd., 2020). Several participants were removed from the sample as they did not answer the question ($N = 99$).

Several themes emerged during analysis of the answers (see Table 14 for theme frequencies). By the far the most common theme was "respecting the environment". The theme of "rules" was the second most occurring theme; alongside referring to the Countryside Code individuals frequently mentioned more 'common-sense' rules or heuristics, such as "take only photos, leave only footprints". Waste behaviours were also specifically mentioned by around half the participants, with individuals noting that not leaving waste, litter or rubbish was a key feature of a responsible visitor.

Table 14 - Study One - Theme Frequency for Responses to "What makes a responsible visitor to the Brecon Beacons?" (continued on next page)

Theme	Identified when…	Examples	Frequency
Respecting the Environment	Individuals refer to being respectful to the natural world	*Being respectful of the environment* *To be respectful to nature…* *Respect the wildlife*	47
Waste Behaviours	Specific reference to waste/litter	*Cleaning up after yourself* *People who take their rubbish home!* *No littering*	33
Rules	Actual rules, such as the countryside code but also turn of phrases and local rules	*Take only photos, leave only footprints* *Leave it as you found it* *Follow countryside Rules*	26
Respecting People	Responses referring to being friendly or respectful to other people	*Respect shown to local people…* *Manners and consideration of others, kindness* *…consideration for others*	9

Theme	Identified when…	Examples	Frequency
Appreciation & Enjoyment	An individual references enjoyment	*Enjoy the opportunity of seeing beautiful scenery*	
		…enjoys the opportunity of seeing beautiful scenery	7
		Appreciation of the landscape and its significance	
Living Landscape	Comments are made about the fact the BBNPA is a working & living landscape	*Respect shown to local people…*	
		…supporting local business	7
		Respect for the farmers…	
Other & Miscellaneous	Responses that did not fit into any clear theme	*Driving carefully*	
		Freedom	7
		Pay parking fees	

Predicting Consistency across Contexts. A difference score was computed for the PEBs, which involved subtracting the score for behaviours in a home context from behaviours in a national park context, to measure behavioural consistency across contexts and test H$_3$.

A series of standard multiple regressions were conducted (see

Behaviour	Regression Model (Predictors)	Predictor Parame

		Beta (standardised)	*t*
When walking, I kept to designated paths and trails.	Green Identity	.102	.621
	Nature Relatedness	-.092	-.574
	Place Attachment for Home	-.094	-.601
	Place Attachment for National Park	-.169	-1.043
	NEP Score	-.087	-.512
	PBC Home	**.150**	.967
	PBC National Park	-.044	-.270
Avoided littering (throwing rubbish on the street/path).	Green Identity	.184	1.272
	Nature Relatedness	.210	1.501
	Place Attachment for Home	-.239	-1.743
	Place Attachment for National Park	-.051	-.356
	NEP Score	.026	.174
	PBC Home	**-.264**	-1.946
	PBC National Park	.078	.542
Recycled my waste (e.g. glass).	Green Identity	.020	.140
	Nature Relatedness	-.010	-.071
	Place Attachment for Home	.181	1.346
	Place Attachment for National Park	.009	.065
	NEP Score	**-.368**	-2.510
	PBC Home	-.329	-2.466
	PBC National Park	.283	2.016
Conserved water.	Green Identity	-.084	-.539
	Nature Relatedness	-.336	-2.227
	Place Attachment for Home	-.212	-1.434
	Place Attachment for National Park	-.119	-.776
	NEP Score	**.401**	2.487
	PBC Home	.034	.229
	PBC National Park	-.121	-.784

Table 15 for multiple regressions table), to examine whether behavioural consistency could be predicted by Green Identity, Place Attachment, Nature Relatedness, New Ecological Paradigm and Perceived Behavioural Control. As no significant change was found for any of the measures, except Green Identity, the first recorded score for each participant (from part one) was used. For consistency, the first recorded score was used for Green Identity.

Checking for multicollinearity, there were no bivariate correlations above .7, tolerance values below .10 or variance inflation factor (VIF) values exceeding 10 – indicating little to no multicollinearity between independent variables. In checking for outliers, no scores had a Mahalanobis distance exceeding the critical value for seven independent variables of 24.32 (Pallant, 2010).

None of the models explain the variance for behaviours to a significant level. Observing the adjusted R^2 values, the model with the highest explanation of variance is for 'recycled my waste' with the model predicting 23.3% of variance.

Looking at the Beta values and the significant values (column marked Sig.), some of the variables make significantly unique contributions to the equations. NEP score, perceived behavioural control at home, Nature Relatedness, Place Attachment for National Park, Green Identity and perceived behavioural control in the NP made at least one significant unique contribution to the prediction to at least one behaviour. Place attachment for home was the only variable to not make a statistically significant unique contribution to any of the behaviours. As such, H_3 can be partially accepted, as the factors mediated behavioural consistency for some, but not all, of the behaviours.

3.2.5.8 Other Factors

There were no significant differences for behavioural consistency when controlling for income, education level, visitor type, duration of visit or recruitment channel.

3.2.5.9 Perceived Behavioural Control across Contexts

Exploring other factors that may play a role in mediating behaviours, perceived behavioural control was measured for both a home and a national park context. A paired samples t-test was conducted to measure if there was any significant difference in perceived behavioural control between contexts. There was a significant difference in PBC in a home context ($M = 3.91$, $SD = .714$) and in a national park context ($M = 2.08$, $SD = .874$); $t(52) = -10.78$, $p = .000$. Participants had higher perceived behavioural control in a home context than in a national park context.

3.2.5.10 Changes in Attitudes

The results indicate a significant change only in Green Identity, with individuals showing a higher Green Identity post-visit ($M = 1.83$, $SD = 0.75$) compared to pre-visit ($M = 1.16$, $SD = 1.02$); $t(52) = -6.079$, $p = .000$. No significant result was found for Nature Relatedness pre-visit ($M = 1.054$, $SD = .587$) and post-visit ($M = 1.05$, $SD = .590$); $t(51) = -1.583$, $p = .120$, meaning that H_4 can be rejected.

Table 15 - Study One - Multiple Regressions for Behaviours. Significant values in **bold***. Largest Beta value in red

Behaviour	Regression Model (Predictors)	Predictor Parameters			Model Parameters	
		Beta (standardised)	*t*	Sig.	F	Adj. R^2
When walking, I kept to designated paths and trails.	Green Identity	.102	.621	.538	.600	-.057
	Nature Relatedness	-.092	-.574	.569		
	Place Attachment for Home	-.094	-.601	.551		
	Place Attachment for National Park	-.169	-1.043	.302		
	NEP Score	-.087	-.512	.611		
	PBC Home	**.150**	.967	.339		
	PBC National Park	-.044	-.270	.788		
Avoided littering (throwing rubbish on the street/path).	Green Identity	.184	1.272	.210	2.706	.187
	Nature Relatedness	.210	1.501	.140		
	Place Attachment for Home	-.239	-1.743	.088		
	Place Attachment for National Park	-.051	-.356	.724		
	NEP Score	.026	.174	.863		
	PBC Home	**-.264**	-1.946	.058		
	PBC National Park	.078	.542	.590		
Recycled my waste (e.g. glass).	Green Identity	.020	.140	.889	3.214	.233
	Nature Relatedness	-.010	-.071	.943		
	Place Attachment for Home	.181	1.346	.185		
	Place Attachment for National Park	.009	.065	.949		
	NEP Score	**-.368**	-2.510	**.016***		
	PBC Home	-.329	-2.466	**.018***		
	PBC National Park	.283	2.016	.050		
Conserved water.	Green Identity	-.084	-.539	.592	1.854	.109
	Nature Relatedness	-.336	-2.227	**.031***		
	Place Attachment for Home	-.212	-1.434	.159		
	Place Attachment for National Park	-.119	-.776	.442		
	NEP Score	**.401**	2.487	**.017***		
	PBC Home	.034	.229	.820		
	PBC National Park	-.121	-.784	.437		

Behaviour	Regression Model (Predictors)	Predictor Parameters			Model Parameters	
		Beta (standardised)	t	Sig.	F	Adj. R^2
Encouraged other people to save energy.	Green Identity	.144	.767	.449	.936	-.012
	Nature Relatedness	-.047	-.259	.797		
	Place Attachment for Home	-.296	-1.659	.107		
	Place Attachment for National Park	**.345**	1.855	.073		
	NEP Score	-.074	-.380	.707		
	PBC Home	.195	1.098	.281		
	PBC National Park	.117	.625	.537		
Turned off the tap when brushing teeth.	Green Identity	**-.375**	-2.258	**.029***	1.186	.027
	Nature Relatedness	-.146	-.907	.370		
	Place Attachment for Home	-.041	-.258	.798		
	Place Attachment for National Park	.087	.529	.600		
	NEP Score	.085	.496	.623		
	PBC Home	-.101	-.648	.521		
	PBC National Park	-.026	-.156	.877		
Eaten organic, locally-grown or in season food.	Green Identity	-.026	-.171	.865	2.182	.140
	Nature Relatedness	**.322**	2.221	**.032***		
	Place Attachment for Home	-.251	-1.762	.085		
	Place Attachment for National Park	-.093	-.625	.535		
	NEP Score	-.226	-1.457	.152		
	PBC Home	-.010	-.068	.946		
	PBC National Park	.233	1.567	.124		
Bought products with less packaging.	Green Identity	-.159	-.901	.373	.581	-.068
	Nature Relatedness	.147	.863	.393		
	Place Attachment for Home	**-.253**	-1.517	.137		
	Place Attachment for National Park	.006	.034	.973		
	NEP Score	.042	.232	.818		
	PBC Home	-.069	-.416	.680		
	PBC National Park	-.107	-.613	.544		

Behaviour	Regression Model (Predictors)	Predictor Parameters			Model Parameters	
		Beta (standardised)	t	Sig.	F	Adj. R^2
Taken short showers (less than 3 minutes long) or infrequent baths.	Green Identity	.002	.010	.992	1.253	.038
	Nature Relatedness	.173	1.060	.296		
	Place Attachment for Home	.225	1.408	.167		
	Place Attachment for National Park	.078	.466	.644		
	NEP Score	-.227	-1.298	.202		
	PBC Home	-.194	-1.221	.230		
	PBC National Park	**.279**	1.666	.104		
Avoided wasting food (e.g. by using leftovers).	Green Identity	-.327	-2.086	**.043***	1.914	.118
	Nature Relatedness	-.157	-1.037	.306		
	Place Attachment for Home	.003	.018	.985		
	Place Attachment for National Park	-.298	-1.933	.060		
	NEP Score	.381	2.346	**.024***		
	PBC Home	-.114	-.775	.443		
	PBC National Park	**-.404**	-2.595	**.013***		
Turned off lights when not in use.	Green Identity	.006	.032	.974	.535	-.073
	Nature Relatedness	-.196	-1.171	.248		
	Place Attachment for Home	.028	.172	.864		
	Place Attachment for National Park	-.180	-1.057	.297		
	NEP Score	**.277**	1.546	.130		
	PBC Home	.049	.303	.764		
	PBC National Park	.028	.164	.870		

Behaviour	Regression Model (Predictors)	Predictor Parameters			Model Parameters	
		Beta (standardised)	*t*	Sig.	F	Adj. R^2
Used reusable water bottles instead of single-use bottles.	Green Identity	-.174	-1.039	.305	.632	-.054
	Nature Relatedness	.156	.963	.341		
	Place Attachment for Home	-.101	-.637	.527		
	Place Attachment for National Park	-.031	-.186	.853		
	NEP Score	-.137	-.786	.436		
	PBC Home	-.175	-1.111	.273		
	PBC National Park	**-.226**	-1.359	.181		
Used my own bags at the shops.	Green Identity	.030	.172	.864	.385	-.098
	Nature Relatedness	.062	.369	.714		
	Place Attachment for Home	-.023	-.136	.893		
	Place Attachment for National Park	**.257**	1.490	.144		
	NEP Score	-.117	-.646	.522		
	PBC Home	.031	.188	.852		
	PBC National Park	.029	.170	.866		
Purchased environmentally friendly products.	Green Identity	-.115	-.715	.479	1.755	.103
	Nature Relatedness	.093	.594	.556		
	Place Attachment for Home	-.109	-.714	.480		
	Place Attachment for National Park	.087	.547	.587		
	NEP Score	**-.487**	-2.914	**.006****		
	PBC Home	-.066	-.437	.664		
	PBC National Park	-.156	-.975	.336		
Avoided eating meat.	Green Identity	-.008	-.050	.960	1.408	.057
	Nature Relatedness	-.153	-.966	.340		
	Place Attachment for Home	.051	.329	.744		
	Place Attachment for National Park	**-.413**	-2.558	**.014***		
	NEP Score	.246	1.451	.155		
	PBC Home	-.008	-.050	.960		
	PBC National Park	.088	.544	.589		

*$p < .05$

** $p < .005$

3.3   Discussion of Study One

3.3.1   Main Findings

The results of the study reveal some insights into consistency of behaviours across contexts. The study also reveals several methodological issues and flaws with on-site data collection, and highlights the issue of studying cross-contextual behaviour change, especially between a transient context (the National Park) and a more permanent one (home).

In response to research question one, 'Do environmental behaviours and attitudes change across contexts, between home and the National Park?' results reveal that within each separate context, some behaviours significantly correlated. Principal component analysis (PCA) conducted on data for behaviours at home found emerging behavioural clusters: home consumption and everyday behaviours (see

Table 16 for the clusters and the behaviours within them). A third component was also discovered but the components did not appear to be clustered. This means we can partially accept H_1: behaviours correlate to some extent within contexts. However, these findings also highlight the need for further research to better define and explore the emerging behavioural clusters. Previous research has found defined behavioural clusters, in which behaviours are closely linked and fall into a behavioural category (e.g., travel behaviours, resource consumption behaviours or home consumption behaviours (Barr et al., 2005; Lynn, 2014; Thøgersen, 2004). Our research indicates such clusters may form within a static (home) context, but not within a more transient (NP) one.

Between contexts, one significant difference in frequency of performance for behaviours was found. The results indicated that participants reported purchasing environmentally friendly products more often in a home context than in a NP context. Many of the behaviours correlated across contexts. This is surprising to an extent, as previous research has suggested individuals will reduce their PEBs across contexts, especially from a home to a holiday context (Whitmarsh et al., 2018). The findings suggest that most PEBs are being performed across contexts, with most individuals reporting that they perform the behaviours most of the time.

Comparisons between day visitors and other visitors were expected to show differences in performance of the behaviours that could be classed as home behaviours like 'turned off the taps when brushing teeth'. However, even though day visitors probably wouldn't have brushed their teeth or turned off lights during their stay, no such difference occurred, with day visitors reporting

that they performed all the behaviours to the same degree to other visitors. This may be explained through social desirability, a common issue with self-report methods (Holtgraves, 2004). It may also highlight an issue with interpretation. Participants may simply think back to the last time they brushed their teeth (which may have been at home, for day visitors) and then answering questions based on this. There was an option for "not at all" but not an option for "I did not brush my teeth" for example. It highlights an issue with using self-report measures and when combined with the low sample size in this study, may indicate a false positive result.

Table 16 – Study One - Broad Behavioural Clusters Identified During Principal Component Analysis for 'Behaviours in a Home Context'.

Cluster	Behaviour
Everyday Behaviours	When walking, I kept to designated paths and trails.
	Avoided littering (throwing rubbish on the street/path).
	Recycled my waste (e.g. glass).
	Conserved water.
	Used reusable water bottles instead of single-use bottles.
	Used my own bags at the shops.
	Purchased environmentally friendly products
	Avoided eating meat
	Turned off the tap when brushing teeth
	Eaten organic, locally-grown or in season food
	Bought products with less packaging
Undefined	Used my own bags at the shops
	Encouraged other people to save energy
	Avoided wasting food (e.g. by using leftovers)
Home Consumption	Taken short showers (less than 3 minutes long) or infrequent bath
	Avoided wasting food (e.g. by using leftovers)
	Turned off lights when not in use

Despite this, the reason that behaviours may have remained consistent across contexts may be because overnight visitors were staying in accommodation which was similar to a typical home context. Thus contexts may not have changed to such a degree that it elicited behaviour change. Previous research has highlighted that behaviours that are in similar clusters are more likely to elicit behavioural consistency (Thøgersen, 2004). This may highlight why behaviours that are identical or require the same equipment (e.g., toothbrush) remain consistent, despite being performed in different contexts (Snively, 2004; Littleford et al., 2014).

The lack of any significant difference in performance of behaviours across contexts is at odds with the finding that participants reported significantly lower PBC in a national park context compared with a home context. Previous work has found that PBC can play a significant role in PEBs, but the findings here found that PBC did not mediate behaviours.

When investigating H_2, results indicate that post-visit behavioural intentions were greater than pre-visit self-reported performance, for some behaviours. However, this was only the case for just over half of the behaviours. This means we can partially accept H_2, as PEB did increase post-visit (as measured with behavioural intention), but only for eight of the fifteen behaviours: use reusable water bottles, use my own bags at the shops, purchase environmentally friendly products, avoid eating meat, encourage other people to save energy, eat organic or locally-grown food, buy products with less packaging, take short showers or infrequent baths and avoid wasting food. The results mean that hypothesis H_2 can be partially accepted, as participants' intentions to perform behaviours post-visit were greater than their self-reported behaviours pre-visit.

These findings are also in contrast to other research, which has found that visiting nature-based contexts can lead to an increase in PEBs (Ballantyne et al., 2009, 2011; Powell et al., 2012; Powell & Ham, 2008). This may be due to the fact that the effect from visiting the NP alone was not a strong enough intervention in itself, and previous research has often investigated education programs and interpretation paired with visits to a natural site, which could explain the lack of an effect in this study (Dearden et al., 2007; Orams, 2002).

H_3 – behaviours will be mediated by Green Identity, New Ecological Paradigm, PBC, and Nature Relatedness scale score – is partially accepted, as results indicate that none of the predictors (NEP, NR-6, PBC, and Green Identity) were able to predict all the behaviours. However, all of them predicted consistency across contexts for at least one behaviour. This could be due to

the low sample size, with low power meaning that the full extent of the predictors could not be detected. This does not align with previous research, where these predictors predicted most PEBs. Additionally, none of the predictors predicted the two additional / novel behaviours which have not been previously researched ("when walking I keep to designated paths and trails" and " I avoided littering"). This may indicate that participants did not interpret these behaviours in the intended way.

The results found that only Green Identity changed post-visit, with a significant increase in Green Identity score post-visit for participants. The results mean that H_4 is rejected – Nature Relatedness will increase post-visit to the BBNP – as only Green Identity increased post-visit. This is in contrast to previous work, which has found that Nature Relatedness increases after exposure to nature-based contexts (Wheaton et al., 2016). The fact that these findings do not support previous research may be due to the low sample size. The low statistical power may mean that any differences were simply not detected. However, this may also be due to the fact that research into nature-relatedness, and indeed much of the research into visits to nature-based contexts, is conducted in State and NPs in the United States, which are vastly different to UK NPs, offering genuinely wild and natural experiences, compared to the UK (Kendall, 2015; Monbiot, 2018a; Rowe, 2020). Contrastingly, results indicated that visiting the national park led to a significant increase in green identity post-visit. This is important as it suggests that individuals may be more susceptible to interventions aimed at changing PEBs post-visit or during visits, rather than before visits, which is in line with previous research (Dearden et al., 2007).

3.3.2   Exploratory Findings

The addition of several exploratory analyses allowed for some insight into the attitudes of visitors towards responsibility in the National Park. When investigating attitudes towards the responsibility of visitors in the BBNP, thematic analysis revealed that many visitors thought that respecting the environment was the main trait of a responsible visitor. This was closely followed by waste behaviours, with participants suggesting that not littering was a key trait of a responsible visitor. This is consistent with much previous research on PEB which indicates that being pro-environmental is strongly associated in people's minds with reducing waste, despite recycling and other waste-reduction practices being less effective in reducing environmental impact than other PEBs like cutting car use (e.g. Whitmarsh, 2009).

The ranking question asked participants who they believed was most responsible for protecting and conserving the Brecon Beacons National Park. The results revealed that over half the participants believed that the BBNPA were most responsible for protecting and conserving the National Park. However, who participants ranked as most responsible for conserving or protecting the BBNP did not predict PEBs, with no difference between participants who ranked visitors as most responsible and those who did not, for example. The fact that most visitors ranked the BBNPA as most responsible for conserving and protecting the NP is interesting. The perception from the public that the BBNPA are most responsible contrasts with the powers and ownership of land that the BBNPA have. The BBNPA own around 20% of the land in the National Park, with the rest largely privately owned by landowners and farmers. Much of the BBNPA management strategies place responsibility onto visitors, but this may be at odds with visitor perceptions. There appears to be a lack of awareness as to how the BBNPA operates, and this may well lend itself to further investigation. If, for example, the majority of individuals believe that the BBNPA own the majority of land in the BBNP, this may then lead to reactance to messaging from the BBNPA (Sussman and Gifford, 2012).

3.3.3   Methodological Issues

The study had several methodological issues. A low sample size is one of the largest issues with the data. Advertisements on some of the online channels were not sent out until four weeks prior to the study finishing; this distribution was out of the researcher's control. This distribution channel was expected to be one of the best recruitment channels and indeed, whilst it ran for only 4 weeks, around 40% of the total participants were recruited through this channel. Whilst an attrition rate of 51.4% for the study is relatively high, the fact that initial recruitment for part one of the study was low (n_1 = 107) meant that part two (n_2 = 52) was severely underpowered.

The second major limitation of the study is the reliance on self-report measures, rather than actual behaviours. Measuring actual behaviour was outside of the scope of the research, with actual behavioural measurements having higher costs both financially and in time, than self-report measures. However, this study highlights some of the issues associated with self-report measures. Social desirability bias in particular can be an issue with self-report. When asking participants if they littered whilst in the BBNP the majority answered that they never littered (M = 4.92). However, we know from GPS logging of litter of sites across the Brecon Beacons National Park, and from the

BBNPA that litter is an issue across the BBNP. Almost certainly, some of the participants would have littered whilst visiting the BBNPA. Littering is a behaviour that is socially undesirable, and one that is important to participants in the study, as evidenced by the high frequency of participants who mentioned littering/waste in the open-ended question 'what makes a responsible visitor to the Brecon Beacons National Park?'.

Whilst the self-report measures offer relatively fast data collection and are effective at collecting data on a wide variety of behaviours, there is a clear need for new methods to be developed to measure behaviours, particularly for behaviours performed within the NP.

3.3.4   Considerations for Future Research

Investigating the PEBs of individuals across contexts is difficult, as highlighted in Study One. Some of the methodological issues highlighted can be overcome by changing methods, recruitment channels and measures, although these come with caveats. Recruitment is one of the largest issues with Study One, which suffered from a small sample size and, subsequently, low power. The recruitment method that was both the most reliable and allowed for recruitment of individuals prior to their trip was through advertisement online, both on social media pages and through the customer base of a holiday lettings agency. However, recruiting through social media limits the sample to individuals who are on those specific social media pages. Recruiting through the holiday lettings agency limits the sample to individuals who are having an overnight trip to the Brecon Beacons National Park, which means that day-trippers and overnight visitors not staying in a holiday home would not be recruited. Additionally with the Holiday Lettings Agency, controlling when advertisements go out is beyond the control of the researcher.

The mixed recruitment approach used in Study One allows for a broader sample but recruiting on-site means that the self-report measures for behaviours at home are being posed to participants who are already in the BBNP and may not have been home for a prolonged period. Within environmental psychology, a host of studies have investigated actual behaviour of individuals in a home context: measuring water consumption during showering to kerbside recycling. Measuring individual behaviours can be relatively easy (Martiskainen and Ellis, 2011; McCoy and Lyons, 2017; Miliute-Plepiene et al., 2016). Measuring behaviours in a nature-based context is also possible, however, objectively measuring behaviours across contexts is not and thus

the majority of research relies on self-report measures (Cialdini, 2003; P. Wesley Schultz et al., 2013; Verfuerth et al., 2019). Taking water consumption during a shower as an example, participants would be required to have a measuring device fitted both at home and in the holiday letting they are staying in. This is not impossible; however, this kind of study would be more obtrusive and far more time-consuming and costly than a study using self-report measures.

Much research into cross-context behaviour change has looked at domestic behaviours in a home context. Consumption, travel, waste behaviours and more general PEBs are often similar or shared across contexts; such as between home and workplace contexts, or home and holiday contexts (Barr et al., 2010; Verfuerth et al., 2019). It is important to note that studies investigating behaviours across home and nature-based contexts need to measure behaviours that are context-specific, meaning that comparisons are difficult.

In contrast to other contexts, behaviours in nature-based contexts are often dissimilar to behaviours in a home context. Behaviours such as 'going off path' or 'disturbing wildlife' are context-specific and cannot be compared directly to home behaviours. Conversely, many of the PEBs that occur in a home context may never occur in nature-based contexts, especially if visitors are not staying overnight in the nature-based context; recycling, purchasing of environmentally friendly products, switching off lights, energy and water consumption and other domestic behaviours may never occur in a nature-based context.

Most research investigating environmental behaviours has focused on PEBs relating to consumption and energy behaviours, rather than pro-conservation or pro-nature behaviours. Recent research investigating a broader range of environmental behaviours have attempted to explore pro-conservation behaviours. However, the pro-conservation behaviours explored in the research also included broad behaviours that do not apply to nature-based contexts (Richardson et al., 2020).

To allow proper comparison of behaviours between home and nature-based contexts, Study One study recruited participants who were staying in holiday lettings, where more typical domestic behaviours (recycling, energy usage etc.) were more likely to occur. However, a clear issue with this method is that by asking participants about their behaviours in a holiday letting, they are essentially reporting their behaviours in a domestic context that is not their home, rather than a true nature-based context.

3.3.5   Conclusions

The results and issues raised by Study One indicate that future studies need to recruit larger samples, use an objective measure of behaviour, and have a focus on specific behaviours related to nature-based contexts. Whilst the study suffers from low power, the findings do warrant further research and will aid in the development of interventions for future work.

The fact that behavioural intentions increased, compared to past-behaviours, suggests that visits to the BBNP may influence behavioural intention. This indicates that the visit itself may act as an intervention, and suggests that future work could look at the impact of visits alone on PEBs. The study also highlights a need to pursue comparison studies between visitors and non-visiting control groups. The significant increase in green identity scores, post-visit, may indicate that visiting the NP increases Green Identity. However, a comparison between visitors and a non-visiting control group would need to be conducted to establish if it were the visit that contributed to a change in green identity or a confounding variable.

Overall, the study highlights the difficulty in collecting data in nature-based contexts. Issues like seasonal variations in visitor numbers mean that recruitment is easiest during spring and summer but much harder during autumn and winter. With the benefit of using a variety of recruitment channels, the recruitment issue may be overcome. The vast difference between what behaviours are possible to perform for day visitors and overnight visitors means that testing true nature-based context behaviours is difficult. Finally the study highlights the necessity for research investigating PEBs and EDBs in a nature-based context with objective measures. Chapter Four, which follows, presents a study utilising behavioural mapping as a possible tool to objectively measure behaviours in a nature-based context.

3.4   Summary

This thesis will investigate behaviour change across a home and national park context, with a series of studies that investigate the behaviour of visitors to the BBNP and investigate cross-contextual behaviour change. Furthermore, the thesis will present a series of studies that aim to measure an environmentally damaging behaviour, littering, objectively within the National Park.

Moreover, the research will test the effectiveness of interventions in the National Park. The research aims to provide insight into the potential behavioural spillover effects of interventions targeting visitors to the NP.

Despite being highlighted by Ramkissoon et al. (2012) nearly a decade ago, there has been little focus on the spillover effects and cross-contextual behaviour change between home and nature-based contexts, or even behaviour change more generally within nature-based contexts. Research has identified the factors and mediators at play within contextual behaviour change, and has explored behavioural spillover, between home, workplace and holiday contexts, but there is a real need to focus on these within nature-based contexts (Esfandiar et al., 2022; Ramkissoon et al., 2012).

Methods to measure environmental behaviours, behaviour change and spillover vary greatly. Researching behaviour change across a nature-based and home context provides the opportunity to utilise existing methods, as well as to develop and test new methods. Additionally, collaboration with the BBNPA offers an interesting path for research in the field, providing the chance to develop interventions and research methods which could have lasting impact. It will also provide insights into how researchers can work with practitioners to develop collaborative research projects in the future. This collaboration, and the necessity to research within a specific geographical area, also presents unique research challenges.

4   Chapter 4 – Behavioural Mapping & Interventions to Reduce EBDs

4.1   Introduction

Study One investigated cross-contextual environmental behaviour and attitude change. The findings from the study suggested that behaviours were consistent between a home and national park context. However, the findings were limited by low sample size and power. Also, the study did not utilise any objective measures of behaviour. As discussed previously, there has been little research that has attempted to investigate behaviours in a nature-based context (Barr et al., 2010; Ramkissoon et al., 2012).

Chapter Four presents three empirical studies which aim to measure the behaviour of visitors to the BBNP, using objective measures. First, a feasibility study provides insight into the effectiveness of behavioural mapping techniques, utilising GPS logging to measure the extent of litter across two sites in the BBNP. Building on the feasibility study, Study Two uses these behavioural mapping methods to measure the effectiveness of an intervention designed to reduce dog fouling. Finally, Study Three outlines a message framing intervention-study, conducted on-site in the BBNP, that measures the effectiveness of different message framing on litter.

The studies in this chapter do not investigate attitudes of visitors. Indeed, the studies do not recruit participants or use self-report measures at all, but rather use behavioural observations. The purpose of the studies is to test the effectiveness of behavioural mapping as an objective measure of EDBs, and of the second and third studies to test the effectiveness of interventions. As mentioned in Chapters One and Two, the BBNPA do not currently empirically measure the effectiveness of interventions. Developing a methodology that they can use to test the behaviour of visitors to sites is important – as it will form the foundation for future research and inform the BBNPA management plan.

4.1.1   Behavioural Mapping & Tracking

The BBNPA log incidents of EDBs and criminal activity, such as burnt-out cars, fly-tipping and livestock worrying. However, wardens report issues through a variety of channels, and no database is used to collate reports (J. Pimm (BBNPA Warden), personal communication, August, 2020). The BBNPA currently direct resources to areas known to have the most issues, based on anecdotal and

warden reports; very few objective measurements of EDBs are used by the BBNPA within the BBNP. One notable exception to this are the previously mentioned Llangattock Litter Pickers (see Chapter 1, section 1.2.3), who run litter-picks on roadside verges near Crickhowell (Llangattock Litter Pickers, 2021b). The group conduct litter-picks and log the type and weight of litter collected, using this to help highlight the issue of roadside litter in the BBNP as well as to keep the roadsides cleaner[12].

Adopting new methods like this to measure behaviours is necessary to fully understand the behaviour of visitors to the BBNP. Study One used self-report measures to investigate the behaviour of visitors in the BBNP, but there are clear limitations to self-report measures, as outlined previously. In terms of behaviours in a NP context, self-report measures cannot reliably inform practitioners or researchers of either the true frequency or location of EDBs.

Behavioural mapping has been used to address some of the issues associated with self-report measures. The technique is used in environmental psychology and other fields to record an individual's behaviours and movement in a specific location and, often, at a specific time (Fan Ng, 2016). The technique involves an observer either covertly or overtly observing individuals as they move around spaces, and documenting their behaviours. In addition to simply counting frequency of behaviours though, mapping also provides location data, which is then used to 'map' where behaviours occur. It has been used in investigations in many different locations and settings, from aquarium usage to behaviours in public squares (Hampton et al., 2015; Yalowitz & Bronnenkant, 2009). The technique, whilst useful for enclosed areas that are easily observed either via electronic tracking or with observers stationed watching the location, requires an observer to be able to record the movement and behaviour of individuals whilst they use a space. The output differs from typical data gained from frequency counts of behaviours. For example, Figure 10 – Example of a Behavioural Map, from shows a behavioural map from a study investigating doctors and nurses movements in a hospital ward (Guinther & Carll-White, 2014). These maps allow for richer understanding of behaviours, as well as the chance to inform interventions.

The method was originally fairly limited to smaller areas and indoor spaces, which were easily observed by either cameras or researchers. Additionally, these methods also ran the risk of being overt, meaning that participants would know they were being observed and thus could

---

[12]The researcher contacted the organiser for the Llangattock Litter Pickers and suggested a collaboration between their work and the thesis research. The Llangattock Litter Pickers were unable to collaborate.

reduce the ecological validity. That was until recent advancements in GPS and camera devices, which allow for "remote" behavioural mapping and analysis of individuals (Fan Ng, 2016).
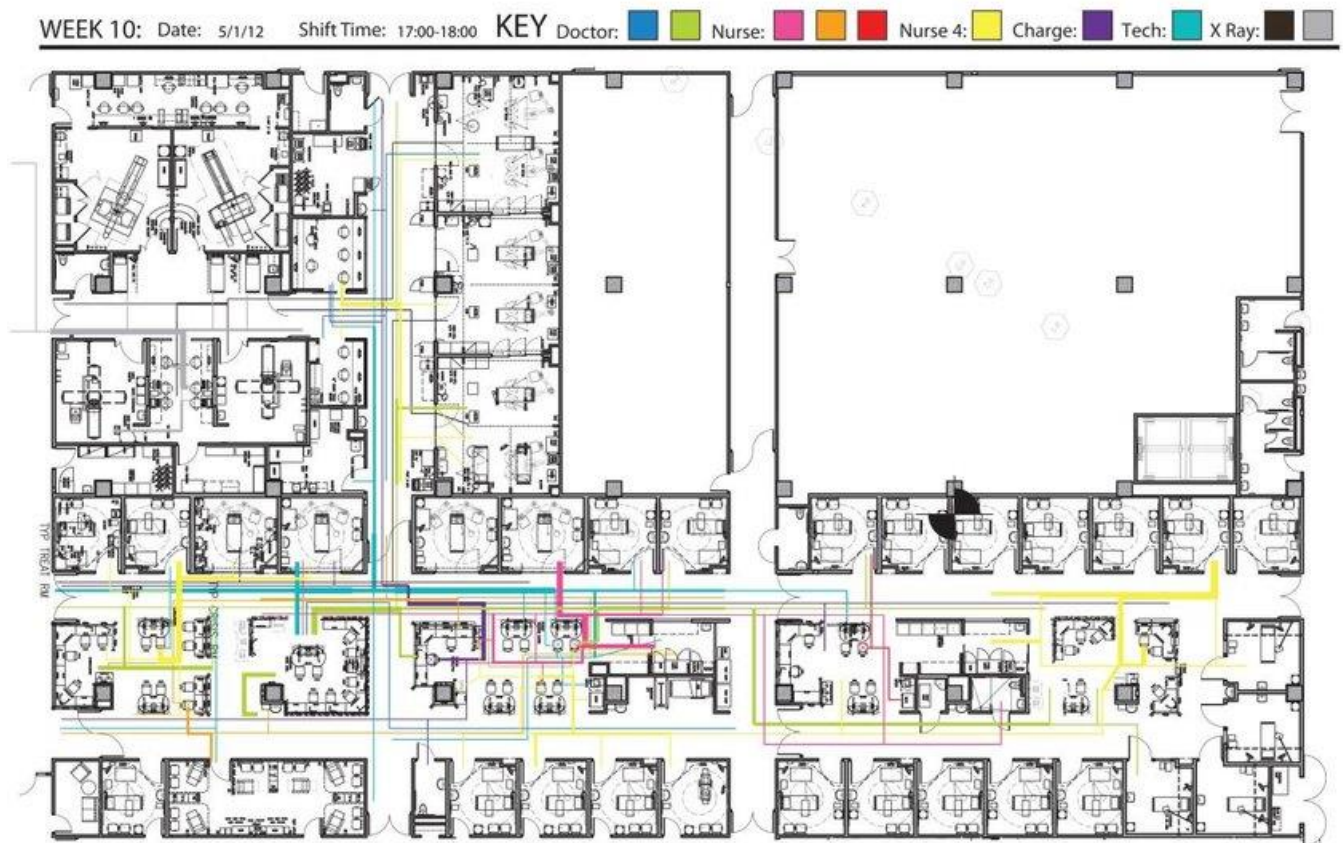
Figure 10 – Example of a Behavioural Map, from Guinther and Carll-White (2014)

Whilst not used extensively in the field of environmental psychology, behavioural mapping has been shown to be an effective way to explore the behaviours of individuals who are in nature-based contexts, and successfully implemented in larger areas. Work from Smith and Dunkley (2018) utilised GPS enabled cameras to observe the roaming and exploring behaviours of children in the Brecon Beacons National Park. The participants were given GPS-enabled cameras and researchers were able to overtly observe the participants' behaviours as well as mapping where these occurred. This was expanded by the authors in another research project which investigated wayfinding in adults using a digital map app (T. A. Smith et al., 2020).

Behavioural mapping methods allow for behaviours to be observed and mapped, allowing for greater insights and applications. However, despite the insights they offer, there are several reasons the behavioural mapping methods mentioned above would not work for mapping environmentally significant behaviours. Observation options are limited; covertly observing

individuals would be very difficult on larger sites or sites with few visitors, as researchers would need to follow participants around large areas and would not be able to be covert. Using GPS-enabled cameras would not be appropriate for a study investigating EDBs. Given the social undesirability of these behaviours, it is unlikely visitors who are aware they are being filmed would perform EDBs. To overcome these issues, behavioural mapping methods need to record behaviours after they have occurred.

Some forms of behavioural mapping rely on tracking physical traces, known as 'accretion', to map behaviours. Accretion is the deposition of material on a physical environment as a result of people's past behaviours or their interactions with the physical environment (Fan Ng, 2016). Note this term is very similar to the term 'behavioural residue', but in this thesis, the more up to date definition "accretion" will be used (S. D. Gosling et al., 2002). This technique allows larger areas to be evaluated and can be used to map accretion from EDBs.

As mentioned previously, Llangattock Litter Pickers complete litter-picks and surveys, measuring weight and categorising litter; however the data is not open-access and is collected predominantly for lobbying purposes (Llangattock Litter Pickers, 2021b). Outside of the BBNP, the Snowdonia Society, a charity who work on protecting and conserving the Snowdonia National Park, have utilised GPS logging of litter to map littering (Snowdonia Society, 2018a). The group conducted a litter pick on Snowdon and logged pieces of litter using a GPS tracker, and then created a heatmap which can be used to show people the 'hot spots' on-sites (Snowdonia Society, 2018b). Whilst behavioural mapping does not allow for investigations into who is performing a behaviour, it does allow for evaluations of the behaviour and could offer a measure of the effectiveness of interventions, if systematic monitoring is performed (Sommer & Sommer, 2002).

4.1.2 On-site Interventions

As discussed in Chapter Two, empirical research investigating the impact that nature-based visits have on behaviours and attitudes is limited. Similarly, a review investigating the status of conservation messaging research found that whilst interest in conservation messaging is growing, the research is not being developed with behavioural theory or empirical knowledge in mind (Ardoin et al., 2015; Kidd et al., 2019). Within the BBNPA, some interpretation, signage and messaging aimed at changing visitor behaviour is informed by the work of Ham et al. (2008) (S.

Jones (BBNPA staff), personal communications, 2018). This work, *A Guide for Managers Who Want to Use Strategic Communication to Influence Visitor Behaviour*, provides guidance that focuses on persuasive communication theory and surveying of visitors, through to the development of communications (S. H. Ham et al., 2009). However, as discussed in Chapter Two, the vast majority of the communications aimed at changing behaviour developed by the BBNPA often do not follow any kind of behaviour change theory and are not informed by research.

There is a selection of studies that can inform such interventions and interpretation though. Perhaps the most prominent study is by Cialdini et al. (2006), who examined theft of petrified wood in the Petrified Forest NP in the USA. The researchers placed their own pieces of wood along a section of path and were able to count and assess if wood was taken. Although the researchers were unable to measure any stolen wood that was not placed as part of the experiment, they were able to objectively measure theft behaviour. The researchers also measured the impact that different message frames (in the form of signage placed at the start of the path) had on theft, finding that normative messages were most effective at reducing theft (Cialdini et al., 2006). The researchers conducted the research in collaboration with park rangers who, unconvinced by the finding that their original signage was the least effective, refused to change the signage.

More recent work investigated disturbance to wildlife. Researchers tested the effectiveness of interventions aimed at encouraging safe wildlife viewing. The intervention took the form of signage with a tongue-in-cheek tone, which featured the slogan "sometimes the best relationship is along distance relationship (Abrams et al., 2020). The work sought to test the effectiveness of these new interventions, which also include new website pages, social media posts and on-the-ground interaction with the public. This approach was more effective at encouraging visitors to view wildlife from a safe distance than the threat/shock appeals used by park managers before the study (Abrams et al., 2020). This work highlights the necessity to avoid shock campaigns, a technique which is used by the BBNPA (see Figure 3 - Signage used within the Brecon Beacons National Park to encourage responsible visitor behaviours. Note that most of the signs are focused on dog owner behavioursandFigure 35 - Signage on gateposts at the Mountain Visitor Centre).

However, there is some research exploring a more common EDB that occurs in the BBNP. The findings from a GPS logging study on dog fouling were used to directly inform management practices in protected areas. Researchers used GPS logging of dog faeces to find out which areas of paths in a dune system were most impacted. They used this to inform where signage would be

most effectively placed (Natural Resources Wales, 2016). The researchers placed signage at 'hot spots'. The signs showed approximate times to the nearest dog waste bin. The researchers found that signage informed by the GPS logging was significantly more effective at encouraging people to pick up after their dog compared to traditional signage.

The studies outlined above, from both practitioners and academic researchers, are some of the only studies that investigate how to tackle and objectively measure EDBs in a NP or nature-based context. The findings offer insight into how practitioners could use objective methods to measure EDBs on-site as well as how these measurements can be used to inform policy. Despite this, there are a limited number of studies using GPS logging to measure EDBs. This suggests that a feasibility test is required, to test the effectiveness and ease of using this method.

4.1.3   Present Studies

The BBNPA have not previously used behavioural mapping to measure the impact that visitors have on-site. As discussed in Chapter Two, the organisation does not evaluate any signage or interpretation that they use on-site (or online, on social media etc). Whilst signage and interpretation is vetted by staff members, and the organisation does sometimes follow guidelines proposed by Ham et al. (2009), there is currently no testing of intervention effectiveness. Testing the effectiveness of signage is not easy due to the incidental and dispersed nature of behaviours. Behavioural mapping provides the opportunity to do so.

This highlights a clear gap in research, with a need to develop methods to map behaviours in the BBNP and to test interventions. Three studies are presented in this chapter. The feasibility study that follows, in section 4.2, tested an adapted behavioural mapping method, using GPS logging of litter. The study aimed to uncover the practicalities of using this method to measure litter on sites across the NP.

 Study Two, outlines a small-scale study conducted to reduce dog fouling on a site in the BBNP. The study was conducted in collaboration between the researcher, the BBNPA and local charity Pori Natur a Threftadaeth (PONT) Cymru. The study focuses entirely on one EDB, dog fouling. Previous work into this behaviour is also lacking. A systematic review found no good-quality studies investigating interventions to reduce dog fouling (Atenstaedt & Jones, 2011). One small-scale study was conducted by the UK charity, Dogs Trust. The study used stickers encouraging dog

walkers to bin their dog faeces (Harris & Dogs Trust, 2019). However, the research did not utilise structural interventions. The results from Study Two offer interesting insights into both interventions to reduce EDBs as well as insights into the use of behavioural mapping as an objective measure of EDBs.

Finally, Study Three outlines an intervention study that tests the effectiveness of different message frames on litter. The study tests several different message frames, aiming to identify whether interventions can reduce litter at a popular site for visitors in the NP.

4.2   Feasibility Study – GPS Logging

To measure the impact of behaviour onsite, it is vital that a methodology be developed that allows for fast, efficient, and accurate measurement. Building on previous research, a feasibility study was conducted to measure how efficient GPS logging was at measuring litter in the Brecon Beacons National Park.

4.2.1   Method

Two sites, reported by wardens to be impacted by heavy littering, were sampled to test the effectiveness of GPS logging (J. Pimm, personal communications, 2018). The first site was Keeper's Pond (KP) car park, situated in the south-east of the National Park. The site sits between two major towns, Blaenavon in the south and Abergavenny in the North. The second site was the Mountain Visitor Centre (MVC). The MVC sits in the central part of the BBNP and is a popular site for visitors as it offers facilities such as: a large car park, café, shop, visitor information and toilets. Both sites offer several footpaths and trails for visitors to use.

GPS logging routes were representative of a 'typical' walk (see Figure 11 for the route sampled at the MVC and Figure 12 for the route sampled at Keeper's Pond). The route at the MVC was just approximately 5km long. The average walk along that route is estimated to take around 45 minutes to 1 hour, depending on the speed of the individual. The walk around Keeper's Pond was 2.5km, taking around 30-45mins to complete.

During data collection, each piece of litter on, and one metre either side of, the path was logged as a single GPS point, using the mobile application MapMaker for Android (AndroidSeb,

2018). During data collection it took approximately 1hr 30 mins to 2hrs to complete the MVC route and approximately 1hr to 1hr 15mins to complete the Keeper's Pond route.

It was not possible to gather visitor data for either of the sites. However, anecdotal reports from wardens suggested that these sites were both heavily visited (J. Pimm (BBNPA warden), personal communications, 2018).

4.2.2   Statistical Analysis

No statistical analysis was conducted, as data was only collected at one time point and no comparisons were required.

4.2.3   Results

Heatmaps were created using QGIS, to reveal distribution of litter on-site (QGIS Development Team, 2022). The heatmaps offer insight into the density and location of litter on-site. At the MVC , the litter was spread across the paths on-site (see Figure 13 for heatmap of MVC route). The notable high-density areas included: along roads, on the summit of Twyn Y Gaer (a viewpoint that forms the halfway point for those doing the circular walk from the car park) and within 50 metres of the car park entrance. There was also a high density of litter at a crossing point in paths less than 1km from the car park. Notably, the car parks at Keeper's Pond (2 in total) were most heavily littered, with the circular path seeing highest density along the length of the path that follows the road (see Figure 14 for heatmap of Keeper's Pond route). This is expected, as roadside litter from cars will also have been sampled here too.

4.2.4   Discussion

The use of GPS logging to measure the impact of litter on-site offers the chance to gather objective data, where previously all records of litter from the BBNPA were anecdotal. From a practical viewpoint, logging on-site was quick and easy to conduct. However, this is obviously dependent on the size of the site and length of the route. The data gathered not only offers the chance to create visualisations of the litter, but also allows for recording litter at multiple time points to compare differences, changes over time and the effectiveness of interventions.

