Environment Agency

Evidence

The social benefits of Blue Space: a systematic review

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T: 03708 506506

Email: enquiries@environment-agency.gov.uk

Author(s):
Sam Brown

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Environment Agency's Project Manager:
Anna Lorentzon

Environment Agency's Project Executive:
Peter Bailey

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Professor Doug Wilson
Director, Research, Analysis and Evaluation

Executive summary

This report presents the findings of a systematic review of the social benefits of Blue Space carried out by the Environment Agency's Social Science team between April and September 2018. The work sought to build on evidence already produced across government as part of the Blue Space and Green Space research agendas to inform policy and practice. The purpose of the review was to establish what the evidence of the social benefits of Blue Space is, and in particular to answer the research question:

> What are the published data of positive social effects arising from exposure to Blue Space and how does that differ from comparable published data of positive social affects arising from exposure to Green Space?

Method

A systematic approach to the review process was adopted in order to provide evidence that could reliably and usefully inform a range of work streams across the Environment Agency, and potentially other government agencies and departments. It involved:

1. Defining the terms of the review and the evidence eligibility criteria
2. Selecting appropriate evidence databases, querying those databases with the chosen search terms, and supplementing the process by manual searching for recent reviews of the topic to ensure the capture of all eligible studies published since 2004
3. Reviewing the title and abstract of each identified record and then conducting a full text review of each one to identify what to include in the data extraction stage
4. Extracting relevant data and information from each study and entering this into a standardised table to make the review of the selected records easier and to ensure a common basis for assessment
5. Summarising the findings of the range of benefits from Blue Space, the strength of the evidence of those effects, and how the evidence compared to similar evidence of the effects of Green Space

This process returned 77 records. These were scrutinised for quantitative and qualitative evidence on 10 types of benefits: recreation; physical health; mental health; inequality of access; social interaction; place attachment; environmental cooling; educational; tourism, amenity and beauty; and quality of life.

Key findings: benefits of Blue Space

Rivers, lakes and coastal waters were found to provide a range of social and health benefits.

- Half the population interacts with Blue Space at least once a month.
- Visits to Blue Space reflect the seasons.
- People undertake a range of activities at Blue Spaces, with walking being the most popular.
- Blue Space is used for exercise, but most visits are not classified as 'physically active'.
- Living near the coast is associated with more frequent use and more physical activity.

- Living near the coast is associated with lower levels of being overweight and some evidence of higher levels of self-reported mental health.
- People who use Blue Space say they gain psychological benefits from the experience and people report feeling happier when they are in proximity of Blue Space.
- People from ethnic minority groups are less likely to access Blue Space than other people.
- Older people are more likely to visit Blue Space and younger adults less likely.
- There is some evidence of Blue Space increasing the opportunity for beneficial social interaction.
- Blue Spaces can have a beneficial cooling effect on their local environment in the summer.
- Blue Spaces can be important for people's attachment to place and can define a city or region.

Key findings: comparison of the benefits of Blue and Green Space

The comparison of the social benefits of rivers, lakes and coastal to the benefits of the environment in general produced the following findings.

- Most visits to the environment are to Green Space and only 20% are to Blue Space.
- Visits to Green Space are less influenced by the seasons than visits to Blue Space.
- People are prepared to travel further with children to visit the coast than other natural environments.
- People are more likely to take part in intense physical activity at Green Spaces than at Blue Spaces.
- Various items of evidence suggest that Blue Space is associated with appreciating surroundings, longer visits, improvement of mood, and feelings of restoration to a greater degree than Green Space.
- Coastal environments are associated with the opportunity for restorative experiences and reducing the amount of 'noise' in people's minds.
- Evidence is inconclusive for both Green and Blue Spaces on the association of these spaces with stress, anxiety and depression.
- People from ethnic minority groups are more likely to access Green Spaces than Blue Spaces.
- Women are more likely to visit beaches than men.
- Men are more likely to visit woodlands, moors, hills and mountains than women.
- Environmental cooling depends considerably on the types of both Green and Blue Space.

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1 Introduction

The government's '25 Year Environment Plan' in 2018 recognises that Green and Blue Spaces in our built environment are essential to health and happiness (HM Government 2018). It makes a commitment to:

- helping people improve their health and well-being by using Green Spaces
- promote health and well-being through the natural environment

This report presents the findings of a systematic review of the social benefits of Blue Space which was commissioned and carried out by the Environment Agency's Social Science team. The aim was to build on evidence already produced across government as part of both the 'Blue Space' and 'Green Space' research agendas to inform policy and practice. The work was carried out between April and September of 2018.