Overall, the methodology is successful at providing deeper insight than anecdotal reports. Additionally it provides visualisations which are useful for the BBNPA to monitor EDBs and show to stakeholders and funders. The heatmaps also allow for comparisons between time points, meaning that intervention studies can be conducted effectively. They are inevitably limited by the choice of route or area selected for mapping; the selection of a 'typical' walk allows for evidence of littering along a route with high footfall but does not generalise to less popular walks, for example.

Figure 11 - Feasibility Study - Route sampled at Mountain Visitor Centre during behavioural mapping

Figure 12 – Feasibility Study - Route sampled at Keeper's Pond during behavioural mapping
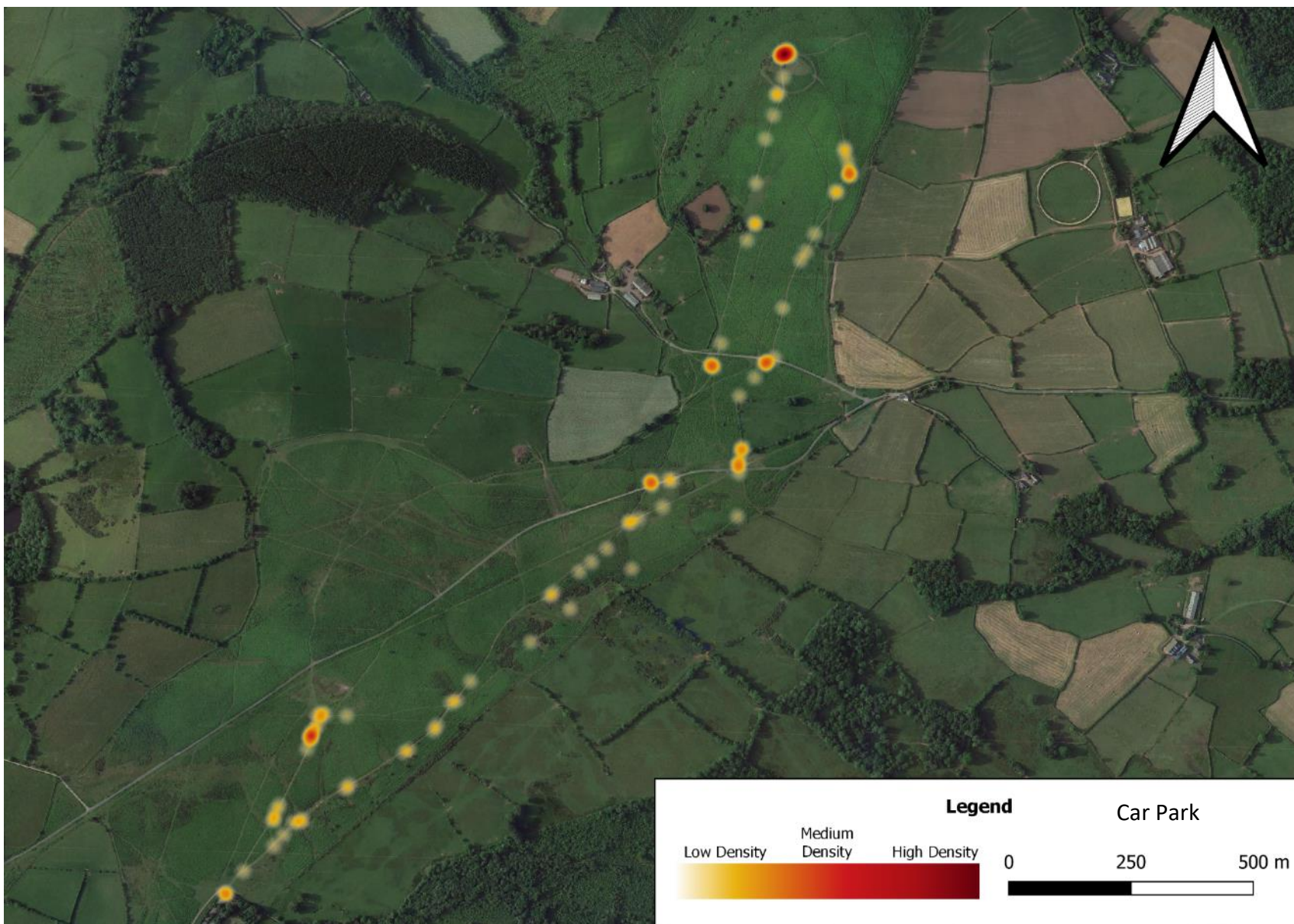
Figure 13 – Feasibility Study - Heatmap of litter at Mountain Visitor Centre during behavioural mapping
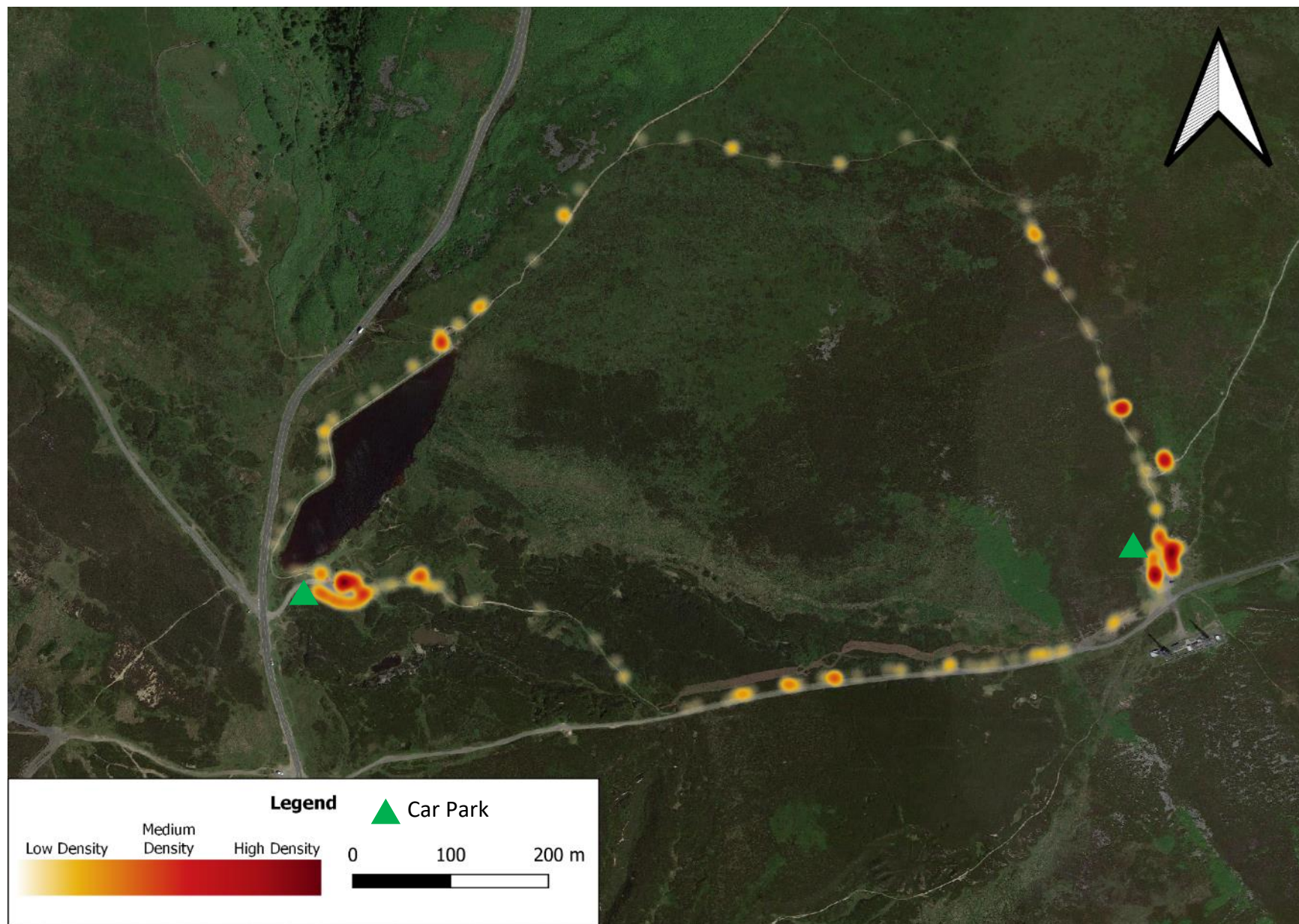
Figure 14 – Feasibility Study - Heatmap for litter at Keeper's Pond

4.3 Study Two – Interventions to Reduce Dog Fouling

4.3.1 Overview

During the planning stage of Study One, Pori Natur a Threftadaeth (PONT) Cymru[13], a conservation grazing organisation, approached the BBNPA about issues on a site in the Black Mountains region of the NP (PONT, 2021). A piece of common land, Y Garn Goch, was becoming overgrown due to lack of grazing on the site (see Figure 15 – Study Two - Map indicating the location of Y Garn Goch, the research site for Study Two. Map produced using Google My Maps (Google, 2022) for a map indicating the location of Y Garn Goch within the BBNPA). PONT were aware that graziers were reluctant to graze on the site due to its popularity with dog walkers, whom graziers believed led to higher risk of dog faeces and livestock disturbance. Both issues were of concern to graziers as faeces from dogs can contain a parasite called neospora. If ingested by livestock, neospora can lead to abortion of pregnancy and still-birth (Anderson et al., 2005). Disturbance to livestock, often known as livestock 'worrying', can put livestock under stress, leading to injuries and potentially abortion in pregnant livestock (National Sheep Association, 2018).

PONT's aims were to measure the issue of dog faeces on-site and, if deemed a problem, to implement an intervention to reduce instances of dog fouling. The intervention developed by PONT comprised of a dog faeces wormery[14], a flip-board that indicated whether cattle were grazing on-site and a compostable faeces-bag dispenser. Intervention research has generally found that the implementation of a combination of information and structural interventions, are more effective than information alone (Whitmarsh et al., 2021). PONT also aimed to ease the worries of graziers so that they felt comfortable grazing the site again. As some of the research aims aligned with the aims of this thesis, I collaborated on the project with PONT and the BBNPA; the results of the research are outlined below and form the basis of Study Two.

Alongside the GPS logging and intervention, PONT also wanted visitors to Y Garn Goch to be surveyed. PONT wanted to investigate dog owner behaviours, such as how often people let dogs off the lead and how often they picked up faeces on the site. For this thesis, the results of the survey

---

[13]More information on PONT Cymru is available at their website: https://www.pontcymru.org/

[14] A dog faeces wormery is essentially a compost bin which contains worms capable of breaking down dog faeces into useable fertiliser. The worms break down the faeces and the fertiliser can be tapped from the bottom of the wormery for use on non-edible crops (e.g., flower beds).

have been omitted. This is, in part, due to a n incredibly low sample size[15] (n = 12) but also because the findings are not relevant to this thesis.

4.3.2   Research Aims & Hypotheses

The research aimed to evaluate the impact of dog faeces on-site, using GPS logging to count the frequency of dog faeces. The research also tested the effectiveness of an intervention, aiming to reduce the instances of dog fouling on the site. It was hypothesised that the intervention would lead to a reduction in faeces across the site (H_1).

4.3.3   Methods

4.3.3.1   Location

Y Garn Goch was the location of focus for this study. The site is known for its two iron age forts, which dominate the landscape in the form of crumbled rock from fort walls, that scatter the and (see Figure 15 for map showing where the site is within the Brecon Beacons National Park and Figure 16 for a view from Y Garn Goch).

4.3.3.2   Design

The study used an AB design. Initial GPS logging at time 1 (T1) took place on 31st January 2018. The follow-up, post-intervention (T2), GPS logging was conducted approximately one year later, on the 19th January 2019.

4.3.3.3   Materials & Apparatus

GPS Logging. The android app MapMaker was used to log GPS points on-site (AndroidSeb, 2018). The data was collected on a Motorola G4 Plus in the first round of logging and on an Honor 8X in the post-intervention logging.

Intervention. An intervention was implemented on-site approximately six months after the GPS logging at T1. The intervention consisted of a dog faeces wormery, a flip-board that indicated whether cattle were grazing on-site and a compostable faeces-bag dispenser (see Figure 17 and Figure 18 for pictures of the intervention used on-site). The intervention was developed and funded

---

[15]Data collection yielded very low visitor numbers. In total, 18 hours were spent in the car park of the site, waiting for potential participants. In total, 5 participants were recruited on-site, the other 7 were recruited via an email distributed by a local who was a community group member.

entirely by PONT. As such, the researcher did not have any input into the design of the intervention. The dog faeces wormery provides visitors the opportunity to bag their dog faeces, which was not possible prior to the interventions placement. Previous to the intervention, visitors would have to take bagged dog faeces home to dispose of. Additionally the provision of dog poo bags ensured that visitors would be able to bag their dog faeces, even if they forget bags. The signage allowed graizers to indicate to visitors when livestock were on-site. It was hoped this would encourage dog owners to place their dog on a lead, so that they were under control.

Informed by the GPS logging at T1, the intervention was placed in the car park of Y Garn Goch. This was due to the highest density of dog faeces within 200 metres of the car park. The car park also offered the most space and was the most convenient place for the intervention to be placed, as it allowed quick access for the graziers to change the sign. It was also at the main entrance to the site, and is the only car park on-site.
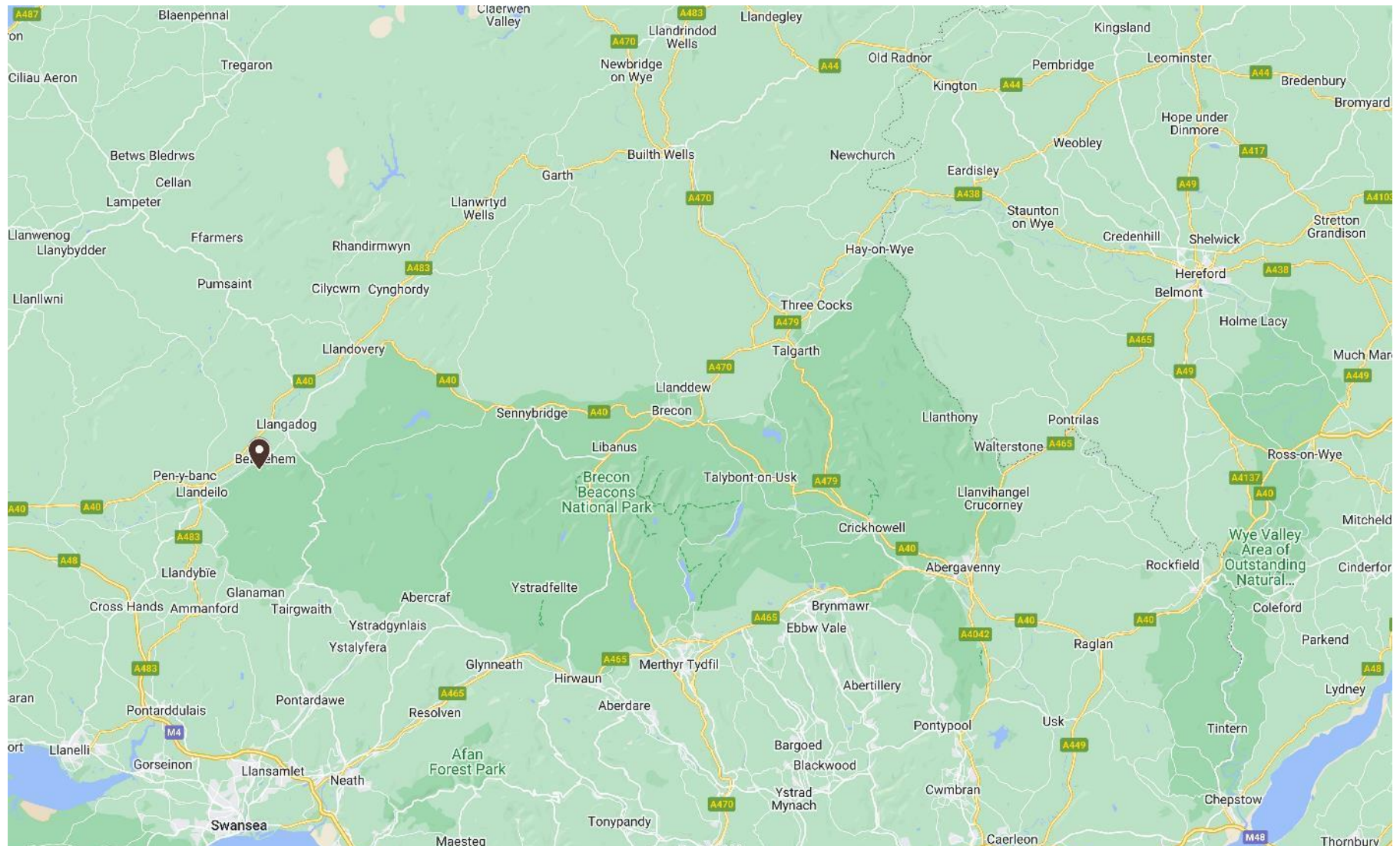
Figure 15 – Study Two - Map indicating the location of Y Garn Goch, the research site for Study Two. Map produced using Google My Maps (Google, 2022)

Figure 16 – Study Two - A view from Y Garn Goch

Figure 17 – Study Two - Dog-faeces wormery (left), grazing flip-board sign (middle) and compostable dog-faeces bag dispenser (right)

Figure 18 – Study Two - Intervention on-site at the car park of Y Garn Goch

4.3.3.4   Design

An AB design was used. Initial baseline was taken at T1, and the intervention was put into place around six months later and being placed indefinitely. Post-intervention, GPS logging at T2 took place one year after T1.Procedure

A pre-intervention GPS log of dog faeces was undertaken (T1) (see Figure 19 – Study Two - Route taken during the GPS logging at time one and time two. the route taken during GPS logging) and any dog faeces was logged with the MapMaker App. The logging included both bagged and unbagged dog faeces. Dog faeces were logged as a single GPS point regardless of size. Individual pieces of dog faeces were counted as one GPS point if they were more than half a metre from any other pieces.

The same route was taken approximately one year later in the post-intervention measurement of the site. The gap of one year between GPS logging was to ensure measurements were taken at the same time of year, which was outside of peak visitor season. This also allowed a long-term measure of the effectiveness of the intervention, which PONT required.
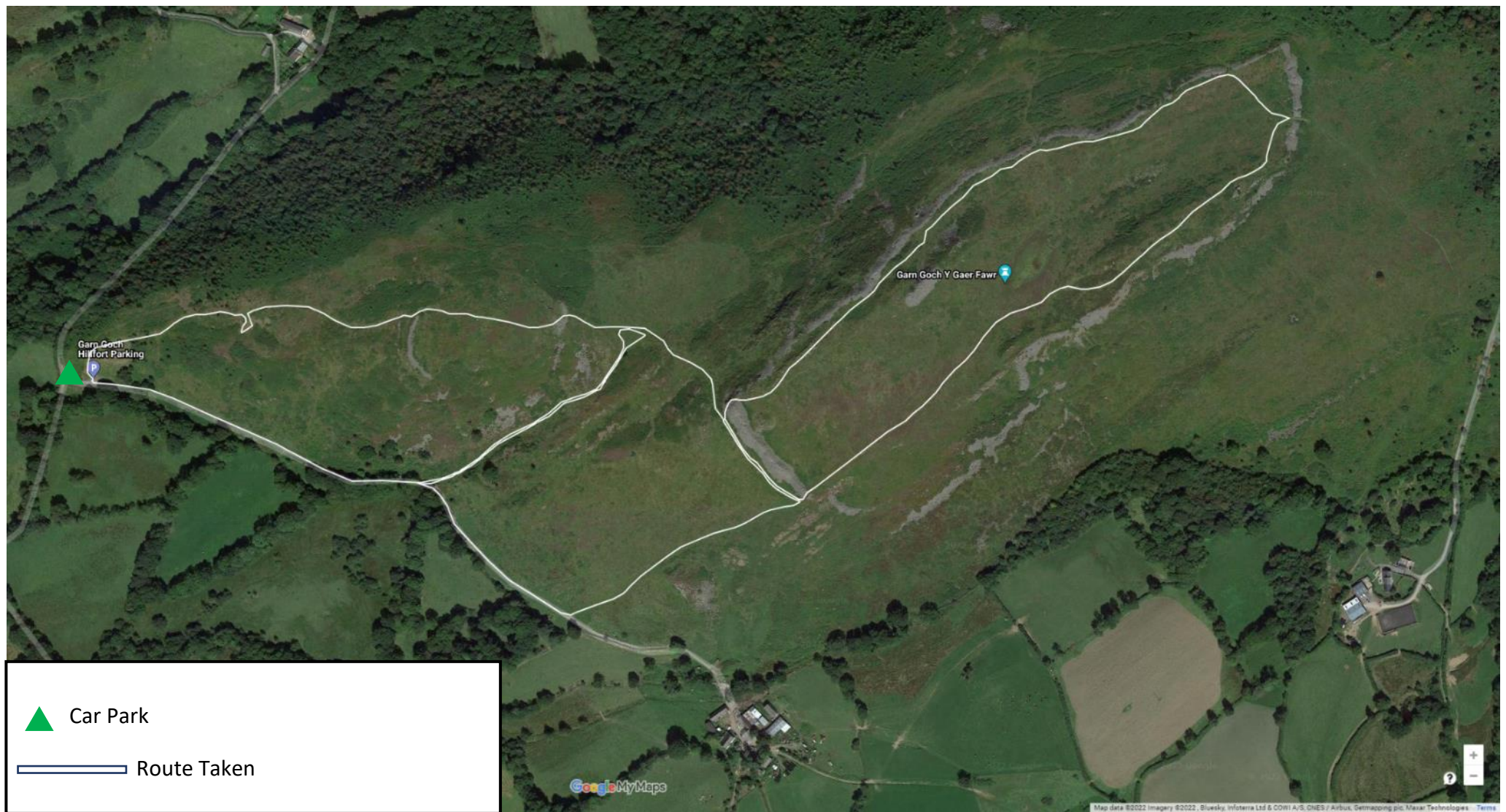
Figure 19 – Study Two - Route taken during the GPS logging at time one and time two.

4.3.3.5 Statistical Analysis

No inferential analysis were conducted, however descriptives were calculated using Excel (Microsoft Corporation, 2022).

4.3.4 Results

4.3.4.1 Intervention Effectiveness

The GPS logging revealed a 95% reduction in dog faeces on the site. A bar chart shows the frequencies of dog faeces pre and post intervention *(see Figure 20 - Study Two - Bar chart showing the frequency of dog faeces pre and post interventio for the bar chart)*. QGIS was used to create heatmaps from the GPS data (QGIS Development Team, 2022). These were used to visualise the highest density areas for dog faeces, these are shown in figures Figure 21 and Figure *22*. The heat maps show a vast difference across the site, with most of the site clear of any dog faeces at post-intervention (T2, frequency = 5), a substantial decrease compared to pre-intervention (T1, frequency = 96), where dog faeces were found along most of the route. In Figure 22 – Study Two - Heatmap of dog faeces on-site post-intervention (T2), whilst the density appears high, each individual 'spot' indicates only one piece of faeces/one instance of dog fouling. For the sake of comparison here, heatmaps have been used, but maps with single dots per GPS point can also be created.
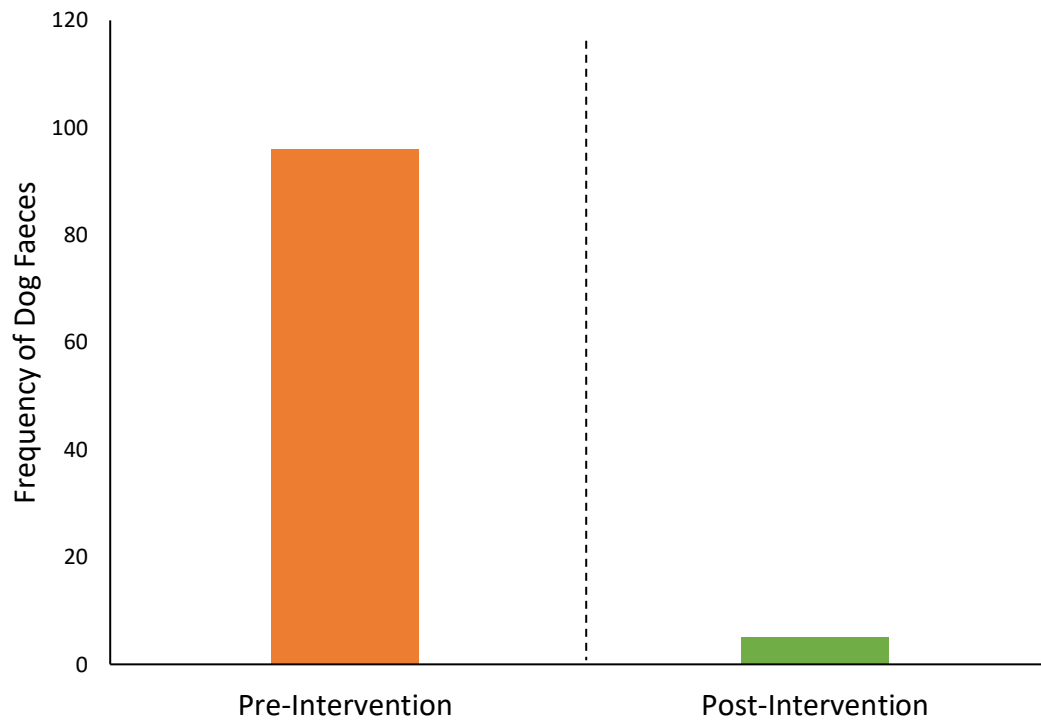
Figure 20 - Study Two - Bar chart showing the frequency of dog faeces pre and post intervention
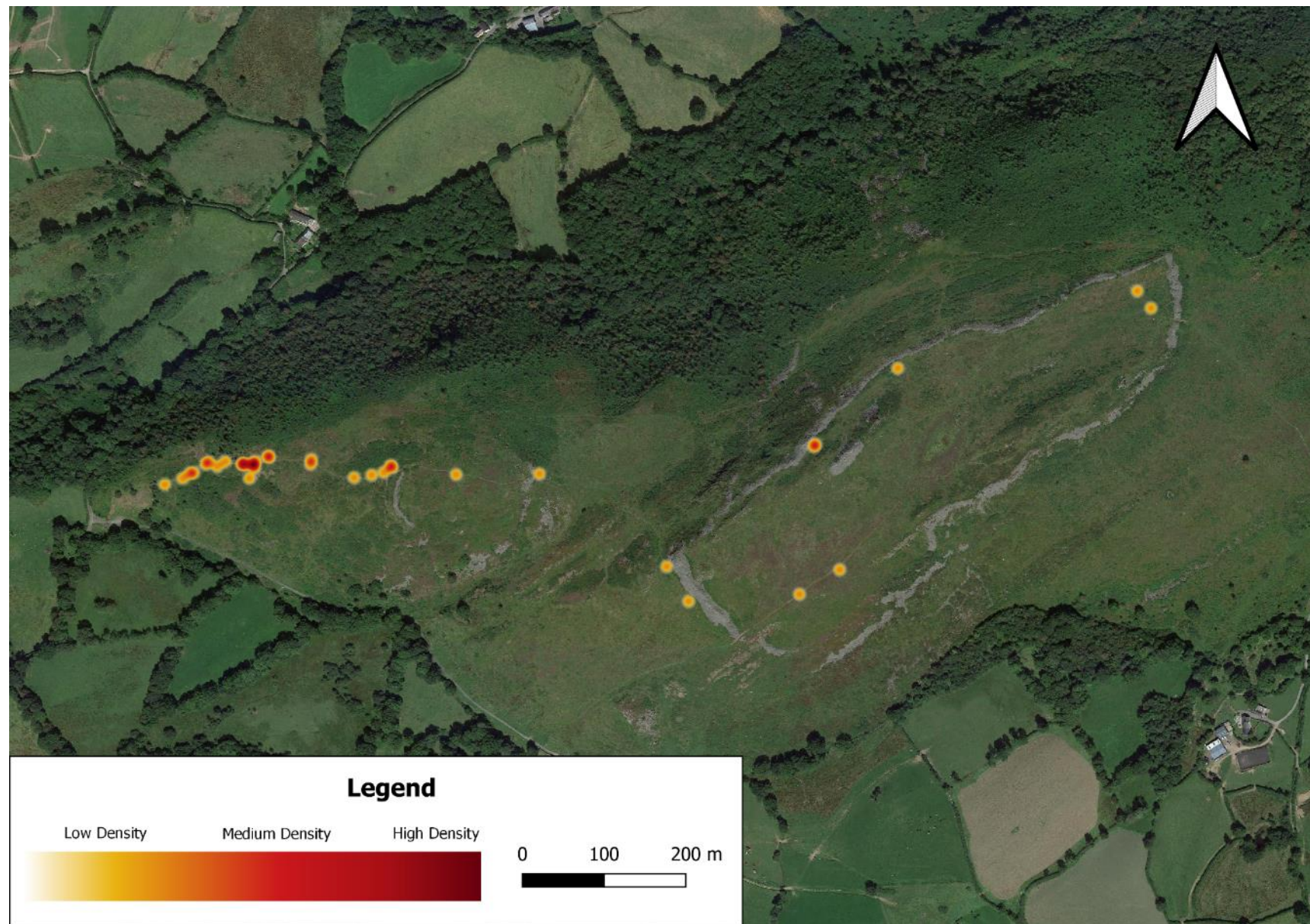
Figure 21 – Study Two - Heatmap of dog faeces on-site pre-intervention (T1)
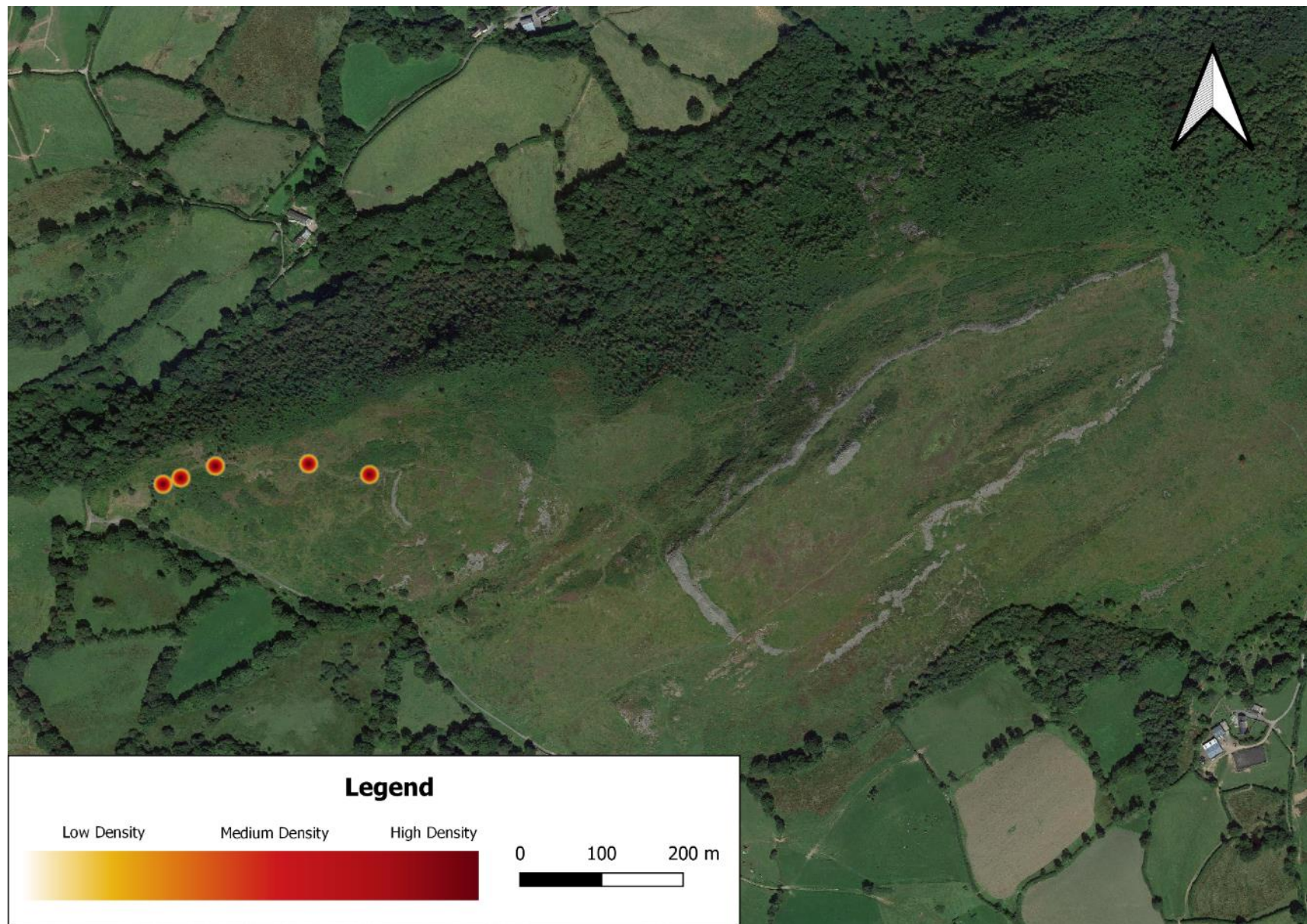
Figure 22 – Study Two - Heatmap of dog faeces on-site post-intervention (T2)

4.3.5   Discussion

The small-scale study, whilst focused on a very specific environmentally damaging behaviour, did provide support for the method of using GPS logging to measure impact on-site. It also provides a viable alternative to traditional methods of measuring behaviours onsite, such as self-report surveys and anecdotal reporting. The GPS logging was a fast and effective method for logging dog faeces. It provided not only a count for dog faeces but also a visualisation of where the dog faeces were most prominent, providing evidence that informed the best place for an intervention to be implemented. Across the BBNP, reports of litter and EDBs are often limited to anecdotal evidence. However, this method provides not only a useful visual representation of data for the BBNPA but also provides a valuable quantifiable and objective measure of accretion.

The research also supports previous research that shows provision of bins (in this case a dog faeces wormery) and information (indicating to visitors whether livestock are currently grazing) are effective at encouraging PEBs (Bernstad, 2014; Sintov et al., 2017; United Nations Environment Programme - GRID-Arendal and Behavioural Insights Team, 2020). Study Two provides an insight into new methods for objective measurement of the behaviour of visitors to the BBNP, but also into the impact that structural interventions and information provision can have on EDBs such as dog fouling. One limitation, however, is the time delay between baseline data collection and post-intervention measurement; while timescale was important to control for visitor number fluctuation across the year, it is possible that other changes occurred during the period to contribute to the observed reduction in dog fouling.

Study Two and the feasibility study provide the foundation for an intervention study looking at a broader and more widespread EDB within the NP – littering. The studies both highlight the effectiveness of GPS logging and behavioural mapping to measure accretion. Additionally, Study Two indicates the method is effective at testing the effectiveness of interventions. The study that follows, Study Three, builds on Study Two and the feasibility study.

4.4   Study Three – Message Frames to Reduce Litter

4.4.1   Overview

As discussed in detail in previous chapters, there is a necessity for research to investigate the impact of interventions on-site in nature-based contexts. Study Two not only offered strong support for the effectiveness of GPS logging to measure behaviours but also gave insights into the effectiveness of interventions implemented on-site to reduce EDBs. However, Study Two and other work investigating interventions in nature-based contexts are limited. So far research has only focused on very specific and niche behaviours like dog fouling or theft of petrified wood (Cialdini, 2003; Natural Resources Wales, 2016; Ramkissoon et al., 2013). Furthermore, there have been very few comparisons of different types of intervention (e.g. different messages) on behavioural outcomes. This is important because Study Two used an integrated structural-informational intervention, so the relative efficacy of the different elements could not be ascertained. Study Three compares different types of informational messaging to identify which is most effective. It builds on findings from previous nature-based studies showing social norm-based messaging to be effective (Cialdini, 2003).

Study Three, presented below, investigates, and compares the effectiveness of identity-framed, norm-framed and 'standard' messages aimed at reducing litter on a site in the BBNP. Study Three will use the same GPS logging methods refined in the feasibility study and Study Two, and investigate the impact that posters with different message frames have on litter levels on a circular path at the MVC. The MVC, as mentioned previously, is a popular visitor site in the central part of the Brecon Beacons National Park.

Littering is one of the most common EDBs that occurs in the BBNP (J. Lawrence, personal communications, 2019). However, the BBNPA have not conducted any objective measures of how much litter impacts on sites. Additionally, at the time Study Three was being planned, the BBNPA had no signage or interventions developed that targeted littering – apart from bins.

4.4.2   Hypotheses

Based on findings from previous research, it is hypothesised that interventions on-site will lead to a significant decrease in the amount of litter, compared to control (H_1). More specifically, it is hypothesised that social norm-framed messages will lead to the greatest reduction in the amount

of litter compared to non-normative message frames (H_2), based on findings from research by Cialdini (2003).

4.4.3 Methods

4.4.3.1 Location

The MVC was the main data collection-site for Study Three. The MVC site had a high count of litter during the feasibility study (see section 4.2) and is also one of the most popular sites for visitors within the BBNP (J. Lawrence, personal communications, September 2018). Unlike many of the sites in the BBNP, the MVC has a car park meter on-site which offers an accurate estimate of visitor numbers. This means that visitor numbers could be controlled for during analysis. The site is also managed and manned, which greatly reduces the likelihood of theft of the intervention or vandalism of the intervention, a problem which has occurred in studies in the past and in the BBNP (Sussman & Gifford, 2012; J. Lawrence, personal communications, May 2018). The main car park only has one main exit onto the common, a gate in the North-eastern corner. The single entrance onto the main path greatly improves the likelihood of visitors seeing the intervention, unlike other sites in the BBNP which have multiple entrances (see Figure 23 for a map of the site).

Figure 23 – Study Three – Aerial view of the Mountain Visitor Centre car park, bins and intervention

4.4.3.2 Design

Two experimental conditions and one control condition were used in the study. Each condition was conducted twice. However, due to issues on-site, the first round of data collection could not be used.

4.4.3.3 Materials & Apparatus

GPS Logging. The android application MapMaker was used to log litter on-site (AndoridSeb, 2018). The application was used on an Honor 8X smartphone. The route selected was the main circular route from the MVC to Twyn Y Gaer and back (see Figure 24 – Study Three - The route sampled during the studyfor the route sampled during Study One). The route was approximately 5km long. During data collection the route took between 1hr 30min and 2hrs to walk.

Litter Picking. A litter-picker and bag-ring (with black bag) was used to collect litter on-site during logging. Each bag was weighed using a digital weighing scale when the logging was completed. Litter was picked along the route taken only. Litter was collected from up to one metre either side of the path. Additionally, each piece of litter that was picked and logged during the litter pick was counted.

Intervention. Three different experimental signs were designed (see Figure 25 – Study Three- Posters used in Study Three. Social norms framing (left), identity framing (middle) and "standard" messaging (right).for the English versions of the posters used in the experiment). The signs were also translated into Welsh, as any interpretation distributed in the NP by the BBNPA must be in both English and Welsh. The Welsh signage was on the opposite side of the poster stand. The first sign contained a social norms message frame. Social norms have been found to be effective at encouraging PEBs and have been used successfully within a nature-based context previously (Cialdini et al., 2006; P. Wesley Schultz et al., 2008; Trelohan, 2020). The second sign contained identity message framing. The findings from Study One indicated that visitors' perceive not littering as the most important aspect of being a "responsible visitor", thus identity frames are test in this study. Additionally, messages around identity have been used successfully to elicit behaviour change in the past in a nature-based context (Elmauer et al., 2017; Powell & Ham, 2008; Trelohan, 2020). The third sign used 'traditional' messaging. This 'traditional' messaging, whilst not

explicitly explored in literature, is similar in style and message to the signage developed and used by the BBNPA at the time of the study, comprising a simple exhortation to avoid littering.

The signs were printed onto A1-size poster paper, and placed into a poster stand, which was placed at a gate at the end of the car park. This gateway leads to a circular walk from the main car park to Twyn Y Gear and back (see Figure 26 – Study Three – for a picture of the signs on-site).

Figure 24 – Study Three - The route sampled during the study

Figure 25 – Study Three- Posters used in Study Three. Social norms framing (left), identity framing (middle) and "standard" messaging (right).

Figure 26 – Study Three – Location of the intervention

4.4.3.4 Procedure

The timeline for the procedure used in Study Three is shown in Table 17. The research was conducted over a ten-week period, with weekly litter picks and GPS logging occurred every Wednesday from 3rd July to the 7th August 2019. Logging was conducted on the same day every week to ensure that the amount of litter logged was from a set period of seven days. GPS logging involved plotting a GPS point for every individual piece of litter. This litter was also collected, and each piece was counted. Additionally, the weight of litter collected was measured at the end of litter picks.

Conditions were run twice, in order to allow for differences in temperature, weather and visitor numbers. However, the data collected for the first five weeks of the data collection period was unusable. The researcher ensured that all staff members at the MVC were aware of the research being conducted on-site and asked that any volunteer litter picks were cancelled during data collection.

However, it transpired that for the first five weeks of the data collection period that volunteer litter picks had been conducted. Thus the first five-weeks of data were not used. The conducting of litter picks, inside the data collection period means that the amount of litter logged by the researcher would not necessarily represent seven days' worth of litter, but could represent as little as 24 hours' worth of litter. This means that testing the effectiveness of interventions was not possible for the first five weeks.

Table 17 - Study Three - Outline of Research Procedure

Week 1 – Removal of Litter	
Litter pick with no GPS logging	

Week 2 – Baseline	
No Signage	Litter pick with GPS logging – Baseline measurement
Week 3 – Identity Condition	
Identity Signage	Litter pick with GPS logging – Identity Condition measurement
Week 4 – Norms Condition	
Norms Signage	Litter pick with GPS logging – Norms Condition measurement
Week 5 – Standard Condition	
Standard Signage	Litter Pick with GPS Logging – Standard Condition measurement
Week 6 – Control Condition	
No Signage	Litter pick with GPS logging – Control Condition measurement

Data Not Used in Analysis

Week 7 – Identity Condition	
Identity Signage	Litter pick with GPS logging – Identity Condition measurement
Week 8 – Norms Condition	
Norms Signage	Litter pick with GPS logging – Norms Condition measurement
Week 9 – Standard Condition	
Standard Signage	Litter Pick with GPS Logging – Standard Condition measurement
Week 10 – Control Condition	
Litter pick with GPS logging – Control Condition measurement	

Data Used in Analysis

4.4.3.5 Statistical Analysis

The number of pieces of litter were counted on the site for each condition. Additionally, GPS logging was used to create heatmaps in QGIS (QGIS Development Team, 2022). Finally, weight data was also used to compare weight of litter between conditions.

4.4.4 Results

4.4.4.1 Weight

The results for the weight of litter collected for each condition is presented in Figure 27 – Study Three - Weight of litter collected across conditions Although it is not possible to run statistics on the data, the results do indicate that the three experimental conditions had greater weights of
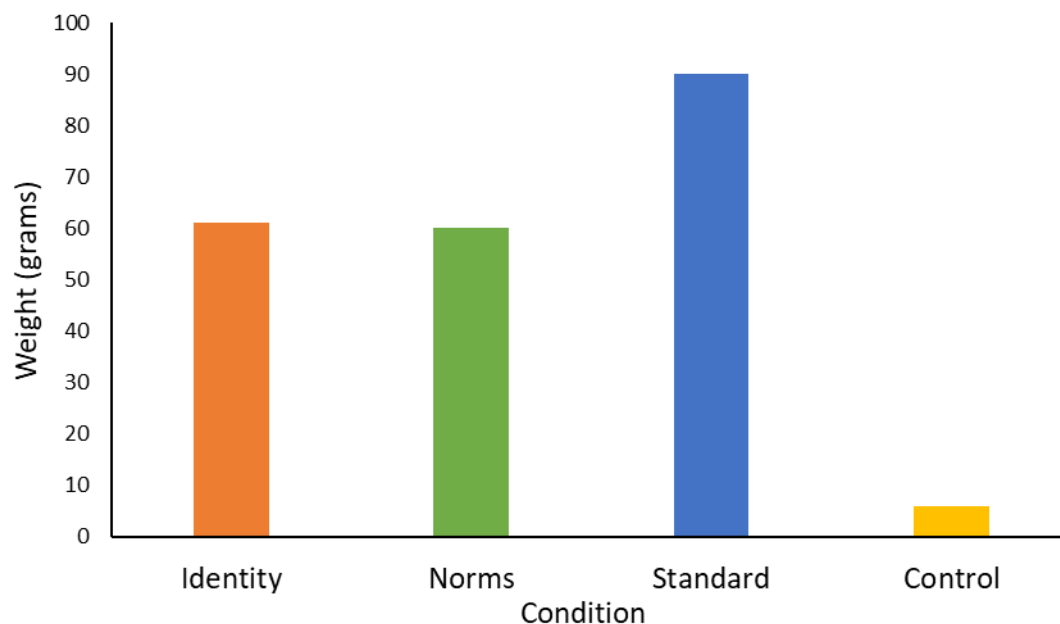
Figure 27 – Study Three - Weight of litter collected across conditions

litter collected than the control condition.

4.4.4.2 Frequency

The number of pieces of litter was also counted, with totals for each week presented in Figure 28 – Study Three - Bar chart showing the frequency of litter on-site in the four conditionsThe bar chart shows that the Norms condition had the lowest frequency of litter, although this was only just below the Control condition frequency. When comparing the heatmaps for each condition, there is a clear spread across the site for all the conditions (see Figures Figure 29Figure 30,

Figure 31 Figure 32 for the heatmaps for each condition and Figure 33 for the heatmap of litter on-site across all conditions combined). This is the case for all conditions except for the social norms condition, in which the litter is confined to small areas on the path, rather than being distributed along the entire pathway. The frequency of litter was also lowest for the Norms condition, with only 18 pieces of litter being collected. Whilst it is not possible to see if this difference is statistically significant, it is a substantial difference compared to the other conditions, except for the control condition which had the second lowest litter count at 24 pieces.
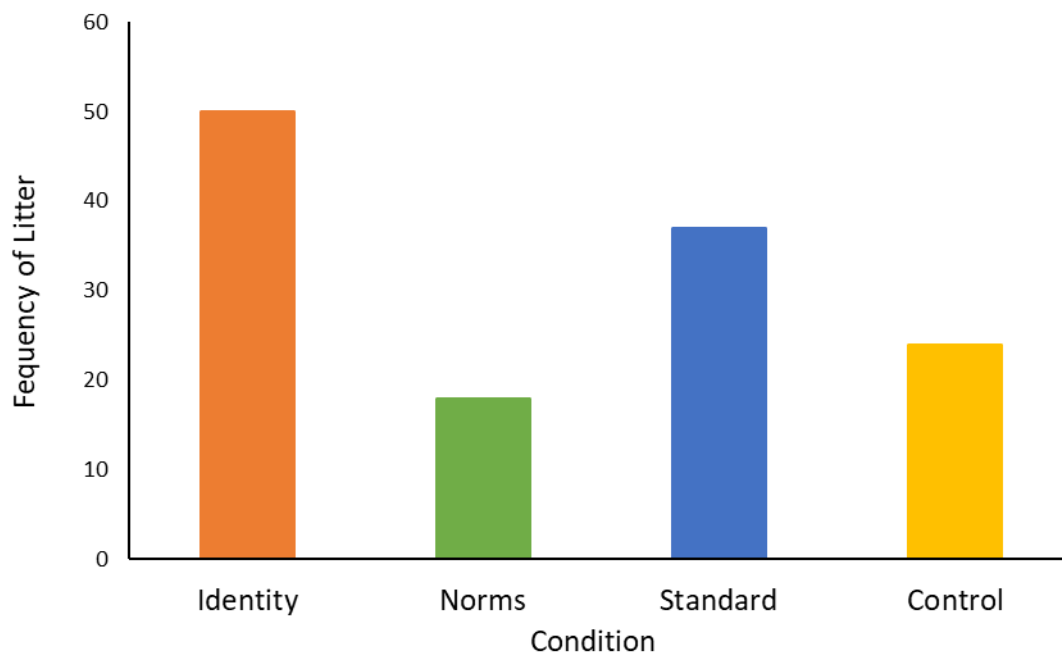
Figure 28 – Study Three - Bar chart showing the frequency of litter on-site in the four conditions

Figure 29 – Study Three - Heatmap for litter for Identity Condition

Figure 30 – Study Three - Heatmap of litter for Norms Condition

Figure 31 – Study Three - Heatmap of litter for Standard Condition

Figure 32 – Study Three - Heatmap for litter Control Condition

Figure 33 – Study Three - Heatmap of all litter across all conditions

4.4.4.3 Data Reliability

An issue with comparing measurements of litter across conditions is that the weight of litter can be drastically increased by a single piece of heavy litter. For example, in the standard week, a glass bottle was collected which weighed far more than any of the other individual pieces. This meant that despite the weight for the standard condition being the highest, it was only the second highest week for amount of litter (see Figure 34 – Study Three - Weight & frequency of litter for each conditionfor a bar graph showing weight and frequency of litter for each condition). The frequency of litter seems to be the most accurate and reliable form of measuring litter.
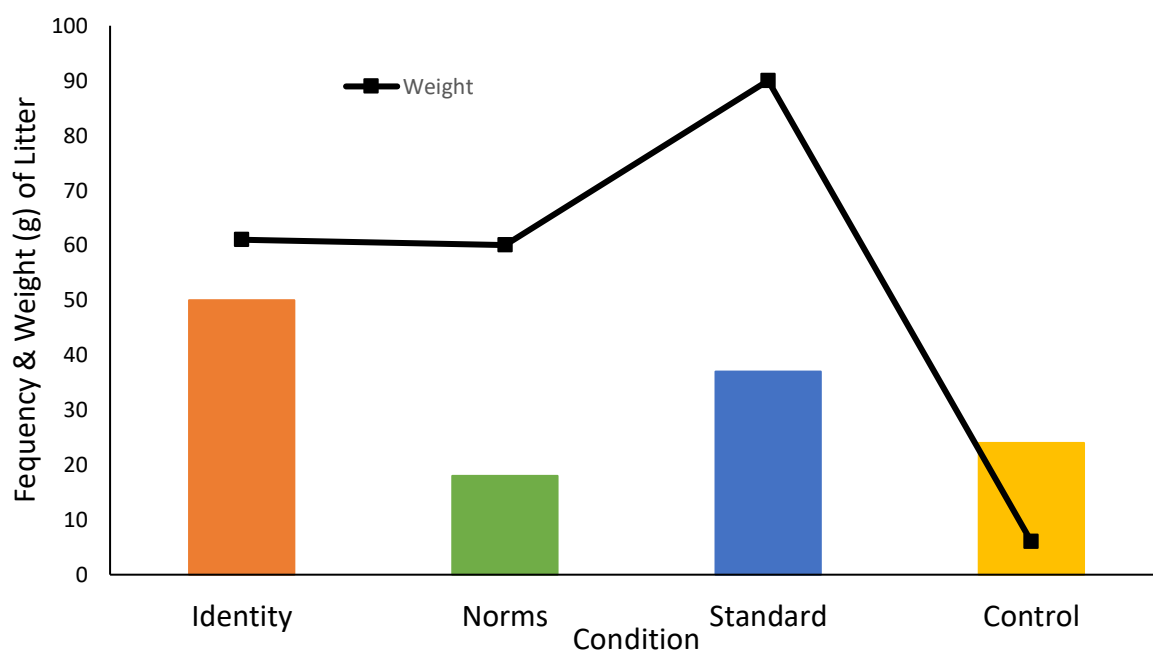
Figure 34 – Study Three - Weight & frequency of litter for each condition

4.4.5 Conclusions for Study Three

The results from the study indicated that there was a difference in litter levels between control and experimental conditions, meaning that H_1 can be accepted. There was a difference in litter levels between experimental conditions, and norms message framing led to a notable reduction in litter compared to other conditions, including the control condition, meaning that H_2 can be accepted. The inability to run statistics to test for a significant difference is a clear methodological flaw. However, proper statistical analysis would have been possible if a mean frequency was calculated. This would have been possible if the first five-weeks of data were usable.

Looking at the data (without statistical analysis), the results do suggest that norms messaging was most effective at reducing litter frequency. This is in line with previous research, as discussed previously. Work from Cialdini (2003) found that norms signage was effective at reducing theft in a NP in the United States. Many other studies have found that normative messaging is the most effective at encouraging PEBs and/or discouraging EDBs (Bergquist et al., 2017; Bergquist & Nilsson, 2016; Nigbur et al., 2010).

The study itself did have some methodological issues that may have contributed to unreliable data. Whilst the researcher made every effort to ensure that staff were aware that the research was being conducted, some issues still arose. Despite being assured by BBNPA staff that litter picks would not happen during data collection, after five weeks of data collection the researcher was made aware that volunteers had still been litter picking across the site. This led to five weeks of data being abandoned as it was not deemed reliable. The researcher made every effort to ensure that no litter picks were conducted during the remaining four weeks of data collection. Despite this, there is a possibility that litter picks were conducted throughout the entire data collection period, which would be confounding variable that would greatly reduce the reliability and validity of the data. This may explain why there was no substantial difference between experimental and control conditions. If litter picks had been conducted during data collection, then the litter collected during the research litter-picks would not be a true representation of litter on-site. As the volunteer litter picks were also sporadic, there was no way to control for these in analysis.

The second confounding variable is visitor numbers. The study was originally developed to include car park data, so that visitor numbers could be controlled for; weeks with larger numbers of visitors could potentially lead to higher litter frequency, regardless of condition. Due to data

collection issues at the BBNPA, the study was unable to include car park data. As such, there was no way to control for visitor numbers during analysis. This means that weeks with lower litter counts may have been due to lower visitor numbers and conversely weeks with high litter may have had substantially higher visitor numbers. Nevertheless, there is no reason to believe this is the case, or that there was systematic variation in visitor numbers across conditions.

A third confounding variable focuses on the norms condition specifically, although has repercussions for the entire study. There is potential that the researcher's litter picking – conducted to ensure all conditions started with the same litter levels – catalysed the effects of the social norms messaging in the Norms condition. Norms research has explored the 'broken window theory'. This theory, at its core, proposes that one unrepaired broken window will lead to more broken windows because "one unrepaired broken window is a signal that no one cares, and so breaking more windows costs nothing" (Wilson & Kelling, 1982). The first broken window acts as a social norm – indicating to people that the location is not clean, tidy or looked after etc and therefore further damage is fine (Wilson & Kelling, 1982). The 'broken window' is one example of a behavioural norm, the same theory can be applied to litter, graffiti etc. In fact, research has found that areas with higher levels of litter have increased rates in littering behaviours from people in that area. Conversely, those areas where litter picks had been conducted or that had been cleaned, saw less instances of littering behaviour from visitors (Alhanifi et al., 1990; Ramos & Torgler, 2012; Sagebiel et al., 2020). This means that the litter picks conducted as part of the research may have inadvertently boosted the effects of the social norms messaging.

Whilst this cannot be proven, previous research and the broken window theory would suggest the lack of litter across the site may have acted as an intervention itself. Therefore there is potential that the lack of litter was a confounding variable across all conditions. Overcoming this issue would be difficult. It would require the management of litter levels across conditions, to compare if the presence, or lack of, litter on the site impacts littering behaviours.

Conversely, one could argue that as the BBNPA hold litter picks frequently across sites (including the site of the research, the MVC) that it was more ecologically valid to run the study with a baseline level of no litter. However, future work could explore the difference in signage effectiveness with varying litter levels.

The research, despite finding no difference in litter levels between conditions, did highlight the areas with the highest density of litter on the site. Most litter was found within 1km of the car park exit, on the main pathway (as seen in Figure 33 – Study Three - Heatmap of all litter *across all conditions*). This suggests that visitors are littering soon after leaving the car park, or shortly before arriving back at the car park. There are bins in the car park, however these are situated at the south-west of the car park near to the visitor centre itself (see Figure 23 for the placement of bins at the MVC). Some visitors who park at the end of the car park may never actually come into close proximity of a bin, thus it is suggested that a bin placed close to the gate would be beneficial.

As well as adding in bins, research has found that informing people of how far they are from a bin, in walking minutes, is an effective way to encourage bin use (Natural Resources Wales, 2016). This could be implemented at the MVC site and along paths as there are already signposts along the route. Current signage indicates footpath direction and some behavioural messaging (see Figure 35 for an example of the kind of signage placed on footpaths around the MVC), although this is mainly focused on livestock worrying and dog behaviours. Adding a small sign indicating distance to the next bin would be cost-effective and easy. The placement of a bin within the first 1km of the car park would also be expected to reduce littering. Whilst a bin requires constant upkeep, with the bin needing emptying daily, it would be less effort for volunteers than litter-picks.

In summary, the study found that normative messaging did lead to a decrease in littering compared to both standard and identity message frames, however the control condition also saw a substantial reduction in littering compared to the two other experimental conditions. However, without the possibility to conduct statistical analysis, further research needs to be conducted. Future research should also ensure the collection of visitor number data and repeated conditions, to confirm whether the differences were significant and to control for visitor numbers.

Figure 35 - Signage on gateposts at the Mountain Visitor Centre

4.5 Discussion of Chapter Four

4.5.1 Overview

The studies presented in Chapter Four offer an insight into novel approaches for both researchers and practitioners to objectively measure behaviours in nature-based contexts. Both studies also provide support for previous work which has found that structural interventions are the most effective at eliciting behaviour change, and are more effective than information alone (Blankenship et al., 2006; Ferguson et al., 2016).

Study Two showcased that a novel intervention, a dog faeces wormery, faeces bag dispenser and signage could lead to substantial behaviour change. The findings revealed that the intervention led to a 95% decrease in the amount of dog faeces on the site. The findings highlights the effectiveness of structural interventions, and indicate a much more effective intervention than stickers which were previously used in research (Harris & Dogs Trust, 2019). Additionally they fill a gap in the field, as very few studies have previously investigated interventions to reduce dog fouling behaviour (Atenstaedt & Jones, 2011).

Study Three, conversely, showed that information alone was not enough to substantially change behaviour. Whilst there are indications that norms were effective at reducing littering on the site, the results are not vastly different from control. Whilst message frames

Both studies provided insight into a novel methodology not commonly utilised by environmental psychologists. Behavioural mapping has not been used extensively in research into littering or EBDs in nature-based contexts, but the work outlined here shows that it has great potential as a tool for both practitioners and researchers.

Similar methods have been utilised by environmental psychologists before. Multi-faceted field recordings, for example, have been used in a longitudinal study to investigate PEBs. In one study, researchers offered participants the chance to engage in various PEBs (e.g., recycling, signing petitions), over a period of eight months - as a measure of actual behaviour (Weigel & Newman, 1976). Other studies have successfully used methods that objectively measure behaviour such as energy/water meters/monitors and novel laboratory tasks (Lange et al., 2018; McCalley & Midden, 2002; McCoy & Lyons, 2017). However, unlike behavioural mapping, these methods cannot be easily adapted to measure behaviours in nature-based contexts.

Behavioural mapping is one of the only methods that offers an objective measure of behaviours in nature-based contexts, overcoming the issues associated with measuring behaviour unobtrusively across large geographical/physical areas. However, behavioural mapping – of this kind - cannot be used to measure individual behaviour, but rather the behaviour of all visitors to a site. Additionally, the method cannot control for confounding variables, for example litter being dumped by cars or blown in from other areas. The method also relies on accretion, and some behaviours do not leave behind an easily measurable physical trace (e.g., disturbance to wildlife).

Measuring behaviours like disturbance to wildlife would require interdisciplinary work; working with ecologists to measure the impact of visitors on wildlife breeding success, for example (Mcclung et al., 2004; Tratalos et al., 2021). The methods outlined in this chapter, whilst limited to some behaviours, offer a far more robust, accurate and reliable way to monitor the impact of visitors to sites than the current anecdotal reports used by the BBNPA. They are also easy to implement for practitioners. If implemented, they would increase the use of objective data and reduce reliance on anecdotal reports in the BBNP.

The studies also provide insights into the efficacy of different behaviour change interventions, including to reduce dog fouling (Study Two) and littering (Study Three). Study Two provides evidence to suggest that structural interventions may be most effective at eliciting behaviour change. Although this was not directly tested, the findings indicate that the structural interventions used in Study Two were more effective than the information interventions used in Study Three. This is in line with previous work, which has found that structural interventions are, on the whole, more effective at eliciting behaviour change than information alone (Blankenship et al., 2006; Chaudhary et al., 2021; M. A. Ferguson et al., 2016; Thomas & Sharp, 2013).

4.5.2   Implications for Practitioners

Study Two showed that a combined structural-informational intervention can be extremely effective in reducing EDBs (dog fouling) on a particular site. Study Three found information provision alone may help reduce littering, but also highlighted that the path from the MVC to Twyn Y Gaer was heavily littered and that the BBNPA should introduce some kind structural intervention on the path, ideally in the form of a bin, to reduce litter on paths.

Additionally, it is important that organisations do not rely on anecdotal reporting or studies without baseline data. A lack of baseline data collection is commonplace, and was a problem during numerous studies conducted during the COVID-19 lockdown in the UK (Forgrave, 2020; Morris, 2020). Future work needs to ensure that data is collected at multiple time-points and that factors such as visitor numbers, which could confound results, are considered. Further discussion of suggestions for practitioners can be found in Chapter Six.

Studies Two and Three also offered new insight into the extent of dog fouling and littering on-site, presenting a low cost and easy method for organisations like the BBNPA to use. The GPS logging requires little training and can be used by volunteers who are already conducting litter-picks on-site. There is also the possibility to expand the survey/mapping methods in future. Advanced litter logging techniques using drone and machine learning technologies have become more accessible for organisations and researchers. Companies like Ellipsis Earth have utilised aerial imagery and video to run machine-learning surveys of plastic waste on coastlines around the world (Ellipsis Earth, 2020).

4.5.3   Implications for Research

Both studies, whilst offering insights, also showcase the challenges of conducting fieldwork. Study Two caused some controversy amongst locals. During data collection, leaflets created by PONT were distributed to survey participants on-site (n = 5) that contained information on neosporosis, the parasite found in dog faeces. This led to three complaints from participants, who questioned the integrity of me as a scientist and of PONT, the BBNPA and Cardiff University in addition to questions around who was funding the research. The issue was resolved with an FAQ sent out to the complainants. However, this incident highlights the potential for reactance when conducting research in the field, and in the placing of interventions to change behaviour. Y Garn Goch was not actually a well-visited site (18 hours yielded only five participants), and thus the locals that regularly used the site reacted with great interest to the research. This highlights the need to work with all stakeholders when developing research on small sites, and to ensure that researchers are aware of potential reactance from local communities (de Juan et al., 2017; Di Chiacchio, 2021; Hodgson et al., 2022). Additionally, Study Three shows that applied collaborative research, whilst rewarding, can face issues. The loss of five-weeks of data collection due to volunteer litter-picks was avoidable. This also highlights the necessity to work and communicate with all stakeholders is

essential to overcome potential pitfalls (de Juan et al., 2017; Di Chiacchio, 2021; Hodgson et al., 2022).

4.5.4 Summary

The studies outlined in Chapter Four offer insights into measuring and changing two specific behaviours: littering and dog fouling. They highlight the potential efficacy of low-cost behavioural interventions and of monitoring methods to assess behaviour change. However, neither Study Two nor Study Three investigated any of the other EDBs considered in this thesis. Additionally, none of the presented studies investigated cross-contextual behaviour change and could not investigate the mediators of behaviours. As such, further work needs to utilise a mixed-methods approach to uncover not only the impact/scale of behaviours and the effectiveness of interventions, but also whether there are any relationships between behaviours in a home context and behaviours in a nature-based context.

The studies that follow, in Chapter Five, do not include behavioural mapping methods. Instead, they focus on measuring cross-context behaviour change. Study Four builds on the findings and intervention explored in Study Three, utilising self-report measures of behaviour to test the effectiveness of different message frames using posters administered to visitors online pre-visit to the BBNP. The final study, Study Five, utilises a different objective method to measure PEBs and explores how virtual visits to nature may impact environmental behaviours and attitudes.

5   Chapter 5 – Novel Virtual Interventions for Behaviour Change

5.1   Introduction

Chapter Four presented studies investigating new and innovative methods to measure visitor impact in the BBNP. An intervention study that focused on littering behaviours (Study Three) and one on dog fouling (Study Two). Chapter Five presents two intervention studies (Study Four and Study Five). Studies Four and Five maintain the theme of trialling novel measures of behaviour and novel interventions. Both studies attempt to uncover the impact that interventions aimed at encouraging PEBs in a nature-based context have on behaviours and attitudes in nature-based contexts. Additionally, both studies investigate potential cross-contextual behaviour change in a home context.

Study Four is an online experimental study, which tests the effectiveness of different message frames on visitors' behaviour. The study uses pre-visit online exposure to a poster, with measures for post-visit to test whether the message frames impact behaviour.

Study Five adopts and adapts elements from all previous studies. However, the study takes a new direction in methodology with the inclusion of virtual reality. The addition of virtual reality may seem unexpected; however, the technology allows for more extensive comparisons between "visits" to the BBNP and control conditions. Additionally, the technology allows for more variables to be controlled.

5.1.1   Intervention Testing

Study Three investigated the effectiveness of signage aiming to reduce litter on one site in the National Park, testing various message frames. The study found no significant difference in litter on-site between experimental or control conditions. Moreover, the study did not provide a measure of individuals' behaviour or environmental attitudes. Conversely, Study One provided insight into behaviours and attitude change across a home and NP context but did not include an intervention. As previously mentioned, signage and interpretation are one of the only ways that the BBNPA are able to directly communicate with members of the public and elicit behaviour change, but testing signage on-site whilst also collecting data from participants is difficult. Successfully managing to achieve all three elements – testing the effectiveness of an intervention, using an

objective measure of behaviour, and measuring change in individuals' attitudes and beliefs – is difficult.

Few studies have attempted to achieve all three of these aims. One study that did manage to use an objective measure of individuals' behaviour, compare interventions, and investigate individuals' attitudes and beliefs was a study conducted by Brown et al. (2010). Evaluating the effectiveness of the Theory of Planned Behaviour model, the researchers also tested several message frames. They placed signage place at the start of a trail, a crushed drinks can (the litter) along the trail and then covertly observed people walking past or picking up the can from down the trail. The number of people who picked up/did not pick up the litter was counted. Additionally, the researchers stopped visitors and interviewed them about their beliefs (behavioural, normative and control beliefs). They found that normative beliefs are the most effective at encouraging individuals to pick up litter (Brown et al., 2010).

However, this method is time intensive and requires multiple researchers to be present. Furthermore, whilst it would be beneficial to encourage people to pick up litter within the NP, it would be more effective to stop the littering in the first place. Study Four therefore investigates interventions to reduce littering. The study investigates the effectiveness of different signage on behaviour, utilising an online intervention. Study Five also utilises message frames (via virtual reality), investigating how these impact behavioural intentions.

5.1.2   Virtual Reality For Behaviour Change

Defining Virtual Reality (VR) has been a point of contention within literature. An early review from Steure (1993) defines virtual reality as "a real or simulated environment in which a perceiver experiences telepresence." "Telepresence" is a term used to describe any medium-sized sense of presence; "presence is what happens when the participant 'forgets' that their perceptions are mediated by technologies" (Lombard & Ditton, 1997). Essentially, how

Whilst VR technology has changed significantly since the 90s, the essence of VR has remained the same and the definition still stands (Takac et al., 2021). For this thesis, VR is defined as any environment which is presented through an electronic device that creates a sense of telepresence. VR head-mounted displays (also known as headsets or HMDs) allow users to immerse themselves within a location with full 360-degree image and sounds. VR headsets can be used to

place users into fictional and computer-generated worlds, which allow for movement around space. They can also be used to experience real-world locations and settings through 360° videos.

The adoption of VR as a research tool and consumer product has been discussed extensively within literature (Bailenson, 2018). In the last decade, VR has been used in a variety of sectors and fields for various tasks; as a training tool, therapy tool and educational tool, VR is becoming an increasingly adopted technology (Bailenson, 2018; Browning et al., 2020; Huygelier et al., 2019; Poeschl & Doering, 2013; Rubens et al., 2018; Tanja-Dijkstra et al., 2018; Taufik et al., 2021). VR is also rapidly becoming a viable and popular media format, with documentaries in VR such as Travelling While Black being nominated for, and Zero Days winning, an Emmy (Felix & Paul Studios, 2019; Scatter, 2022). With VR costing less than £300 (in 2021), the accessibility of VR for both researchers and consumers is increasing too. As the technology has become more reliable and affordable, it is being adopted in less obvious fields.

Within environmental psychology, research has explored VR nature. VR nature is the viewing / experiencing of nature through virtual reality. Researchers discussed the potential impact VR nature could have on how we value and preserve 'real' nature over 20 years ago, when VR was in its infancy (Levi & Kocher, 1999). Levi and Kocher (1999) discussed the extent to which VR nature would influence individuals' perceptions of the natural world. The researchers suggested that widespread adoption of VR nature had the potential to decrease support for preservation and conservation of real-world nature.

Most contemporary research has focused on the benefits of VR nature, with research investigating VR nature for improving psychological wellbeing and restoration. Large projects like "Virtual Nature", aiming to investigate the effectiveness of VR in boosting wellbeing indicate the start of a new wave in VR nature research within environmental psychology (Virtual Nature, 2018). Research has generally found that VR nature can have significant positive benefits, although not to the extent that real-world nature can (Chiricoid et al., 2021; Kalantari et al., 2022; Orr et al., 2021; Richler, 2022; Van Houwelingen-Snippe et al., 2021). For example, recent research found that shinrin-yoku (forest-bathing) using VR can have similar restorative benefits to forest-bathing in a real-world forest (Reese et al., 2022). Whilst there are numerous studies suggesting the benefits of VR nature, a recent systematic literature review from Frost et al. (2022) suggests that further work is needed to expand our understanding of the potential positive benefits of VR nature.

Research has further investigated how VR nature can influence nature-relatedness. Research has found that VR can elicit a sense of reflection in individuals on how they perceive their own role towards nature (Spangenberger et al., 2022). In contrast to the predictions of Levi and Kocher (1999), that VR nature would decrease support for conservation of real-world nature, these findings suggests that VR nature can have a positive impact on attitudes towards conservation of real-world nature (Bec et al., 2021; Markowitz & Bailenson, 2021; Platoni, 2015).

Further countering the predictions made by Levi and Kocher (1999), recent research has investigated the potential for VR nature to be used for "second-chance" tourism (Bec et al., 2021). Researchers suggest that VR can be used to create tourism experiences for locations that have been impacted by over-tourism, damaged, or destroyed, to such an extent that visiting them physically would have significant negative impacts. The researchers suggest that preservation of locations using virtual and mixed-reality methods would help create experiences that can foster a sense of connection for "visitors" whilst also increasing attitudes towards conservation and protection of the locations themselves (Bec et al., 2021).

Extensive work has investigated the impact that VR can have on psychological factors and attitudes. However, VR nature as a tool for behaviour change is still relatively understudied. What little work has been conducted has often utilised embodiment experiences. These embodiment experiences allow for individuals to experience "being" some other object / life-form within VR. For example, participants can "become" a tree within VR (Spangenberger et al., 2022). Additionally, much of the research, like most studies investigating VR nature on wellbeing, has utilised computer-generated environments for use within VR nature (CG VR).

For example, researchers have investigated the effect of embodiment tasks within VR (the authors use the term immersive virtual environments[16]) on conservation attitudes and behaviours (Ahn et al., 2016; Platoni, 2015). In one study participants crawled around on all fours and "acted" as a cow for the first part of the experiment within VR, where they could see a reflected cow avatar that represented them. They experienced this for a few minutes, before being told that they have been grazing for one hundred days and are now the optimal weight, so they are being sent to a slaughterhouse. They were told to wait whilst the sound of a truck engine grew closer, and the floor

---

[16] Confusingly, some researchers also to refer to VR experiences as immersive virtual environments (IVEs). IVEs are defined by these authors as "digitally rendered spaces offering sensory-rich simulations that allow users to experience mediated events in the virtual world as they might in the physical world, to enhance feelings of interconnectedness and involvement with nature" (Ahn et al., 2016, p. 400). However, in this thesis, VR will be used as IVEs are VR experiences.

began to shake. The VR ended at this point. Those participants that took part in the VR showed greater interconnection between their self and nature compared to those who had just watched a video. This led to greater perceptions of environmental risk and involvement with nature which persisted for one week (Ahn et al., 2016).

Other research has found that environmental behaviours can also be influenced by experiences in VR. Researchers investigated the impact of a VR experience, during which participants cut down a virtual tree, on paper conservation behaviours. They compared the results of these VR participants with participants who watched a video depicting the tree-cutting process, and participants who read a description of the tree-cutting process. After being exposed to one of the three conditions participants were asked to clean up a spilled cup of water, the number of paper napkins they used was used as an indicator of environmental behaviour. Those who cut-down the tree in VR used significantly fewer paper towels than participants in other conditions (Ahn, Bailenson, & Park, 2014).

As discussed, many of the studies investigating VR nature have used embodiment and interaction with the environment within CG VR. However, the accessibility of CG VR nature is questionable. The largest barrier to accessibility is the associated costs of developing a CG VR experience that involves embodiment or interaction[17]. Whilst research suggests that the use of CG VR nature is more effective at immersing individuals than 360° video in VR – the costs associated with CG VR can be very high and are beyond the resources available in this thesis research (Bailenson, 2018; Yeo et al., 2020). Recent work from Reese et al. (2021) also suggests that VR nature that involves interaction is more stressful than VR nature that is passive (e.g., does not require interaction from the viewer). The researchers suggest that future work needs to consider the use of interaction within VR nature, as interactivity could actually counter the potential positive benefits of VR nature (Reese et al., 2021). These findings highlight that passive VR may offer more accessible experiences, as they have reduced costs and are less stressful for viewers.

VR nature that utilises 360° video offers a middle-ground between the visceral experience of real-world nature and CG VR nature, that simulate interactive environments, or use embodiment tasks, where confounding variables can be controlled. Finally, passive VR that uses 360° video is far more accessible to both researchers and the wider public – as these can be viewed using mobile

---

[17]The costs of developing rudimentary CG VR experiences range from around £5000 for a basic application up and beyond £15,000 for a more complex experience (Agile, 2022)

phones and tablets and do not require additional expensive hardware like a VR headset (Bailenson, 2018; Motive.io, 2020).

Thus far, no study has examined the influence of 360° video, within a passive VR nature experience, on environmental attitudes and behaviours. The research presented here, in Study Five, aims to fill that gap.

5.1.3   Measuring Pro-Environmental Behaviours

An objective measure of actual PEB is difficult to obtain, in particular in a laboratory setting, where participants are placed in an artificial setting. A number of scholars have tried to develop measurable actions that can be used as indicators of pro-environmental behaviour. Lange, Steinke, and Dewitte (2018) developed the "Pro-Environmental Behaviour Task", a computerised paradigm in which participants must choose between modes of transport for a fictional journey. Participants are required to choose between a car or a bike to as their mode of transport for a fictional journey. The participants wait longer during the task if they choose the slower but more environmentally friendly option. If participants choose the car this causes lights to turn on during the "journey". This novel method is proposed as a 'objective' laboratory measure of PEB (Lange et al., 2018). However, the task requires a complex laboratory set up, as well as providing participants with a live visual representation of energy usage/their environmental impact. Often the impact of environmental behaviours is not so obvious or clear to individuals, indeed it has been suggested this is why changing environmental behaviours can be so difficult, due to psychological distance (Breves & Schramm, 2021; Van Lange & Huckelba, 2021). If behaviours are not obviously having an impact, people are more likely to perform them without thinking about the environmental impact/consequences.

Other studies have attempted to measure environmental behaviours in a more subtle, less costly and, arguably, more ecologically valid way. Research from Evans et al. (2013) used a filler task that required participants to dispose of waste paper, giving them the choice between a recycling bin and waste paper bin. They used participants' choices as a measure of PEB, finding that priming certain behavioural motives led to an increase in recycling. This method was successful, but the researchers also tried to use participants' choice of either new or scrap paper in the filler task as a measure of behaviour. Finding no significant difference in participants' choices, the researchers

believed that the behaviour was not salient enough as an environmental behaviour, so was not an appropriate behavioural measure. Other researchers have used donation to charities as a measure of PEB, seeing how participants donate to environmental charities based on exposure to various stimulus or tasks (Carrico et al., 2018; Shreedhar & Mourato, 2018). These measures are like the "Pro-Environmental Behaviour Task", in that they are salient behaviours. They are also, especially in the case of charitable giving, at risk from social desirability. Additionally, whilst 'objective' measures are measurable, their ecological validity and generalisability to PEBs in real life is questionable (Lange & Dewitte, 2019). As such, the use of a filler task that requires participants to dispose of paper is the more appropriate and requires less set-up than the charity donation method. This method is used in Study Five, which is presented in this chapter.

5.1.4   Studies in Chapter Five

Two studies are reported in this chapter. The first, Study Four, is an online poster study that investigates the effectiveness of different message frames on PEBs. The study investigates different message frames shown to participants using posters that are viewed online. The study investigates if message frames have an impact on the behaviour of visitors to the Brecon Beacons National Park. Study Four's results inform some of the methods of Study Five.

Study Five is a laboratory study which investigates the impacts of virtual visits to the Brecon Beacons National Park. In particular, the study uses VR nature, with participants viewing 360° videos of real-world locations, to encourage PEBs. To tackle the issues associated with self-report measures of environmental behaviours, Study Five uses an objective measure of behaviour in addition to self-report measures: a filler task that required participants to dispose of paper. The study recruited participants through a university participant panel.

5.2   Study Four – Online Poster Study

5.2.1   Overview

Study Two is an intervention study, investigating the impact that interventions targeting behaviours in a NP context have on behaviours within a NP context. Additionally, the study investigates any potential spillover effects on behaviours in a home-context. The study aims to

overcome the limitations of Studies One and Two. In particular it aims to achieve a large sample size and to allow for testing of multiple experimental conditions in parallel.

5.2.2   Hypotheses

It is hypothesised that individuals in the experimental conditions will report performing PEBs more frequently in the BBNP than those in the control condition (H_1).

Secondly, it is hypothesised that social norms messaging will lead to increased performance of PEBs in the BBNP compared to the other conditions (H_2).

Based on the findings from Study One, it is hypothesised participants in the experimental conditions will have higher intention to perform behaviours at home, post-visit than control participants (H_3).

Also based on the findings from Study One, it is hypothesised that Green Identity and NR-6 scores will increase, post-visit to the BBNP (H_4).

Finally, it is hypothesised, based on the findings from Study One, that Green Identity, NEP and NR-6 scores will mediate behavioural consistency across contexts (H_5).

5.2.3   Methods

5.2.3.1   Design

The study was an independent measures design. The study was split into two parts. Part one was completed prior to a visit to the BBNP. Part one asked participants about past behaviours at home. Participants were also asked about environmental attitudes (as outlined in the measures section that follows). At the end of part one, participants were randomly assigned into one of four conditions. In the three experimental conditions participants viewed a poster for 10 seconds. In the control condition, participants did not view a poster.

Part two was sent via email to participants approximately 24 hours after the date they stated they would be leaving the Brecon Beacons National Park. Part two of the study involved participants answering questions about their visit to the BBNP including performance of PEBs. Part

two also contained measures of environmental attitudes (as outlined in the measures section). Finally part two asked participants about their behavioural intention for home.

5.2.3.2 Participants

Participants were recruited between June 1st and September 30th 2019. Recruitment was conducted through an advertisement placed in an email to customers of Brecon Beacons Holiday Cottages. This letting agency deals with visitors to over 400 holiday rental properties in the Brecon Beacons National Park.

An a-priori power analysis was conducted using G*Power (Faul et al., 2007). An estimated effect size of 0.17 was used, based on the work of Maki et al. (2019). The power analysis found that 130 was the minimum number of participants required for statistical power to be reached.

After removal of incomplete surveys for part one, a total sample size of 77 was achieved for part one. In total, 53 participants completed both part one (pre-visit and exposure to intervention) and part two (post-visit, past behaviours in the NP and behavioural intention for home) of the study in full, giving an attrition rate of 69% for Study Four. The control condition had a sample size of 11, the Identity condition had a sample size of 14. Finally, the Norms condition had a sample size of 13 whilst the Standard condition had a sample size of 15.

Of those who completed part one, the majority were first-time visitors (48.1%) who were staying for longer than four nights (76.6%). For those who completed both parts of the study, the majority were first-time visitors (47.2%) who were staying longer than four nights (81.1%). For participant demographics, see Table 18. Demographics were similar across conditions.

5.2.3.3 Materials & Apparatus

Online Survey. Every part of the study was hosted on Qualtrics (Qualtrics, 2022). The study was separated into two parts, with a pre-study recruitment form.

Recruitment Form. The online recruitment form was accessed by potential participants directly through the advertisement, within an email from Brecon Beacons Holiday Cottages. The recruitment form contained information on the study. It stated that participants would be asked about environmental behaviours but did not include information about the purpose of the posters. The form also asked participants if they would be going to the BBNP before 30th September 2019. It

asked them the expected arrival date to the National Park. Finally, the recruitment form also asked whether participants consented to the study.

Table 18 – Study Four - Participant Demographics

Demographic	Category		Sample Part one (n)	%	Sample Part two (n)	%
Sex		Female	57	74.0	42	79.2
		Male	20	26.0	11	20.8
Age		Prefer not to say	0	0	1	1.9
		18-24	1	1.3	1	1.9
		25-34	6	7.8	2	3.8
		35-54	35	45.5	23	43.4
		55-54	25	32.5	19	35.8
		65+	9	11.7	7	13.2
Residence		United Kingdom	74	96.1	51	96.2
		Rest of Europe	3	3.9	2	3.8
Home Residence		Urban	26	33.8	18	34.0
		Suburban	22	28.6	12	22.6
		Rural	29	37.7	23	43.4
Visitor Type		Local	3	3.9	0	0
		Visitor	74	96.1	53	100.0
Number of previous visits in last 2 years		First visit	37	48.1	25	47.2
		Infrequent: 1 – 3 Times	31	40.3	20	37.7
		Frequent: 4 – 6 times	7	9.1	6	11.3
		Very frequently: 7+ times	2	2.6	2	3.8
Length of stay		Short stay (1-3 nights)	18	23.4	10	18.9
		Long stay (4+ nights)	59	76.6	43	81.1

5.2.3.4 Measures

Part One. *Demographics.* Participants were asked about demographics such as age, gender, income and home location (e.g. if participants are local to the Brecon Beacons or from outside the Brecon Beacons).

Green Identity. Green identity was the only measure to change between pre- and post-visit in Study One. It was also found to predict some PEBs. Therefore it was included in Study Four. The 5-item scale was adapted from the green-identity scale used by Whitmarsh and O'Neill (2010).

NEP. The New Ecological Paradigm has been found to be a predictor of PEBs within previous literature. It also predicted some of the PEBs within Study One. As no change was recorded in Study One, the NEP was measured in part one only.

Place Attachment. The same adapted 6-item place attachment scale used in Study One were used here for home (see Table 19 for the items adapted from Halpenny (2010)).

Past Behaviours. Part one asked participants about their past behaviours in a home context on a 5-point likert scale (1 = not at all, 5 = all the time) (see Table *20* - Study Four - Behaviours Under Investigation (continued on next page) for the behaviours investigated).

Responsibility. The question on responsibility which featured in Pilot Study One offered interesting insight into visitors' beliefs on who is responsible for conserving and protecting the National Park. As such, an open-ended qualitative question "Who do you think is most responsible for protecting and conserving the BBNP and why?", was used to further explore themes around responsibility.

In addition, an open-ended question was used to explore visitors' perceptions around what makes a responsible visitor. The question "What makes a responsible visitor to the Brecon Beacons National Park?" was used. A ranking question was also used to explore visitors' attitudes towards who is "most responsible for conserving and protecting the Brecon Beacons National Park". The participants were required to order a list of possible organisations and individuals from one to seven (1 = most responsible, 7 = least responsible); visitors, local residents, BBNPA, Natural Resources Wales, Local Councils, Landowners and Welsh Government.

Effectiveness Rating. An intervention effectiveness scale was created to gauge participants' opinions on how effective they believed the poster would be. Only those allocated to an experimental condition were asked this question.

Participants were asked "How effective do you think this poster will be at encouraging you to not litter?" answering on a five-point scale (5 = extremely effective, 4 = very effective, 3 = moderately effective, 2 = slightly effective, 1 = not effective at all).

Part Two. *NR-6.* The Nature-Relatedness scale was found to predict some environmental behaviours in Study One. Therefore it was also used as a measure within Study Four. Due to the lack of change in Study One, NR-6 was measured at one time point, post-visit / during part two.

Past Behaviours. Participants were asked about their behaviours (see Table 20 for the behaviours under investigation) in the BBNP on a 5-point likert scale (1 = not at all, 5 = all the time).

Green Identity. As green identity was found to change post-visit previously, therefore it was also measured during part two.

Behavioural Intentions. Participants were asked to report how likely they believed they were to perform a behaviour at home in the future (see Table 20 for the behaviours under investigation), using a 5-point likert scale (1 = not likely at all, 5 = very likely).

Table 19 – Study Four - Adapted Place Attachment Scale

Original Items (Halpenny, 2010)	Adapted Items for Home & Local Area	Adapted Items for Brecon Beacons National Park
Point Pelee National Park means a great deal to me	My local area means a great deal to me	The Brecon Beacons National Park means a great deal to me
I identify strongly with Point Pelee National Park	I identify strongly with my local area	I identify strongly with the Brecon Beacons National Park
Visiting Point Pelee National Park says a lot about who I am	Living in my local area says a lot about who I am	Visiting the Brecon Beacons National Park says a lot about who I am
I feel I can really be myself in Point Pelee National Park	I feel like I can really be myself in my local area	I feel like I can really be myself in the Brecon Beacons National Park
When I visit Point Pelee National Park, others see me the way I want them to see me	When I am in my local area, others see me the way I want them to see me	When I visit the Brecon Beacons National Park, others see me the way I want them to see me

Table 20 - Study Four - Behaviours Under Investigation (continued on next page)

Behavioural Domain	Behaviour (past – home context)	Behaviour (past – Brecon Beacons National Park context)	Behaviour (intention - home context)
National Park behaviours	When walking, I kept to designated paths and trails	When walking, I kept to designated paths and trails	When walking, I will keep to designated paths and trails.
	Avoided littering (throwing rubbish on the street/path)	Avoided littering (throwing rubbish on the street/path)	I will avoid littering (throwing rubbish on the street/path)
Domestic & everyday behaviours	Recycled my waste (e.g. Glass)	Recycled my waste (e.g. Glass)	I will recycle my waste (e.g. Glass)
	Turned off the tap when brushing teeth	Turned off the tap when brushing teeth	I will turn off the tap when brushing my teeth
	Used reusable water bottles instead of single-use bottles	Used reusable water bottles instead of single-use bottles	I will use reusable drinks bottles instead of single-use bottles
	Turned off lights when not in use	Turned off lights when not in use	I will turn off lights when not in use

Behavioural Domain	Behaviour (past – home context)	Behaviour (past – Brecon Beacons National Park context)	Behaviour (intention - home context)
Consumption behaviours	Eaten organic, locally-grown or in season food	Ate organic, locally-grown or in season food	I will eat organic, locally-grown or in season food
	Took short showers (less than 3 minutes long) or infrequent baths	Took short showers (less than 3 minutes long) or infrequent baths	I will take short showers (less than 3 minutes long) or infrequent baths
	Bought products with less packaging	Bought products with less packaging	N/A
	Avoided eating meat	Avoided eating meat	I will avoid eating meat
Other behaviours	Encouraged other people to save energy	Encouraged other people to save energy	Encourage other people to save energy

The Poster Intervention. Three variations of a poster were created that targeted littering behaviours (see Figure 36 – Study Four - Posters used in Study Four. From left to right: identity messaging, standard messaging and social norms messaging for the posters used). The three variations had the same image but varied in the message framing used: identity, standard and social norms. The identity condition poster contained messaging relating to identity, with a slogan "As a responsible person in the Brecon Beacons National Park, you would not drop litter." The standard messaging contained the slogan "Please do not litter when in the Brecon Beacons National Park." The standard messaging was so-called because it was similar to the style of messaging used throughout the BBNP by the BBNPA. Finally, the social norms condition contained the slogan "Most people in the Brecon Beacons National Park do not litter." All the posters also contained a vector image of a person placing litter in a bin.

The poster was viewed within Qualtrics and was optimised for screen (Qualtrics, 2022). The poster page was displayed for 10 seconds, before automatically moving onto the next page. This ensured all participants were shown the poster for the same amount of time. Participants were aware of the timer, as the instruction specified "Please look at the poster below. You have **10 seconds** to view the poster and then you will automatically move onto the next page."
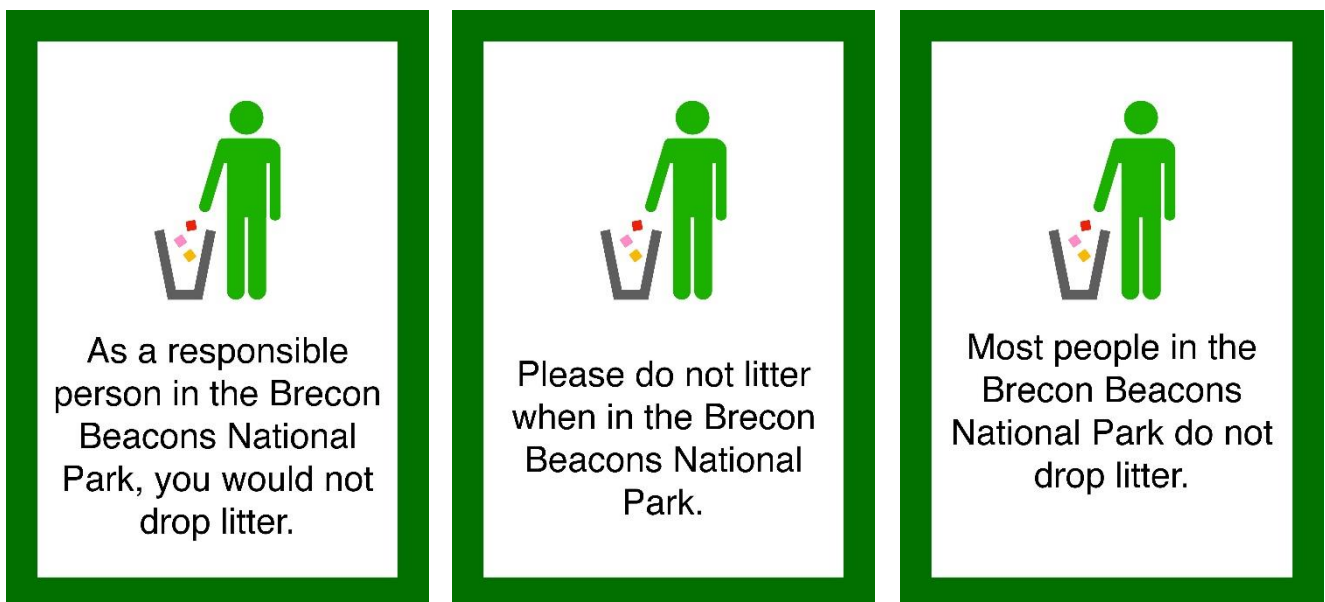
Figure 36 – Study Four - Posters used in Study Four. From left to right: identity messaging, standard messaging and social norms messaging

5.2.3.5 Statistical Analysis

It is hypothesised that individuals in the experimental conditions will report performing PEBs more frequently in the BBNP than those in the control condition (H_1)

H_1 and H_2 were investigated with a series one-way ANOVAs, to test for differences in performance of PEBs in the BBNP across conditions.

H_3 was tested using a series of one-way ANOVAs, to look for differences in behavioural intention, post-visit, between conditions.

Finally, H_4 was tested using one-way ANOVAs, to test for significant changes in NR-6 and Green Identity score between Part One and Part Two.

An exploratory one-way ANOVA was conducted to investigate participant's effectiveness ratings for posters.

To test H_5, a difference score was computed for the PEBs. This involved subtracting the score for behaviours in a home context from behaviours in a national park context. This score was used in a series of multiple linear regressions, to measure if these factors mediated behavioural consistency across contexts.

A thematic analysis was conducted on responses to the open-ended questions asking participants about responsibility.

5.2.4 Results

5.2.4.1 Condition vs. Behaviours in BBNP

A series of one-way ANOVAs were conducted to see if there was a difference in performance of environmental behaviours in the BBNP between conditions. The results indicated no significant difference in performance of behaviours in the BBNP between conditions (see Table 21 for the results of the ANOVAs).

5.2.4.2 Condition vs. Behavioural Intentions for Home

A series of one-way ANOVAs were conducted to see if there was a difference in performance of environmental behaviours in the home, post-visit, between conditions. The results

indicated no significant difference in performance of behaviours at home, post-visit, between conditions (see Table 22 for the results of the ANOVAs).