1.1 Background

The Blue Space research agenda emerged only relatively recently from the longstanding and established literature on Green Space. The latter developed over a period of approximately 2 decades and now comprises a substantial body of work. This work considers the impacts of vegetated areas on the human populations exposed to them and the future role such spaces might have in a sustainably developing society and economy (Foley and Kistemann 2015).

Much of the work date has focused on revealing the physical and mental health benefits that can emerge from the use of spaces like urban parks or areas of woodland. There is now a considerable body of evidence that these environments are associated with a range of positive health outcomes such as reduced cardiovascular morbidity and mortality, reductions in obesity and the risk of type 2 diabetes, and improved pregnancy outcomes (WHO 2016).

However, there is as yet mixed evidence that interventions attempting to utilise Green Space as a means of addressing specific problems are effective in doing so. Although there is some compelling evidence to suggest that a number of these interventions do hold promise, the evidence underpinning some Green Space interventions is considered to be inconclusive (WHO 2017).

Research into the potential effects of the water environment has formed a part of the Green Space agenda with water bodies such as ponds, rivers and lakes included in its definition. Over the past few years, however, researchers have begun to consider these effects separately and to investigate their impacts on human populations as being distinct from that of Green Space. Accordingly the concept of Blue Space has begun to emerge and a new research agenda has begun to form around it. This line of enquiry is in its early stages, but to date has followed a very similar path to that taken by Green Space researchers. That is, investigating the impacts of Blue Space on human populations, and in doing so creating a new and separate body of evidence that complements existing evidence and the debates that have emerged from it (Foley and Kistemann 2015).

Although the implications of this work for government agencies and departments are recognised, relatively few projects had been commissioned that collated the work or synthesised potential connections with policy objectives. The agenda is of particular interest to the Environment Agency, which has strategic oversight over the management of many of England's water bodies. There is therefore a need to draw together an understanding of the range of evidence that has been produced and the

balance of the effects that have so far been demonstrated.

1.2 The research question

The purpose of this review was to establish what the evidence of the social benefits of Blue Space is, and in particular to consider:

- the range of effects that have been explored
- the balance of the evidence of those effects in each case
- how that compares to similar evidence of the effects of Green Space

This can be translated into the following research question:

> What are the available published data of positive social effects arising from exposure to Blue Space and how does that differ from comparable available published data of positive social affects arising from exposure to Green Space?

That question can be broken down into 2 distinct objectives:

1. To set out the available published evidence of the positive social effects of Blue Space
2. To compare this against comparable available evidence of the positive social effects of Green Space

1.3 Defining key terms

To answer the research question effectively, it is necessary to define the following key terms.

1.3.1 Blue Space

For the purpose of this review, Blue Space is defined using a modified version of the definition set out by the BlueHealth research project (funded by the EU's Horizon 2020 programme):

> 'Outdoor environments – either natural or manmade – that prominently feature water and are accessible to humans either proximally (being in, on, or near water) or distally (being able to see, hear or otherwise sense water)' (Grellier et al. 2017).

Because this work is primarily intended to inform environmental management policy and practice, evidence around the effects of virtual representations of Blue Space are excluded.

Note that, for the purposes of this review, a distinction is drawn between Blue Space as an environment and water as a substance. Clearly water forms the basis of all life on Earth and, through its role in sustaining biological organisms and their associated ecosystems, provides a significant social benefit. Equally the physical properties of water enable a wide range of industrial processes that are beneficial to various populations both within England and across the globe. All such examples are considered to be beyond the scope of this review and, by extension, all bodies of evidence relating to the use of water as a substance are excluded.

1.3.2 Green Space

In contrast to Blue Space, defining the concept of Green Space is relatively complex. This is partly because of the wide range of disciplinary contexts in which it has so far been operationalised and the tendency for authors not to define the term as they use it (Taylor and Hochuli 2017). From those definitions that have been given, however, it is possible to draw out 2 overarching themes (Taylor and Hochuli 2017):

- those that define Green Space as relating to naturally vegetated spaces
- those that consider it as vegetated spaces within an urban context

To ensure consistency with the definition of Blue Space both Green Space as natural vegetated areas and Green Space as vegetation with the urban context are included in this review. Studies that consider the effects of virtual representations of Green Spaces are excluded.