Table 21 – Study Four - A Series of One-Way ANOVAs Conducted to Test Mean Differences in Behaviours in the BBNP Between Conditions (continued on next page)

Behaviour	Condition												df	F	Sig.
	Control			Norms			Standard			Identity					
	n	M	SD	n	M	SD	n	M	SD	n	M	SD			
When walking I kept to designated paths and trails	13	4.62	0.506	13	4.62	0.506	15	4.60	0.507	13	4.85	0.376	3	0.806	0.496
Avoided littering (throwing rubbish on the street/path).	13	5.00	0.000	13	5.00	0.000	15	5.00	0.000	13	5.00	0.000	3	*	*
Used reusable water bottles instead of single-use bottles.	13	4.62	0.650	13	4.69	0.630	15	5.00	0.000	13	4.62	0.870	3	1.275	0.293
Recycled my waste (e.g. glass).	13	4.62	1.121	13	4.85	0.376	15	4.87	0.352	13	4.54	1.127	3	0.543	0.655
Turned off taps when brushing teeth.	13	4.77	0.439	13	4.54	0.877	15	4.87	0.352	13	4.77	0.439	3	0.846	0.475
Encouraged other people to save energy.	12	3.25	1.603	13	3.08	1.382	15	4.20	1.265	13	3.23	1.363	3	1.930	0.137

Behaviour	Control			Norms			Standard			Identity			df	F	Sig.
	n	M	SD	N	M	SD	n	M	SD	n	M	SD			
Avoided eating meat.	13	2.77	1.301	13	3.00	1.414	15	3.60	1.404	13	2.77	1.423	3	1.146	0.340
Ate organic, locally-grown or in season food.	13	3.00	1.000	13	3.23	1.235	15	3.53	0.834	13	3.15	1.068	3	0.663	0.579
Bought products with less packaging.	12	3.33	0.888	13	3.54	1.050	15	3.67	0.900	13	3.15	0.987	3	0.762	0.521
Took short showers (less than 3 minutes long) or infrequent baths.	13	3.92	1.382	13	3.62	1.044	15	3.47	1.246	13	3.46	1.198	3	0.416	0.743
Turned off lights when not in use.	13	4.54	0.660	13	4.46	0.519	15	4.73	0.458	13	4.23	0.927	3	1.380	0.260

*Standard deviations are the same across conditions (.000) there an ANOVA cannot be conducted

Table 22 – Study Four - A Series of One-Way ANOVAS Conducted to Test for Any Differences Between Behavioural Intentions for Home, post-visit, Across Conditions (continued on next page)

Behaviour	Condition												df	F	Sig.
	Control			Norms			Standard			Identity					
	n	M	SD	n	M	SD	n	M	SD	n	M	SD			
When walking, I will keep to designated paths and trails.	13	4.62	0.506	13	4.62	0.506	15	4.53	0.516	15	4.67	0.617	3	0.156	0.926
I will avoid littering (throwing rubbish on the street path/path).	13	5.00	0.000	13	5.00	0.000	15	5.00	0.000	15	5.00	0.000	3	*	*
I will recycle my waste (e.g. glass).	13	4.85	0.555	13	4.85	0.376	15	4.93	0.258	15	4.93	0.258	3	0.253	0.859
I will avoid eating meat.	13	2.85	1.281	13	3.38	1.387	15	3.87	1.356	15	3.33	1.234	3	1.406	0.251
I will use reusable water bottles instead of single-use bottles.	13	4.62	0.506	13	4.77	0.439	15	4.93	0.258	15	4.53	0.640	3	1.981	0.128

Behaviour	Control			Norms			Standard			Identity			df	F	Sig.
	n	M	SD	n	M	SD	n	M	SD	n	M	SD			
I will turn off the taps when brushing teeth.	13	4.69	0.480	13	4.69	0.480	15	4.73	0.594	15	4.80	0.414	3	0.149	0.930
I will encourage others to conserve energy.	12	4.17	0.718	13	4.08	0.954	15	4.67	0.488	15	4.13	0.834	3	1.865	0.147
I will eat organic, locally grown or in-season food.	13	3.85	0.689	13	3.77	0.832	15	4.07	0.799	15	3.73	0.884	3	0.507	0.679
I will turn of lights when not in use.	12	4.58	0.515	13	4.69	0.480	15	4.87	0.352	15	4.67	0.617	3	0.790	0.505
I will take short showers (less than 3 minutes long) or infrequent baths.	13	4.00	1.225	13	4.00	0.913	15	3.87	1.302	15	4.13	0.990	3	0.141	0.935

* Standard deviations are the same across conditions (.000) therefore an ANOVA cannot be conducted

5.2.4.3 Condition vs. Green Identity

Due to an error during data collection, the data collected for Green Identity in part two was corrupted. This means that no analysis can be conducted on green identity changes between pre-visit and post-visit / pre or post intervention.

5.2.4.4 Condition vs. Nature-Relatedness

A one-way ANOVA was conducted to see if there was any difference in participants' relatedness to nature across conditions. The results indicated no significant difference between conditions for NR-6 scores (see Table 23 for the results).

Table 23 – Study Four - Results from a One-Way ANOVA to Test for Differences in Nature-Relatedness Across Conditions

	Condition												ANOVA		
	Control			Identity			Norms			Standard					
	n	M	SD	n	M	SD	n	M	SD	n	M	SD	df	F	Sig.
NR-6 Score	13	0.77	.644	15	1.18	.411	13	0.90	.735	15	1.27	.566	3	2.153	.105

5.2.4.5 Effectiveness Ratings of Posters

Participants in the experimental condition rated the effectiveness of the poster they were shown on a five-point scale. A one-way ANOVA was conducted. The results indicated there was no significant difference between effectiveness ratings between conditions (see Table 24 for the results).

Table 24 – Study Four - Mean Effectiveness Ratings of the Posters in Each Condition

Condition	n	Mean Effectiveness Rating	SD
Identity	20	3.65	.988
Norms	17	3.24	1.091
Standard	20	3.50	1.192

5.2.4.6 Responsibility

Two open-ended questions asked participants (N = 56) about the of responsibility. A thematic analysis was conducted using NVivo (QSR International Pty Ltd., 2020). Eleven themes emerged. 48.2% of participants mentioned respecting the environment. Whilst 28.6% mentioned the more abstract, "leaving no trace". Finally, nearly a quarter (23.2%) of participants mentioned laws, rules and regulations – i.e., "follow the country code" (see Table 25 for all themes uncovered, frequencies and percentages of occurrences).

Participants (N = 56) were also asked a ranking question "Who do you think is most responsible for protecting and conserving the Brecon Beacons National Park?". The frequency of first (most responsible) and last (least responsible) rankings are shown in Figure 37 – Study Four - Frequency of First and Last Place Ranking for the Responsibility Question. The results show a similar pattern to the same question's results in Study One.
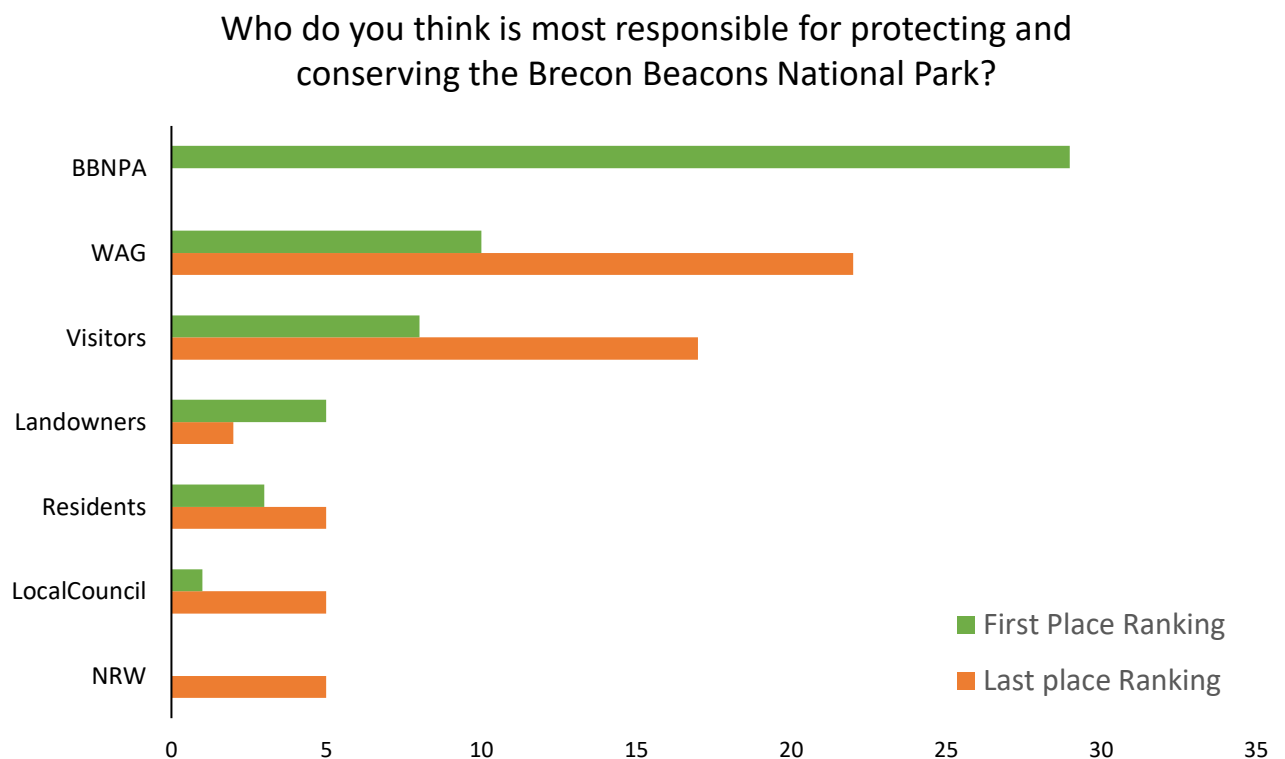
Figure 37 – Study Four - Frequency of First and Last Place Ranking for the Responsibility Question

Table 25 – Study Four - Frequency of Thematic Codes from Responses to the Question "What makes a responsible visitor to the Brecon Beacons National Park?"

Theme	Identified When...	Example...	Frequency	% of Participants
Respecting the Environment	Mentions of respecting the environment or area	*"someone who respects the land"*	27	48.2
Leave No Trace	Mentions of not leaving an impact or leaving	*"Leaving it in the state it was when you visited"*	16	28.6
Rules, Regulations and Laws	Mentions of laws, rules and regulations	*"Follow Country Code"*	13	23.2
No Littering	Mentions of avoiding littering or picking up litter	*"leaves no litter"*	10	17.9
Respecting Wildlife	Mentions of respecting wildlife	*"considerate of the wildlife"*	7	12.5
Staying on Paths	Mentions of not going off-path	*"Staying on designated rights of way where designated"*	5	8.9
Respecting Local Communities	Mentions of respecting locals, residents and people who work in the National Park	*"considerate to farmers"*	4	7.1
Supporting Local Communities	Mentions of supporting (financially) local communities	*"spend money to support local economy"*	4	7.1
Considering Other Users	Mentions of being considerate of other visitors and people in the National Park	*"consideration for others including people"*	4	7.1
Appreciating Nature	Mentions of appreciating and enjoying the environment	*"someone who appreciates the local beauty"*	4	7.1
Sustainable Travel	Mentions of travelling sustainability within or to the National Park	*"consider impact of travel e.g., routes chosen, CO2 emitted"*	3	5.4

5.2.4.7   Behaviours between Contexts

Descriptives were calculated and mean average response to the questions "how often did you perform X behaviour at home/in the Brecon Beacons National Park?" and "how often do you intend to perform X behaviour at home?" for each condition (see Figure 38 – Study Four - Bar Chart Showing the Mean Average Response to the Question "in the last week at home how often have you performed X behaviour?" for Behaviours at Home. Error bars represent standard deviatio,Figure 39 – Study Four - Bar chart showing the mean average response to the question "during your visit to the BBNP how often did you perform X behaviour?" for behaviours in the BBNP. Error bars represent standard deviation

Figure 40 – Study Four - Bar chart showing the mean average response to the question "during the next week at home how often do you intend to perform X behaviour?", post-visit to the BBNP. Error bars represent standard deviation for the bar graphs and Table 26Table 27, Table 28 for descriptives).

A Pearson product-moment correlation coefficient was computed to assess the relationship between behaviours in a home context (pre-visit) and the NP context, regardless of condition. The analysis revealed many positive correlations between behaviours in a home and NP context (see Table 29 for the correlation matrix).

All but one of the behaviours – "recycled my waste" – correlated across contexts. Some behaviours correlated to a greater degree than others. The most performed behaviour across all conditions and contexts, was "avoided littering" (see Table 26 Table 27 for the mean scores). The least performed behaviour was 'avoided eating meat' (see Table 26Table 27 for the mean scores). Across contexts there was little variation in commonality of behaviours.

In general, the strongest relationships observed were between the same behaviour in each context, with "avoided eating meat" showing the strongest positive correlation across contexts ($r = .917$, $n = 55$, $p > .01$). "Encouraged other people to save energy" also shows a very strong positive relationship across contexts ($r = .649$, $n = 55$, $p > .01$).
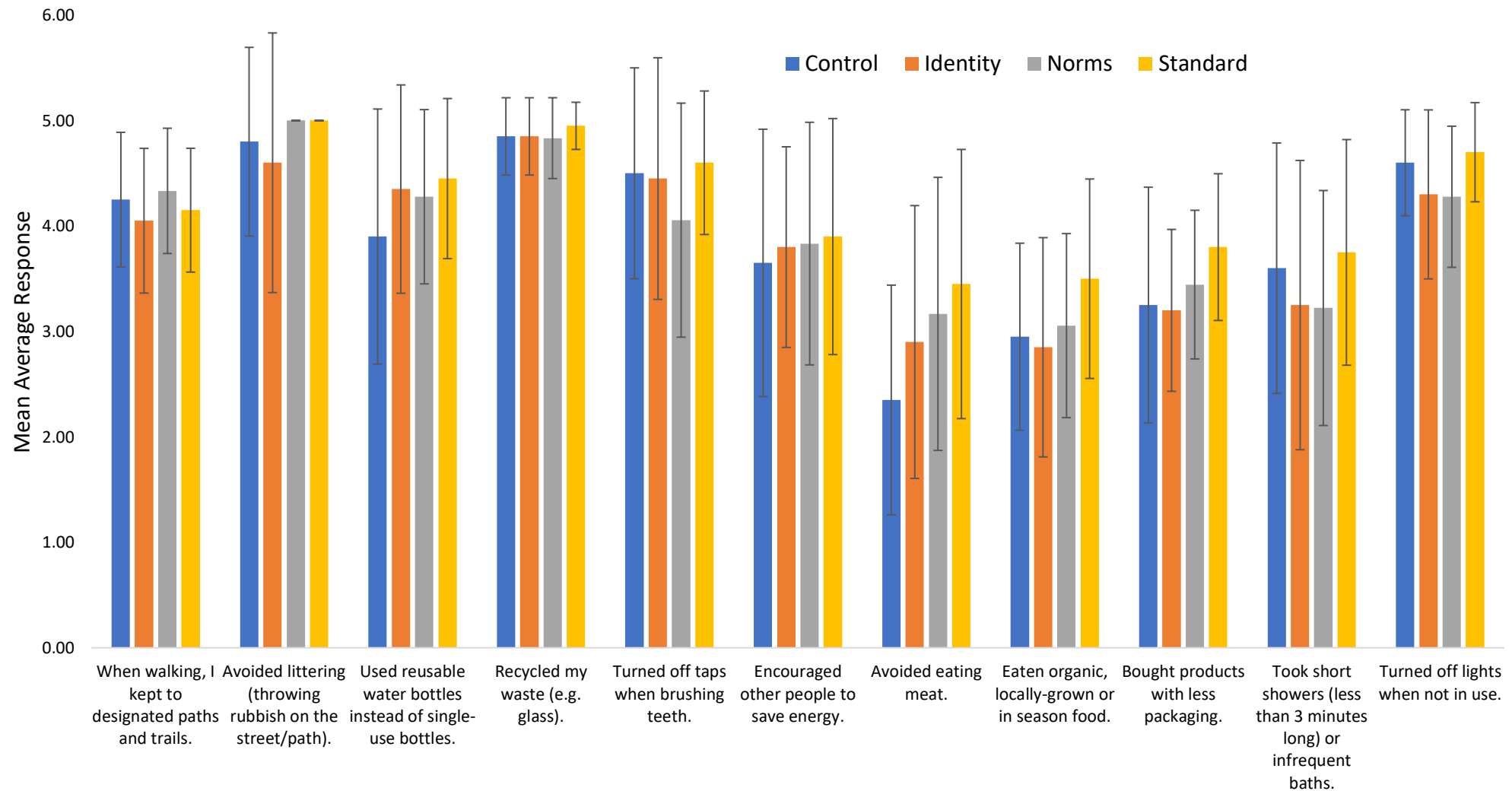
Figure 38 – Study Four - Bar Chart Showing the Mean Average Response to the Question "in the last week at home how often have you performed X behaviour?" for Behaviours at Home. Error bars represent standard deviation

Table 26 – Study Four - Descriptives for Responses to the Question "in the last week at home how often have you performed X behaviour?"

	Condition											
Behaviours	Control			Identity			Norms			Standard		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
When walking, I kept to designated paths and trails.	20	4.25	0.639	20	4.05	0.686	18	4.33	0.594	20	4.15	0.587
Avoided littering (throwing rubbish on the street/path).	20	4.80	0.894	20	4.60	1.231	18	5.00	0.000	20	5.00	0.000
Used reusable water bottles instead of single-use bottles.	20	3.90	1.210	20	4.35	0.988	18	4.28	0.826	20	4.45	0.759
Recycled my waste (e.g. glass).	20	4.85	0.366	20	4.85	0.366	18	4.83	0.383	20	4.95	0.224
Turned off taps when brushing teeth.	20	4.50	1.000	20	4.45	1.146	18	4.06	1.110	20	4.60	0.681
Encouraged other people to save energy.	20	3.65	1.268	20	3.80	0.951	18	3.83	1.150	20	3.90	1.119
Avoided eating meat.	20	2.35	1.089	20	2.90	1.294	18	3.17	1.295	20	3.45	1.276
Eaten organic, locally-grown or in season food.	20	2.95	0.887	20	2.85	1.040	18	3.06	0.873	20	3.50	0.946
Bought products with less packaging.	20	3.25	1.118	20	3.20	0.768	18	3.44	0.705	20	3.80	0.696
Took short showers (less than 3 minutes long) or infrequent baths.	20	3.60	1.188	20	3.25	1.372	18	3.22	1.114	20	3.75	1.070
Turned off lights when not in use.	20	4.60	0.503	20	4.30	0.801	18	4.28	0.669	20	4.70	0.470
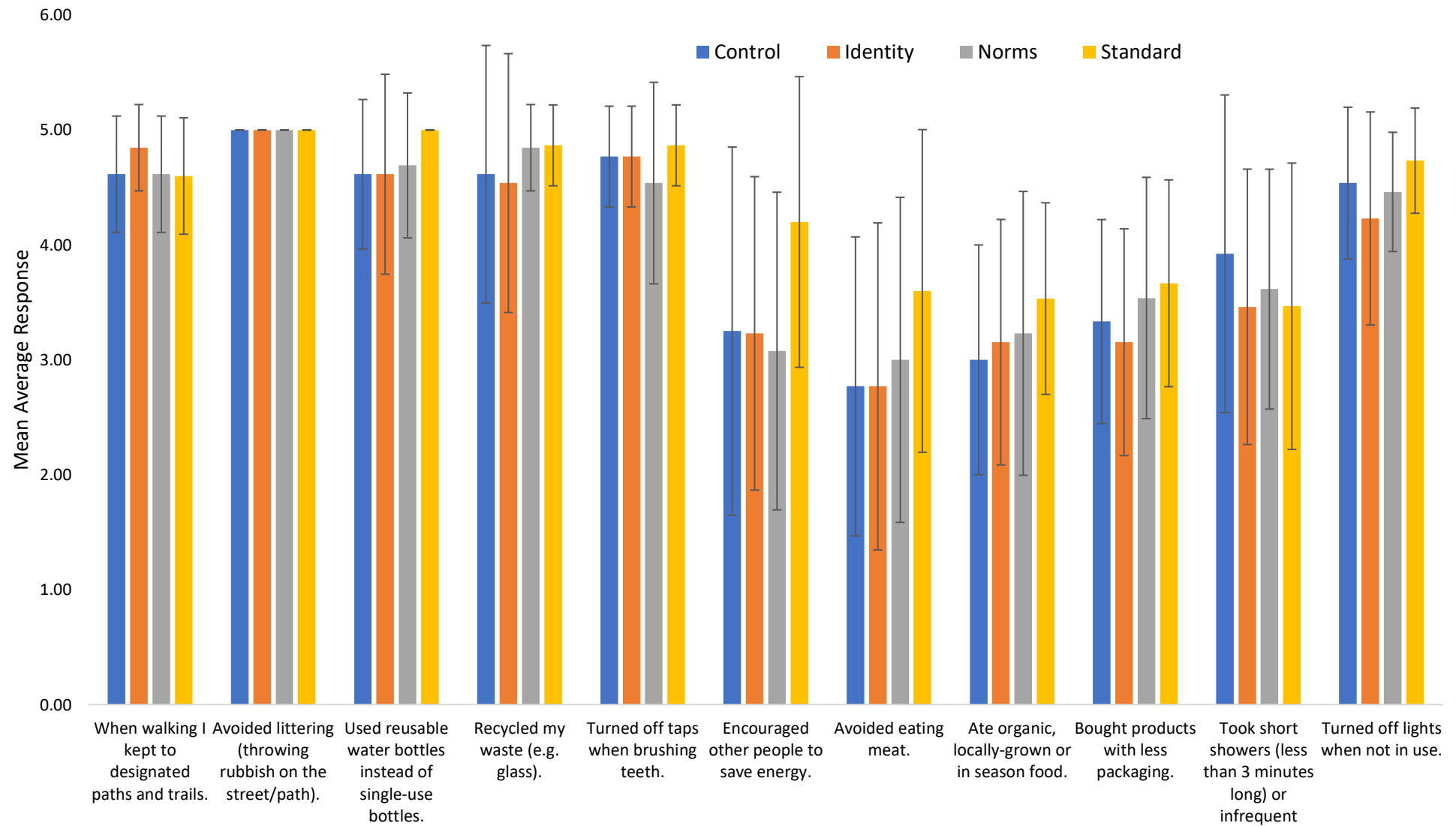
Figure 39 – Study Four - Bar chart showing the mean average response to the question "during your visit to the BBNP how often did you perform X behaviour?" for behaviours in the BBNP. Error bars represent standard deviation

Table 27 – Study Four - Descriptive Statistics for Responses to the Question "during your visit to the BBNP how often did you perform X behaviour?"

| Behaviour	Condition											
	Control			Identity			Norms			Standard		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
When walking I kept to designated paths and trails.	13	4.62	0.506	13	4.85	0.376	13	4.62	0.506	15	4.60	0.507
Avoided littering (throwing rubbish on the street/path).	13	5.00	0.000	13	5.00	0.000	13	5.00	0.000	15	5.00	0.000
Used reusable water bottles instead of single-use bottles.	13	4.62	0.650	13	4.62	0.870	13	4.69	0.630	15	5.00	0.000
Recycled my waste (e.g. glass).	13	4.62	1.121	13	4.54	1.127	13	4.85	0.376	15	4.87	0.352
Turned off taps when brushing teeth.	13	4.77	0.439	13	4.77	0.439	13	4.54	0.877	15	4.87	0.352
Encouraged other people to save energy.	12	3.25	1.603	13	3.23	1.363	13	3.08	1.382	15	4.20	1.265
Avoided eating meat.	13	2.77	1.301	13	2.77	1.423	13	3.00	1.414	15	3.60	1.404
Ate organic, locally-grown or in season food.	13	3.00	1.000	13	3.15	1.068	13	3.23	1.235	15	3.53	0.834
Bought products with less packaging.	12	3.33	0.888	13	3.15	0.987	13	3.54	1.050	15	3.67	0.900
Took short showers (less than 3 minutes long) or infrequent baths.	13	3.92	1.382	13	3.46	1.198	13	3.62	1.044	15	3.47	1.246
Turned off lights when not in use.	13	4.54	0.660	13	4.23	0.927	13	4.46	0.519	15	4.73	0.458
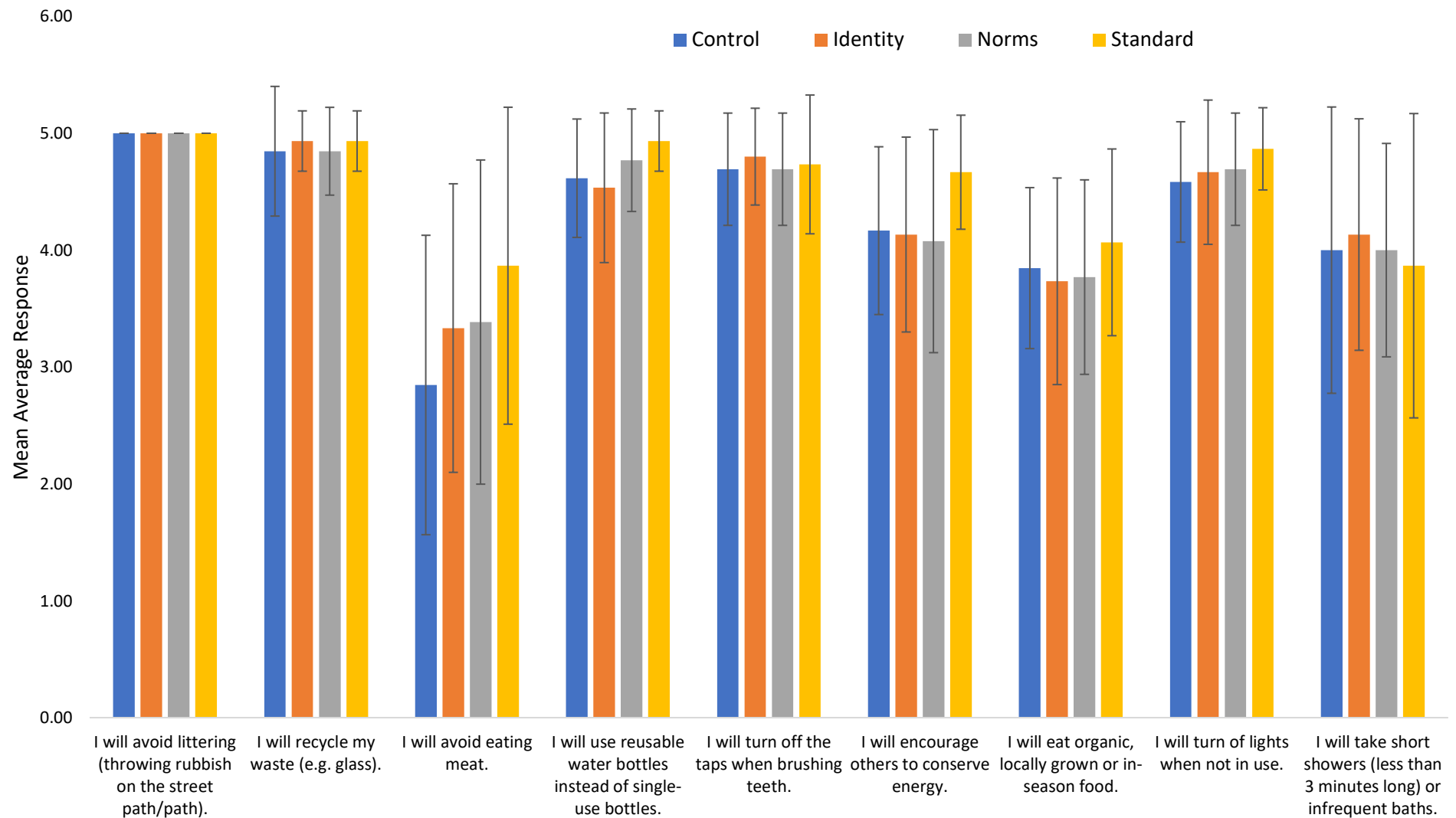
Figure 40 – Study Four - Bar chart showing the mean average response to the question "during the next week at home how often do you intend to perform X behaviour?", post-visit to the BBNP. Error bars represent standard deviation

Table 28 – Study Four - Descriptives for the Responses to the Question "in the next week at home how often do you intend to perform X behaviour?"

Behaviour	Condition											
	Control			Identity			Norms			Standard		
	N	M	SD	N	M	SD	N	M	SD	N	M	SD
I will avoid littering (throwing rubbish on the street path/path).	13	5.00	0.000	15	5.00	0.000	13	5.00	0.000	15	5.00	0.000
I will recycle my waste (e.g. glass).	13	4.85	0.555	15	4.93	0.258	13	4.85	0.376	15	4.93	0.258
I will avoid eating meat.	13	2.85	1.281	15	3.33	1.234	13	3.38	1.387	15	3.87	1.356
I will use reusable water bottles instead of single-use bottles.	13	4.62	0.506	15	4.53	0.640	13	4.77	0.439	15	4.93	0.258
I will turn off the taps when brushing teeth.	13	4.69	0.480	15	4.80	0.414	13	4.69	0.480	15	4.73	0.594
I will encourage others to conserve energy.	12	4.17	0.718	15	4.13	0.834	13	4.08	0.954	15	4.67	0.488
I will eat organic, locally grown or in-season food.	13	3.85	0.689	15	3.73	0.884	13	3.77	0.832	15	4.07	0.799
I will turn of lights when not in use.	12	4.58	0.515	15	4.67	0.617	13	4.69	0.480	15	4.87	0.352
I will take short showers (less than 3 minutes long) or infrequent baths.	13	4.00	1.225	15	4.13	0.990	13	4.00	0.913	15	3.87	1.302

Table 29 – Study Four - Correlation matrix for Behaviours in a Home Context vs. Behaviours in a NP Context (significant correlations in **bold**, negative correlations in red)

Behaviour	1	2	3	4	5	6	7	8	9	10	11
1 - When walking, I kept to designated paths and trails	**.373****	.c	-0.015	-0.059	**-.276***	-0.091	-0.157	0.031	0.080	0.054	-0.110
2 - Avoided littering (throwing rubbish on the street/path).	-0.095	.c	0.188	-0.048	-0.062	-0.048	0.103	0.168	0.220	-0.041	0.116
3 - Used reusable water bottles instead of single-use bottles.	0.035	.c	**.571****	0.189	0.127	0.267	0.074	0.212	0.139	-0.132	-0.108
4 - Recycled my waste (e.g. glass).	0.137	.c	-0.037	0.096	**.276***	0.264	-0.169	0.201	0.050	0.257	0.110
5 - Turned off taps when brushing teeth.	-0.177	.c	0.074	-0.129	**.510****	0.049	0.025	-0.118	0.109	0.193	**.294***
6- Encouraged other people to save energy.	-0.022	.c	0.070	0.129	0.201	**.649****	0.122	0.141	0.172	0.243	0.179
7 - Avoided eating meat.	0.020	.c	0.003	0.064	-0.104	0.027	**.917****	0.100	0.013	0.194	0.032
8 - Eaten organic, locally-grown or in season food.	-0.079	.c	0.010	0.123	0.017	**.279***	**.285***	**.575****	**.387****	0.259	0.122
9 - Bought products with less packaging.	-0.030	.c	0.127	0.209	-0.139	**.380****	0.224	**.382****	**.528****	**.370****	**.280***
10 - Took short showers (less than 3 minutes long) or infrequent baths.	0.025	.c	-0.105	-0.046	0.150	0.134	-0.006	0.198	**.325***	**.469****	0.141
11 - Turned off lights when not in use.	0.084	.c	0.010	0.053	**.348***	0.189	-0.135	0.205	**.293***	**.369****	**.627****

* correlation is significant at 0.05 level (two-tailed)

** correlation is sig. to 0.01 level (two-tailed)

c. cannot be computer because at least one of the variables is constant

5.2.4.8 NEP and NR-6 as Predictors of Behavioural Consistency

A difference score was computed for the PEBs. This involved subtracting the score for behaviours in a home context from behaviours in a national park context. This score was used as a measure of behavioural consistency across contexts and test H_5.

A series of standard multiple regressions were conducted to see whether behavioural consistency was predicted by New Ecological Paradigm (NEP) score and Nature-Relatedness 6 (NR-6) score.

Checking for multicollinearity, the bivariate correlation was below .7, tolerance values were below .10 and variance inflation factor (VIF) values were below 10 – indicating little to no multicollinearity between the independent variables. In checking for outliers, no scores had a Mahalanobis distance exceeding the critical value for two independent variables of 13.82 (Pallant, 2016).

None of the models explain the variance for behaviours to a significant level. Observing the adjusted R^2 values, the model with the highest explanation of variance is for "I ate organic, locally-grown or in season food", with the model predicting 11.7% of variance (see Table 30 for the results).

Looking at the Beta values and the significant values (column marked Sig.), both of the predictor variables make significantly unique contributions to the equations. NEP score was able to predict consistency for: "I turned off the taps when brushing my teeth", "I ate organic, locally grown or in season food" and "I turned off the lights when not in use". NR-6 was able to predict consistency for two behaviours: "when walking, I kept to designated paths and trails" and "I turned off taps when brushing my teeth".

Table 30 – Study Four - Results from a series of standard multiple linear regressions for behavioural consistency. Significant results indicated in **bold***

Behaviour / Consistency	Regression Model (Predictors)	Predictor Parameters			Model Parameters	
		Beta (standardised)	*t*	Sig.	F	Adj. R^2
When walking, I kept to designated paths and trails.	NEP Score	-.033	-.232	.818	2.465	.053
	Nature Relatedness	-.287	-2.017	**.049***		
Avoided littering (throwing rubbish on the street/path).	NEP Score	.076	.513	.610	.134	**-.034**
	Nature Relatedness	-.015	-.098	.923		
I used reusable water bottles.	NEP Score	-.171	-1.179	.244	1.520	**.020**
	Nature Relatedness	.231	1.595	.117		
I recycled my waste (e.g., glass).	NEP Score	-.081	-.542	.590	.248	**-.030**
	Nature Relatedness	-.038	-.252	.802		
I turned off taps when brushing my teeth.	NEP Score	-.301	-2.158	**.036***	3.661	.093
	Nature Relatedness	.312	2.238	**.030***		
I encouraged others to save energy.	NEP Score	.122	.817	.418	.493	**-.020**
	Nature Relatedness	.041	.273	.786		
I avoided eating meat.	NEP Score	-.175	-1.186	.241	.706	**-.011**
	Nature Relatedness	.065	.441	.661		
I ate organic, locally-grown or in season food.	NEP Score	.374	2.717	**.009***	4.433	.117
	Nature Relatedness	.039	.281	.780		
I took short showers (less than 4 minutes).	NEP Score	-.243	-1.684	.098	1.716	**.027**
	Nature Relatedness	-.028	-.191	.850		
I turned off lights when not in use.	NEP Score	-.330	-2.364	**.022***	3.604	.091
	Nature Relatedness	.274	1.964	.055		

5.2.5   Conclusions for Study Four

The results of Study Four indicated no difference in performance of environmental behaviours across conditions. A series of one-way ANOVAs were conducted and indicated no significant differences between conditions for behavioural intention for home, post-visit. The results mean that H_1, which predicted that participants in the experimental conditions would perform more PEBs at home than control participants, is rejected. Additionally, H_2 was tested using a series of one-way ANOVAs. The results found no significant difference in performance of PEBs in the BBNP between conditions. The results mean that H_2 can be rejected.

A series of multiple regressions were conducted to see if there was a significant difference in behavioural intention for home (post-visit). The results indicated no significant difference. This means that H_3 - which predicted that those in the experimental conditions would have higher intention to perform behaviours, post-visit, than those in the control condition - can be rejected.

Due to an error in data collection, it was not possible to conduct analysis to test the difference in Green Identity pre and post-visit. Additionally, results from a one-way ANOVA found no significant change in NR-6 score between pre and post-visit.

The final hypothesis, H_5 predicted that Green Identity, NEP and NR-6 scores would mediate behavioural consistency across contexts. Due to the error in data collection, it was not possible to test for Green Identity as a mediator. However, results from a series of multiple linear regressions found that NEP and NR-6, individually, did predict consistency for some behaviours. This means that H_5 can be partially accepted.

Whilst the results reveal no significant difference in performance of behaviour between conditions, the low sample size of the study was not sufficient to reach the required power and this may be why no significant difference was found.

The study also highlights the issue with testing interventions using an online platform, pre-visit. Viewing posters online prior to a trip is a very different experience to viewing posters on-site whilst within the Brecon Beacons National Park. The posters were created to look like images that people would come across whilst visiting the National Park, but perhaps would have been more

suitably created as social media posts, which would more typically be viewed by people prior to a visit[18].

The posters are also not typical of online interpretation used by the BBNPA, which are posted on predominantly on social media and with some context. The posters used in this study are not reflective of the images shared by the BBNPA on their social media (see Appendix B for examples of social media posts from the BBNPA). This is, in part, due to the images not being shared until after Study Four was conducted.

Like Study Four, Study Two similarly tested different message frames of signage, but on-site. However, Study Two did find differences, with norms framed posters leading to decreased littering on-site. The findings from Study Four are in contrast to Study Two, and other research which has found that norms messaging is usually the most effective at eliciting behavioural change (Cialdini, 2003; Goldstein et al., 2008). The low sample size is potentially why no significant differences were detected, as sufficient statistical power was not reached and/or because information was provided outside of the behavioural context in which the behaviour was targeted.

---

[18] Attempts were made to run a study that looked at the effectiveness of different social media posts and campaigns with the BBNPA. However, the BBNPA were not able to allow the researcher access to their social media platforms and thus a study of this nature was not possible.

5.3   Study Five – Virtual Reality as an Intervention to Encourage Pro-Environmental Behaviour

5.3.1   Overview

As outlined in the introduction, virtual reality (VR) is becoming an increasingly popular research tool within environmental psychology. Studies investigating the impact that immersive virtual environments (IVEs), and virtual exposure to nature more broadly, have found that VR nature can have a positive impact on wellbeing and environmental behaviours.

During the process of conducting Study Five, the COVID-19 pandemic occurred. What was once a relatively fringe research topic, suddenly became a viable method for individuals to experience nature safely. During this time, the concept and benefits of exposure to virtual nature were picked up by news outlets, with the BBC even promoting a soundscape of "nature" sounds to help reduce people's stress (BBC, 2020b; Gordon, 2020). The BBC also collaborated with Andy Puddicombe, the founder of Headspace (a meditation and mindfulness app), to produce "Mindful Escapes" a series of nature videos accompanied with 'calming' narration from Andy (BBC, 2020a; Headspace, 2020).

VR enables the BBNP to be 'visited' by anyone within a lab. It offers the chance to ask participants about cross-context behaviour change without the need for participants to physically travel to the Brecon Beacons National Park. A lab-based study, Study Five, investigates how VR can act as an intervention to encourage PEBs. It also investigates if virtual visits to a nature-based context can influence domestic-context behaviours. The research will also investigate whether an intervention within VR can influence behaviours in a nature-based context, with measures of spillover to a domestic-context also conducted.

The study utilised VR to create a "visit" to the BBNP for participants. The study used 360° videos, composed of 2-minute videos from various sites across the Brecon Beacons National Park, or within Cardiff (as a control), for participants to observe.

The VR nature experience aimed to act not only as a "virtual visit" but also as an intervention, as previous work has found that visits to nature can increase PEBs (Cajiao et al., 2022; Deville et al., 2021; Martin et al., 2020a; Tanja-Dijkstra et al., 2018). Four conditions are used. Two conditions allowed for comparisons between the effects of VR nature and VR filmed in an urban

environment (hereafter – VR urban). The other two conditions allowed for comparisons between conditions with and without interpretation (i.e. signage) containing environmental messaging.

Research has found that exposing individuals' to nature can have a positive impact on affect and connectedness to nature, which can lead to increased likelihood of performing PEBs. However, exposure to nature combined with information provision is more effective than exposure to nature alone at eliciting behaviour change (Cajiao et al., 2022; Dearden et al., 2007; Salim et al., 2022). As such, two of the VR conditions contained an additional intervention. The intervention was in the form of interpretation (in the form of a sign) within the VR video. Previous research has found that additional conservation messaging that included anthropogenic causes of species decline, within videos, led to higher rates of donations to charities (Shreedhar & Mourato, 2018).

A laboratory study allows for the use of objective measures of PEBs, albeit in an artificial context. As outlined in section 5.1.3 earlier in this chapter, there are various ways to objectively measure PEBs in the lab. This study utilises an adapted version of the method used in Evans et al. (2013), involving a distractor task and measurement of a recycling behaviour.

5.3.2   Experimental Design

A between-subjects 2 x 2 design was used. Each participant was randomly assigned to one of four conditions. In the control condition, participants viewed an urban scene within VR in the form of a 360° video filmed within Cardiff. In the Experimental Condition, participants viewed a 360° video filmed in the BBNP. In the Experimental Sign Condition participants viewed a 360° video filmed in the same location and position as the Experimental Condition, but also included a sign with facts about the location and pro-environmental messaging. In the BBNP Sign Condition participants viewed the same video as the control condition, but with a sign showing facts about the location and a pro-environmental message.

Table 31 – Study Five - 2x2 Design

Intervention	VR Video Location	
	Brecon Beacons National Park	Cardiff
No intervention	Brecon Beacons National Park Control (BBNPC)	Cardiff Control (CC)
Signage Intervention	Brecon Beacons National Park Experimental (BBNPE)	Cardiff Experimental (CE)

Note. Click the conditions to view the videos on YouTube.

5.3.3   Hypotheses

As research has found that exposure to nature can lead to increased nature relatedness and green identity, it was predicted that participants in both BBNPC and BBNPE conditions would have an increased green identity and greater nature-relatedness, post-exposure than those in CC and CE conditions (H_1).

As interpretation has been found to impact PEBs, it was predicted that participants in the BBNPE and CE conditions would have higher intentions to perform PEBs at home, post-VR, than those in the BBNPC and CC conditions (H_2).

Following on from previous research which found spillover from an intervention targeting general PEBs to recycling, it was predicted that participants in the BBNPE and CE conditions would be more likely to recycle paper after the distractor task than those in the BBNPC and CC conditions (H_3).

Due to the combination of exposure to nature and information provision, it was predicted that participants in the BBNPE condition would report greater behavioural intentions for home PEBs than those in the CE condition, and would recycle the paper more often (H_4).

Finally, it is expected that place attachment will be greater for those in the BBNPE condition than those in the BBNPC condition, due to the addition of information provided in the BBNPE condition (H_5).

5.3.4 Methods

5.3.4.1 Participants

An a priori power analysis was conducted using G*Power Analysis. With an estimated effect size of 0.3, the total sample size required to achieve statistical power was 190. There are several issues with this effect size estimate. Most laboratory-based studies using VR in environmental psychology do not report effect sizes, so this estimation is a "best guess". Additionally, many VR studies use very small sample sizes of around 12 participants per condition. This study aimed to sample 190 participants, which would allow for the detection of effect sizes of 0.3.

Participants were recruited via an online Student Participant Panel. Students in the School of Psychology are required to take part in experiments to obtain course credits. Participants were given two credits for completing part one of the study, the online questionnaire. Participants then received four credits for completing part two, the VR laboratory study.

In March 2020, recruitment and data collection were interrupted by the COVID-19 lockdown. This means that the study was only able to recruit a total of 47 participants. Participant demographics can be viewed in Table 32. An attention filter question was used to determine that participants were paying attention; all participants correctly answered five to the question "Please answer number 5 to this question", so no participants were removed.

Table 32 – Study Five - Participant Demographics

	Factor	Frequency	Percentage
Sex	Male	7	14.9
	Female	40	85.1
Age	18-24	47	100

5.3.4.2 Materials & Apparatus

Apparatus. The 360° videos were filmed with an Insta 360 One X (Insta 360, 2018). Videos were filmed in 5K (5760 x 2880) at 30 frames per second in 360°. The VR headset used to view the 360° video/IVEs was the Oculus Quest (Oculus, 2019). This virtual reality headset is an all-in-one device (see in Figure 41 -Study Five - The Oculus Quest system used. Note that this system is now discontinued and has been superseded by the Oculus Quest 2 ***Error! Reference source not found.*** for a picture of the device). As of September 2020, the device was discontinued and replaced with a newer model. The headset has built in speakers, but as sound is very important, a pair of

Figure 41 -Study Five - The Oculus Quest system used. Note that this system is now discontinued and has been superseded by the Oculus Quest 2

Sennheiser 201 headphones were used in addition to the Oculus Quest system, to ensure that participants had as immersive an experience as possible.

Participants sat down for the duration of the study, viewing the videos from a chair that allowed participants to turn on the spot to view the 360° video in full. Previous research into VR has found no difference in terms of sense of presence, measures such as "realism", "sense of reality" and "flatness", between stationary VR and VR involving movement, such as on a treadmill (Calogiuri et al., 2018).

Filler Task. A filler task was used, adapted from Evans et al. (2013). This task was created entirely to allow for participants to have a need to dispose of paper. Participants were asked to design a logo for the VR experience they had viewed. Colouring pencils, a ruler, a rubber and two sheets of paper were given to the participant to use. The participants were asked to make two logo designs, on separate sheets. They were asked to keep their favourite logo and dispose of the other.

VR Videos. Two 360° videos were produced, both were six minutes and thirty-one seconds long. The videos were edited using Adobe Premiere Pro CC (Adobe Premier Pro CC 2020, version 14.0). All videos started with a calibration screen (see Figure 42 - Study Five - Calibration screen used at the beginning of the 360° videos. Note that this is a panorama image of a 360° video for the calibration screen*Error! Reference source not found.*) which allowed the experimenter to ensure t hat participants had the headset fitted comfortably, properly and that the image was in-focus.

One video was created for BBNP conditions. The BBNP video consisted of six one-minute "scenes" filmed across six different locations in the BBNP. From West to East; Carreg Cennen Castle, Sgwd Gwladys Waterfall, Garn Goch, Twyn Y Gaer, Llangorse Lake and Skirrid Fawr were used in the scenes of the video (see Figure 43 - Study Five - Map showing the VR video locations shown in the BBNP conditions for the map showing the filming locations in the BBNP and Figure 45 – *Study Five – Frame from the Brecon Beacons National Park Control condition video. This frame is taken from the "Skirrid Fawr" scene. Note that this is a panorama image of a 360° video*Figure 46 – *Study Five – Frame from the Brecon Beacons National Park Experimental condition video. This frame is taken from the "Skirrid Fawr" scene. Note that this is a panorama image of a 360° video*

Figure 47 for an example frame from the BBNPC and BBNPE conditions respectively). These locations offer not only an interesting subject matter for VR, but also showcase a broad range of the National Park's geographical and historical features, and main tourist attractions.

The second video was created for the Cardiff conditions. The Cardiff video consisted of six one-minute "scenes" filmed across six locations in the city of Cardiff. The locations included in the video were: The Temple of Peace, Principality Stadium, Millennium Centre, Cardiff Cathedral, Queen's Arcade and Cardiff Castle (see Figure 49 – Study Five - Map showing the VR video locations shown in the Cardiff conditions for a map showing the locations used in the Cardiff conditions and Figure 50 – *Study Five – Frame from the Cardiff Control condition video. This frame is taken from the*

"Wales Millennium Centre" scene. Note that this is a panorama image of a 360° video and Figure 51 – *Study Five – Frame from the Cardiff Experimental condition video. This frame is taken from the "Wales Millennium Centre" scene. Note that this is a panorama image of a 360° video* for screenshots from Cardiff Control and Cardiff Experimental conditions respectively). Like with the BBNP conditions, the locations used in the Cardiff conditions offered an interesting video that showcase a broad range of the city's historical and tourist locations.

Prior to locations being shown in the videos, a short title screen was shown, informing the participant where they were about to view (see Figure 52 - *Study Five - Example of the title screen shown at the beginning of each scene in all videos. This example is for the Wales Millennium Centre scene from the Cardiff conditions. Note that this is a panorama image of a 360° video* for an example of a title screen).

Figure 42 - Study Five - Calibration screen used at the beginning of the 360° videos. Note that this is a panorama image of a 360° video

Figure 43 - Study Five - Map showing the VR video locations shown in the BBNP conditions

Figure 45 – Study Five – Frame from the Brecon Beacons National Park Control condition video. This frame is taken from the "Skirrid Fawr" scene. Note that this is a panorama image of a 360° video

Figure 46 – Study Five – Frame from the Brecon Beacons National Park Experimental condition video. This frame is taken from the "Skirrid Fawr" scene. Note that this is a panorama image of a 360° video

Figure 49 – Study Five - Map showing the VR video locations shown in the Cardiff conditions

Figure 50 – Study Five – Frame from the Cardiff Control condition video. This frame is taken from the "Wales Millennium Centre" scene. Note that this is a panorama image of a 360° video

Figure 51 – Study Five – Frame from the Cardiff Experimental condition video. This frame is taken from the "Wales Millennium Centre" scene. Note that this is a panorama image of a 360° video

Figure 52 - Study Five - Example of the title screen shown at the beginning of each scene in all videos. This example is for the Wales Millennium Centre scene from the Cardiff conditions. Note that this is a panorama image of a 360° video

BBNP Conditions. Both BBNP conditions used the same 360° video. In addition, a sign was edited into the BBNP experimental condition video.

Cardiff Conditions. One 360° video was used for the Cardiff conditions. In addition, the experimental condition also contained a sign.

Intervention. An intervention was edited into the 360 video for the Cardiff Experimental Condition and the BBNP experimental condition. The intervention was a sign, placed in the video, that was visible to participants. Signage used social norms messaging and information that aimed to elicit greater place attachment for the location from viewers. The signs contained a title, showing the location name, the logo of the corresponding organisation that the Virtual Reality was associated to (Cardiff University or BBNPA) as well as information and facts about the location. The signs also contained a pro-environmental message "Responsible visitors take their rubbish home or use a bin" with a graphic of a person placing rubbish into a bin (see Figure 56 - Study Five - Example of the sign used within the BBNP Experimental condition video. The example shown here is used within the Skirrid Fawr scene for an example of a sign used in the BBNP Experimental condition video and Figure 53 – Study Five - Example of the sign used in the Cardiff Experimental condition video. The example here was used within the Millennium Centre scene.

Figure 54 - Study Five - Floorplan of the lab. Blue circle indicates position of general waste bin. The green circle indicates the location of the recycling bin. The red circle indicates the area in which participants viewed the video within virtual reality. The upper seat is where the researcher satFigure 55 for an example of a sign used in the Cardiff Experimental condition video).
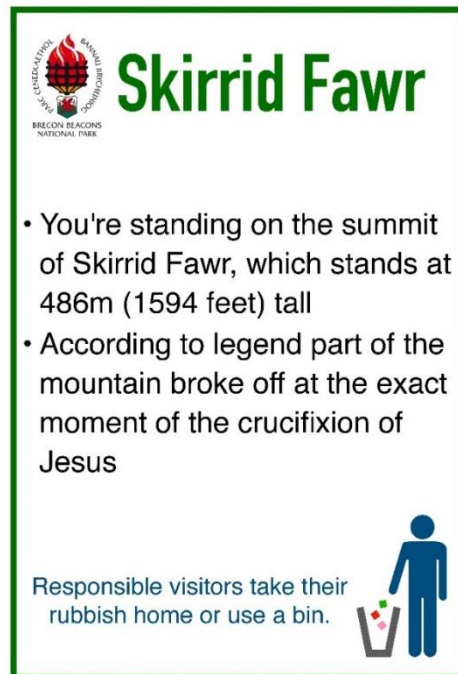
Figure 56 - Study Five - Example of the sign used within the BBNP Experimental condition video. The example shown here is used within the Skirrid Fawr scene

Figure 53 – Study Five - Example of the sign used in the Cardiff Experimental condition video. The example here was used within the Millennium Centre scene.

Room Layout & Bins. The room in which the experiment took place was approximately

10m² (see Figure 57 - *Study Five - Floorplan of the lab. Blue circle indicates position of general waste*

bin. The green circle indicates the location of the recycling bin. The red circle indicates the area in

which participants viewed the video within virtual reality. The upper seat is where the researcher sa

for the room layout). The bins used were a standard recycling bin (open-top, blue, plastic bin with a

recycling logo on it) and standard waste bin (metal open-top bin) of similar size (around six-litre

capacity). The bins were placed next to each other, with the recycling bin furthest away from the
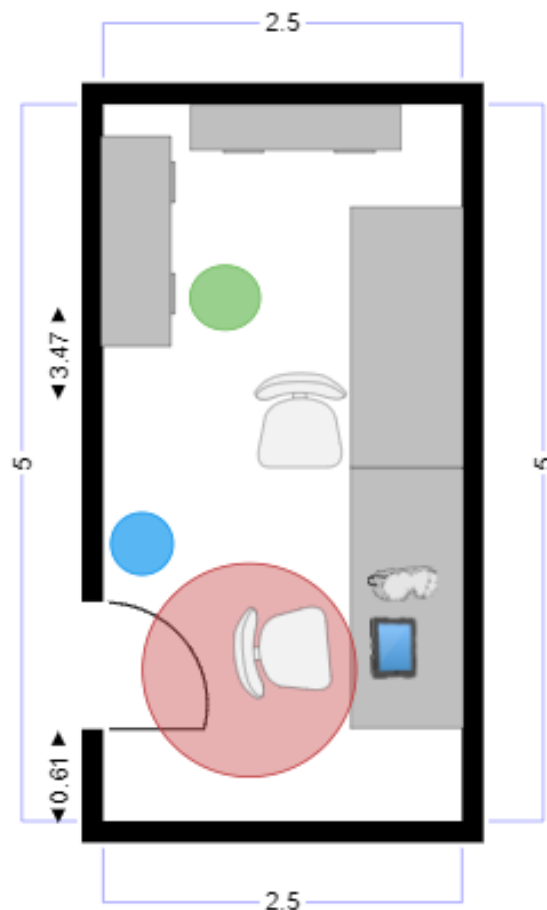
Figure 57 - Study Five - Floorplan of the lab. Blue circle indicates position of general waste bin. The green circle indicates the location of the recycling bin. The red circle indicates the area in which participants viewed the video within virtual reality. The upper seat is where the researcher sat

participant and the general waste bin closer, using similar methods to Evans et al., 2013.

Participants were sat on an office chair that allowed them to freely rotate and view the entire 360°

video.

5.3.4.3   Measures & Scales

Virtual Reality Usage. Participants were asked about previous VR use, if they had used VR in the last two years and, if so, what they had used VR for. More participants had not used VR before (n = 29) than had (n = 18). With most of those participants having used VR one to two times in the last two years (n = 12). No participants owned a VR headset or used a VR headset on a regular (at least once a week) basis. Further descriptives can be found in Table 33.

Table 33 – Study Five - Virtual Reality Usage Among Participants

	Factor	Frequency	% of Participants
Have you used a Virtual Reality Headset before?	No	29	61.7
	Yes	18	38.3
How many times have you used a virtual reality headset in the last two years?	I have used one but not in the last two years	2	4.3
	1 – 2 times	12	25.5
	3 – 6 times	2	4.3
	7 – 10 times	2	4.3
What have you done in VR? (tick all that apply)	Gaming	11	23.4
	Watching videos	6	12.8
	Creating Art/Models	1	2.1
	Theme Park Attraction	6	12.8
	Other	2	4.3

Green identity. Green Identity was included in Study five to investigate if this change would occur after a virtual visit to the BBNP. It was included in both part one and part two.

Nature Relatedness. Connectedness to nature has been found to change after exposure to VR nature, so it is included as a measure in Study five (Reese et al., 2022; Tanja-Dijkstra et al., 2018; Yu et al., 2018). It was included as a measure in both part one and part two.

New Ecological Paradigm. The New Ecological Paradigm has been found to be a predictor of PEBs within previous literature and studies within this thesis. It was included as a measure in part one.

Responsibility. The same ranking scale used in previous studies within this thesis was included in Study Five, in part two. All participants were asked about this – as all participants viewed a section of information about the BBNP. It was included as an exploratory measure, to see if there was any difference in perceptions around who was responsible between those visiting the BBNP in real-life and those who were visiting in VR or not visiting at all. The question required participants to rank who they believed were most responsible for protecting and conserving the BBNP from a list of seven stakeholders: from one (most responsible) to seven (least responsible).

Past PEBs at Home. Part one of the study asked participants about their PEBs in the last week within a home-context. The behaviours included are outlined in Table 34.

PEB Intention in the BBNP. Participants did not visit the BBNP in person. As such, to measure PEBs within the National Park, part two included items that ask about a hypothetical trip to the BBNP. For example, "If you were to travel to the National Park, how likely would you to perform X behaviour?". (see Table 34 for the behaviours). Only those participants in the BBNP conditions were asked this.

PEB Intentions for Home. Eleven items on a five-point likert scale (with 1 being always and 5 being never) were used to ask participants about their PEB intentions, in part two. The behaviours investigated are outlined in Table 34.

Table 34 -Study Five - Behaviours Under Investigation

Behavioural Domain	Behaviour (Past – Home Context)	Behaviour (Intention – BBNP Context)	Behaviour (Intention – Home Context)
National Park Behaviours	When walking, I kept to designated paths and trails	When walking, I will keep to designated paths and trails	When walking, I will keep to designated paths and trails
	Avoided littering (throwing rubbish on the street/path)	Avoid littering (throwing rubbish on the street/path)	Avoid littering (throwing rubbish on the street/path)
Domestic & Everyday Behaviours	Recycled my waste (e.g. glass)	Recycle my waste (e.g. glass)	Recycle my waste (e.g. glass)
	Turned off the tap when brushing teeth	Turn off the tap when brushing my teeth	Turn off the tap when brushing my teeth
	Used my own bags at the shops	Use your own bags at the shops	Use your own bags at the shops
	Used reusable water bottles instead of single-use bottles	Use reusable drinks bottles instead of single-use bottles	Use reusable drinks bottles instead of single-use bottles
	Turned off lights when not in use	Turn off lights when not in use	Turn off lights when not in use
Consumption Behaviours	Purchased environmentally friendly products	Purchase environmentally friendly products	Purchase environmentally friendly products
	Eaten organic, locally-grown or in season food	Eat organic, locally-grown or in season food	Eat organic, locally-grown or in season food
	Conserved water	Conserve water	Conserve water
	Taken short showers (less than 3 minutes long) or infrequent baths	Take short showers (less than 3 minutes long) or infrequent baths	Take short showers (less than 3 minutes long) or infrequent baths
	Bought products with less packaging	Buy products with less packaging	Buy products with less packaging
	Avoided eating meat	Avoid eating meat	Avoid eating meat
	Avoided wasting food (e.g. by using leftovers)	Avoid wasting food (e.g. by using leftovers)	Avoid wasting food (e.g. by using leftovers)
Other Behaviours	Encouraged other people to save energy	Encourage other people to save energy	Encourage other people to save energy

Presence Scale. A presence scale was used as a manipulation check to detect any differences in presence across conditions. The presence scale was adapted from (Slater et al., 1994). The items were adapted for the BBNP and Cardiff conditions. For example, The Slater, Usoh-Steed items were worded to relate to the condition – *"Please rate your sense of being in The Brecon Beacons National Park, on the following scale from 1 to 7, where 7 represents our normal experience of being in a place,"* for the BBNP condition participants or, *"Please rate your sense being in Cardiff, on the following scale from 1 to 7, where 7 represents our normal experience of being in a place,"* for Cardiff condition participants.

Measure of Actual PEB Performance. The measure of actual PEB performance is whether the participants placed the waste paper into the general waste or the recycling bin after the filler task.

Knowledge of the BBNP. Participants were also asked about the Brecon Beacons National Park; if they had heard of the BBNP prior to the study and if they had ever visited and, if so, how many times in the last two years. All participants were then given some information on the Brecon Beacons National Park:

The Brecon Beacons National Park is one of three National Parks in Wales and is centred on the Brecon Beacons range of hills in southern Wales, North of Cardiff. It includes the Black Mountain in the west, Fforest Fawr (Great Forest) and the Brecon Beacons in the centre and the Black Mountains in the east.

Most of the national park is bare, grassy moorland grazed by Welsh mountain ponies and Welsh mountain sheep, with scattered forestry plantations, and pasture in the valleys. It is known for its remote reservoirs, waterfalls including the 90-foot (27 m) Henrhyd Waterfall and the falls at Ystradfellte, and its caves, such as Ogof Ffynnon Ddu. The Brecon Beacons Mountain Centre was opened in 1966 to help visitors understand and enjoy the area. Ravens, peregrine falcons, wheatears, ring ouzels, and the rare merlin breeds in the park. The red kite can also be spotted (Wikipedia, 2019).

This was included to allow those in the Cardiff conditions to have enough information to answer the questions that followed: an open-ended question asking who participants though were most responsible for protecting and conserving the BBNP, an open-ended question asking what makes a responsible visitor to the BBNP and a ranking question asking participants who they believed was most responsible for protecting and conserving the BBNP.

Suspicion Filter. An open-ended question asked participants if they were suspicious of anything during the study. This was used as a suspicion filter. Which ascertained if participants were suspicious of the logo design task, and specifically of the need to place one of their logo designs into a bin. Participants responses to the suspicion questions were coded as suspicious if there was direct mention of either the bins or being asked to throw away their least favourite logo.

5.3.4.4 Procedure

Part 1. Upon giving consent, participants completed part one of the study online. Upon completion of part one, participants signed up to part two, selecting a slot for at least one week later.

Part 2. Participants came to the lab to complete part two of the study. Participants were asked to take a seat and given an information sheet specific to the condition they had been assigned to. Participants were not told that there were other conditions.

The participants in the BBNP conditions were told that the VR video they were going to experience was created by the BBNPA to showcase the NP to those who may not have visited before. Those in the two Cardiff conditions were told that Cardiff University had created the video to showcase Cardiff to people who may not have visited before.

Participants were then given the VR headset, and the experimenter adjusted the headset to ensure that the video was in focus and the participant was comfortable. Participants were then asked to select "play". The participants then watched the video.

After watching the video, participants were asked to design a logo for the virtual reality experience. They were informed to create two logo designs on two separate sheets of paper, and to then dispose of their least favourite. The participants were given five-minutes to complete the task. The researcher left the room during this time and a timer was placed on the desk in front of them.

Participants were asked to open the door to the lab and inform the researcher when they had finished.

Participants then completed the part two questionnaire on an iPad. Participants were then debriefed, given a debrief form to read and allowed to ask any questions. Prior to leaving, participants were asked to not share information about the experiment with others – so as not to inform any potential participants.

5.3.4.5   Data Analysis

Data was analysed using SPSS (IBM, 2022). Thematic analysis was conducted on open-ended questions, using NVivo (QSR International Pty Ltd., 2020).

Two Green Identity scores were created (for part one and part two), by calculating a mean score across the five-items of the Green Identity scale.

Two Nature Relatedness scores (for part one and part two) were calculated for participants, by averaging the scores across each of the six-items of the Nature Relatedness scale.

An overall score for Place Attachment for Cardiff was calculated for every participant, calculated by averaging the scores across the five-items of the Place Attachment scale. Participants in the BBNP conditions were also scored for place attachment to the Brecon Beacons National Park. This was also calculated with a mean score across the five items.

A Slater-Usoh Steed presence score was calculated for all participants, this was calculated by counting how many items participants scored either six or seven to the items in the scale, which is the method suggested by the scale creators Slater et al. (2013). This was used as a manipulation check, offering insight into any differences in perceived realism between conditions.

A New Ecological Paradigm score was calculated for each participant, with scores calculated using a mean across the six items. This was only measured at one time point, in part one, as Studies One and Two both found that NEP score was stable across time.

To test hypothesis one, a series of paired-samples t-tests were conducted, to investigate whether participants in both BBNPC and BBNPE conditions had an increased green identity and greater nature-relatedness post-VR compared to pre-VR, than those in CC and CE conditions. A one-way analysis of variance (ANOVA) was used to test hypothesis two that participants in the BBNPE

and CE conditions would have higher intentions to perform PEBs (in a home context) than those in the BBNPC and CC conditions. A Pearson's chi-square was conducted to investigate hypothesis three, which hypothesised that participants in BBNPE and CE conditions will be more likely to recycle paper after the distractor task than those in the BBNPC and CC conditions.

5.3.5 Sample Size Justification

Due to the Global COVID-19 crisis, data collection in-person was cancelled halfway through data collection.

A total sample of 47 participants was achieved (N = 47). However, due to randomised allocation to conditions, which was originally established for 190 participants, the participants were not evenly spread across conditions after 47 participants. Totals for each condition are shown in

Table 35 – Study Five - Frequency and Percentages of Participants in Conditions

Condition	Frequency	Percentage of Participants
Brecon Beacons National Park Experimental (BBNPE)	6	12.8
Brecon Beacons National Park Control (BBNPC)	20	42.6
Cardiff Experimental (CE)	8	17.0
Cardiff Control (CC)	13	27.7

5.3.6 Results

5.3.6.1 Manipulation Check (Slater Usoh-Steed Presence Scale)

An independent samples t-test was conducted to compare Slater Usoh-Steed scores (0 = low realism, 6 = high realism) between participants in the BBNP conditions and participants in the Cardiff conditions. The independent samples t-test found a significant difference in participants' realism scores, with those in the Cardiff condition participants rating the realism as higher (*M* = 2.2, *SD* = 1.5) than those participants in the BBNP conditions (*M* = 1.2. *SD* = 2.2; *t* (45) = -2.27, *p* = .0.28, two tailed).

5.3.6.2 Home Context Behaviours

Participants were asked about their performance of ten behaviours at home, in the past week (see Table 36 for the descriptives). "Recycling waste" was the most commonly performed

behaviour (*M* = 4.60) whilst "eating organic or locally-grown or in-season food" was the least commonly performed behaviour (*M* = 2.36).

Table 36 - Study Five - Frequency of Past Behaviours in a Home Context

Behaviour	Home-context (Past Behaviours)		
	N	Mean Frequency (descending)	*SD*
Recycled my waste (e.g. glass).	47	4.60	0.496
Turned off taps when brushing teeth.	47	4.49	0.953
When walking, I kept to designated paths and trails.	47	4.40	0.577
Used reusable water bottles instead of single-use bottles.	47	4.32	0.695
Turned off lights when not in use.	47	4.17	0.892
Avoided eating meat.	47	3.19	1.555
Encouraged other people to save energy.	47	3.06	1.374
Bought products with less packaging.	47	2.85	1.042
Took short showers (less than 3 minutes long) or infrequent baths.	47	2.40	1.210
Eaten organic, locally-grown or in season food.	47	2.36	0.819

5.3.6.3 Effect of information on PEB Intention for Home

A series of one-way ANOVAs were conducted to see if there were any differences in behavioural intentions across conditions. The results indicate there was no difference between conditions (see Table 37 for the results of the one-way ANOVAs

Table 37 – Study Five - Results from a Series of One-way ANOVAs for Behavioural Intention for Home vs. Condition

Behaviour	Condition												Sum of Squares	df	Mean Square	F	Sig.
	BBNP Control			BBNP Experimental			Cardiff Control			Cardiff Experimental							
	n	M	SD	n	M	SD	n	M	SD	n	M	SD					
I will avoid littering (throwing rubbish on the street path/path).	20	4.85	0.366	6	5.00	0.000	8	4.88	0.354	13	4.92	0.277	0.120	3	0.040	0.396	0.757
I will recycle my waste (e.g. glass).	20	4.85	0.366	6	5.00	0.000	8	5.00	0.000	13	4.69	0.480	0.638	3	0.213	1.720	0.177
I will avoid eating meat.	20	3.25	1.482	6	4.17	1.329	8	4.00	1.069	13	3.54	1.450	5.675	3	1.892	0.971	0.415
When walking, I will keep to designated paths and trails.	20	4.40	0.598	6	4.17	1.169	8	4.50	0.535	13	4.38	0.506	0.396	3	0.132	0.303	0.823
I will use reusable water bottles instead of single-use bottles.	20	4.70	0.571	6	4.83	0.408	8	4.63	0.518	13	4.77	0.439	0.188	3	0.063	0.241	0.868
I will turn off the taps when brushing teeth.	20	4.45	1.099	6	4.50	0.548	8	5.00	0.000	13	4.62	0.768	1.792	3	0.597	0.815	0.493
I will encourage others to conserve energy.	20	3.60	1.142	6	4.00	1.095	8	3.75	1.165	13	4.00	0.913	1.572	3	0.524	0.448	0.720
I will eat organic, locally grown or in-season food.	20	3.00	0.973	6	3.50	0.837	8	3.00	1.195	13	3.08	0.862	1.236	3	0.412	0.438	0.727
I will turn off lights when not in use.	20	4.65	0.489	6	4.67	0.516	8	4.75	0.463	13	4.54	0.519	0.237	3	0.079	0.320	0.811
I will take short showers (less than 3 minutes long) or infrequent baths.	20	2.95	1.276	6	3.67	1.033	8	2.75	1.282	13	2.69	1.032	4.256	3	1.419	1.007	0.399

5.3.6.4 Effect of information on PEB Intentions in BBNP

A series of independent t-tests were conducted to explore whether there was a difference in pro-environmental behavioural intentions for a hypothetical visit to the BBNP between BBNPE and BBNPC conditions. The independent t-tests found no difference between the conditions for any of the behavioural Intentions (see Table 38 for the results of the t-test).

Table 38 – Study Five - Results of a Series of Independent t-tests Conducted for BBNP Conditions vs. PEB Intention for BBNP

Behaviour	Condition	*n*	*M*	*SD*	t	*df*	*p*
When walking, I will keep to designated paths and trails.	BBNPE	6	3.50	1.643	-1.208	24	0.239
	BBNPC	20	4.15	0.988			
I will avoid littering (throwing rubbish on the street path/path).	BBNPE	6	5.00	.000*	*	-	-
	BBNPC	20	5.00	.000*			
I will recycle my waste (e.g. glass).	BBNPE	6	5.00	0.000	1.268	24	0.217
	BBNPC	20	4.70	0.571			
I will avoid eating meat.	BBNPE	6	4.33	1.033	1.976	24	0.060
	BBNPC	20	3.10	1.410			
I will use reusable water bottles instead of single-use bottles.	BBNPE	6	5.00	0.000	1.797	24	0.085
	BBNPC	20	4.55	0.605			
I will turn off the taps when brushing teeth.	BBNPE	6	4.67	0.516	0.350	24	0.729
	BBNPC	20	4.55	0.759			
I will encourage others to conserve energy.	BBNPE	6	4.17	0.753	0.637	24	0.530
	BBNPC	20	3.85	1.137			
I will eat organic, locally grown or in-season food.	BBNPE	6	3.33	0.816	0.456	24	0.652
	BBNPC	20	3.15	0.875			
I will turn off lights when not in use.	BBNPE	6	4.67	0.516	0.072	24	0.943
	BBNPC	20	4.65	0.489			
I will take short showers (less than 3 minutes long) or infrequent baths.	BBNPE	6	3.50	0.837	1.172	24	0.253
	BBNPC	20	2.85	1.268			

*t cannot be computed because the standard deviations of both groups are 0.

5.3.6.5   Condition vs. Recycling Behaviour

Seven participants were removed from the analysis as they were deemed to have high suspicion that would have impacted their recycling behaviour. This left a total of 40 participants who were included in the analysis (n = 40).

Participants who did nothing to the paper, left it on the desk or had removed the paper were classed as "Missing/Desk". Participants who placed the paper into the recycling bin were classed as "Recycling" and participants who placed the paper into the general waste bin were categorised as "General Waste".

A Pearson's chi-square was conducted to find out if there was a difference across experimental and control conditions for recycling behaviour. The results of the chi-square test indicated no significant difference between conditions, X^2 (2. n = 40) = .46 p = .074, *Cramer's V* = .4.
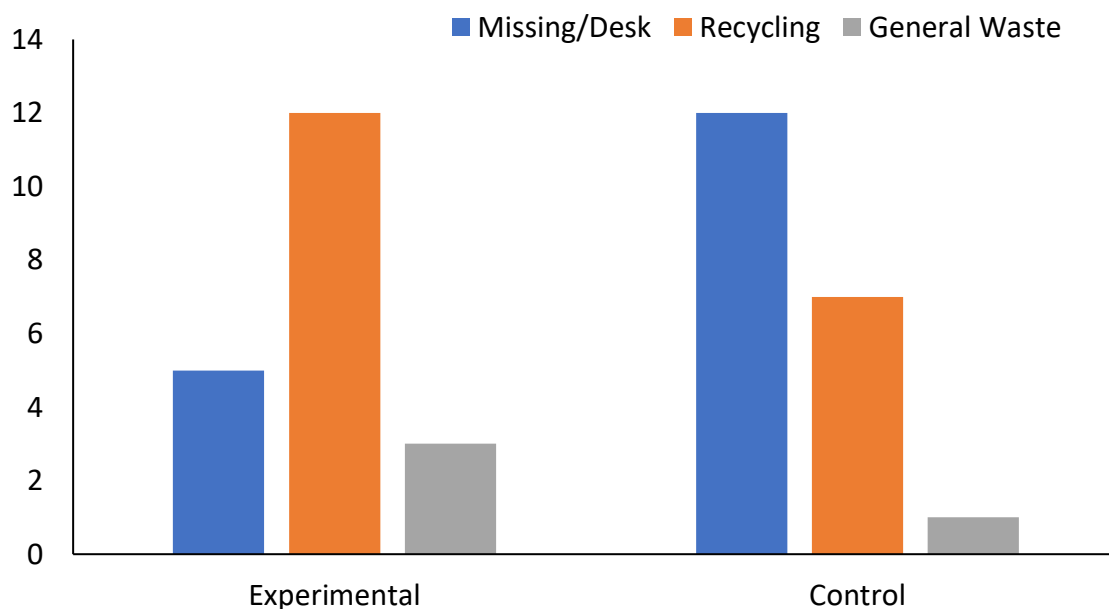
Figure 58 – Study Five - Frequency of what participants did with the paper after the filler task

5.3.6.6   Condition vs. Nature-Relatedness

Paired-samples t-tests were used to test for any change in nature-relatedness score between part one and part two. For participants in the BBNP conditions, a paired-samples t-test found a statistically significant increase in Nature Relatedness between part one (M = 3.46 , SD = .83) and part two (M = 3.71, SD = .83), t (25) = -.573, p = .004 (two-tailed). The mean increase in Nature Relatedness scores was 0.26 with a 95% confidence interval ranging from -0.42 to -0.91. The eta squared statistic (.013) indicated a small effect size. A paired samples t-test found no significant

difference between Nature Relatedness scores between part one (*M* = 3.19 , *SD* = .08) and part two (*M* = 3.37, *SD* = .67) for those in the Cardiff conditions, *t* (20) = .189, *p* = .074 (two-tailed).

An independent-samples t-test was conducted to see if there was a significant difference in nature-relatedness score between BBNP and Cardiff conditions for part one. The results indicated no significant difference in NR-6 scores between those in the Cardiff condition (*M* = 3.19, *SD* = .80) and those in the BBMP conditions (*M* = 3.46, *SD* = .83), *t*(45) = 1.13, p = .264.

A second independent samples-test found no significant difference in NR-6 scores for part two between Cardiff condition participants (*M* = 3.38, *SD* = .67) and BBNP condition participants (*M* = 3.72, *SD* = .83), *t*(45) = 1.54, p = .130.

5.3.6.7 Condition vs. Green Identity

Paired samples t-tests were conducted to measure for any significant change in Green Identity score between part one and part two. For those in the BBNP conditions, a paired-samples t-test found no significant difference for Green Identity scores between part one (*M* = 1.42, *SD* = .43) and part two (*M* = 1.48, *SD* = .44), *t* (25) = -3.198, *p* = .57 (two-tailed). Conversely, a paired-samples t-test for those in the Cardiff conditions found a significant increase in green identity between part one (*M* = 3.19, *SD* = .80) and part two (*M* = 3.37, *SD* = .67), *t* (20) = -3.189, *p* = .005). The mean increase in Green Identity scores was 0.18 with a 95% confidence interval ranging from -.30 to -.06. The eta squared statistic (0.34) indicates a large effect size.

5.3.6.8 Condition vs. Place Attachment for BBNP

An independent samples t-test was conducted to test if there was a difference in place attachment between participants in the Brecon BBNPC and BBNPE conditions, testing H_5. The results revealed no significant difference (see Table 39 for the results).

Table 39 – Study Five - Results of an Independent t-test to Compare Place Attachment for the BBNP Between BBNP Conditions

Condition	N	Mean	*SD*	F	*p*	t	*df*
BBNPE	6	3.67	.65	.000	.099	1.668	24
BBNPC	20	3.11	.74				

5.3.6.9 Responsibility

A ranking question, the same used in Study One and Study Four, was used to explore attitudes around responsibility of protecting and conserving the Brecon Beacons National Park. This was included to see if perceptions were the same for those with limited information about the BBNP compared to the previous studies. The results show that, like the other studies in this thesis, that participants ranked the BBNPA as the most responsible most frequently, with the Welsh Assembly Government and Landowners being most frequently ranked as least responsible (see Figure 59 – Study Five - Bar chart showing the frequency of first and last place rankings for the question "Who do you think is most responsible for preserving and protecting the Brecon Beacons National Park?"

for the bar chart showing results).

5.3.7 Discussion of Study Five
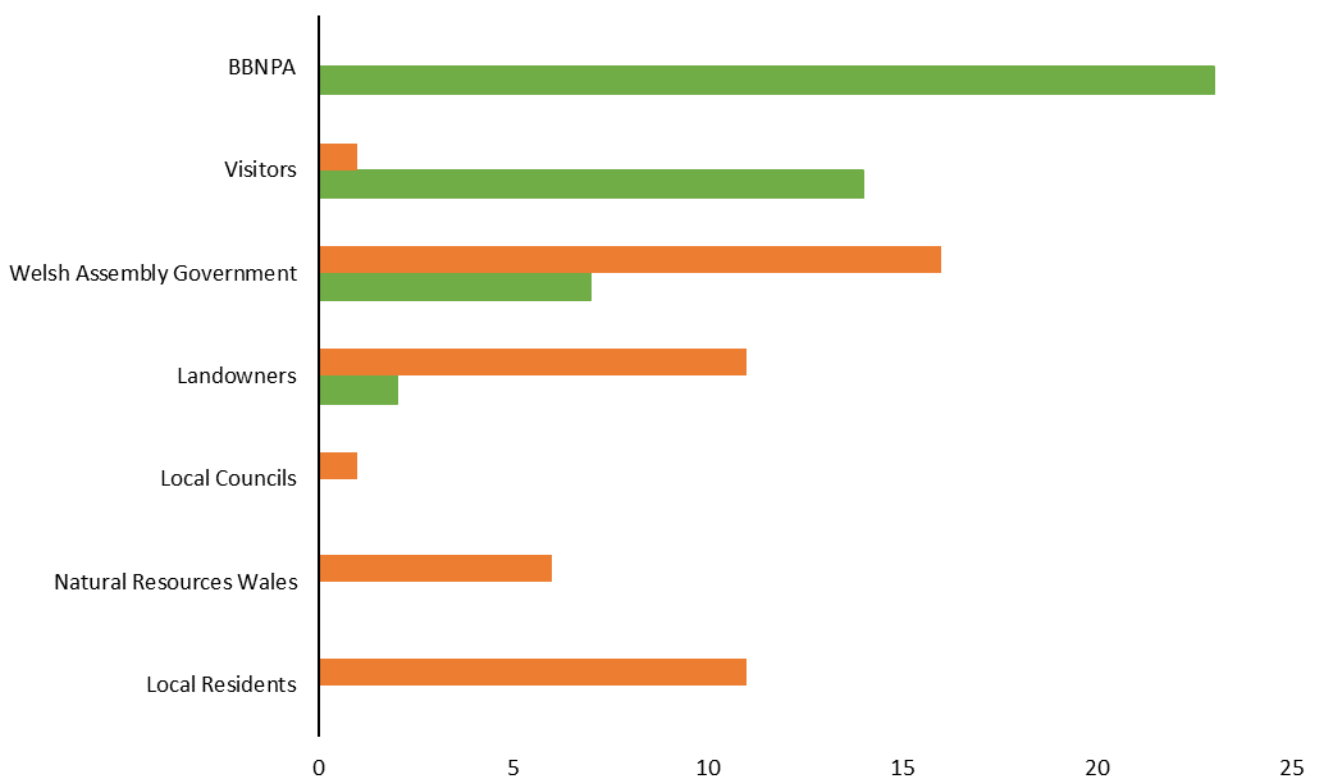
Figure 59 – Study Five - Bar chart showing the frequency of first and last place rankings for the question "Who do you think is most responsible for preserving and protecting the Brecon Beacons National Park?"

The results of Study Five indicated a significant increase in nature-relatedness for those in the BBNP conditions, but no change in green identity. Therefore, H_1 is partially accepted. Results from a series of one-way ANOVAs found no significant difference in intention to perform PEBs at home, post-VR, across conditions. Therefore, H_2 can be rejected.

H$_3$ predicted that participants in BBNPE and CE conditions would be more likely to recycle paper than those in BBNPC and CC conditions. Results indicated no significant difference in recycling behaviours between conditions. Therefore, the results mean that H$_3$ is rejected.

No difference between recycling or intention to perform PEBs between conditions means that H$_4$ can also be rejected. Finally, Results from an independent samples t-test found no significant difference for place attachment for the BBNP across BBNPE and BBNPC conditions. This means that H$_5$ is rejected.

Study Five was a novel investigation into how VR nature can alter environmental behaviours and attitudes. Whilst the results found no difference in recycling behaviour between conditions. The results also indicated no significant difference between conditions in disposal of logo designs. This may be because the measure was not salient enough a behaviour for participants to be influenced by the pro-environmental messaging in the experimental conditions. Evans et al. (2013) with which the measure was adapted, highlighted this may be an issue with the option of recycling or general waste. Additionally, many of the participants left the paper on the desk or removed the paper completely. This suggests that maybe the instructions were not clear enough, as participants were unaware they had to dispose of the paper.

The results indicated that NR-6 scores increased for those who in the BBNP conditions. This significant change was detected despite the low sample size. Whilst this could be a type II error, this may actually indicate that larger effects may be observed with larger sample sizes. This would align with recent work from (Reese et al., 2022).

Whilst NR-6 increased, Green Identity did not increase for those in either of the BBNP conditions. However, a significant increase in Green Identity was detected for those in the Cardiff Conditions. These findings are an anomaly. They cannot be explained by theory or previous work. The results may be due to a Type I error, due to a low sample size. However, they also warrant further explorations of VR urban experiences.

Sample size was a limitation of Study Five. The pausing of all in-person data collection due to the COVID-19 pandemic led to unbalanced sample sizes for each condition and the study not reaching the target sample size of 190. Both experimental conditions (BBNPE and CE) had fewer participants than their control counterparts. However, the sample size for Study Five is higher than many of the other VR studies conducted within environmental psychology and related fields, where

often sample sizes of 30 and lower are regularly used (Reese et al., 2022). As sufficient sample size was not achieved, statistical power was not reached, which means results are not conclusive.

The results of the study offer some insights into VR nature and its impact on PEBs. The study provides further support for the applications of VR nature as a tool / catalyst for increasing connectedness to nature. Whilst the study found no change in behaviours, this increase in connectedness to nature is promising. Many individuals, especially during the COVID-19 pandemic, have felt less connected to nature in recent years (Martin et al., 2020b; Natural England, 2017; Samus et al., 2022; R. White & Van Der Boor, 2020). During national lockdowns in the UK, the public were restricted to the amount of time they could spend outside in public areas. Research found that those with private gardens maintained their connectedness to nature and reported higher mental wellbeing than those without (Samus et al., 2022).

This thesis cannot discuss the COVID-19 lockdowns, without acknowledging the fact that the UK lockdowns disproportionately impacted minority ethnic groups. Research has found that the percentage of homes without a garden is higher among ethnic minorities, with Black people in England nearly four times as likely as White people to have no outdoor space at home (Jassi & Dutton, 2020). Without outdoor space, mental wellbeing and connectedness to nature is negatively impacted (Duke & Soulsbury, 2020; Samus et al., 2022) This aligns with previous research which indicated that ethnic minorities, overall, felt less connected to nature on average (Natural England, 2017). Whilst the findings from Study Five indicate that VR nature may help to increase connectedness to nature, it is important to highlight that it should not be used as a substitute for connecting with nature in the real-world. In fact, the author actively discourages the use of VR nature as a substitute for genuine time outdoors. Conservation organisations should engage more with those who have lower than average connectedness to nature, by providing more opportunities to ethnic minority and individuals from low-socioeconomic groups.

With that said, there is potential for VR nature to be used to enhance relationships with natural spaces and nature-based contexts like NPs. Recent research found that a lack of visits to NPs during lockdowns led to decreased interest in protecting and conserving those NPs from the public (Souza et al., 2021). VR nature may offer an opportunity for conservation organisations like the BBNPA to maintain relationships with visitors despite barriers to visitation (e.g., travel restrictions and lockdowns). Before COVID-19, the creation of VR experiences was relatively niche. However, with experts predicting that global pandemics at this level may become more frequent,

the likelihood of further national and international lockdowns / restrictions remains high in the future (Marani et al., 2021; Megan Scudellari, 2020). During these times, VR nature, and indeed virtual nature in general, may offer the chance for organisations like the BBNPA to maintain relationship with visitors, as well as for visitors to maintain and enhance their connection with nature. The implications and recommendations for practitioners in terms of VR nature are explored in more detail in Chapter 6, section 6.2.3.1.

Study Five also offers insight into the potential future for VR as a tool for environmental psychologists. Creating virtual visits to locations is now easier than ever; creating VR nature / virtual visits does not require expensive equipment and is relatively time efficient. The camera equipment used for Study Five has now been updated, and the new model (the Insta 360 One X2) has better resolution and can capture more immersive 360° ambisonic audio than the model used in Study Five. The VR headset used has also been surpassed by a newer model (the Oculus Quest 2) which provides higher resolution than the headset used in Study Five, the Oculus Quest. Optimising the 360° video for VR, whilst time consuming, provides an immersive and engaging experience that requires virtually no set up time compared to other technologies. Overall, Study Five indicates the potential for VR as a tool for environmental psychologists, giving researchers the ability to place participants in any location. With ever expanding libraries of 360° video available online, researchers do not necessarily have to film stimuli themselves, and are able to showcase locations from all over the globe with ease.

Additionally, at the time of writing, this study is one of the only studies to utilise 360° video within a VR nature study. Previous studies have utilised CG VR nature, which is costly to produce as it requires animators / designers to design CG VR environments. The use of 360° video of real-world locations offers a more ecologically sound approach, whilst also keeping research costs considerably lower. Footage can be obtained through using inexpensive 360° cameras or, alternatively, stock footage for VR can be purchased and licensed from websites like VR-Gorilla (VR-Gorilla, 2022). Future work should investigate the potential differences between CG VR nature and VR nature that uses 360° video.

Finally, one measure not explored within this study was the impact of VR nature on wellbeing. Wellbeing has been explored within this research area in numerous studies. As mentioned previously, the use of VR nature for increasing wellbeing has increased during the COVID-19 pandemic, and future research should include measures of wellbeing. This is essential; an

understanding of the potential impacts on wellbeing (positive or negative) could help elevate, or bring into question, the use of VR nature as a tool for research or for its use by the public.

5.4   Discussion of Chapter Five

5.4.1   Overview of Findings

Whilst using very different methodologies, both Study Four and Five attempted to uncover the effectiveness of different interventions on PEBs and environmental attitudes and beliefs. Study Four offered no significant results but did indicate the difficulty in testing individuals' behaviours across a home and a nature-based context. In addition it highlighted that interventions targeting behaviours in one context to change behaviours in others, may not be successful. Further work which utilises the BBNPA's social media channels, with targeted social media ads, would provide further insight and offer a more ecologically valid method than that used in Study Four.

Study Five provides further support for the notion that information provision alone is not effective at eliciting behaviour change. It also provides insights into the effectiveness of VR nature, that uses 360 video, as a tool for behaviour change. Whilst there was no significant difference in performance of PEB between conditions, the low power and

Furthermore, it did reveal that VR nature has the potential to increase nature-relatedness. The study provides an insight into the use of 360° video for research into VR nature, which stands out amongst the many studies that utilise CG VR nature when conducting VR nature research.

5.4.2   Interventions

Neither study provided solid evidence for or against the use of specific message frames or VR nature as a catalyst for environmental behaviour change. This is mainly due to the low sample sizes, which makes it difficult to detect the expected effects sizes. Future work with larger sample sizes may provide more reliable insights.

However, information provision alone is generally considered less effective than provision of structural interventions combined with information provision (Whitmarsh et al., 2021). This aligns with the other studies presented in this thesis, as well as previous work. Study Two for example found that the provision of information along with a structural intervention (dog poo wormery) was

highly effective at eliciting behaviour change. Further work needs to ensure direct comparisons can be made between information provision alone, and information provision combined with structural or other interventions. This would provide explicit comparisons.

5.4.3   Virtual Nature

Study Three provided useful insights into the potential for VR nature has a research tool for environmental psychologists. The benefits of using VR nature that utilises 360° video are substantial. The studies allow for more ecologically valid comparisons between real-world and VR nature, as well as substantial cost and time saving compared to studies that rely on CG VR. This rapidly growing research area will likely become well-established over the coming years, as technology becomes more accessible and widely adopted by the public. Additionally, the opportunity to explore "second-chance" and "last-chance" tourism, as well as embodiment scenarios, provides interesting potential for future research.

Finally, VR nature offers the chance for conservation organisations to showcase natural sites to new audiences that are geographically distanced from locations. However, VR nature cannot increase connectedness to nature or improve wellbeing to the same extent as actual contact with real-world nature. As such, VR nature should be seen as a tool for enhancement, not a replacement for nature.

As technology becomes more and more engrained in our lives, and as the general public become increasingly disconnected from nature, VR nature may surpass the foreboding predictions made by Levi and Kocher (1999) and become an unlikely catalyst to help foster connections to nature, for a world where individuals are more reliant and connected to technology than ever.

5.4.4   Methodological Issues

As with several of the studies outlined within this thesis, both Study Four and Five had low sample sizes. Future work, especially collaborative work, needs to ensure that participant recruitment is more successful. Longer-term recruitment would allow for a larger sample size to be gained from platforms like the Brecon Beacons Holiday Cottages. Further insights into how future work can build stronger participant recruitment are outlined in Chapter Six.

5.4.5   Conclusions

The final two studies in this thesis, presented in Chapter Five, offer a glimpse into the potential for future work investigating behaviour change across home and nature-based contexts. The studies faced difficulties, due to online recruitment issues and the dawn of the COVID-19 pandemic. However, they also provided clear evidence that information provision alone is not enough to elicit substantial behaviour change. Study Five also highlighted the potential for VR nature as a research tool; a tool which has the potential to change the way we build interventions. Whilst, Study Four suggests that message frames informed by scientific theory would provide organisations like the BBNPA the chance to greatly reduce the negative impact that visitors have in nature-based contexts.

6   Chapter 6 – General Discussion

6.1   Overview

The series of studies presented in this thesis provide some insight into the factors shaping behaviour change. Additionally, they highlight the difficulty in investigating behaviour change across a home and nature-based context, as well as the necessity for collaborative projects to come to early agreement on research objectives and project aims.

The discussion that follows is broken down into five sections. Section 6.2 gives an overview of the findings from the studies in this thesis. The section comprises sub-sections based on the research questions outlined in Chapter 2, Section 2.7. This section also explores how these findings fit into the research landscape and includes discussions on measuring behaviour change and implications for theory.

Section 6.3 focuses on recommendations and implications for the BBNPA and other practitioners in the field of conservation management. It outlines changes that could be implemented by the BBNPA to reduce the negative impacts that visitors have on the NP; from signage to data collection, this section suggests easy and cost-effective ways that the BBNPA could utilise behaviour change research and theory.

Section 6.4 discusses the direction that future research could take. It outlines the way in which collaborative projects should be conducted, outlining lessons learned from the presented research. Additionally, the section discusses future research focused on behavioural spillover in nature-based contexts. Finally, section 6.5 gives a concise summary of the thesis and concluding reflections.

6.2   Findings

6.2.1   Question 1 – Do PEBs and attitudes change across contexts, between home and the National Park?

The studies in this thesis found very little evidence for cross-contextual behaviour change. In fact, all the studies indicated that behaviours remained consistent across contexts. Answering research questions one, two and three, the findings of Study One, Two and Three all indicated that

individuals perform behaviours to the same degree in a National Park context as they do in a home context.

This is in contrast to most studies conducted in the research area, which have found that behaviours are generally inconsistent between contexts (Nilsson et al., 2016). There are two potential factors that may play a role in the differing findings from this thesis research. One factor is the large potential for type II errors due to low sample sizes across the studies. The pitfalls with recruitment have been discussed in detail in the discussion section of each chapter. However, the other factor that may have played a role is worthy for discussion here.