1.3.3 Positive social effects

This review takes no position on what is or is not admissible as a positive effect. Recognising what counts as positive is likely to depend on the disciplinary context of a piece of work and relies on the judgement of its authors. In that sense all studies that show the positive effects of Blue Space on a human population are included. To appropriately contextualise these data, all studies that show negative effects for the same outcome are also then included.

The term ‘social’ is interpreted to mean that an effect must be felt by or have implications for more than a single individual. Consequently, studies that report only the individual effects of Blue Space are excluded. Where data on purely individual effects are used as part of an analysis that demonstrates other wider social benefits (for example, positive effects on mental health or an increased likelihood of visiting), then those studies are included.

1.3.4 Comparable data

Comparable data are taken to be data that form a separate outcome of the same study. Because of the range of different study designs and methodological approaches used to research Blue Space and the variety of social and cultural contexts in which that research has taken place, it is considered unlikely that data taken from 2 different studies would be similar enough to form the basis of a reliable comparison.

2 Methodology

To provide an answer to the research question that could reliably and usefully inform a range of work streams across the Environment Agency, and potentially other government agencies and departments, a systematic approach was taken to the review process based as far as possible on that set out in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins and Green 2011). A review search protocol was produced but was not published externally prior to the review process.

2.1 Constructing the eligibility criteria

The first stage was to define the terms of the review, determining the eligibility criteria. This was done through liaison with the research team at the start of the review project and took account of the way key concepts were defined. They form the inclusion criteria through which studies were included or excluded at the review stage. This process is described below.

2.1.1 Population

Studies featuring all human populations were eligible for inclusion in the review.

2.1.2 Intervention(s)

To be eligible for inclusion in the review, studies needed to include one of the following interventions:

- sensory exposure to Blue Space
- visiting Blue Space – used as a proxy for sensory exposure
- proximity to Blue Space – used as a proxy for visitation
- participation in practices that necessitate exposure to Blue Space (for example, sailing)

Simulated or virtual exposure to representations of Blue Space (for example, through the use of photographs) was excluded.

2.1.3 Comparator(s)

Studies did not need to feature a comparator to be eligible for the review, but where studies featured one or more of the comparators listed below, the data were extracted for comparison:

- sensory exposure to Green Space
- visiting Green Space– used as a proxy for sensory exposure
- proximity to Green Space– used as a proxy for visitation
- participation in practices that necessitate exposure to Green Space (for example, fell running)

Comparators featuring simulated or virtual exposure to Green Space (for example, through the use of photographs) were excluded.

2.1.4 Outcome(s)

Studies that featured any positive social effect as an outcome were eligible for inclusion in the review.

2.1.5 Study design

Studies with the following research designs were excluded:

- those using economic concepts theories or methods
- those using an ecosystem service framing
- those not in the English language

Studies that employed economic concepts, theories or methods were excluded because economic outcomes were not of interest in the review.

Studies that positioned themselves according to an ecosystem service framework were excluded because they imposed a schema that evaluated and categorised the benefits of environmental phenomena that was not of interest in the review.

Studies that featured both qualitative and quantitative methodologies were included to ensure that:

- as a wide range of evidence as possible was captured by the review
- the review was capable of incorporating evidence produced in a wide range of disciplinary contexts

2.1.6 Inclusion dates

The review excluded studies that were published before 1 January 2004 and included studies up to the date of the searches in April, 2018.

2.2 Retrieving the records

Having determined the eligibility criteria, the records could be retrieved for review. This involved a process of:

- selecting a number of appropriate databases
- querying those databases with a set of relevant search terms
- supplementing the process by manual searching of recent reviews of the topic to make sure all of the eligible studies had been captured

2.2.1 Databases selected

The databases used in the review were selected to ensure that all the relevant disciplinary journals were included in the search process. In this case the searches needed to interrogate the social sciences literature, the health sciences literature and the physical sciences literature more broadly to make sure all the studies investigating Blue Space could be captured.

Access to the databases was through the Environment Agency's subscription to the Athens portal, which provides a range of information resources for staff to use. Four of these were academic databases, from which the following were selected for use:

- Science Direct
- PubMed

Google's advanced search facility was used to search the grey literature.