As has been touched upon within this thesis already, UK National Parks are a unique context. One could suggest that National Parks are the same as any nature-based context. However, it is argued here that National Parks, and specifically UK National Parks, cannot be directly compared or categorised as simply another "nature-based context". This is because UK National Parks are 'living landscapes', where industry, tourism, communities, wildlife and geography combine to form the quintessential 'British countryside' (Brecon Beacons National Park Authority, 2021b; Monbiot, 2018a; Pratt-Heaton, 1999). Agriculture dominates UK National Parks, including the BBNP (Raven-Ellison, 2021). This is in stark contrast to locations that gain National Park status in other countries (Glover, 2019). Additionally, there is a distinct lack of biodiversity and wildlife within UK National Parks. Studies investigating the benefits of visits to nature (including blue and green spaces) tend to focus on sites of natural beauty with high biodiversity – something which is very limited in most UK National Parks (Cockburn, 2021; Cuff, 2020; Rowe, 2020).

A pivotal report from Glover (2019) found that UK National Parks have less biodiversity, but greater protection, than other UK landscapes, for example, Areas of Outstanding Natural Beauty (AONBs). In fact, the IUCN class UK National Parks in category V (the second lowest) and defines them as "a protected area managed mainly for landscape/seascape protection and recreation." In contrast, US National Parks like Yellowstone are in Category II – the international standard for National Parks (Crofts et al., 2014). The contrast with National Parks in the US and abroad signifies that research hoping to apply the same methods, or hoping to replicate findings from research conducted elsewhere, should do so with caution. The fact that behaviours remained consistent between contexts, may be because the contextual shift was relatively limited and failed to impact on visitors.

Furthermore, the nature of National Parks in the UK means that visitors can be both transient (staying for one day / a short amount of time) or static (staying overnight). This again contrasts with many other nature-based contexts. Green and blue space research often focuses on locations that allow only for day visitation and/or that do not incorporate the potential for domestic behaviours to be performed (e.g., staying in a holiday cottage) (Maund et al., 2019; M. P. White et al., 2013).

Indeed, it could be argued that UK National Parks fall into the broad category of a "holiday context". Research into holiday contexts however often investigate domestic behaviours, so this would negate day visitors who are not 'on holiday' and cannot perform the associated behaviours. One topic discussed earlier in this thesis is that comparisons between behaviours at home (e.g., domestic behaviours) and behaviours in a NP context cannot be easily made. Context-specific behaviours within the NP (e.g., disturbance to wildlife, walking off path) do not translate as typical "home" / domestic behaviours. Conversely, most of the typical domestic behaviours (e.g., recycling, turning off light switches) cannot be performed by day visitors to National Parks. Thus, the question is raised as to how useful it is trying to draw comparisons and investigate spillover between behaviours that are quite distinct.

UK National Parks exist in a grey-area, being neither truly natural or nature-based nor urban or domestic. The choice to treat UK National Parks as "nature-based contexts" was made at the beginning of this thesis because it aligned well with research goals and the wider research literature. However, there are inevitable limitations to applying methodologies developed in US National Parks and elsewhere to research investigating UK National Parks, since there are large differences. Instead, developing methodologies that can test the unique aspects that make up UK NPs is essential.

The report from Glover (2019) on behalf of the Department for Environment, Food & Rural Affairs suggests that UK National Parks need to improve their biodiversity whilst also encouraging greater visitor numbers, in order to reconnect more people with nature. The likely trade-offs from these competing objectives indicate how essential it is to develop stronger research methodologies to uncover visitor behaviours and interventions in UK National Parks.

6.2.2 Question 2 – What are the main predictors of pro-environmental behaviours (PEBs) in the National Park and at home?

The findings from the research did not provide evidence for any of the measured factors predicting PEBs on a large-scale. The studies measured a variety of factors: perceived behavioural control, green identity, nature-relatedness, new ecological paradigm, and place attachment (for both home and NP). The findings revealed that some of the factors (nature-relatedness, green identity and place attachment) all predicted some behaviours within the studies to a significant degree.

There was evidence from the studies to suggest attitudinal changes occurred after visiting the NP. The results of Study One indicated a significant increase in green identity post-visit to the BBNP. In addition, Study Three found that nature-relatedness was greater for participants who viewed the BBNP in VR compared to participants who viewed urban scenes. These findings suggest that visits to nature (even in VR) can be beneficial for increasing a sense of connection to nature. Additionally, Study One did find a significant difference in perceived behavioural control between a home and NP context.

However, despite the predictions that changes in these factors would mediate / predict behaviours, the results indicated that these factors only predicted some behaviours. The findings from the research provide some support to the value-belief-norm model, rather than the broader theory of planned behaviour model. Crucially, the results do not indicate that any of the factors predicted the majority of PEBs under investigation. Perceived behavioural control, interestingly, did differ across contexts in Study One, however it did not predict many behaviours within contexts or consistency between contexts to a large degree.

The low sample size may have led to type II errors. However, there is also the possibility that the NP does not offer enough "nature", so changes in environmental attitudes and beliefs, that may mediate wider behaviour change, do not occur. As mentioned in the previous section, UK National Parks – including the Brecon Beacons National Park - are lacking in biodiversity. In fact, research has found that, in the UK, connectedness to nature is more likely to increase following visits to coastlines than areas operationalised with protected/designated area status, including National Parks (Wyles et al., 2017). This aligns with the presented research and may explain why in most of the presented studies, nature-relatedness scores did not change post-visit.

6.2.3 Question 3 – Can interventions reduce instances of environmentally damaging behaviours (EDBs) in the National Park?

Studies One, Two, Three and Four all tested the effectiveness of different interventions to encourage PEBs, to answer research question three. Apart from the intervention used in Study Two, none of the interventions tested in the studies led to any significant behaviour change.

Studies Three and Four utilised different message frames to reduce littering, and resembled pivotal work conducted in US NPs (Cialdini, 2003; Cialdini et al., 2006). Neither of the studies conclusively found that norms messaging was significantly more effective than any other message frames. This is in contrast to many studies and a recent systematic review, which identified that normative messages are most effective at reducing littering behaviours (Chaudhary et al., 2021).

As mentioned in the discussion section for Study Three (see section 4.4.5) there is also a confounding variable of litter levels. The 'broken window theory' would suggest that the removal of litter from the research area during the study may have catalysed the effect of the norms messaging in Study Three (Ramos & Torgler, 2012; Sagebiel et al., 2020; Wilson & Kelling, 1982). This is a rather large confounding variable, and an important note for future research. Future work should investigate if the litter levels on sites have an impact on litter – to a greater or lesser degree than signage or other management methods alone. This is also an important note for practitioners, as it would provide insights into the effectiveness of litter picks – which may have wider reaching impact than simply removing litter. The litter picks may actually lead to behaviour change in visitors - reducing littering behaviours.

When comparing the results from the studies that used information provision alone (Studies Three, Four and, to an extent, Five), with Study Two, which provided a structural intervention – there is a stark difference in effectiveness. Study Two targeted a niche behaviour, dog fouling. However, the results offered a glimpse into how novel interventions, developed to target an EDB, can be highly effective. The dog faeces wormery and signage did not utilise normative messages, nor were they based on behaviour change theory. The interventions were developed by practitioners rather than academics. However, the effectiveness of the intervention highlights the importance of working with, and learning from, practitioners.

This aligns with previous work which has found that information provision alone is not enough to elicit behaviour change, but rather combined structural interventions with information provision are the most effective (Whitmarsh et al., 2021). This is also consistent with models like the theory of planned behaviour, and social practice theory, which suggest that context are critical drivers of behaviours (Brown et al., 2010; Goh et al., 2017; Whitmarsh et al., 2021).

Additionally, this thesis also explored novel methods for testing the effectiveness of interventions, testing the effectiveness of different methods to measure behaviour. The studies outlined in this thesis utilised many different methods for measuring behaviours and cross-context behavioural change, including both self-report and objective methods.

The research echoed findings from other work, with pros and cons for both options being shown. The objective behavioural mapping methods used in Studies Two and Three were effective at measuring behaviour across a large geographical area and provided data which the BBNPA had never previously had. However, these methods don't allow for links to psychological variables. Understanding the behaviour of individuals is impossible with the behavioural mapping techniques and this is a significant flaw compared to the self-report measures utilised in the other studies.

However, self-report measures are not without issues too. One interesting finding from the presented research is that for every study that used self-report measures, participants answered almost every single time that they never littered. The salience of this behaviour shone through when asking participants about what makes a responsible visitor to the BBNP, with "not littering" being mentioned more than any other quality. This highlights a potential issue of using self-report to measure EDBs in particular. Social desirability may be why that participants always answered they did not litter, as it is statistically impossible for everyone to not be littering. However, unlike the behavioural mapping methods, self-report allow for a wider variety of behaviours to be explored as well as the added benefit of being able to link with psychological variables.

Finally, Study Five utilised a measure of actual behaviour, providing insights into how lab-based studies can provide an opportunity to measure PEBs in an objective way. The methods adapted from Evans et al. (2013) provided an additional, objective, measure of PEB alongside self-report. From a practical standpoint, the method relies on participants following instructions, and a high number of participants did nothing with the paper they were supposed to dispose of. This was not noted as an issue by Evans et al. (2013).

6.2.3.1 Question 3a – Can a virtual visit to the National Park lead to changes in pro-environmental behaviours and attitudes?

Study Three showcased the potential for VR nature to use 360° video and is potentially one of the first of its kind to use such stimuli instead of CG VR. This study answered research question 3a; it did not find any significant changes to PEB. Comparing these findings with other research into VR nature's effect on PEBs is difficult though. Study Three, unlike previous research, did not utilise CG VR with embodiment or interactive elements. At the time of writing, all the studies that have measured the impact of VR nature on behaviour have used CG VR with an embodiment or interactive element. This highlights the novelty of this study in particular, and the need for further research to explore how VR nature that uses 360° video impacts behaviour. It may be that the lack of interactivity or embodiment within the VR nature experience used in Study Three was the reason no change in behaviour occurred. Indeed, the saliency of completing tasks like chopping down trees, or embodying other beings/entities, like a cow, may provide more obvious and salient links to the real-world and to behaviours for individuals (Ahn et al., 2016; Smit et al., 2021; Spangenberger et al., 2022; Taufik et al., 2021; Vankov Id et al., 2021).

Whilst no changes to performance of PEBs was found, Study Three did find a significant change in nature-relatedness for those in the BBNP condition. This might indicate that with a larger sample size and greater power, VR nature could have a significant impact on both attitudes and behaviour. Further work needs to be conducted to establish how effective VR nature experiences are at changing behaviours as well as attitudes (Markowitz & Bailenson, 2021).

The study stands out for its low-budget approach. Previous work has utilised complex and expensive VR rooms, CG VR environments, haptic feedback devices and embodiment experiences (Ahn, 2011; Reese et al., 2022; Spangenberger et al., 2022; Tanja-Dijkstra et al., 2018; Yeo et al., 2020). Study Three used technology - a 360° camera and VR headset - costing only £800 in total and available on the consumer market. As the use of this technology is expanding, there will always be research that relies on the use of top-of-the-range VR technology. However, there is merit and reason to use the budget-friendly consumer options. Most notably, if studies are hoping to test the effectiveness of VR as a behaviour change tool or indeed as a way to increase wellbeing, then using technology that is more accessible to the average member of the public is essential. Especially if benefits are to reach the wider public.

6.2.4 Question 4 - Does behavioural spillover occur between a home and National Park context?

The studies outlined in the thesis failed to find any evidence for the presence of behavioural spillover across contexts. However, this is not surprising. In their meta-analysis, Maki et al. (2019) outline that large sample sizes are required to have the best chance to detect behavioural spillover, which often manifests as a very small-to-negligible effect (Geiger, 2022). This highlights that firstly, the low sample sizes may also have led to type II errors.

Crucially though, the interventions used in Study Four and Five also failed to elicit any behaviour change in initial behaviours within a BBNP context. Therefore it would not be possible for spillover to occur between contexts, as spillover relies on an initial change in behaviour (Geiger, 2022; Lanzini & Thøgersen, 2014; Verfuerth et al., 2019; Whitmarsh et al., 2018). Additionally, a recent literature review from Esfandiar et al. (2022) highlights the lack of research investigating spillover within protected-areas and specifically the occurrence of spillover from nature-based contexts to home contexts. This highlights that the work undertaken within this thesis has covered new ground and can inform future studies hoping to investigate spillover from NP contexts to home contexts.

6.3 Recommendations & Implications for Practitioners

6.3.1 Developing Behavioural Interventions

The findings from the research conducted in this thesis all strengthen the previous work that has found that a combination of interventions is more effective at eliciting pro-environmental behaviour change than one intervention alone (Abrahamse et al., 2007; Klöckner, 2013; MIchie et al., 2011; Nye & Hargreaves, 2010; Whitmarsh et al., 2021). In particular, the work shows that information alone is not sufficient to stimulate behaviour change (Dockerty et al., 2005; UNEP-WTO, 2005; Whitmarsh et al., 2021).

Whilst direct comparisons between combined and isolated interventions were not explicitly compared here (with the exception of Study Five, where VR nature alone was compared with VR nature with and an additional intervention). There is clear evidence that the most effective

intervention to elicit pro-environmental behaviour change was the intervention in Study Two, which combined information provision with structural interventions in the form of a dog faeces wormery and compostable bag dispenser.

The interventions within this thesis were developed using the classifications from Steg and Vlek (2009). However, the classifications provided by these authors are simplified. The BCW may be considered a more suitable framework for future work. For this thesis, it would have provided longer term understanding of the importance of using theory to develop interventions and campaigns for the BBNPA. However, the BCW requires considerable time to understand and also a more unified approach from different departments within organisations, which is often not possible to implement, especially as an outside collaborator with only a short amount of time to enact changes (Michie et al., 2014).

A lack of resources mean that practitioners may not be able to keep up to date with the latest research or may not be able to utilise scientific literature to inform behavioural interventions. Conversely, a lack of applied research or collaborative partnerships means that academics may not work with practitioners. Interestingly, the only intervention to have a significant impact on behaviour change was the practitioner-developed dog faeces wormery and signage in Study Two. This highlights the necessity for researchers to be embedded within organisations, either through collaborative projects, placements, or long-term secondments. It also emphasises the necessity of collaboration and inter-disciplinary work. Whilst many of the interventions developed by practitioners lack foundations in behaviour change theory, the most effective intervention tested in this thesis was a product of practitioner knowledge and expertise.

Despite the research not explicitly testing the effectiveness of pre-existing BBNPA interventions, the author did review interventions during the course of research and has a number of suggestions. The largest consistent error with BBNPA behaviour change is signage. The use of incorrect social norms to promote behaviours on signage is commonplace. As outlined at numerous points in the thesis, signage asking for one behaviour but showing the opposite is a common occurrence on BBNPA signs, social media posts and interpretation. Utilising social norms is essential in order for the BBNPA to successfully implement interventions that will have a positive impact (Esfandiar et al., 2021).

The findings from the Feasibility Study, Study Two and Three showed that litter and dog faeces accumulated around car parks, roads and popular sitting/rest areas. This is useful for site-specific visitor management and suggests that the BBNPA focus their efforts on areas like this.

The research presented in this thesis provides some insight into the interventions that the BBNPA could utilise to change behaviour on-site. The main findings indicate that structural interventions are more impactful than information provision alone. Study Two highlighted that the placement of a dog faeces wormery along with a faeces bag dispenser led to a 95% reduction in fouling. These kind of structural intervention are most effective because they enable individuals to perform PEBs (Steg & Vlek, 2009). However, they are often costly to implement. Additionally, it is not always possible to place interventions like bins or wormerys on sites in the BBNP – placing a bin on a summit of a mountain, for example, would be unfeasible. Therefore there is a need to rely on information provision alone in some circumstances.

Relying on information provision alone means that messaging needs to be effective and built on theory. The findings from this thesis indicate that norms messages may be most effective at eliciting behaviour change. As highlighted, there is potential that for Study Three the effect of the norms messaging may have been boosted due to the lack of litter on the site, although this only adds weight to the theory that social norms are effective at eliciting behaviour change. Thus, wherever possible, the BBNPA should create social norms around PEBs: by creating signage showing individuals performing target behaviours or having volunteers conduct litter picks on busy routes/days for visitors, to help establish PEBs as the norm.

Finally, ensuring that signage, messaging and target behaviours are consistent across the NP will also aid the effectiveness of interventions (Bonell et al., 2020; Navarro-Bailón, 2012). As previously discussed, the number of stakeholders within the BBNP means that signage, messaging and even target behaviours differ between sites (e.g., sites owned by the BBNPA and sites owned by NRW). This requires discussion with stakeholders early on. Tackling conservation issues is not easy for the BBNPA, especially with so many stakeholders involved. Whilst the BBNPA already work to ensure that some stakeholders have the chance to express their opinions, it is essential that all stakeholders, including visitors and researchers, get the chance to have their say in management practices (Hodgson et al., 2022). This will allow for better collaboration with stakeholders, and with more consistent signage and messaging across the entire NP.

Additionally, the exploratory work which investigated visitor perceptions around responsibility suggest that visitors placed the most responsibility to protect and conserve the BBNP onto the BBNPA. This highlights that the BBNPA should use messaging that highlights that responsibility is shared, and that everyone, including visitors, need to help protect and conserve the NP. Shifting visitors beliefs around responsibility, to elicit a greater sense of personal responsibility may help to encourage PEBs (Andersson et al., 2012; Brown et al., 2010; Eden, 1993; Font et al., 2016; Schultz et al., 2013)

6.3.2   Data Collection

Collecting data is essential for practitioners to build a better picture of the landscape, and to provide valuable insight into the behaviours performed by visitors. Robust data capture can inform management and conservation practices.

For example, the issue of dogs is of great concern to UK National Park Authorities, including the BBNPA. However, the extent of the problem is not properly understood or well-researched. Collecting data on problem behaviours is essential, as it ensures resources are being used efficiently. Collecting data before and after implementing any campaigns will also help inform any interventions and provide evidence of intervention effectiveness. This is particularly useful for organisations like the BBNPA with limited budgets that need to know if resources are being used effectively.

One of the issues with Study Three, was that it was unable to control for visitor numbers during intervention testing. Visitor numbers is an essential form of data that NP authorities should attempt to capture regularly, as part of the wider visitor management strategy. For most sites, there are no parking meters, so collecting data based on car park payments is not possible. For the sites where data is collected using pay & display or paid for car parks, it needs to be collected in a more systematic way. Collecting car park data is only useful if it is collected at set intervals. Collecting car park payment data sporadically, and without corresponding dates, as tends to happen, offers little insight.

Currently within the BBNP, car park data is collected using on-site personnel who manually update a website, which visitors can use to check car park capacity (Brecon Beacons National Park Authority, 2021c). Recent developments at the BBNPA mean that several cloud-based car park

counters will be implemented in Waterfall Country, which should be used to inform interventions and future management (J. Lawrence, personal communications, June 2020).

However, there is potential to utilise existing data from social media to measure visitor numbers and environmental impact. Culturonomics – the use of user-generated data to understand visitor behaviours and motivations in National Parks and natural areas, is a potentially useful tool for practitioners (Hausmann et al., 2018; Tenkanen et al., 2017). Collecting data through social media has been found to be an effective tool for monitoring visitor preferences and behaviours, as well as being utilised for the development of conservation strategies (Sinclair et al., 2020; Väisänen et al., 2021). Research has found that the number of photos posted to Flickr (a photo sharing platform) can reliably indicate the number of visitors to locations. On top of this, information on the origin of visitors (gathered from information on their public profile) can also be collected and provide information on visitors without the need for surveys (Ciesielski & Stereńczak, 2021; Sessions et al., 2016; Sinclair et al., 2020). This would bring down costs, save time and crucially allow for NP authorities to utilise data quickly and efficiently (Duda & Nobile, 2010; Sinclair et al., 2020)

The findings from the Feasibility Study, Study Two and Three showed the effectiveness of behavioural mapping at providing site level information. However, if this methodology was carried out across the NP, it would provide a landscape level picture, which would allow for more effective visitor management across the BBNP. Combining behavioural mapping data with social media data could give broad insights into how visitor numbers impact sites, and where interventions are most needed (Väisänen et al., 2021).

At the time of writing, the BBNPA does not conduct any analysis on their social media accounts (J. Lawrence, personal communications, 2021). Furthermore, there is no research conducted to look at other social media platforms, to scan for photo posting or to collect data. Adopting methods that utilise social media and technology could allow for quick and reliable collection of visitor information and numbers across the NP. In addition it could allow for automated adjustment to visitor recommendations (shared through social media) based on car park data, social media data and path counters. This would allow the BBNPA opportunities to divert individuals away from busy areas during peak times, and distribute them across the NP, meaning that honey-pot sites do not need to bear the brunt of negative impacts.

In addition, it would allow for reliable measures of visitor numbers, and some data on visitor characteristics, without the need to conduct surveys. Given that the BBNPA have not conducted a visitor survey since 2016/17, the chance to gather data passively, and constantly, offers unique benefits over costly and time-consuming in-person surveys (Brecon Beacons National Park Authority, 2017).

6.4 Future Research

6.4.1 Collaborations with Practitioners

Collaboration is essential for research to provide positive impacts and rewards for society (Lewis, 2021). The research presented in this thesis would not have been possible without the input of the BBNPA. The guidance and help offered by individuals working at the BBNPA was crucial for the development and implementation of several of the studies outlined in this thesis. However, there were also several issues that hindered studies: litter-picks conducted during data collection and the lack of car park data in Study Three, and resistance to some proposed research projects (e.g., a social media intervention study). This highlights the necessity to bring everyone on board within an organisation to ensure that the practical aspects of collaboration and research can run smoothly on-the-ground. It is inevitable that collaborative research projects that involve large organisations like the BBNPA are going to cross teams, locations and staff members. Ensuring proper communication and awareness of the collaborative project with all staff and volunteers that will be impacted by the research is essential.

This raises a second point. It is crucial that research aims, and project goals are discussed and agreed before data collection starts. The nature of the collaboration in this project was not fully established before the BBNPA wanted to start collecting data. As such, adjustments and realigning of research aims and goals occurred during the first 12 months of the project. Whilst this was essential to ensure that the project was successful, and beneficial for both collaborative partners, it was a time-consuming process. This highlights the need for all parties to come to agreements swiftly, but also for lead researchers to maintain autonomy to make executive decisions.

In addition, funding needs to cover all the costs of the research. This thesis research received the normal level of funding from the ESRC for a PhD. There was no formal agreement for the BBNPA to input any financial backing for the research, resulting in the research budget being spent

within the first 12 months – as petrol costs quickly decreased funds. Ensuring that funding is fully planned for in the early stages of collaboration planning will ensure that research is not hindered by a lack of financial assets.

Making data open source to researchers and the general public could also provide further insights for practitioners. Publishing open-source data has the potential to allow anyone to access and manipulate data, which could allow for easier outsourcing of data analysis by practitioners. It also has the potential for community scientists to uncover trends in data that may not have been found previously. This is highlighted by Wellington (2014), who was able to utilise open source data from New York to find the worst places to park. Wellington (2014) argues that if more organisations make their data open source, then problems can be solved faster and more effectively with the help of community scientists.

6.4.2   Behaviour Change & Cross-Context Behaviour Change

Latest behavioural spillover research indicates that spillover should not be the end-goal or focus of research, but rather measured in addition to the main measures targeting one behaviour, since spillover is difficult to achieve in practice and does not automatically occur (Maki et al., 2019). This is particularly important where two very different contexts may make cross-context spillover particularly challenging. Future work needs to treat UK National Parks as a distinct context, rather than a generic 'nature-based' context. The qualities of UK NPs mean that they do not encapsulate typical traits of green space / nature-based contexts. The crossover of domestic behaviours for some visitors, and the complete lack of potential to perform domestic behaviours for others, means that comparison of the same behaviour across multiple contexts becomes problematic. To overcome this issue, research could focus solely on either day-visitors or overnight visitors. Whilst this research did not find any difference in performance of behaviours between these visitor groups, the sample sizes were too low for any real comparisons to be drawn.

In terms of methodology, the research presented in this thesis utilised some new methodologies for the academic field and for practitioners alike. Future research needs to expand upon these and explore the potential for behavioural mapping to be used across wider geographic locations, by measuring multiple sites across the NP, for example. This would provide a landscape level overview of EDBs and allow the BBNPA to properly distribute resources.

In addition to the behavioural mapping techniques, the 360° videos used within Study Three are novel to the field. Future work should include VR nature that uses 360° video in comparisons between CG VR nature and real-world nature. 360° video used within VR has the potential to offer a middle-ground for researchers in terms of time and cost. In addition, it offers benefits over the more commonly used CG VR nature – including a potential increase in ecological validity and the chance to compare real-world locations across real-life experience and VR.

6.4.2.1 Dogs in the Countryside

The National Park Authority, along with other National Parks and organisations across the UK are very concerned about dogs in the countryside, in relation to sheep worrying and disturbance to wildlife (J. Lawrence, personal communications, January 2019)[19]. The problem is such a concern for National Parks and organisations nationwide that it has sparked many campaigns, research into dog owner attitudes, and even an all-party parliamentary group to tackle livestock worrying caused by dogs (All-Party Parliamentary Group For Animal Welfare, 2017; Hampshire County Council & Kennel Club, 2016; Jenkinson, 2007; National Sheep Association, 2017; Peak District National Park Authority, 2008; Tilt, 2017).

Despite the very active approach that organisations are taking to tackle the issue, there remains scant evidence or literature to suggest that this is as widespread or prevalent an issue as would justify such huge reactions. Additionally, despite a huge amount of money and time being spent to encourage people to be "a responsible dog owner", there is no consistency in campaigns and no definitive way to measure behavioural impact (J. Lawrence, personal communications, May 2018).

The author therefore suggests that National Park Authorities and similar organisations concerned about dogs in the countryside conduct research to investigate the impact of dogs in the NP. This should not only focus on livestock worrying, but also disturbance to wildlife. Understanding the nature and extent of a problem will improve how money is spent and resources focused. This also highlights the importance of data collection, explored in the next section.

---

[19]The author attended three separate conferences/discussion days, in 2017 and 2018, relating to dogs in the countryside. During which multiple National Park Authorities, DEFRA, Natural England, Keep Wales tidy and local farmers attended.

6.5   Summary & Conclusions

With the global climate and biodiversity crises potentially bringing humanity towards a new global extinction event, it is necessary now more than ever that everyone behaves pro-environmentally (Bradshaw et al., 2021). Ensuring that natural landscapes, including UK National Parks, are rewilded, protected and conserved is also an essential piece in the jigsaw that will help slow and reduce the impacts of climate change (Bradshaw et al., 2021; Diaz et al., 2006; Monbiot, 2018b; Rees, 2020). To build resilience against climate change, and to cope with ever-growing visitor numbers, it is crucial for UK NPs to employ robust behaviour change techniques.

This research, conducted in collaboration with the BBNPA, focused on the behaviour of visitors to the BBNP. The aims of this thesis were to uncover whether cross-context behaviour change occurred, how visitors could be encouraged to perform more pro-environmental behaviours whilst in the National Park, and whether visiting the NP had any impact on PEBs, beliefs and attitudes.

The studies presented in the thesis give insight into how collaborative research projects with conservation practitioners can work. The thesis research also faced several problems during data collection. Sampling channels failed to secure the anticipated number of participants, or simply did not work as a recruitment method. The COVID-19 pandemic significantly inhibited data collection. This meant that low sample size plagued the studies, meaning that all studies suffered from low power.

The COVID-19 pandemic has also highlighted the necessity to further develop VR nature and for conservation management organisations to build effective behaviour change interventions. With lockdown leading to potential negative shifts in visitors' attitudes towards National Parks, the need to develop effective interventions is greater than ever (Souza et al., 2021). Additionally, COVID-19 showed that virtual nature was a viable solution to help combat disconnection from nature and potentially improve wellbeing (BBC, 2020b, 2020a; Kalantari et al., 2022; Klein & Hilbig, 2018; Yeo et al., 2020).

The thesis also reinforced the efficacy of two novel methodologies that have not been tested before: VR laboratory studies using 360° video and behavioural mapping of litter using GPS are methods which are both new to the field. The behavioural mapping method developed in this thesis offers practitioners a new and scientifically sound approach to behaviour measurement,

something which is desperately needed. The use of 360° for VR research opens up the possibility to compare real-world locations within VR, and reduces the cost and time required to conduct conventional VR studies.
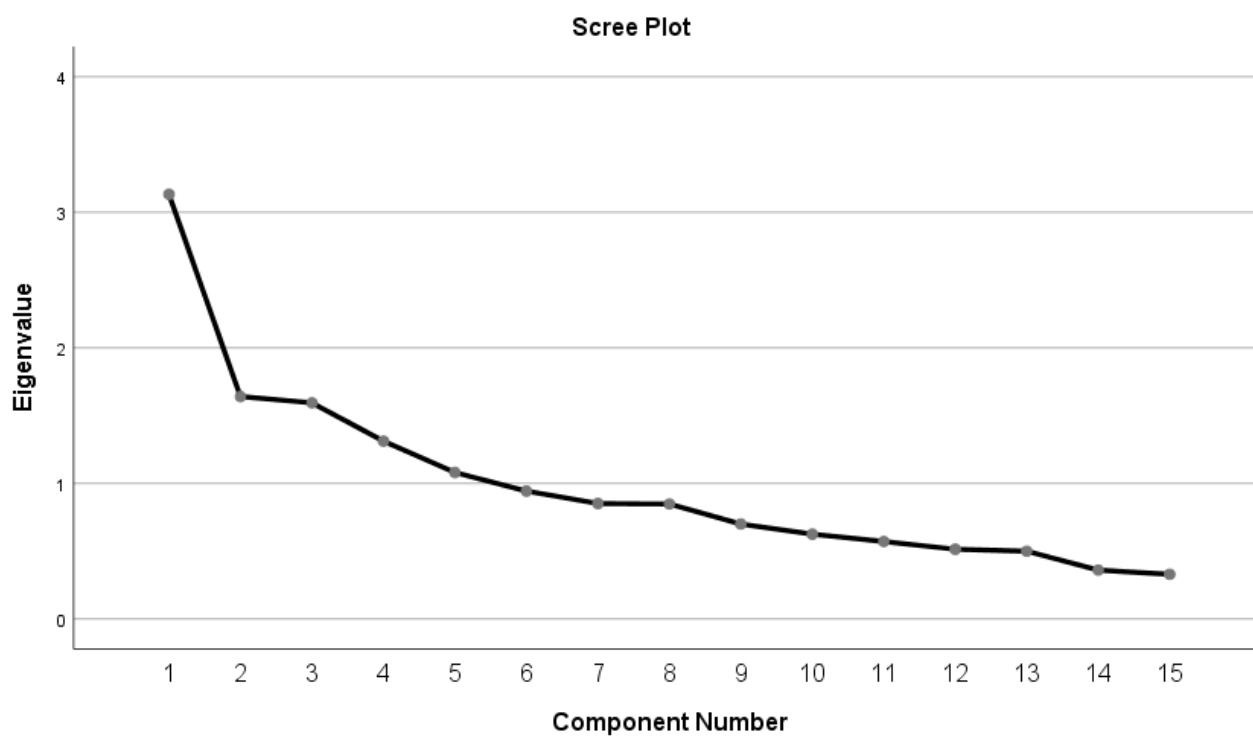
The collaborative project uncovered a disconnect between practitioners and academic research. A reliance on anecdotal and subjective measures of behaviour meant that, prior to this research, the BBNPA had no data or methods to monitor littering, dog fouling and other EDBs in the NP. It also highlighted that research needs to adapt methods for practitioners, as well as being flexible to their needs. Conversely, Study Two (that investigated dog fouling behaviour) was an unexpected addition to this thesis but indicated that practitioner-designed interventions can be more effective than theory-designed ones. This highlights that two-way learning is an important benefit of collaborative research projects.

Finally, the research in this thesis attempted to do what many research projects, across all fields, never attempt – to have a genuine, real-world, positive impact (Hiltzik, 2015; Ioannidis, 2005). Fusing academic research with on-the-ground conservation management is never an easy task. However, this thesis research could be used as the foundation for a prosperous relationship between the Brecon Beacons National Park Authority and Cardiff University.
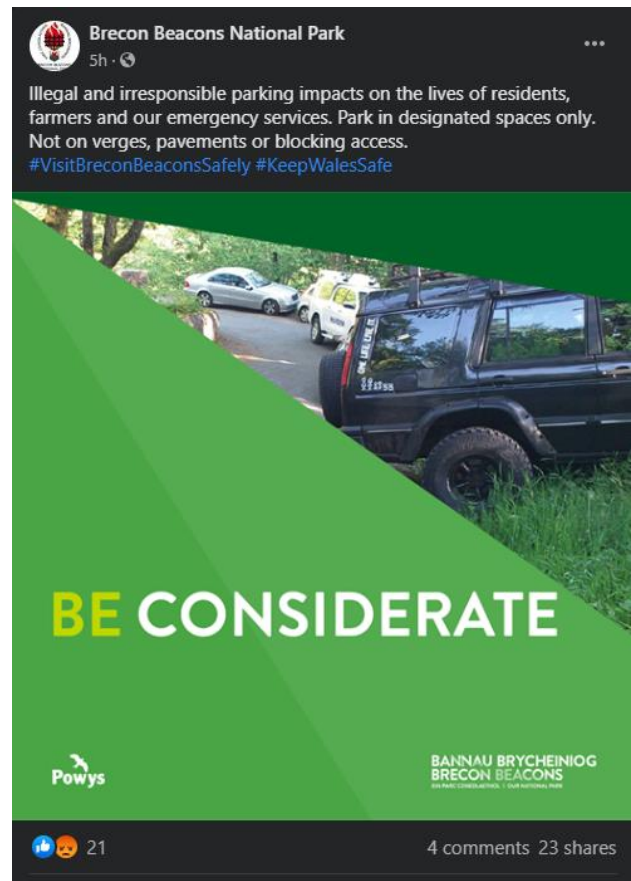
Appendices

Appendix A

Scree-plot from principal components analysis of behaviours in a home context in Study One

Appendix B

Example of social media posts from the BBNPA encouraging behaviour change

Brecon Beacons National Park
21 August at 19:00 ·

Car parks are normally full by mid morning so please check our Car Park Page before visiting to see if there are spaces available. If the weather is bad, our overflow car parks will not be open. Have a back up plan in place and please don't park dangerously or illegally. #VisitBreconBeaconsSafely #KeepWalesSafe
https://carpark.beacons-npa.gov.uk/

BE PREPARED

Powys — BANNAU BRYCHEINIOG BRECON BEACONS

12 — 9 shares

Like — Comment — Share

Brecon Beacons National Park
5h ·

Illegal and irresponsible parking impacts on the lives of residents, farmers and our emergency services. Park in designated spaces only. Not on verges, pavements or blocking access. #VisitBreconBeaconsSafely #KeepWalesSafe

BE CONSIDERATE

Powys — BANNAU BRYCHEINIOG BRECON BEACONS

21 — 4 comments 23 shares

Brecon Beacons National Park
Yesterday at 08:00 ·

We're seeing a huge increase in antisocial behaviour from visitors which is impacting negatively on local residents and impairing others' enjoyment of the area. Please respect that...
🚐 Car parks are not for campervans overnight
⛺ Wild camping is illegal
🔥 Camp fires cause damage to our environment
🗑 Litter endangers wildlife
💩 Toileting and dog poo poses a health hazard
🚗 Irresponsible parking can make it difficult for our emergency services to access the area.
Thank you.
#VisitBreconBeaconsSafely #KeepWalesSafe

BE RESPONSIBLE

Brecon Beacons National Park
23 August at 08:00 ·

We are working with Dyfed Powys Police and South Wales Police to ensure people are parking responsibly. Parking and camping illegally will result in fines and enforcements. #VisitBreconBeaconsSafely #KeepWalesSafe

BE WITHIN THE LAW

Powys — BANNAU BRYCHEINIOG BRECON BEACONS

45 — 2 comments 11 shares

Like — Comment — Share

References

Abrahamse, W., & Matthies, E. (2012). Informational strategies to promote pro- environmental behaviour : Changing knowledge , awareness and attitudes. *Environmental Psychology: An Introduction*, *February*, 223–232.

Abrahamse, W., & Steg, L. (2013). Social influence approaches to encourage resource conservation: A meta-analysis. *Global Environmental Change*, *23*(6), 1773–1785. https://doi.org/10.1016/j.gloenvcha.2013.07.029

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology*, *25*(3), 273–291. https://doi.org/10.1016/j.jenvp.2005.08.002

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2007). The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents. *Journal of Environmental Psychology*, *27*(4), 265–276. https://doi.org/10.1016/j.jenvp.2007.08.002

Abrams, K. M., Leong, K., Melena, S., & Teel, T. (2020). Encouraging Safe Wildlife Viewing in National Parks: Effects of a Communication Campaign on Visitors' Behavior. *Environmental Communication*, *14*(2), 255–270. https://doi.org/10.1080/17524032.2019.1649291

Agile. (2022). *How Much Does VR Application Development Cost? | Agilie app development company blog*. https://agilie.com/en/blog/how-much-does-vr-application-development-cost

Ahn, S. J. G. (2011). *Embodied Experiences in Immersive Virtual Environments Effects on Pro-Evironmental Attitude and Behaviour*.

Ahn, S. J. G., Bailenson, J. N., & Park, D. (2014). Short- and long-term effects of embodied experiences in immersive virtual environments on environmental locus of control and behavior. *Computers in Human Behavior*, *39*, 235–245. https://doi.org/10.1016/j.chb.2014.07.025

Ahn, S. J. G., Bostick, J., Ogle, E., Nowak, K. L., McGillicuddy, K. T., & Bailenson, J. N. (2016). Experiencing Nature: Embodying Animals in Immersive Virtual Environments Increases Inclusion of Nature in Self and Involvement With Nature. *Journal of Computer-Mediated*

Communication, *21*(6), 399–419. https://doi.org/10.1111/jcc4.12173

Alhanifi, A., Cialdini, R., & Reno, R. (1990). *Recycling the Concept of Norms to Reduce Littering in Public Places*.

All-Party Parliamentary Group For Animal Welfare, A. (2017). *Tackling livestock worrying and encouraging responsible dog ownership*. *November*.

All, P., Mcmahan, E., Estes, D., & Murfin, J. S. (2018). *Nature Connectedness Moderates the Effect of Nature Exposure on Explicit and Implicit Measures of Emotion*.

Almosa, Y., Parkinson, J., & Rundle-Thiele, S. (2017). Littering Reduction: A Systematic Review of Research 1995–2015. *Social Marketing Quarterly*, *23*(3), 203–222. https://doi.org/10.1177/1524500417697654

Alzubaidi, H., Slade, E. L., & Dwivedi, Y. K. (2021). Examining antecedents of consumers' pro-environmental behaviours: TPB extended with materialism and innovativeness. *Journal of Business Research*. https://doi.org/10.1016/j.jbusres.2020.01.017

Anderson, M. L., Andrianarivo, A. G., & Conrad, P. A. (2005). Neosporosis in cattle. *Veterinary Clinics of North America - Food Animal Practice*, *21*(2 SPEC. ISS.), 473–483. https://doi.org/10.1016/j.cvfa.2005.03.004

Andersson, M., Eriksson, O., & von Borgstede, C. (2012). The effects of environmental management systems on source separation in the work and home settings. *Sustainability*. https://doi.org/10.3390/su4061292

Appeaning Addo, K., Jayson-Quashigah, P. N., Codjoe, S. N. A., & Martey, F. (2018). Drone as a tool for coastal flood monitoring in the Volta Delta, Ghana. *Geoenvironmental Disasters*, *5*(1). https://doi.org/10.1186/s40677-018-0108-2

Ardoin, N. M., Wheaton, M., Bowers, A. W., Hunt, C. A., & Durham, W. H. (2015). Nature-based tourism's impact on environmental knowledge, attitudes, and behavior: a review and analysis of the literature and potential future research. *Journal of Sustainable Tourism*, *23*(6), 838–858. https://doi.org/10.1080/09669582.2015.1024258

Atenstaedt, R. L., & Jones, S. (2011). Interventions to prevent dog fouling: A systematic review of the evidence. *Public Health*, *125*(2), 90–92. https://doi.org/10.1016/j.puhe.2010.09.006

Bailenson, J. N. (2018). *Experience on Demand: What Virtual Reality Is, How It Works, and What It Can Do* (1st ed.). W.W. Norton.

Ballantyne, R., Packer, J., & Falk, J. (2011). Visitors' learning for environmental sustainability: Testing short- and long-term impacts of wildlife tourism experiences using structural equation modelling. *Tourism Management*, *32*(6), 1243–1252. https://doi.org/10.1016/j.tourman.2010.11.003

Ballantyne, R., Packer, J., & Hughes, K. (2009). Tourists' support for conservation messages and sustainable management practices in wildlife tourism experiences. *Tourism Management*, *30*(5), 658–664. https://doi.org/10.1016/j.tourman.2008.11.003

Balundė, A., Jovarauskaitė, L., & Poškus, M. S. (2019). Exploring the Relationship Between Connectedness With Nature, Environmental Identity, and Environmental Self-Identity: A Systematic Review and Meta-Analysis. *SAGE Open*, *9*(2). https://doi.org/10.1177/2158244019841925

Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology*, *27*(1), 14–25. https://doi.org/10.1016/j.jenvp.2006.12.002

Barr, S., & Coles, T. (n.d.). Changing Behaviours for a Changing Climate : a lifestyles approach. *Research Gate*. http://www.researchgate.net/publication/265154282

Barr, S., Gilg, A. W., & Ford, N. (2005). The household energy gap: Examining the divide between habitual- and purchase-related conservation behaviours. *Energy Policy*, *33*(11), 1425–1444. https://doi.org/10.1016/j.enpol.2003.12.016

Barr, S., Shaw, G., Coles, T., & Prillwitz, J. (2010). "A holiday is a holiday": practicing sustainability, home and away. *Journal of Transport Geography*, *18*(3), 474–481. https://doi.org/10.1016/j.jtrangeo.2009.08.007

Bartlett, M. S. (1954). A Note on the Multiplying Factors for Various χ 2 Approximations. *Journal of the Royal Statistical Society*, *16*(2), 296–298.

Bates, A. E., Primack, R. B., Moraga, P., & Duarte, C. M. (2020). COVID-19 pandemic and associated lockdown as a "Global Human Confinement Experiment" to investigate biodiversity

conservation. *Biological Conservation*, *248*(May), 108665.
https://doi.org/10.1016/j.biocon.2020.108665

BBC. (2020a). *BBC Four - Mindful Escapes: Breathe, Release, Restore - Making Mindful Escapes*.
https://www.bbc.co.uk/programmes/articles/38RhbBzQSb1LK8phgnQx8lw/making-mindful-
escapes

BBC. (2020b). *Covid-19 Collection - BBC Archive*. https://www.bbc.co.uk/archive/covid-
19_collection/zrfq2sg

Bec, A., Moyle, B., Schaffer, V., & Timms, K. (2021). Virtual reality and mixed reality for second
chance tourism. *Tourism Management*, *83*, 104256.
https://doi.org/10.1016/j.tourman.2020.104256

Becken, S. (2007). Tourists' perception of international air travel's impact on the global climate and
potential climate change policies. *Journal of Sustainable Tourism*, *15*(4), 351–368.
https://doi.org/10.2167/jost710.0

Behaviour Change. (2016). *Using social norms on shared paths | Behaviour Change : Behaviour
Change*. https://behaviourchange.org.uk/case-studies/using-social-norms-on-shared-paths

Behavioural Insights Team. (2011). Behaviour and Energy. *Energy*, *1*(July), 35.
http://www.cabinetoffice.gov.uk/resource-library/behaviour-change-and-energy-use

Behavioural Insights Team. (2019). *Behaviour Change for Nature: A Behavioral Science Toolkit for
Practitioners*. www.bi.team

Bem, D. (1967). Self-Perception: an Alternative Interpretation of Cognitive Dissonance Phenomena.
Psychological Review, *74*(6), 535. https://doi.org/10.1037/h0025146

Bergquist, M., & Nilsson, A. (2016). I saw the sign: Promoting energy conservation via normative
prompts. *Journal of Environmental Psychology*, *46*, 23–31.
https://doi.org/10.1016/j.jenvp.2016.03.005

Bergquist, M., Nilsson, A., & Hansla, A. (2017). Contests versus norms: Implications of contest-based
and norm-based intervention techniques. *Frontiers in Psychology*, *8*(NOV), 1–10.
https://doi.org/10.3389/fpsyg.2017.02046

Bernstad, A. (2014). Household food waste separation behavior and the importance of

convenience. *Waste Management*, *34*(7), 1317–1323.
https://doi.org/10.1016/j.wasman.2014.03.013

Blanken, I., van de Ven, N., & Zeelenberg, M. (2015). A Meta-Analytic Review of Moral Licensing.
Personality and Social Psychology Bulletin. https://doi.org/10.1177/0146167215572134

Blankenship, K. M., Friedman, S. R., Dworkin, S., & Mantell, J. E. (2006). Structural interventions:
Concepts, challenges and opportunities for research. *Journal of Urban Health*, *83*(1), 59–72.
https://doi.org/10.1007/s11524-005-9007-4

Bleys, B., Defloor, B., Van Ootegem, L., & Verhofstadt, E. (2018). The environmental impact of
individual behavior: Self-assessment versus the ecological footprint. *Environment and
Behavior*, *50*(2), 187–212. https://doi.org/10.1177/0013916517693046

Bonell, C., Michie, S., Reicher, S., West, R., Bear, L., Yardley, L., Curtis, V., Amlôt, R., & Rubin, J.
(2020). Harnessing behavioural science in public health campaigns to maintain "social
distancing" in response to the COVID-19 pandemic: key principles. *Journal of Epidemiol
Community Health*, *74*(8). https://doi.org/10.1136/jech-2020-214290

Bradshaw, C. J. A., Ehrlich, P. R., Beattie, A., Ceballos, G., Crist, E., Diamond, J., Dirzo, R., Ehrlich, A.
H., Harte, J., Harte, M. E., Pyke, G., Raven, P. H., Ripple, W. J., Saltré, F., Turnbull, C.,
Wackernagel, M., & Blumstein, D. T. (2021). Underestimating the Challenges of Avoiding a
Ghastly Future. *Frontiers in Conservation Science*, *1*(January), 1–10.
https://doi.org/10.3389/fcosc.2020.615419

Brecon Beacons Holiday Cottages. (2021). https://www.breconcottages.com/

Brecon Beacons National Park Authority. (2013). *Brecon Beacons Visitor Management Plan*.
September.

Brecon Beacons National Park Authority. (2014). *Brecon Beacons National Park State of the Park
Report 2014*.

Brecon Beacons National Park Authority. (2015). *A Management Plan for the Brecon Beacons
National Park 2015-2020*.

Brecon Beacons National Park Authority. (2017). *Brecon Beacons National Park Visitor Survey 2016-
17*.

Brecon Beacons National Park Authority. (2018). *Dog code - Brecon Beacons National Park, Wales*. http://www.breconbeacons.org/dogs

Brecon Beacons National Park Authority. (2021a). *Illegal Off-roading | Brecon Beacons National Park Authority*. https://www.beacons-npa.gov.uk/environment/wardens/illegal-off-roading/

Brecon Beacons National Park Authority. (2021b). *Purposes and Duty | Brecon Beacons National Park Authority*. https://www.beacons-npa.gov.uk/the-authority/who-we-are/aims-and-purposes/

Brecon Beacons National Park Authority. (2021c). *Waterfall Country Car Park Status*. https://carpark.beacons-npa.gov.uk/

Brecon Beacons National Park Authority. (2021d). *What is a National Park? | Brecon Beacons National Park Authority*. https://www.beacons-npa.gov.uk/the-authority/who-we-are/what-is-a-national-park/

Breves, P., & Schramm, H. (2021). Bridging psychological distance: The impact of immersive media on distant and proximal environmental issues. *Computers in Human Behavior*, *115*, 106606. https://doi.org/10.1016/j.chb.2020.106606

Brick, C., & Lai, C. K. (2018). Explicit (but not implicit) environmentalist identity predicts pro-environmental behavior and policy preferences. *Journal of Environmental Psychology*, *58*(July), 8–17. https://doi.org/10.1016/j.jenvp.2018.07.003

British Mountaineering Club. (2017, April 6). *Mend Our Mountains fixes popular footpath in the Brecon Beacons*. https://www.thebmc.co.uk/mend-our-mountains-fixes-popular-footpath-in-the-brecon-beacons-national-park

Brown, T. J., Ham, S. H., & Hughes, M. (2010). Picking up litter: An application of theory-based communication to influence tourist behaviour in protected areas. *Journal of Sustainable Tourism*, *18*(7), 879–900. https://doi.org/10.1080/09669581003721281

Browning, M. H. E. M., Mimnaugh, K. J., van Riper, C. J., Laurent, H. K., & LaValle, S. M. (2020). Can Simulated Nature Support Mental Health? Comparing Short, Single-Doses of 360-Degree Nature Videos in Virtual Reality With the Outdoors. *Frontiers in Psychology*, *10*(January), 1–14. https://doi.org/10.3389/fpsyg.2019.02667

Brundtland, G. H. (1987). Our Common Future: Report of the World Commission on Environment and Development. *United Nations Commission*, *4*(1), 300. https://doi.org/10.1080/07488008808408783

Buckley, R. (2004). The effects of world heritage listing on tourism to australian national parks. *Journal of Sustainable Tourism*, *12*(1), 70–84. https://doi.org/10.1080/09669580408667225

Cajiao, D., Leung, Y. F., Larson, L. R., Tejedo, P., & Benayas, J. (2022). Tourists' motivations, learning, and trip satisfaction facilitate pro-environmental outcomes of the Antarctic tourist experience. *Journal of Outdoor Recreation and Tourism*, *37*, 100454. https://doi.org/10.1016/j.jort.2021.100454

Calogiuri, G., Litleskare, S., Fagerheim, K. A., Rydgren, T. L., Brambilla, E., & Thurston, M. (2018). Experiencing nature through immersive virtual environments: Environmental perceptions, physical engagement, and affective responses during a simulated nature walk. *Frontiers in Psychology*, *8*(JAN), 1–14. https://doi.org/10.3389/fpsyg.2017.02321

Carfora, V., Caso, D., Sparks, P., & Conner, M. (2017). Moderating effects of pro-environmental self-identity on pro-environmental intentions and behaviour: A multi-behaviour study. *Journal of Environmental Psychology*, *53*, 92–99. https://doi.org/10.1016/j.jenvp.2017.07.001

Carrico, A. R., Raimi, K. T., Truelove, H. B., & Eby, B. (2018). *Putting Your Money Where Your Mouth Is : An Experimental Test of Pro-Environmental Spillover From Reducing Meat Consumption to Monetary Donations*. https://doi.org/10.1177/0013916517713067

Catlin, J. R., & Wang, Y. (2013). Recycling gone bad: When the option to recycle increases resource consumption. *Journal of Consumer Psychology*, *23*(1), 122–127. https://doi.org/10.1016/j.jcps.2012.04.001

Cattell, R. B. (1966). Multivariate Behavioral Translator disclaimer The Scree Test For The Number Of Factors. *Multivariate Behavioral Research*, *1*(2), 245–276. https://doi.org/10.1207/s15327906mbr0102

Chan, K. (1998). Mass communication and pro-environmental behaviour: waste recycling in Hong Kong. *Journal of Environmental Management*, *52*(4), 317–325. https://doi.org/10.1006/jema.1998.0189

Chang, L. (2016). *UN Using Virtual Reality to Build Empathy, Catalyze Change | Digital Trends*. Digital Trends. https://www.digitaltrends.com/virtual-reality/un-using-virtual-reality/

Chaudhary, A. H., Polonsky, M. J., & McClaren, N. (2021). Littering behaviour: A systematic review. *International Journal of Consumer Studies*, *December 2020*, 1–33. https://doi.org/10.1111/ijcs.12638

Chen, M. F. (2015). An examination of the value-belief-norm theory model in predicting pro-environmental behaviour in Taiwan. *Asian Journal of Social Psychology*, *18*(2), 145–151. https://doi.org/10.1111/ajsp.12096

Chiricoid, A., Clewis, R. R., Yaden, D. B., & Gaggioli, A. (2021). *Nature versus art as elicitors of the sublime: A virtual reality study*. https://doi.org/10.1371/journal.pone.0233628

Cialdini, R. (2003). Crafting normative messages to protect the environment. *Current Directions in Psychological Science*, *12*(4), 105–109. https://doi.org/10.1111/1467-8721.01242

Cialdini, R. B., Trost, M. R., & Newsom, J. T. (1995). Preference for Consistency: The Development of a Valid Measure and the Discovery of Surprising Behavioral Implications. *Journal of Personality and Social Psychology*, *69*(2), 318–328. https://doi.org/10.1037/0022-3514.69.2.318

Cialdini, R., Demaine, L., Sagarin, B., & Barrett, D. (2006). Managing social norms for persuasive impact. *Social …*. https://doi.org/10.1080/15534510500181459

Ciesielski, M., & Stereńczak, K. (2021). Using Flickr data and selected environmental characteristics to analyse the temporal and spatial distribution of activities in forest areas. *Forest Policy and Economics*, *129*(May). https://doi.org/10.1016/j.forpol.2021.102509

Cimato, F., & Mullan, M. (2010). Adapting to Climate Change: Analysing the Role of Government. *Defra Evidence and Analysis Series*, *January*, 78.

Climate Change Committee. (2021). *Climate Change Committee*. https://www.theccc.org.uk/

Cockburn, H. (2021, June). *Rewild national parks to tackle climate and biodiversity crisis, government told | The Independent*. The Independent. https://www.independent.co.uk/climate-change/news/rewilding-national-parks-biodiversity-crisis-b1862022.html

Cohen, E. (1978). The impacts of tourism on the physical environment. *Annals of Tourism Research*,

April/June, 215–237. https://doi.org/10.1177/0047287578017002151

Collado, S., Medler, S. H., Passafaro, P., Vesely, S., & Klöckner, C. A. (2020). Social Desirability in Environmental Psychology Research: Three Meta-Analyses. *Front. Psychol*, *11*, 1395. https://doi.org/10.3389/fpsyg.2020.01395

Committee on Climate Change. (2020). The Sixth Carbon Budget: The UK's path to Net Zero. *The Carbon Budget*, *December*, 34.

Cook, A. J., Kerr, G. N., & Moore, K. (2002). Attitudes and intentions towards purchasing GM food. *Journal of Economic Psychology*, *23*(5), 557–572. https://doi.org/10.1016/S0167-4870(02)00117-4

Cornelissen, G., Pandelaere, M., Warlop, L., & Dewitte, S. (2008). Positive cueing: Promoting sustainable consumer behavior by cueing common environmental behaviors as environmental. *International Journal of Research in Marketing*. https://doi.org/10.1016/j.ijresmar.2007.06.002

Creaser, A. V, Clemes, S. A., Costa, S., Hall, J., Ridgers, N. D., Barber, S. E., & Bingham, D. D. (2021). The Acceptability, Feasibility, and Effectiveness of Wearable Activity Trackers for Increasing Physical Activity in Children and Adolescents: A Systematic Review. *Public Health*, *18*, 6211. https://doi.org/10.3390/ijerph18126211

Crofts, R., Dudley, N., Mahon, C., Partington, R., Phillips, A., Pritchard, S., & Stolton, S. (2014). Putting Nature on the Map: A Report and Recommendations on the Use of the IUCN System of Protected Area Categorisation in the UK. In *United Kingdom: IUCN National Committee UK http://www. iucn-uk. org/portals/0/PNOTM_2014_full_report. pdf*.

Crossan, C., & Salmoni, A. (2019). A Simulated Walk in Nature: Testing Predictions from the Attention Restoration Theory. *Environment and Behaviour*. https://doi.org/10.1177/0013916519882775

Cuff, M. (2020). *Creating a new National Park won't be enough to restore the UK's lost biodiversity, conservationists warn*. I News. https://inews.co.uk/news/environment/uk-national-park-restore-lost-biodiversity-conservation-wildlife-666241

Culiberg, B., & Elgaaied-Gambier, L. (2016). Going green to fit in - understanding the impact of social norms on pro-environmental behaviour, a cross-cultural approach. *International Journal*

of Consumer Studies, *40*(2), 179–185. https://doi.org/10.1111/ijcs.12241

Daryanto, A., & Song, Z. (2021). A meta-analysis of the relationship between place attachment and pro-environmental behaviour. *Journal of Business Research*, *123*(May 2020), 208–219. https://doi.org/10.1016/j.jbusres.2020.09.045

Dasmann, R. F. (1972). Towards a system for classifying natural regions of the world and their representation by national parks and reserves. *Biological Conservation*, *4*(4), 247–255. https://doi.org/10.1016/0006-3207(72)90119-X

de Juan, S., Gelcich, S., & Fernandez, M. (2017). Integrating stakeholder perceptions and preferences on ecosystem services in the management of coastal areas. *Ocean and Coastal Management*, *136*, 38–48. https://doi.org/10.1016/j.ocecoaman.2016.11.019

Dearden, P., Bennett, M., & Rollins, R. (2007). Perceptions of diving impacts and implications for reef conservation. *Coastal Management*, *35*(2–3), 305–317. https://doi.org/10.1080/08920750601169584

Deville, N. V, Powers Tomasso, L., Stoddard, O. P., Wilt, G. E., Horton, T. H., Wolf, K. L., Brymer, E., Kahn, P. H., & James, P. (2021). Time Spent in Nature Is Associated with Increased Pro-Environmental Attitudes and Behaviors. *Int. J. Environ. Res. Public Health*, *18*, 7498. https://doi.org/10.3390/ijerph18147498

Devine-Wright, P., & Howes, Y. (2010). Disruption to place attachment and the protection of restorative environments: A wind energy case study. *Journal of Environmental Psychology*, *30*(3), 271–280. https://doi.org/10.1016/j.jenvp.2010.01.008

Di Chiacchio, L. (2021). Do the policies implemented in protected natural areas in europe allow for pro-environmental behaviour of their stakeholders? *Proceedings of the European Conference on Knowledge Management, ECKM*, 983–987. https://doi.org/10.34190/EKM.21.043

Diaz, S., Fargione, J., Chapin III, S. F., & Tilman, D. (2006). Biodiversity Loss Threatens Human Well-Being. *PLoS Biology*, *4*(8). https://doi.org/: 10.1371/journal.pbio.0040277

Dietz, T., Gardner, G. T., Gilligan, J., Stern, P. C., & Vandenbergh, M. P. (2009). Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions. *Proceedings of the National Academy of Sciences*, *106*(44), 18452–18456.

https://doi.org/10.1073/pnas.0908738106

Dockerty, T., Lovett, A., S€, G., Appleton, K., & Parry, M. (2005). Visualising the potential impacts of climate change on rural landscapes. *Computers., Environment and Urban Systems*, *29*. https://doi.org/10.1016/j.compenvurbsys.2004.05.004

Doherty, T. J. (2018). Individual impacts and resilience. *Psychology and Climate Change: Human Perceptions, Impacts, and Responses*, 245–266. https://doi.org/10.1016/B978-0-12-813130-5.00010-2

Dolan, P., & Galizzi, M. M. (2015). Like ripples on a pond: Behavioral spillovers and their implications for research and policy. In *Journal of Economic Psychology*. https://doi.org/10.1016/j.joep.2014.12.003

Donahue, M. L., Keeler, B. L., Wood, S. A., Fisher, D. M., Hamstead, Z. A., & McPhearson, T. (2018). Using social media to understand drivers of urban park visitation in the Twin Cities, MN. *Landscape and Urban Planning*, *175*(March), 1–10. https://doi.org/10.1016/j.landurbplan.2018.02.006

Duda, M. D., & Nobile, J. L. (2010). The Fallacy of Online Surveys: No Data Are Better Than Bad Data, Human Dimensions of Wildlife. *Human Dimensions of Wildlife*, *15*(1), 55–64. https://doi.org/10.1080/10871200903244250

Duke, L., & Soulsbury, C. D. (2020). Human-wildlife interaction networks at urban blue spaces. *Area*, *n/a*(n/a). https://doi.org/https://doi.org/10.1111/area.12683

Düking, P., Tafler, M., Wallmann-Sperlich, B., Sperlich, B., & Kleih, S. (2020). Behavior change techniques in wrist-worn wearables to promote physical activity: Content analysis. *JMIR MHealth and UHealth*, *8*(11). https://doi.org/10.2196/20820

Dunlap, R. (2012). *New Ecological Paradigm (NEP) Scale*.

Eat Farm Now. (2021). *Sheep worrying explained by farmers - Eat Farm Now*. https://eatfarmnow.com/2020/04/06/sheep-worrying-explained-by-a-shepherd/

Eden, S. E. (1993). Individual environmental responsibility and its role in public environmentalism. *Environment & Planning A*, *25*(12), 1743–1758. https://doi.org/10.1068/a251743

Edwards, V., & Knight, S. (2006). *Understanding the Psychology of Walkers with Dogs: New*

Approaches to Better Management. July, 56.

Ellipsis Earth. (2020). *identify | Ellipsis Earth*. https://www.ellipsis.earth/identify

Elmauer, K., Cattoen, E., Lenze, B., & Berghausen, K. (2017). *Influencing behaviour of visitors and residents in protected areas*. *6*(November), 137–139.

Esfandiar, K., Dowling, R., Pearce, J., & Goh, E. (2021). What a load of rubbish! The efficacy of theory of planned behaviour and norm activation model in predicting visitors' binning behaviour in national parks. *Journal of Hospitality and Tourism Management*, *46*(September 2020), 304–315. https://doi.org/10.1016/j.jhtm.2021.01.001

Esfandiar, K., Pearce, J., Dowling, R., & Goh, E. (2022). Pro-environmental behaviours in protected areas: A systematic literature review and future research directions. *Tourism Management Perspectives*, *41*(January 2021), 100943. https://doi.org/10.1016/j.tmp.2022.100943

Evans, L., Maio, G. R., Corner, A., Hodgetts, C. J., Ahmed, S., & Hahn, U. (2013). Self-interest and pro-environmental behaviour. *Nature Climate Change*, *3*(2), 122–125. https://doi.org/10.1038/nclimate1662

Fan Ng, C. (2016). Behavioural Mapping and Tracking. In R. Gifford (Ed.), *Research Methods for Environmental Psychology* (First, pp. 29–51). John Wiley & Sons, Ltd.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191. https://doi.org/10.3758/BF03193146

Felix & Paul Studios. (2019). *Travelling While Black*. https://www.felixandpaul.com/?projects/travelingwhileblack/awards

Ferguson, C., Davidson, P. M., Scott, P. J., Jackson, D., & Hickman, L. D. (2015). Contemporary Nurse Augmented reality, virtual reality and gaming: an integral part of nursing. *Contemporary Nurse*. https://doi.org/10.1080/10376178.2015.1130360

Ferguson, M. A., McDonald, R. I., & Branscombe, N. R. (2016). Global Climate Change: A Social Identity Perspective on Informational and Structural Interventions. In *Understanding Peace and Conflict Through Social Identity Theory. Peace Psychology Book Series.* (1st ed., pp. 145–164). Springer.

Festinger, L., & Carlsmith, J. M. (1959). Cognitive consequences of forced compliance. *Journal of Abnormal and Social Psychology*, *58*(2), 203–210. https://doi.org/10.1037/h0041593

Fforest Fawr Geopark. (2021). *Fforest Fawr | UNESCO Global Geopark*. https://www.fforestfawrgeopark.org.uk/

Font, X., Garay, L., & Jones, S. (2016). Sustainability motivations and practices in small tourism enterprises in European protected areas. *Journal of Cleaner Production*, *137*, 1439–1448. https://doi.org/10.1016/j.jclepro.2014.01.071

Forgrave, A. (2020, August 19). *Pictures show incredible impact of lockdown on Snowdonia and Anglesey beauty spots - North Wales Live*. Daily Post. https://www.dailypost.co.uk/news/north-wales-news/pictures-show-incredible-impact-lockdown-18788034

Frost, S., Kannis-Dymand, L., Schaffer, V., Millear, P., Allen, A., Stallman, H., Mason, J., Wood, A., & Atkinson-Nolte, J. (2022). Virtual immersion in nature and psychological well-being: A systematic literature review. *Journal of Environmental Psychology*, *80*(January), 101765. https://doi.org/10.1016/j.jenvp.2022.101765

Frumkin, H. (2001). Beyond toxicity: Human health and the natural environment. *American Journal of Preventive Medicine*, *20*(3), 234–240. https://doi.org/10.1016/S0749-3797(00)00317-2

Fryxell, G. E., & Lo, C. W. H. (2015). The Influence Of Environmental Knowledge And Values On Managerial Behavior In China: A Comparison Of Managers In Guangzhou And Beijing. *10th International Conference of the Greening of Industry Network*, 1–35. https://www.researchgate.net/profile/Carlos_Lo/publication/268255926_THE_INFLUENCE_OF_ENVIRONMENTAL_KNOWLEDGE_AND_VALUES_ON_MANAGERIAL_BEHAVIOR_IN_CHINA_A_COMPARISON_OF_MANAGERS_IN_GUANGZHOU_AND_BEIJING/links/54bb931d0cf24e50e940406b.pdf

Gabe-Thomas, E., Walker, I., Verplanken, B., & Shaddick, G. (2016). Householders' mental models of domestic energy consumption: Using a sort-and-cluster method to identify shared concepts of appliance similarity. *PLoS ONE*, *11*(7), 1–15. https://doi.org/10.1371/journal.pone.0158949

Gammon, K. (2019). *Super bloom: can this tiny California town avoid another "flowergeddon"? | Environment | The Guardian*. The Guardian.

https://www.theguardian.com/environment/2019/mar/15/california-superbloom-flowergeddon-anza-borrego

Gammon, K. (2020). "It's a photo orgy": is Yosemite's rare firefall too beautiful for its own good? | US news | The Guardian. *The Guardian*. https://www.theguardian.com/us-news/2020/feb/17/yosemite-firefall-national-park-horsetail-fall

Geffroy, B., Samia, D. S. M., Bessa, E., & Blumstein, D. T. (2015). How Nature-Based Tourism Might Increase Prey Vulnerability to Predators. *Trends in Ecology and Evolution*, *30*(12), 755–765. https://doi.org/10.1016/j.tree.2015.09.010

Geiger, J. L., Steg, L., van der Werff, E., & Ünal, A. B. (2019). A meta-analysis of factors related to recycling. *Journal of Environmental Psychology*, *64*(July 2017), 78–97. https://doi.org/10.1016/j.jenvp.2019.05.004

Geiger, S. J. (2022). Proenvironmental behaviour spillover. *Nature Reviews Psychology*, *315*(2019), 101694. https://doi.org/10.1038/s44159-022-00043-1

Gell, F. (2019). The Blue Planet effect: the plastics revolution is just the start | Fiona Gell | Opinion | The Guardian. *The Guardian*. https://www.theguardian.com/commentisfree/2019/mar/25/plastics-revolution-marine-life

Geller, S. E., Abrahamse, W., Guan, B., & Sussman, R. (2016). Applying Behavioural Science for Environmental Sustainability. In R. Gifford (Ed.), *Resesarch Methods for Environmental Psychology* (1st ed., pp. 307–322). Wiley Blackwell.

Gifford, R., & Nilsson, A. (2014). Personal and social factors that influence pro-environmental concern and behaviour: A review. *International Journal of Psychology*, *49*(3), 141–157. https://doi.org/10.1002/ijop.12034

Glover, J. (2019). *Landscapes Review: Final Report*. 1–167. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/833726/landscapes-review-final-report.pdf

Goh, E., Ritchie, B., & Wang, J. (2017). Non-compliance in national parks: An extension of the theory of planned behaviour model with pro-environmental values. *Tourism Management*, *59*, 123–127. https://doi.org/10.1016/j.tourman.2016.07.004

Goldstein, N. J., Cialdini, R. B., & Griskevicius, V. (2008). *A Room with a Viewpoint : Using Social Norms to Motivate Environmental Conservation in Hotels*. *35*(3), 472–482. https://doi.org/10.1086/586910

Google. (2022). *My Maps*. https://www.google.com/maps/d/

Gordon, L. (2020, April 28). *Can virtual nature be a good substitute for the great outdoors? The science says yes. - The Washington Post*. Washington Post. https://www.washingtonpost.com/video-games/2020/04/28/can-virtual-nature-be-good-substitute-great-outdoors-science-says-yes/

Gosling, E., & Williams, K. J. H. (2010). Connectedness to nature, place attachment and conservation behaviour: Testing connectedness theory among farmers. *Journal of Environmental Psychology*, *30*(3), 298–304. https://doi.org/10.1016/j.jenvp.2010.01.005

Gosling, S. D., Ko, S. J., Mannarelli, T., & Morris, M. E. (2002). *A Room With a Cue : Personality Judgments Based on Offices and Bedrooms*. *82*(3), 379–398. https://doi.org/10.1037//0022-3514.82.3.379

Guagnano, G. A., Stern, P. C., & Dietz, T. (1995). Influences on Attitude-Behavior Relationships: A Natural Experiment with Curbside Recycling. *Environment and Behavior*, *27*(5), 699–718. https://doi.org/10.1177/0013916595275005

Guinther, L., & Carll-White, A. (2014). Utilizing Emergency Departments as Learning Spaces through a Post-Occupancy Evaluation. *Journal of Learning Spaces*, *3*(1).

Halkiopoulos, S. (2018). *Improving transition out of the Armed Forces : engaging families through behavioural insights*.

Halpenny, E. A. (2010). Pro-environmental behaviours and park visitors: The effect of place attachment. *Journal of Environmental Psychology*, *30*(4), 409–421. https://doi.org/10.1016/j.jenvp.2010.04.006

Ham, J., Midden, C., & Beute, F. (2009). Unconscious persuasion by Ambient Persuasive Technology: Evidence for the effectivity of subliminal feedback. *Adaptive and Emergent Behaviour and Complex Systems - Proceedings of the 23rd Convention of the Society for the Study of Artificial Intelligence and Simulation of Behaviour, AISB 2009*, *May 2014*, 16–21.

Ham, S. H., Brown, T. J., Curtis, J., Weiler, B., Hughes, M., & Poll, M. (2009). *Promoting Persuasion in Protected Areas*.

Ham, S. H., & Hughes, M. (2010). *Picking up Litter : An Application of Theory-based Communication to Influence Tourist Behaviour in Protected Areas This article was downloaded by : [Griffith University Library] Journal of Sustainable Tourism Picking up litter : an application of theory*. *April 2014*. https://doi.org/10.1080/09669581003721281

Ham, S. H., Weiler, B., Hughes, M., Brown, T. J., Curtis, J., & Poll, M. (2008). Asking visitors to help: Research to guide strategic communication for protected area management sustainable tourism. In *Russell The Journal Of The Bertrand Russell Archives*.

Hamann, K. R. S., & Reese, G. (2020). My Influence on the World (of Others): Goal Efficacy Beliefs and Efficacy Affect Predict Private, Public, and Activist Pro-environmental Behavior. *Journal of Social Issues*, *76*(1), 35–53. https://doi.org/10.1111/josi.12369

Hampshire County Council & Kennel Club. (2016). *Dogs on your land*.

Hampton, K. N., Goulet, L. S., & Albanesius, G. (2015). *Change in the social life of urban public spaces : The rise of mobile phones and women , and the decline of aloneness over 30 years*. *52*(October 2013), 1489–1504. https://doi.org/10.1177/0042098014534905

Hamstead, Z. A., Fisher, D., Ilieva, R. T., Wood, S. A., McPhearson, T., & Kremer, P. (2018). Geolocated social media as a rapid indicator of park visitation and equitable park access. *Computers, Environment and Urban Systems*, *July 2017*, 0–1. https://doi.org/10.1016/j.compenvurbsys.2018.01.007

Hares, A., Dickinson, J., & Wilkes, K. (2010). Climate change and the air travel decisions of UK tourists. *Journal of Transport Geography*, *18*(3), 466–473. https://doi.org/10.1016/j.jtrangeo.2009.06.018

Harland, P., Staats, H., & Wilke, H. (1999). Explaining proenvironmetal intention and behavior by personal norms and the theory of planned behavior. *Journal of Applied Social Psychology*, *29*(2), 505–528.

Harris, L., & Dogs Trust. (2019). *The Big Scoop : A novel intervention to encourage human behaviour change to reduce dog fouling in public areas* (Issue February).

Hausmann, A., Toivonen, T., Slotow, R., Tenkanen, H., Moilanen, A., Heikinheimo, V., & Di Minin, E. (2018). Social Media Data Can Be Used to Understand Tourists' Preferences for Nature-Based Experiences in Protected Areas. *Conservation Letters*, *11*(1), 1–10. https://doi.org/10.1111/conl.12343

Hayes, N. (2020). *The Book of Trespass: Crossing the Lines that Divide Us* (1st ed.). Bloomsbury.

Headspace. (2020). *Meditation and Sleep Made Simple - Headspace*. https://www.headspace.com/?utm_source=google&utm_medium=cpc&utm_campaign=9172 56451&utm_content=51529952052&utm_term=217943262927&headsapce&gclid=Cj0KCQiA4 8j9BRC-ARIsAMQu3WQPx8n2NKaBdk5DHsHMkHFJrGKypq6vdbi8whmkj1vEgZXgeVW48pwaAsUAEALw _wcB

Hemmelder, S., Marra, W., Markies, H., & De Jong, S. M. (2018). Monitoring river morphology & bank erosion using UAV imagery – A case study of the river Buëch, Hautes-Alpes, France. *International Journal of Applied Earth Observation and Geoinformation*, *73*(July), 428–437. https://doi.org/10.1016/j.jag.2018.07.016

Herbelin, B., Vexo, F., & Thalmann, D. (2002). Sense of Presence in Virtual Reality Exposures Therapy. *First International Workshop on Virtual Reality Rehabilitation, VRMHR*, *June 2014*.

Herman, D. J. (1992). *Loving Them to Death : Legal Controls on the Type and Scale of Development in the National Parks*. *1*, 2–67.

Hernández Bernardo, B., Martín, A. M., Ruiz, C., & Hidalgo, M. del C. (2010). The role of place identity and place attachment in breaking environmental protection laws. *Journal of Environmental Psychology*, *30*(3), 281–288. https://doi.org/10.1016/j.jenvp.2010.01.009

Hiltzik, M. (2015, November 30). *Are most academic papers really worthless? Don't trust this worthless statistic - Los Angeles Times*. Los Angeles Times. https://www.latimes.com/business/hiltzik/la-fi-mh-are-academic-papers-really-worthless-20151130-column.html

Hodgson, I. D., Fischer, A., Redpath, S. M., Young, J. C., Hodgson, I. D., Fischer, A., Redpath, S. M., & Young, J. C. (2022). Fight or Flight ? Understanding Different Stakeholder Responses to Conservation Conflicts Fight or Flight ? Understanding Different Stakeholder Responses to

Conservation Conflicts. *Society & Natural Resources*, *0*(0), 1–18. https://doi.org/10.1080/08941920.2022.2048933

Holroyd, M. (2018, March 19). *English Tourism Week 2018: Making great memories in England's National Parks - DCMS blog*. Department for Digital, Culture, Media and Sport. https://dcmsblog.uk/2018/03/english-tourism-week-2018-making-great-memories-englands-national-parks/

Holtgraves, T. (2004). Social Desirability and Self-Reports: Testing Models of Socially Desirable Responding. *Personality and Social Psychology Bulletin*, *30*(2), 161–172. https://doi.org/10.1177/0146167203259930

Hughes, J., Richardson, M., & Lumber, R. (2018). Evaluating connection to nature and the relationship with conservation behaviour in children. *Journal for Nature Conservation*. https://doi.org/10.1016/j.jnc.2018.07.004

Hughes, K., Packer, J., & Ballantyne, R. (2011). Using post-visit action resources to support family conservation learning following a wildlife tourism experience. *Environmental Education Research*, *17*(3), 307–328. https://doi.org/10.1080/13504622.2010.540644

Hume, S., Reilly, F. O., Groot, B., Kozman, E., Barnes, J., Chande, R., & Sanders, M. (2018). *Retention and Success in Maths and English A Practitioner Guide to Applying Behavioural Insights Table of Contents. February*, 1–49.

Huygelier, H., Schraepen, B., van Ee, R., Vanden Abeele, V., & Gillebert, C. R. (2019). Acceptance of immersive head-mounted virtual reality in older adults. *Scientific Reports*, *9*(1), 1–12. https://doi.org/10.1038/s41598-019-41200-6

IBM. (2022). *IBM SPSS Statistics 23 for Windows* (pp. 2–5). IBM Corp.

Intergovernmental Panel on Climate Change. (2019). *The IPCC and the Sixth Assessment cycle*.

International Dark-Sky Association. (2021). *Brecon Beacons National Park (Wales) | International Dark-Sky Association*. https://www.darksky.org/our-work/conservation/idsp/reserves/breconbeacons/

Ioannidis, J. P. A. (2005). Why Most Published Research Findings Are False. *PLoS Medicine*, *2*(8). https://doi.org/10.1371/journal.pmed.0020124

Ivanova, D., Barrett, J., Wiedenhofer, D., Macura, B., Callaghan, M., & Creutzig, F. (2020). Quantifying the potential for climate change mitigation of consumption options. *Environmental Research Letters*, *15*(9). https://doi.org/10.1088/1748-9326/ab8589

Jachimowicz, J. M., Hauser, O. P., O'Brien, J. D., Sherman, E., & Galinsky, A. D. (2018). The critical role of second-order normative beliefs in predicting energy conservation. *Nature Human Behaviour*, *2*(10), 757–764. https://doi.org/10.1038/s41562-018-0434-0

Jassi, J., & Dutton, A. (2020). *Access to garden spaces : England*. 1–9.

Jenkinson, S. (2007). *Managing dogs in the wood*. *March*.

Jepson, R. G., Harris, F. M., Platt, S., & Tannahill, C. (2010). The effectiveness of interventions to change six health behaviours: A review of reviews. *BMC Public Health*, *10*. https://doi.org/10.1186/1471-2458-10-538

Johnson. (2021, March 28). Welcome back! UK's national parks brace for staycation invasion | National parks | The Guardian. *The Guardian*. https://www.theguardian.com/environment/2021/mar/28/staycation-invasion-national-parks-seek-relief-from-chaos-of-last-summer

Johnson, & Onwuegbuzie, A. J. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher*, *33*(7), 14–26. https://doi.org/10.3102/0013189X033007014

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). *Toward a Definition of Mixed Methods Research*. https://doi.org/10.1177/1558689806298224

Jorgensen, B. S., & Stedman, R. C. (2001). Sense of Place As an Attitude: Lakeshore Owners Attitudes Toward Their Properties. *Journal of Environmental Psychology*, *21*(3), 233–248. https://doi.org/10.1006/jevp.2001.0226

Juhl, H. J., Fenger, M. H. J., & Thøgersen, J. (2017). Will the consistent organic food consumer step forward? An empirical analysis. *Journal of Consumer Research*, *44*(3), 519–535. https://doi.org/10.1093/jcr/ucx052

Kaida, N., & Kaida, K. (2015). Spillover effect of congestion charging on pro-environmental behavior. *Environment, Development and Sustainability*, *17*(3), 409–421.

https://doi.org/10.1007/s10668-014-9550-9

Kaiser, H. F. (1970). A SECOND GENERATION L I T T L E JIFFY. *Psychometrika*, *35*(4), 401–415. https://doi.org/10.1007/BF02291817

Kalantari, S., Xu, T. B., Mostafavi, A., Lee, A., Barankevich, R., Boot, W., & Czaja, S. (2022). *Using a Nature-based Virtual Reality Environment for Improving Mood States and Cognitive Engagement in Older Adults: A Mixed-method Feasibility Study*.

Kardong-Edgren, S., Farra, S. L., Alinier, G., & Michael Young, H. (2019). *A Call to Unify Definitions of Virtual Reality*. https://doi.org/10.1016/j.ecns.2019.02.006

Keep Wales Tidy. (2021). *Keeping Litter Off Our Roads*.

Kendall, A. (2015). *UK vs USA (National Parks) What Are The Differences? Top 5 - Wilderness Scotland*. Wilderness Scotland. https://www.wildernessscotland.com/blog/top-5-differences-between-national-parks-in-the-us-and-uk/

Khajeh, E., Dabestani, R., & Fathi, S. (2015). The role of upstream and downstream social marketing in electricity consumption management. *International Journal of Business Innovation and Research*, *9*(3), 311–328. https://doi.org/10.1504/IJBIR.2015.069138

Khalil, E. L., & Feltovich, N. (2018). Moral licensing, instrumental apology and insincerity aversion: Taking immanuel kant to the lab. *PLoS ONE*, *13*(11), 1–24. https://doi.org/10.1371/journal.pone.0206878

Kidd, L. R., Garrard, G. E., Bekessy, S. A., Mills, M., Camilleri, A. R., Fidler, F., Fielding, K. S., Gordon, A., Gregg, E. A., Kusmanoff, A. M., Louis, W., Moon, K., Robinson, J. A., Selinske, M. J., Shanahan, D., & Adams, V. M. (2019). Messaging matters: A systematic review of the conservation messaging literature. *Biological Conservation*, *236*(April), 92–99. https://doi.org/10.1016/j.biocon.2019.05.020

Klein, S. A., & Hilbig, B. E. (2018). How virtual nature experiences can promote pro-environmental behavior. *Journal of Environmental Psychology*, *60*(February), 41–47. https://doi.org/10.1016/j.jenvp.2018.10.001

Klöckner, C. A. (2013). A comprehensive model of the psychology of environmental behaviour-A meta-analysis. *Global Environmental Change*, *23*(5), 1028–1038.

https://doi.org/10.1016/j.gloenvcha.2013.05.014

Kollmuss, A., & Agyeman, J. (2002). Mind the Gap: Why Do People Behave Environmentally and What are the Barriers to Pro-Environmental Behaviour. *Environmental Education Research*, *8*(3), 239–260. https://doi.org/10.1080/1350462022014540

Kormos, C., & Gifford, R. (2014). The validity of self-report measures of proenvironmental behavior: Ameta-analytic review. *Journal of Environmental Psychology*, *40*, 359–371. https://doi.org/10.1016/j.jenvp.2014.09.003

Kort, Y. A. W. De, Mccalley, L. T., & Midden, C. J. H. (2008). *Persuasive Trash Cans*. 870–891.

Kusmanoff, A. M., Fidler, F., Gordon, A., Garrard, G. E., Bekessy, S. A., Lecciones, C., Dirigir, P., & Encuadre, U. (2020). Five lessons to guide more effective biodiversity conservation message framing. *Conservation Biology*, *34*(5), 1131–1141. https://doi.org/10.1111/cobi.13482

Lacasse, K. (2016). Don't be satisfied, identify! Strengthening positive spillover by connecting pro-environmental behaviors to an "environmentalist" label. *Journal of Environmental Psychology*. https://doi.org/10.1016/j.jenvp.2016.09.006

Lake District National Park. (2017). *Path Erosion and Management*.

Lange, F., & Dewitte, S. (2019). Measuring pro-environmental behavior: Review and recommendations. *Journal of Environmental Psychology*, *63*(October 2018), 92–100. https://doi.org/10.1016/j.jenvp.2019.04.009

Lange, F., Steinke, A., & Dewitte, S. (2018). The Pro-Environmental Behavior Task: A laboratory measure of actual pro-environmental behavior. *Journal of Environmental Psychology*. https://doi.org/10.1016/j.jenvp.2018.02.007

Lanzini, P., & Thøgersen, J. (2014). Behavioural spillover in the environmental domain: An intervention study. *Journal of Environmental Psychology*, *40*, 381–390. https://doi.org/10.1016/j.jenvp.2014.09.006

Laviille, S. (2020). *Park staff in England tell of litter chaos as "Super Saturday" looms | Waste | The Guardian*. The Guardian. https://www.theguardian.com/environment/2020/jun/28/park-staff-in-england-tell-of-litter-chaos-as-super-saturday-looms

Leave No Trace. (2018). *New Social Media Guidance | Leave No Trace*. https://lnt.org/blog/new-

social-media-guidance

Lee, Y., De Young, R., & Marans. (1995). *Factors Influencing Individual Recycling Behavior in Office Settings: A Study of Office Workers in Taiwan*.

Leggett, W. (2014). The politics of behaviour change: Nudge, neoliberalism and the state. *Policy and Politics*, *42*(1), 3–19. https://doi.org/10.1332/030557312X655576

Levi, D., & Kocher, S. (1999). Virtual nature: The future effects of information technology on our relationship to nature. *Environment and Behavior*, *31*(2), 203–226. https://doi.org/10.1177/00139169921972065

Lewis, Y. (2021). Research collaborations bring big rewards: the world needs more. *Nature*, *594*(7863), 301–302. https://doi.org/10.1038/d41586-021-01581-z

Lind, H. B., Nordfjærn, T., Jørgensen, S. H., & Rundmo, T. (2015). The value-belief-norm theory, personal norms and sustainable travel mode choice in urban areas. *Journal of Environmental Psychology*, *44*, 119–125. https://doi.org/10.1016/j.jenvp.2015.06.001

Littleford, C., Ryley, T. J., & Firth, S. K. (2014). Context, control and the spillover of energy use behaviours between office and home settings. *Journal of Environmental Psychology*, *40*, 157–166. https://doi.org/10.1016/j.jenvp.2014.06.002

Llangattock Community Council. (2021). *Llangattock Litter Pickers*. https://www.llangattock-cc.gov.wales/community-groups/llangattock-litter-pickers/

Llangattock Litter Pickers. (2021a). *Llangattock Litter Pickers (@LlangattockPick) / Twitter*. https://twitter.com/LlangattockPick?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor

Llangattock Litter Pickers. (2021b). *Llangattock Litter Pickers | Facebook*. https://www.facebook.com/LlangattockLitterPickers/

Lombard, M., & Ditton, T. (1997). At the heart of it all: The concept of presence. *Journal of Computer-Mediated Communication*, *3*(2). https://doi.org/10.1111/J.1083-6101.1997.TB00072.X/4080403

Lopreiato, J. O., Downing, D., Gammon, W., Lioce, L., Sittner, B., Slot, V., Spain, A. E., & Terminology & Concepts Working Group. (2021). *Healthcare Simulation Dictionary* (2.1).

https://www.ssih.org/dictionary

Lynn, P. (2014). Distinguishing dimensions of pro-environmental behaviour. In *ISER Working Paper Series*. https://www.iser.essex.ac.uk/research/publications/working-papers/iser/2014-19.pdf%0Ahttps://www.iser.essex.ac.uk/research/publications/working-papers/iser/2014-19

Mackay, C. M. L., & Schmitt, M. T. (2019). Do people who feel connected to nature do more to protect it? A meta-analysis. *Journal of Environmental Psychology*, *65*(December 2018), 101323. https://doi.org/10.1016/j.jenvp.2019.101323

Maki, A., Carrico, A. R., Raimi, K. T., Truelove, H. B., Araujo, B., & Yeung, K. L. (2019). Meta-analysis of pro-environmental behaviour spillover. *Nature Sustainability*, *accepted f*(April), 307–315. https://doi.org/10.1038/s41893-019-0263-9

Maller, C, Townsend, M., Pryor, A., & Brown, P. (2006). Healthy nature healthy people:'contact with nature'as an upstream health promotion intervention for populations. *Health Promotion …*. https://doi.org/10.1093/heapro/dai032

Maller, Cecily, Townsend, M., Pryor, A., Brown, P., & St Leger, L. (2006). Healthy nature healthy people: "contact with nature" as an upstream health promotion intervention for populations. *Health Promotion International*, *21*(1), 45–54. https://doi.org/10.1093/heapro/dai032

Marani, M., Katul, G. G., Pan, W. K., & Parolari, A. J. (2021). Intensity and frequency of extreme novel epidemics. *Proceedings of the National Academy of Sciences of the United States of America*, *118*(35), 0–3. https://doi.org/10.1073/pnas.2105482118

Margetts, E. A., & Kashima, Y. (2017). Spillover between pro-environmental behaviours: The role of resources and perceived similarity. *Journal of Environmental Psychology*, *49*, 30–42. https://doi.org/10.1016/j.jenvp.2016.07.005

Markowitz, D. M., & Bailenson, J. N. (2021). Virtual reality and the psychology of climate change. *Current Opinion in Psychology*, *42*, 60–65. https://doi.org/10.1016/j.copsyc.2021.03.009

Martin, L., White, M. P., Hunt, A., Richardson, M., Pahl, S., & Burt, J. (2020a). Nature contact, nature connectedness and associations with health, wellbeing and pro-environmental behaviours. *Journal of Environmental Psychology*, *68*, 101389.

Martin, L., White, M. P., Hunt, A., Richardson, M., Pahl, S., & Burt, J. (2020b). Nature contact, nature

connectedness and associations with health, wellbeing and pro-environmental behaviours. *Journal of Environmental Psychology*, *68*(February 2019), 101389. https://doi.org/10.1016/j.jenvp.2020.101389

Martiskainen, M., & Ellis, J. (2011). The role of smart meters in encouraging behavioural change - prospects for the UK. *Energy Efficiency*, *4*(2007), 209–221. http://sro.sussex.ac.uk/25044/

Marzano, M., & Dandy, N. (2012). Recreationist behaviour in forests and the disturbance of wildlife. *Biodiversity and Conservation*, *21*(11), 2967–2986. https://doi.org/10.1007/s10531-012-0350-y

Maund, P. R., Irvine, K. N., Reeves, J., Strong, E., Cromie, R., Dallimer, M., & Davies, Z. G. (2019). *Wetlands for Wellbeing : Piloting a Nature-Based Health Intervention for the Management of Anxiety and Depression*. 1–17. https://doi.org/10.3390/ijerph16224413

Mayer, F. S., & Frantz, C. M. P. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology*, *24*(4), 503–515. https://doi.org/10.1016/j.jenvp.2004.10.001

Mazar, N., & Zhong, C. B. (2010). Do green products make us better people? *Psychological Science*, *21*(4), 494–498. https://doi.org/10.1177/0956797610363538

McCalley, L. T., & Midden, C. J. H. (2002). Energy conservation through product-integrated feedback: The roles of goal-setting and social orientation. *Journal of Economic Psychology*, *23*(5), 589–603. https://doi.org/10.1016/S0167-4870(02)00119-8

Mcclung, M. R., Seddon, P. J., Massaro, M., & Setiawan, A. N. (2004). Nature-based tourism impacts on yellow-eyed penguins Megadyptes antipodes: does unregulated visitor access affect fledging weight and juvenile survival? *Biological Conservation*, *119*. https://doi.org/10.1016/j.biocon.2003.11.012

McCoy, D., & Lyons, S. (2017). Unintended outcomes of electricity smart-metering: trading-off consumption and investment behaviour. *Energy Efficiency*, *10*(2), 299–318. https://doi.org/10.1007/s12053-016-9452-9

McGrath, C., Palmgren, J., & Liljedahl, M. (2019). Twelve tips for conducting qualitative research interviews Twelve tips for conducting qualitative research interviews. *Medical Teacher*. https://doi.org/10.1080/0142159X.2018.1497149

Megan Scudellari. (2020). The Pandemic's Future. *Nature*, *584*(August). https://media.nature.com/original/magazine-assets/d41586-020-02278-5/d41586-020-02278-5.pdf

Meyers-Levy, J., & Zhu, R. (2007). The Influence of Ceiling Height: The Effect of Priming on the Type of Processing That People Use. *Journal of Consumer Research*, *34*(2), 174–186. https://doi.org/10.1086/519146

Miao, L., & Wei, W. (2013). Consumers' pro-environmental behavior and the underlying motivations: A comparison between household and hotel settings. *International Journal of Hospitality Management*, *32*(1), 102–112. https://doi.org/10.1016/j.ijhm.2012.04.008

MIchie, S., Stralen, M. M. Van, & West, R. (2011). *The behaviour change wheel : A new method for characterising and designing behaviour change interventions The behaviour change wheel : A new method for characterising and designing behaviour change interventions*. *42*(April). https://doi.org/10.1186/1748-5908-6-42

Michie, S, Atkins, L., & West, R. (2014). *The Behaviour Change Wheel Book - A Guide To Designing Interventions*. http://www.behaviourchangewheel.com/

Michie, Susan, Fixsen, D., Grimshaw, J. M., & Eccles, M. P. (2009). Specifying and reporting complex behaviour change interventions: The need for a scientific method. *Implementation Science*, *4*(1), 1–6. https://doi.org/10.1186/1748-5908-4-40

Microsoft Corporation. (2022). *Microsoft Excel*. https://www.microsoft.com/en-gb/microsoft-365/excel?legRedir=true&CorrelationId=272674cf-c25a-403c-acd6-4cbdba327968&rtc=1

Miliute-Plepiene, J., Hage, O., Plepys, A., & Reipas, A. (2016). What motivates households recycling behaviour in recycling schemes of different maturity? Lessons from Lithuania and Sweden. *Resources, Conservation and Recycling*, *113*, 40–52. https://doi.org/10.1016/j.resconrec.2016.05.008

Monbiot, G. (2018a). Britain's national parks are a farce: they're being run for a tiny minority | George Monbiot | Opinion | The Guardian. *The Guardian*. https://www.theguardian.com/commentisfree/2018/feb/28/britain-national-parks-reclaim-rewild

Monbiot, G. (2018b, June 29). Our natural world is disappearing before our eyes. We have to save it | George Monbiot | Opinion | The Guardian. *The Guardian*. https://www.theguardian.com/commentisfree/2018/jun/29/natural-world-disappearing-save-it

Morris, S. (2020, May 20). *Rare UK wildlife thriving in lockdown, reveals National Trust | Environment | The Guardian*. The Guardian. https://www.theguardian.com/environment/2020/may/20/rare-uk-wildlife-thriving-in-lockdown-reveals-national-trust

Mostafa, M. M. (2007). Gender differences in Egyptian consumers' green purchase behaviour: The effects of environmental knowledge, concern and attitude. *International Journal of Consumer Studies*, *31*(3), 220–229. https://doi.org/10.1111/j.1470-6431.2006.00523.x

Motive.io. (2020). *Comparing 360 Video vs. Virtual Reality*. https://www.motive.io/blog/vr-training/comparing-360-video-vs-virtual-reality/

NASA. (2021). *Effects | Facts – Climate Change: Vital Signs of the Planet*. https://climate.nasa.gov/effects/

Nash, N., Whitmarsh, L., Capstick, S., Hargreaves, T., Poortinga, W., Thomas, G., Sautkina, E., & Xenias, D. (2017). Climate-relevant behavioral spillover and the potential contribution of social practice theory. *Wiley Interdisciplinary Reviews: Climate Change*, *8*(6). https://doi.org/10.1002/wcc.481

Nash, R. (1970). The American Invention of National Parks. *American Quarterly*, *22*(3), 726. https://doi.org/10.2307/2711623

National Parks UK. (2018). *The impacts of tourism*. https://nationalparks.uk/students/ourchallenges/tourism/impactsoftourism

National Parks UK. (2021). *Brecon Beacons Mountains // Brecon Beacons National Parks*. https://www.nationalparks.uk/park/brecon-beacons/

National Sheep Association. (2016). *Sheep Worrying by Dogs Survey (April 2016) 233*. *April*.

National Sheep Association. (2017). *Sheep Worrying by Dogs Survey*. *April*.

National Sheep Association. (2018). *Sheep Worrying*. https://www.nationalsheep.org.uk/dog-

owners/sheep-worrying/

Natural England. (2017). *Monitor of Engagement with the Natural Environment: Headline Report from the 2015-16 survey*. *May*, 1–12.

Natural Resources Wales. (2016). *Dog Fouling Behaviour Change: Pilot Study*.

Navarro-Bailón, M. Á. (2012). Strategic consistent messages in cross-tool campaigns: Effects on brand image and brand attitude. *Journal of Marketing Communications*, *18*(3), 189–202. https://doi.org/10.1080/13527266.2011.567455

New Forest National Park Authority. (2022). *UK National Parks*. https://www.newforestnpa.gov.uk/about-us/uk-national-parks/

Nigbur, D., Lyons, E., & Uzzell, D. (2010). *Attitudes , norms , identity and environmental behaviour : Using an expanded theory of planned behaviour to predict participation in a kerbside recycling programme*. 259–284. https://doi.org/10.1348/014466609X449395

Nik Ramli, N. A. R., & Wahid, N. H. A. (2012). Positive Spillover of Pro-Environmental Behavior Phenomenon: The Influence of Organizational and Family Factors. *International Proceedings of Economics Development and Research*, *56*(79). https://doi.org/10.7763/IPEDR

Nilsson, A., Bergquist, M., & Schultz, W. P. (2016). *Environmental Education Research Spillover effects in environmental behaviors, across time and context: a review and research agenda*. https://doi.org/10.1080/13504622.2016.1250148org/10.1080/13504622.2016.1250148

Nisbet, E. K., & Zelenski, J. M. (2013). The NR-6: A new brief measure of nature relatedness. *Frontiers in Psychology*, *4*(NOV), 1–11. https://doi.org/10.3389/fpsyg.2013.00813

Nolan, J. M., Schultz, P. W., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2008). Normative social influence is underdetected. *Personality and Social Psychology Bulletin*, *34*(7), 913–923. https://doi.org/10.1177/0146167208316691

Nye, M., & Hargreaves, T. (2010). Exploring the social dynamics of proenvironmental behavior change. *Journal of Industrial Ecology*, *14*(1), 137–149. https://doi.org/10.1111/j.1530-9290.2009.00193.x

Office for National Statistics. (2018). UK environmental accounts: 2018. *Statistical Bulletin*, 1–43. https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/ukenvironmentalaccount

s/2017

Orams, M. B. (2002). The effectiveness of environmental education: can we turn tourists into "greenies''?" *Progress in Tourism and Hospitality Research*, *3*(4), 295–306. https://doi.org/10.1002/(sici)1099-1603(199712)3:4<295::aid-pth85>3.3.co;2-4

Orr, N., Yeo, N. L., Dean, S. G., White, M. P., & Garside, R. (2021). *"It Makes You Feel That You Are There": Exploring the Acceptability of Virtual Reality Nature Environments for People with Memory Loss "It Makes You Feel That You Are There": Exploring the Acceptability of Virtual Reality Nature Environments for People with Memory Loss. Geriatrics*. https://doi.org/10.3390/geriatrics6010027

Otto, S., & Pensini, P. (2017). Nature-based environmental education of children: Environmental knowledge and connectedness to nature, together, are related to ecological behaviour. *Global Environmental Change*, *47*(August), 88–94. https://doi.org/10.1016/j.gloenvcha.2017.09.009

Oxley, J. A., Evans, B., & Montrose, V. T. (2017). Prevention of sheep worrying in the UK: Rethinking the approach. *Journal of Veterinary Behavior: Clinical Applications and Research*, *19*(July 2016), 61–63. https://doi.org/10.1016/j.jveb.2017.02.001

Pallant, J. (2016). *SPSS Survival Manual* (6th ed.). OPen University Press.

Peak District National Park Authority. (2008). *Paws on the Moors Homepage*. http://www.pawsonthemoors.org/

Perkins, H. W., Linkenbach, J. W., Lewis, M. A., & Neighbors, C. (2010). Effectiveness of social norms media marketing in reducing drinking and driving: A statewide campaign. *Addictive Behaviors*. https://doi.org/10.1016/j.addbeh.2010.05.004

Perron, G. M., Côté, R. P., & Duffy, J. F. (2006). Improving environmental awareness training in business. *Journal of Cleaner Production*, *14*(6–7), 551–562. https://doi.org/10.1016/j.jclepro.2005.07.006

Pidd, H. (2021). *"The litter was a shock": 2020's Covid-driven rush on UK national parks | National parks | The Guardian*. The Guardian. https://www.theguardian.com/environment/2021/jan/01/the-litter-was-a-shock-2020-covid-rush-on-uk-national-parks

Platoni, K. (2015). *We have the technology : how biohackers, foodies, physicians, and scientists are transforming human perception, one sense at a time*. https://www.kqed.org/futureofyou/144683/stanfords-virtual-reality-lab-turned-me-into-a-cow-then-sent-me-to-the-slaughterhouse

Poeschl, S., & Doering, N. (2013). The german VR simulation realism scale - psychometric construction for virtual reality applications with virtual humans. *Annual Review of CyberTherapy and Telemedicine*, *11*(June), 33–37. https://doi.org/10.3233/978-1-61499-282-0-33

Pollack, G. (2019). *Every Influencer In LA Took The Same Photo With Wildflowers This Weekend : LAist*. Laist.Com. https://laist.com/2019/03/12/every_influencer_in_la_took_the_same_photo_this_weekend.php

PONT. (2021). *What is PONT? | PONT*. https://www.pontcymru.org/about/what-is-pont/

Poortinga, W., Whitmarsh, L., & Suffolk, C. (2013). The introduction of a single-use carrier bag charge in Wales: Attitude change and behavioural spillover effects. *Journal of Environmental Psychology*, *36*, 240–247. https://doi.org/10.1016/j.jenvp.2013.09.001

Pouso, S., Borja, A., Fleming, L. E., Gómez-Baggethun, E., White, M. P., & Uyarra, M. C. (2020). *Maintaining contact with blue-green spaces during the COVID-19 pandemic associated with positive mental health*.

Powell, R. B., Brownlee, M. T. J., Kellert, S. R., & Ham, S. H. (2012). From awe to satisfaction: Immediate affective responses to the Antarctic tourism experience. *Polar Record*, *48*(2), 145–156. https://doi.org/10.1017/S0032247410000720

Powell, R. B., & Ham, S. H. (2008). Can ecotourism interpretation really lead to pro-conservation knowledge, attitudes and behaviour? Evidence from the galapagos Islands. *Journal of Sustainable Tourism*, *16*(4), 467–489. https://doi.org/10.1080/09669580802154223

Prata, J. C., Silva, A. L. P., Walker, T. R., Duarte, A. C., & Rocha-Santos, T. (2020). COVID-19 Pandemic Repercussions on the Use and Management of Plastics. *Environmental Science and Technology*, *54*(13), 7760–7765. https://doi.org/10.1021/ACS.EST.0C02178

Pratt-Heaton, C. (1999). Visitors and Visitor Pressure in the Brecon Beacons National Park. *Tourism*, *August*.

Priestley, S. (2017). Litter Briefing Paper CBP06984. *House of Commons*, *July*, 1–30.

Pucino, N., Kennedy, D. M., Carvalho, R. C., Allan, B., & Ierodiaconou, D. (2021). Citizen science for monitoring seasonal-scale beach erosion and behaviour with aerial drones. *Scientific Reports*, *11*(1), 1–17. https://doi.org/10.1038/s41598-021-83477-6

QGIS Development Team. (2022). *QGIS* (3.22.3). Open Source Geospatial Foundation Project. http://qgis.osgeo.org

QSR International Pty Ltd. (2020). *NVivo* (Released in March 2020). https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home%0A

Qualtrics. (2022). *Qualtrics* (February 2022). Qualtrics. https://www.qualtrics.com

Ramkissoon, H., Weiler, B., & Smith, L. (2012). *Place attachment and pro-environmental behaviour in national parks: The development of a conceptual framework*. *20*(2), 257–276. https://doi.org/10.1080/09669582.2011.602194

Ramkissoon, H., Weiler, B., & Smith, L. D. G. (2013). Place attachment, place satisfaction and pro-environmental behaviour: a comparative assessment of multiple regression and structural equation modelling. *Journal of Policy Research in Tourism, Leisure and Events*, *5*(3), 215–232. https://doi.org/10.1080/19407963.2013.776371

Ramli, N. N. A., & Naja, M. (2011). Spillover of environmentally friendly behaviour phenomenon: The mediating effect of employee organizational identification. *OIDA International Journal of Sustainable Development*, *2*(12), 29–42.

Ramli, N. N. A., & Naja, M. (2012). A Discussion of Underlying Theories Explaining the Spillover of Environmentally Friendly Behavior Phenomenon. *Procedia - Social and Behavioral Sciences*. https://doi.org/10.1016/j.sbspro.2012.08.106

Ramos, J., & Torgler, B. (2012). Are academics messy? Testing the broken windows theory with a field experiment in the work environment. *Review of Law and Economics*, *8*(3), 563–577. https://doi.org/10.1515/1555-5879.1617

Raven-Ellison, D. (2021). *UK National Parks in 100 Seconds*.

https://www.youtube.com/watch?v=Zuzsacn-8aA

Rees, W. E. (2020). Ecological economics for humanity's plague phase. *Ecological Economics*, *169*(November 2019), 106519. https://doi.org/10.1016/j.ecolecon.2019.106519

Reese, G., Kohler, E., & Menzel, C. (2021). *Restore or Get Restored: The Effect of Control on Stress Reduction and Restoration in Virtual Nature Settings*. https://doi.org/10.3390/su13041995

Reese, G., Stahlberg, J., & Menzel, C. (2022). Digital shinrin-yoku: do nature experiences in virtual reality reduce stress and increase well-being as strongly as similar experiences in a physical forest? *Virtual Reality*, *1*, 3. https://doi.org/10.1007/s10055-022-00631-9

Reeves, J. P., John, C. H. D., Wood, K. A., Maund, P. R., Reeves, C. :, John, J. P. ;, Wood, C. H. D. ;, & Maund, K. A. ; (2021). A Qualitative Analysis of UK Wetland Visitor Centres as a Health Resource. *International Journal of Environmental Research and Public Health Article*. https://doi.org/10.3390/ijerph18168629

Restall, B., & Conrad, E. (2015). A literature review of connectedness to nature and its potential for environmental management. *Journal of Environmental Management*, *159*, 264–278. https://doi.org/10.1016/j.jenvman.2015.05.022

Richardson, M., Cormack, A., McRobert, L., & Underhill, R. (2016). 30 days wild: Development and evaluation of a large-scale nature engagement campaign to improve well-being. *PLoS ONE*, *11*(2), 1–13. https://doi.org/10.1371/journal.pone.0149777

Richardson, M., Passmore, H., Barbett, L., Lumber, R., Thomas, R., & Hunt, A. (2020). The Green Care Code: How Nature Connectedness and Simple Activities Help Explain Pro-Nature Coservation Behaviours. *People and Nature*, *January*, 1–19. https://doi.org/10.1002/pan3.10117

Richler, J. (2022). The translational potential of virtual reality. In *Nature Review Psychology*. https://doi.org/10.1038/s44159-021-00016-w

Rodway-Dyer, S., & Ellis, N. (2018). Combining remote sensing and on-site monitoring methods to investigate footpath erosion within a popular recreational heathland environment. *Journal of Environmental Management*, *215*, 68–78. https://doi.org/10.1016/j.jenvman.2018.03.030

Rowe, M. (2020). *Dossier: The failure of Britain's national parks - Geographical Magazine*.

Geographical. https://geographical.co.uk/uk/item/3614-national-parks

Rubens, M., Fertleman, C., Aubugeau-Williams, P., Sher, C., Lim, A.-N., Lumley, S., Delacroix, S., & Pan, X. (2018). A Discussion of virtual reality As a New tool for training Healthcare Professionals. *Frontiers in Public Health*, *6*, 44. https://doi.org/10.3389/fpubh.2018.00044

Ruepert, A., Keizer, K., Steg, L., Maricchiolo, F., Carrus, G., Dumitru, A., García Mira, R., Stancu, A., & Moza, D. (2016). Environmental considerations in the organizational context: A pathway to pro-environmental behaviour at work. *Energy Research and Social Science*, *17*, 59–70. https://doi.org/10.1016/j.erss.2016.04.004

Sagebiel, J., Karok, L., Grund, J., & Rommel, J. (2020). Clean environments as a social norm: A field experiment on cigarette littering. In *Environmental Research Communications* (Vol. 2, Issue 9). Institute of Physics. https://doi.org/10.1088/2515-7620/abb6da

Salim, E., Ravanel, L., & Deline, P. (2022). *Does witnessing the effects of climate change on glacial landscapes increase pro-environmental behaviour intentions? An empirical study of a last-chance destination*. https://doi.org/10.1080/13683500.2022.2044291

Samus, A., Freeman, C., Dickinson, K. J. M., & van Heezik, Y. (2022). Relationships between nature connectedness, biodiversity of private gardens, and mental well-being during the Covid-19 lockdown. *Urban Forestry & Urban Greening*, *69*(January), 127519. https://doi.org/10.1016/j.ufug.2022.127519

Sataloff, R. T., Johns, M. M., & Kost, K. M. (2020). *A SYSTEMS APPROACH TO DELIVERING NET ZERO: RECOMMENDATIONS FROM THE PRIME MINISTER'S COUNCIL FOR SCIENCE AND TECHNOLOGY*.

Scates, D., Dickinson, J. I., Sullivan, K., & Cline, H. (2020). *Using Nature-Inspired Virtual Reality as a Distraction to Reduce Stress and Pain Among Cancer Patients*. https://doi.org/10.1177/0013916520916259

Scatter. (2017). *Zero Days VR on Steam*. https://www.zerodaysvr.com/

Scatter. (2022). *Zero Days VR*. https://www.zerodaysvr.com/

Schmidt, K. (2021). When less is more – Effects of providing simple vs. refined action-knowledge interventions to promote climate-friendly food consumption in German consumers. *Food Quality and Preference*, *94*, 950–3293. https://doi.org/10.1016/j.foodqual.2021.104333

Schultz, P. W. (2002). *Knowledge, education, and household recycling: examining the knowledge-deficit model of behaviour change.* (T. Dietz a). National Academy of Sciences.

Schultz, P. Wesley, Bator, R. J., Large, L. B., Bruni, C. M., & Tabanico, J. J. (2013). Littering in Context: Personal and Environmental Predictors of Littering Behavior. *Environment and Behavior*, *45*(1), 35–59. https://doi.org/10.1177/0013916511412179

Schultz, P. Wesley, Khazian, A. M., & Zaleski, A. C. (2008). Using normative social influence to promote conservation among hotel guests. *Social Influence*, *3*(1), 4–23. https://doi.org/10.1080/15534510701755614

Schultz, P. Wesley, Nolan, J. M., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2007). The Constructive, Destructive, and Reconstructive Power of Social Norms. *Psychological Science*, *18*(5), 429–434. https://doi.org/10.1111/j.1467-9280.2007.01917.x

Schwartz, S. H. (1977). Normative influences on altruism. *Advances in Experimental Social Psychology*, *10*(C), 221–279. https://doi.org/10.1016/S0065-2601(08)60358-5

Sessions, C., Wood, S. A., Rabotyagov, S., & Fisher, D. M. (2016). Measuring recreational visitation at U.S. National Parks with crowd-sourced photographs. *Journal of Environmental Management*, *183*, 703–711. https://doi.org/10.1016/j.jenvman.2016.09.018

Sheppard, S. R. J. (2005). Landscape visualisation and climate change: The potential for influencing perceptions and behaviour. *Environmental Science and Policy*, *8*(6), 637–654. https://doi.org/10.1016/j.envsci.2005.08.002

Sheppard, S. R. J., Shaw, A., Flanders, D., Burch, S., Wiek, A., Carmichael, J., Robinson, J., & Cohen, S. (2011). Future visioning of local climate change: A framework for community engagement and planning with scenarios and visualisation. *Futures*, *43*. https://doi.org/10.1016/j.futures.2011.01.009

Shogren, J. F. (2012). WAEA keynote address behavioral environmental economics: Money pumps & nudges. *Journal of Agricultural and Resource Economics*, *37*(3), 349–360. https://doi.org/10.2307/23496721

Shreedhar, G., & Mourato, S. (2018). *Seeing red, but acting green? Experimental evidence on charitable giving and affect towards biodiversity* (Vol. 301, Issue 301).

http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2018/08/working-paper-301-Shreedhar-and-Mourato-1.pdf

Silvi, M., & Padilla, E. (2021). Pro-environmental behavior: Social norms, intrinsic motivation and external conditions. *Environmental Policy and Governance*. https://doi.org/10.1002/eet.1960

Simmonds, C., McGivney, A., Reilly, P., Maffly, B., Wilkinson, T., Canon, G., Wright, M., & Whaley, M. (2018a). *Crisis in our national parks: how tourists are loving nature to death*. The Guardian. https://www.theguardian.com/environment/2018/nov/20/national-parks-america-overcrowding-crisis-tourism-visitation-solutions

Simmonds, C., McGivney, A., Reilly, P., Maffly, B., Wilkinson, T., Canon, G., Wright, M., & Whaley, M. (2018b). *Crisis in our national parks: how tourists are loving nature to death | Environment | The Guardian*. The Guardian. https://www.theguardian.com/environment/2018/nov/20/national-parks-america-overcrowding-crisis-tourism-visitation-solutions

Sinclair, M., Mayer, M., Woltering, M., & Ghermandi, A. (2020). Using social media to estimate visitor provenance and patterns of recreation in Germany's national parks. *Journal of Environmental Management*, *263*(February), 110418. https://doi.org/10.1016/j.jenvman.2020.110418

Sintov, N., Geislar, S., & White, L. V. (2017). Cognitive Accessibility as a New Factor in Proenvironmental Spillover: Results From a Field Study of Household Food Waste Management. *Environment and Behavior*, 001391651773563. https://doi.org/10.1177/0013916517735638

Sivek, D. J., & Hungerford, H. (1990). Predictors of responsible behavior in members of three wisconsin conservation organizations. *Journal of Environmental Education*, *21*(2), 35–40. https://doi.org/10.1080/00958964.1990.9941929

Slater, M., Steed, A., McCarthy, J., & Maringelli, F. (2013). The Influence of Body movement on Subjective Presence in Virtual Environments. *Journal of Chemical Information and Modeling*, *53*(9), 1689–1699. https://doi.org/10.1017/CBO9781107415324.004

Slater, Mel, Usoh, M., Steed, A., & El, L. (1994). Depth of Presence in Virtual Environments. *Presence*, *3*(2), 130–144.

Smit, E. S., Hendrika, M., Meijers, C., & Nynke Van Der Laan, L. (2021). Using Virtual Reality to Stimulate Healthy and Environmentally Friendly Food Consumption among Children: An Interview Study. *Public Health*, *18*, 1088. https://doi.org/10.3390/ijerph18031088

Smith, M. K. S., Smit, I. P. J., Swemmer, L. K., Mokhatla, M. M., Freitag, S., Roux, D. J., & Dziba, L. (2021). Sustainability of protected areas: Vulnerabilities and opportunities as revealed by COVID-19 in a national park management agency. *Biological Conservation*, *255*(September 2020), 108985. https://doi.org/10.1016/j.biocon.2021.108985

Smith, T. A., & Dunkley, R. (2018). Technology-nonhuman-child assemblages: reconceptualising rural childhood roaming. *Children's Geographies*, *16*(3), 304–318. https://doi.org/10.1080/14733285.2017.1407406

Smith, T. A., Laurier, E., Reeves, S., & Ann, R. (2020). *" Off the beaten map " : Navigating with digital maps on moorland*. *August 2019*, 223–240. https://doi.org/10.1111/tran.12336

Snively, C. A. (2004). Building community-based alliances between GLBTQQA youth and adults in rural settings. *Journal of Gay & Lesbian Social Services*. https://doi.org/10.1300/J041v16n03_07

Snowdonia Society. (2018a). *Our mission*. https://www.snowdonia-society.org.uk/mission/

Snowdonia Society. (2018b). *Snowdon Tidy*. https://www.snowdonia-society.org.uk/project/snowdon-tidy/

Sommer, R., & Sommer, B. (2002). *A Practical guide to Behavioral Research: Tools and Techniques* (5th ed.). Oxford University Press.

Sörqvist, P., & Langeborg, L. (2019). *Why People Harm the Environment Although They Try to Treat It Well: An Evolutionary-Cognitive Perspective on Climate Compensation*. https://doi.org/10.3389/fpsyg.2019.00348

South Downs National Park Authority. (2016). *George & Dean, Britain's Friendliest Walkers*. https://www.youtube.com/watch?v=RdWlrqpXZhw

Souza, C. N., Rodrigues, A. C., Correia, R. A., Normande, I. C., Costa, H. C. M., Guedes-Santos, J., Malhado, A. C. M., Carvalho, A. R., & Ladle, R. J. (2021). No visit, no interest: How COVID-19 has affected public interest in world's national parks. *Biological Conservation*, *256*(September

2020), 109015. https://doi.org/10.1016/j.biocon.2021.109015

Spangenberger, P., Geiger, S. M., & Freytag, S.-C. (2022). Becoming nature: effects of embodying a tree in immersive virtual reality on nature relatedness. In *Nature* (Vol. 12). https://doi.org/10.1038/s41598-022-05184-0

Staats, H. J., Wit, A. P., & Midden, C. Y. H. (1996). Communicating the Greenhouse Effect to the Public: Evaluation of a Mass Media Campaign from a Social Dilemma Perspective. *Journal of Environmental Management*, *46*(2), 189–203.

Stamation, K. A., Croft, D. B., Shaughnessy, P. D., Waples, K. A., & Briggs, S. V. (2008). Educational and Conservation Value of Whale Watching. *Tourism in Marine Environments*, *4*(1), 41–55. https://doi.org/10.3727/154427307784835660

Statistics for Wales. (2017). *Population Projections for National Parks in Wales, 2014-based*. *October*, 28. https://gov.wales/sites/default/files/statistics-and-research/2018-12/170726-population-projections-national-parks-2014-based-en.pdf

Steadman, L., Rutter, D. R., & Field, S. (2002). Individually elicited versus modal normative beliefs in predicting attendance at breast screening: Examining the role of belief salience in the Theory of Planned Behaviour. *British Journal of Health Psychology*, *7*(3), 317–330. https://doi.org/10.1348/135910702760213706

Steg, L., Van De Berg, A. E., & de Groot, J. I. M. (2013). *Environmental Psychology an Introduction* (1st ed.). Blackwell Publishing Ltd.

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology*, *29*(3), 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004

Steinhorst, J., Klöckner, C. A., & Matthies, E. (2015). Saving electricity - For the money or the environment? Risks of limiting pro-environmental spillover when using monetary framing. *Journal of Environmental Psychology*, *43*, 125–135. https://doi.org/10.1016/j.jenvp.2015.05.012

Steinhorst, J., & Matthies, E. (2016). Monetary or environmental appeals for saving electricity? - Potentials for spillover on low carbon policy acceptability. *Energy Policy*, *93*, 335–344.

https://doi.org/10.1016/j.enpol.2016.03.020

Sterl, P., Brandenburg, C., & Arnberger, A. (2008). Visitors' awareness and assessment of recreational disturbance of wildlife in the Donau-Auen National Park. *Journal for Nature Conservation*, *16*(3), 135–145. https://doi.org/10.1016/j.jnc.2008.06.001

Stern, P. C. (2000a). New Environmental Theories: Toward a Coherent Theory of Environmentally Significant Behavior. *Journal of Social Issues*, *56*(3), 407–424. https://doi.org/10.1111/0022-4537.00175

Stern, P. C. (2000b). Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues*, *56*(3), 407–424. https://doi.org/10.1111/0022-4537.00175

Steure, J. (1993). Defining virtual reality: Dimensions determining telepresence. *Journal of Communication*, *42*(4), 73–93.

Stevens, T. (2002). *Case studies - sustainable tourism in national parks and protected areas: an overview*. 49.

Stirratt, M. J., Dunbar-Jacob, J., Crane, H. M., Simoni, J. M., Czajkowski, S., Hilliard, M. E., Aikens, J. E., Hunter, C. M., Velligan, D. I., Huntley, K., Ogedegbe, G., Rand, C. S., Schron, E., & Nilsen, W. J. (2015). Self-report measures of medication adherence behavior: recommendations on optimal use. *Translational Behavioral Medicine*, *5*(4), 470–482. https://doi.org/10.1007/s13142-015-0315-2

Stoeva, K., & Alriksson, S. (2017). Influence of recycling programmes on waste separation behaviour. *Waste Management*, *68*, 732–741. https://doi.org/10.1016/j.wasman.2017.06.005

Sussman, R., & Gifford, R. (2012). Please turn off the lights: The effectiveness of visual prompts. *Applied Ergonomics*, *43*(3), 596–603. https://doi.org/10.1016/j.apergo.2011.09.008

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics* (6th ed.). Pearson Education.

Takac, M., Collett, J., Conduit, R., & De Foe, A. (2021). Addressing virtual reality misclassification: A hardware-based qualification matrix for virtual reality technology. *Clincal Psychology & PSychotherapy*, *28*(3), 538–556.

Tanja-Dijkstra, K., Pahl, S., White, M. P., Auvray, M., Stone, R. J., Andrade, J., May, J., Mills, I., & Moles, D. R. (2018). The Soothing Sea: A Virtual Coastal Walk Can Reduce Experienced and

Recollected Pain. *Environment and Behavior*, *50*(6), 599–625. https://doi.org/10.1177/0013916517710077

Tashakkori, A., & Teddlie, C. (2003). Issues and dilemmas in teaching research methods courses in social and behavioural sciences: US perspective. *International Journal of Social Research Methodology: Theory and Practice*, *6*(1), 61–77. https://doi.org/10.1080/13645570305055

Taufik, D., Kunz, M. C., & Onwezen, M. C. (2021). Changing consumer behaviour in virtual reality: A systematic literature review. *Computers in Human Behavior Reports*, *3*(May), 100093. https://doi.org/10.1016/j.chbr.2021.100093

Teeroovengadum, V. (2019). Environmental identity and ecotourism behaviours: examination of the direct and indirect effects. *Tourism Review*, *74*(2), 257–269. https://doi.org/10.1108/TR-11-2017-0190

Tenkanen, H., Di Minin, E., Heikinheimo, V., Hausmann, A., Herbst, M., Kajala, L., & Toivonen, T. (2017). Instagram, Flickr, or Twitter: Assessing the usability of social media data for visitor monitoring in protected areas. *Scientific Reports*, *7*(1), 1–11. https://doi.org/10.1038/s41598-017-18007-4

The 2 Minute Foundation. (2021). *#2minutebeachclean | Home*. https://beachclean.net/boards

Thøgersen, J. (1999). Spillover processes in the development of a sustainable consumption pattern. *Journal of Economic Psychology*, *20*(1), 53–81. https://doi.org/10.1016/S0167-4870(98)00043-9

Thøgersen, J. (2004). A cognitive dissonance interpretation of consistencies and inconsistencies in environmentally responsible behavior. *Journal of Environmental Psychology*, *24*(1), 93–103. https://doi.org/10.1016/S0272-4944(03)00039-2

Thøgersen, J. (2012). *Pro-Environmental Spillover Review of Research on the Different Pathways Through Which Performing One Pro-Environmental Behaviour Can Influence the Likelihood of Performing Another*. *September 2012*. http://www.behaviourworksaustralia.org/V2/wp-content/uploads/2015/10/Review-of-spillover-researchJohn-Thøgersen.pdf

Thøgersen, J., & Crompton, T. (2009). Simple and painless? The limitations of spillover in environmental campaigning. *Journal of Consumer Policy*, *32*(2), 141–163.

https://doi.org/10.1007/s10603-009-9101-1

Thøgersen, J., Haugaard, P., & Olesen, A. (2010). Consumer responses to ecolabels. *European Journal of Marketing*, *44*(11), 1787–1810. https://doi.org/10.1108/03090561011079882

Thøgersen, J., & Noblet, C. (2012a). Does green consumerism increase the acceptance of wind power? *Energy Policy*, *51*, 854–862. https://doi.org/10.1016/j.enpol.2012.09.044

Thøgersen, J., & Noblet, C. (2012b). Does green consumerism increase the acceptance of wind power? *Energy Policy*, *51*, 854–862. https://doi.org/10.1016/j.enpol.2012.09.044

Thomas, C., & Sharp, V. (2013). Understanding the normalisation of recycling behaviour and its implications for other pro-environmental behaviours: A review of social norms and recycling. *Resources, Conservation and Recycling*, *79*, 11–20. https://doi.org/10.1016/j.resconrec.2013.04.010

Tilt. (2017). *Take the Lead campaign 2017 – South Downs National Park - We Are Tilt*. https://wearetilt.com/take-lead-campaign-2017-south-downs-national-park/

Tonge, J., Ryan, M. M., Moore, S. A., & Beckley, L. E. (2015). The Effect of Place Attachment on Pro-environment Behavioral Intentions of Visitors to Coastal Natural Area Tourist Destinations. *Journal of Travel Research*, *54*(6), 730–743. https://doi.org/10.1177/0047287514533010

Tratalos, J. A., Jones, A. P., Showler, D. A., Gill, J. A., Bateman, I. J., Sugden, R., Watkinson, A. R., & Sutherland, W. J. (2021). Regional models of the influence of human disturbance and habitat quality on the distribution of breeding territories of common ringed plover Charadrius hiaticula and Eurasian oystercatcher Haematopus ostralegus. *Global Ecology and Conservation*, *28*, e01640. https://doi.org/10.1016/j.gecco.2021.e01640

Trelohan, M. (2020). Do Women Engage in Pro-environmental Behaviours in the Public Sphere Due to Social Expectations? The Effects of Social Norm-Based Persuasive Messages. *International Society for Third-Sector Research*. https://doi.org/10.1007/s11266-020-00303-9

Truelove, H. B., Carrico, A. R., Weber, E. U., Raimi, K. T., & Vandenbergh, M. P. (2014). Positive and negative spillover of pro-environmental behavior: An integrative review and theoretical framework. *Global Environmental Change*, *29*, 127–138. https://doi.org/10.1016/j.gloenvcha.2014.09.004

Truelove, H. B., Yeung, K. L., Carrico, A. R., Gillis, A. J., & Raimi, K. T. (2016). From plastic bottle recycling to policy support: An experimental test of pro-environmental spillover. *Journal of Environmental Psychology*, *46*, 55–66. https://doi.org/10.1016/j.jenvp.2016.03.004

Tudor, T., Barr, S., & Gilg, A. (2007). A tale of two locational settings: Is there a link between pro-environmental behaviour at work and at home? *Local Environment*, *12*(4), 409–421. https://doi.org/10.1080/13549830701412513

Tumanan, M. A. R., & Lansangan, J. R. G. (2012). More than just a cuppa coffee: A multi-dimensional approach towards analyzing the factors that define place attachment. *International Journal of Hospitality Management*, *31*(2), 529–534. https://doi.org/10.1016/j.ijhm.2011.07.012

U.K. Government. (2019). *UK becomes first major economy to pass net zero emissions law - GOV.UK*. https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law

Udall, A. M., de Groot, J. I. M., De Jong, S. B., & Shankar, A. (2021). How I See Me—A Meta-Analysis Investigating the Association Between Identities and Pro-environmental Behaviour. *Frontiers in Psychology*, *12*(March). https://doi.org/10.3389/fpsyg.2021.582421

UN Development Programme. (2016). *UNDP Policy and Programme Brief: UNDP Support to the Implementation of the 2030 Agenda for Sustainable Development*. http://www.undp.org/content/dam/undp/library/SDGs/SDG Implementation and UNDP_Policy_and_Programme_Brief.pdf

UNEP-WTO. (2005). Making tourism more sustainable. A guide for policy makers. *Environment*, *54*(2), 222. https://doi.org/92-807-2507-6

United Nations. (2020). *Emissions Gap Emissions Gap Report 2020*. https://www.unenvironment.org/interactive/emissions-gap-report/2019/

United Nations. (2021). *Climate Action | United Nations*. https://www.un.org/en/climatechange

United Nations Environment Programme - GRID-Arendal and Behavioural Insights Team. (2020). *The Little Book of Green Nudges* (Issue September). https://www.grida.no/publications/510

United Nations Framework Convention on Climate Change. (2018). *The Paris Agreement | UNFCCC*. United Nations Framework Convention on Climate Change. https://unfccc.int/process-and-

meetings/the-paris-agreement/the-paris-agreement

Unnava, R. H., & Burnkrant, H. (2015). Social psychology and economics in environmental research. *Journal of Environmental Psychology*, *30*(3), 1. https://doi.org/10.1080/03637750500111815

Väisänen, T., Heikinheimo, V., Hiippala, T., & Toivonen, T. (2021). Exploring human–nature interactions in national parks with social media photographs and computer vision. *Conservation Biology*, *35*(2), 424–436. https://doi.org/10.1111/cobi.13704

Van der Werff, E., Steg, L., & Keizer, K. (2013). It is a moral issue: The relationship between environmental self-identity, obligation-based intrinsic motivation and pro-environmental behaviour. *Global Environmental Change*, *23*(5), 1258–1265. https://doi.org/10.1016/j.gloenvcha.2013.07.018

Van der Werff, E., Steg, L., & Keizer, K. (2014a). Follow the signal: When past pro-environmental actions signal who you are. *Journal of Environmental Psychology*, *40*, 273–282. https://doi.org/10.1016/j.jenvp.2014.07.004

Van der Werff, E., Steg, L., & Keizer, K. (2014b). I Am What I Am, by Looking Past the Present: The Influence of Biospheric Values and Past Behavior on Environmental Self-Identity. In *Environment and Behavior* (Vol. 46, Issue 5). https://doi.org/10.1177/0013916512475209

Van Houwelingen-Snippe, J., Somaya, ·, Allouch, B., Thomas, ·, & Van Rompay, J. L. (2021). Virtual Reality Representations of Nature to Improve Well-Being amongst Older Adults: a Rapid Review. *Journal of Technology in Behavioural Science*. https://doi.org/10.1007/s41347-021-00195-6

Van Lange, P. A. M., & Huckelba, A. L. (2021). Psychological distance: How to make climate change less abstract and closer to the self. *Current Opinion in Psychology*, *42*, 49–53. https://doi.org/10.1016/j.copsyc.2021.03.011

Vankov Id, D., Schroeter, R., & Twisk, D. (2021). *Can't simply roll it out: Evaluating a real-world virtual reality intervention to reduce driving under the influence*. https://doi.org/10.1371/journal.pone.0250273

Vaske, J. J., & Kobrin, K. C. (2001). Place Attachment and Environmentally Responsible Behavior. *The Journal of Environmental Education*, *32*(4), 16–21.

https://doi.org/10.1080/00958960109598658

Verfuerth, C., Jones, C. R., Gregory-Smith, D., & Oates, C. (2019). Understanding Contextual Spillover: Using Identity Process Theory as a Lens for Analyzing Behavioral Responses to a Workplace Dietary Choice Intervention. *Frontiers in Psychology*, *10*. https://doi.org/10.3389/fpsyg.2019.00345

Virtual Nature. (2018). *Background — Virtual Nature*. https://virtual-nature.com/background

VR-Gorilla. (2022). *Licensing Our Content - VR Gorilla - Virtual Reality 360 License*. https://www.vr-gorilla.com/licensing/

Walden-Schreiner, C., Leung, Y. F., & Tateosian, L. (2018). Digital footprints: Incorporating crowdsourced geographic information for protected area management. *Applied Geography*, *90*(December 2017), 44–54. https://doi.org/10.1016/j.apgeog.2017.11.004

Walker, A. J., & Ryan, R. L. (2008). Place attachment and landscape preservation in rural New England: A Maine case study. *Landscape and Urban Planning*, *86*(2), 141–152. https://doi.org/10.1016/j.landurbplan.2008.02.001

Walking the Brecon Beacons. (2021). Facebook. https://www.facebook.com/groups/walkingthebreconbeacons

Wan, C., Shen, G. Q., & Choi, S. (2017). Experiential and instrumental attitudes: Interaction effect of attitude and subjective norm on recycling intention. *Journal of Environmental Psychology*, *50*, 69–79. https://doi.org/10.1016/j.jenvp.2017.02.006

Wang, S., & Xu, H. (2015). Influence of place-based senses of distinctiveness, continuity, self-esteem and self-efficacy on residents' attitudes toward tourism. *Tourism Management*, *47*, 241–250. https://doi.org/10.1016/j.tourman.2014.10.007

Waterfall Country Wales. (2021). *Homepage | Waterfall Country Wales*. https://waterfallcountry.wales/

Watson, J., Cumming, O., MacDougall, A., Czerniewska, A., & Dreibelbis, R. (2021). Effectiveness of behaviour change techniques used in hand hygiene interventions targeting older children – A systematic review. *Social Science and Medicine*, *281*(May), 114090. https://doi.org/10.1016/j.socscimed.2021.114090

Weigel, R. H., & Newman, L. S. (1976). Increasing attitude-behavior correspondence by broadening the scope of the behavioral measure. *Journal of Personality and Social Psychology*, *33*(6), 793–802. https://doi.org/10.1037/0022-3514.33.6.793

Wellington, B. (2014). *How we found the worst place to park in New York City -- using big data | TED Talk*. Ted. https://www.ted.com/talks/ben_wellington_how_we_found_the_worst_place_to_park_in_new_york_city_using_big_data?language=lv

Wheaton, M., Ardoin, N. M., Hunt, C., Schuh, J. S., Kresse, M., Menke, C., & Durham, W. (2016). Using web and mobile technology to motivate pro-environmental action after a nature-based tourism experience. *Journal of Sustainable Tourism*, *24*(4), 594–615. https://doi.org/10.1080/09669582.2015.1081600

Whitburn, J., Linklater, W., & Abrahamse, W. (2020). Meta-analysis of human connection to nature and proenvironmental behavior. *Conservation Biology*, *34*(1), 180–193. https://doi.org/10.1111/cobi.13381

White, M. P., Pahl, S., Ashbullby, K., Herbert, S., & Depledge, M. H. (2013). Feelings of restoration from recent nature visits. *Journal of Environmental Psychology*, *35*, 40–51. https://doi.org/https://doi.org/10.1016/j.jenvp.2013.04.002

White, R., & Van Der Boor, C. (2020). Impact of the COVID-19 pandemic and initial period of lockdown on the mental health and well-being of adults in the UK. *BJPsych Open*, *6*(5), 1–4. https://doi.org/10.1192/bjo.2020.79

Whitmarsh, L., Capstick, S., Nash, N., Poortinga, W., Corner, A., & Stone, A. (2017). *Low-Carbon Behavioural Spillover*. *January*, 1–18.

Whitmarsh, L., & O'Neill, S. (2010). Green identity, green living? The role of pro-environmental self-identity in determining consistency across diverse pro-environmental behaviours. *Journal of Environmental Psychology*, *30*(3), 305–314. https://doi.org/10.1016/j.jenvp.2010.01.003

Whitmarsh, L., Poortinga, W., & Capstick, S. (2021). Behaviour change to address climate change. *Current Opinion in Psychology*, *42*, 76–81. https://doi.org/10.1016/j.copsyc.2021.04.002

Whitmarsh, L, Capstick, S., & Nash, N. (2017). Who is reducing their material consumption and

why? A cross-cultural analysis of dematerialization behaviours. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *375*(2095). https://doi.org/10.1098/rsta.2016.0376

Whitmarsh, L, Haggar, P., & Thomas, M. (2018). Waste reduction behaviors at home, at work, and on holiday: What influences behavioral consistency across contexts? *Frontiers in Psychology*, *9*(DEC). https://doi.org/10.3389/fpsyg.2018.02447

Whitmarsh, Lorraine. (2009). Behavioural responses to climate change: Asymmetry of intentions and impacts. *Journal of Environmental Psychology*, *29*(1), 13–23. https://doi.org/10.1016/j.jenvp.2008.05.003

Whitmarsh, Lorraine, & O'Neill, S. (2010). Green identity, green living? The role of pro-environmental self-identity in determining consistency across diverse pro-environmental behaviours. *Journal of Environmental Psychology*, *30*(3), 305–314. https://doi.org/10.1016/j.jenvp.2010.01.003

Whittle, C., Whitmarsh, L., Hagger, P., Morgan, P., & Parkhurst, G. (2019). User decision-making in transitions to electrified, autonomous, shared or reduced mobility. *Transportation Research Part D: Transport and Environment*, *71*(January), 302–319. https://doi.org/10.1016/j.trd.2018.12.014

Wikipedia. (2019). *Brecon Beacons National Park*. Wikipedia. https://en.wikipedia.org/wiki/Brecon_Beacons_National_Park

Williamson, K., Satre-Meloy, A., Velasco, K., & Green, K. (2018). *Climate Change Needs Behavior Change: Making the Case For Behavioral Solutions to Reduce Global Warming*. rare.org/center

Willis, M. M., & Schor, J. B. (2012). Does Changing a Light Bulb Lead to Changing the World? Political Action and the Conscious Consumer. *Annals of the American Academy of Political and Social Science*, *644*(1), 160–190. https://doi.org/10.1177/0002716212454831

Wilson, J. Q., & Kelling, G. L. (1982). The police and neighborhood safety: Broken windows. *The Atlantic Monthly*, *March*(March), 29–38. https://doi.org/10.4135/9781412959193.n281

Winkel, G., Saegert, S., & Evans, G. W. (2009). *An ecological perspective on theory, methods, and analysis in environmental psychology: Advances and challenges*.

https://doi.org/10.1016/j.jenvp.2009.02.005

Wonneck, L. A., & Hobson, K. (2017). Practice-based spillover effects: Evidence from Calgary's municipal food and yard waste recycling pilot. *Canadian Geographer*, *61*(3), 415–427. https://doi.org/10.1111/cag.12391

Wyles, K. J., White, M. P., Hattam, C., Pahl, S., King, H., & Austen, M. (2017). Are Some Natural Environments More Psychologically Beneficial Than Others? The Importance of Type and Quality on Connectedness to Nature and Psychological Restoration. *Environment and Behavior*, 001391651773831. https://doi.org/10.1177/0013916517738312

Xu, F., Huang, L., & Whitmarsh, L. (2020). Home and away: cross-contextual consistency in tourists' pro-environmental behavior. *Journal of Sustainable Tourism*. https://doi.org/10.1080/09669582.2020.1741596

Yalowitz, S. S., & Bronnenkant, K. (2009). *Timing and Tracking : Unlocking Visitor Behavior Timing and Tracking : Unlocking Visitor Behavior*. *5578*. https://doi.org/10.1080/10645570902769134

Yeo, N. L., White, M. P., Alcock, I., Garside, R., Dean, S. G., Smalley, A. J., & Gatersleben, B. (2020). What is the best way of delivering virtual nature for improving mood? An experimental comparison of high definition TV, 360° video, and computer generated virtual reality. *Journal of Environmental Psychology*, *72*, 101500. https://doi.org/10.1016/j.jenvp.2020.101500

Young, W., Russell, S. V., Robinson, C. A., & Barkemeyer, R. (2017). Can social media be a tool for reducing consumers' food waste? A behaviour change experiment by a UK retailer. *Resources, Conservation and Recycling*, *117*, 195–203. https://doi.org/10.1016/j.resconrec.2016.10.016

Yu, C. P., Lee, H. Y., & Luo, X. Y. (2018). The effect of virtual reality forest and urban environments on physiological and psychological responses. *Urban Forestry and Urban Greening*, *35*(June), 106–114. https://doi.org/10.1016/j.ufug.2018.08.013

Zaalberg, R., & Midden, C. J. H. (2013). Living behind dikes: Mimicking flooding experiences. *Risk Analysis*, *33*(5), 866–876. https://doi.org/10.1111/j.1539-6924.2012.01868.x

Zimmermann, S., Hein, A., Schulz, T., Gewald, H., & Krcmar, H. (2021). Digital Nudging Toward Pro-Environmental Behavior: A Literature Review. *PACIS 2021 Proceedings*, 226.