2.2.2 Conducting the searches

Appropriate searches were conducted in each database in April 2018; these are reproduced in Appendix A. The results of each search were then exported into EndNote X8.2, where duplicates were removed using the included algorithm. The grey literature searches conducted were limited to the UK to ensure the number of records retrieved was manageable within the available resources.

A particular challenge around the development of the search terms used to investigate Blue Space was provided by the ubiquity of the terms 'water', 'river', 'pond' and the names of other water bodies that are commonly used across a wide range of literatures. Using them was found to return exceptionally high numbers of records, even in the context of a wider search string, potentially making the review process unwieldy and unachievable.

2.2.3 Manual searching

Once the electronic searches had been completed and their contents assessed through title and abstract review (see Section 2.3.1), a separate search of the literature by hand was conducted to identify any eligible records that had not been returned. This involved checking similar reviews identified through the title/abstract review process for studies that met the inclusion criteria. Where studies were identified they were selected for full text review.

2.2.4 Obtaining the full text

The full text of each record included at the title/abstract review stage was downloaded electronically from the publisher's website via the Athens portal provided through the Environment Agency's information services. Articles not included in the Athens subscription were requested through the British Library's On Demand service, again via the Environment Agency's information resources team.

2.3 Study selection

The process of applying the inclusion criteria to the studies returned and identifying the studies that were eligible to be taken forward for data extraction took place in 2 stages – a title and abstract review and a full text review of each study.

2.3.1 Title and abstract

The title and abstract review was conducted using the EndNote X8.2 software, which allows records to be organised into sub-folders quickly and effectively. Each record was examined against the inclusion criteria using the information contained its title and abstract and moved into a relevant sub-folder. Excluded studies were moved into one

of several folders depending on the reason for exclusion. Where there wasn't enough information included in the title/abstract to make a firm decision, the article was set aside for further review at the end of the process. If after a second reading a clear decision still could not be made the article was included.

2.3.2 Full text

Records included at the title and abstract review stage were taken forward for full text review. Once the full text of a study had been obtained (see Section 2.2.4), it was checked against the inclusion criteria but also to make sure it presented useable data. Studies that assessed the effects of Blue Space on a social variable but failed to report the data in a way that disaggregated them from that of the other variables being analysed were excluded. The details of the records excluded at full text review are listed in Appendix B along with the reason(s) for their exclusion.

2.4 Data extraction

Studies that were included at the full text review stage were eligible for data extraction. In this process, the information relevant to reviewing the study is entered into a standardised table to facilitate the review process and to ensure a common basis for assessment.

For the purposes of this review, studies were extracted by a single individual directly into the report tables given in Section 3. These differ in format only to accommodate the different forms of quantitative and qualitative data.

2.5 Data synthesis

Once the data had been extracted into the report tables, narrative summaries and analyses of the included studies were produced. These were structured within the report according to the beneficial social outcomes they assessed, so that the narrative remained focused on the research question (see Section 1.2).

2.6 Limitations of the review

The review had the following limitations,

- The time and resource available meant that the review did not conduct an assessment of the internal validity of the studies included. As a consequence the review is not able to make any reliable statements of the strength or weaknesses of the evidence presented, other than to highlight the different types of study design employed and their implications for external validity.
- The review conducted grey literature searches only within a UK context for reasons of time and resource.
- To ensure that the number of records returned remained manageable within the constraints of the resources available, several of the most common terms for denoting Blue Spaces– particularly the geographical names of water bodies such as 'river' and 'lake' – were excluded from the search strategy. It is therefore possible that studies that identified water bodies in those terms and which did not also employ the concept of 'Blue Space' were not retrieved.

The scope of the research question meant that potentially relevant studies were distributed across a variety of disciplines and within bodies of evidence produced over large spans of time. Consequently it is possible that, while every effort was made to ensure the completeness of the evidence bases reported, there are still some studies that were otherwise eligible but were not included in the review because they did not fall within the search dates, or they were published in specialist journals that were not captured by the databases queried.

3 Review findings

The review process returned 77 records (see Figure 3.1). This section presents the findings of the review under the following outcome categories:

- recreation
- physical health
- mental health
- inequality of access
- social interaction
- place attachment
- environmental cooling
- educational
- tourism, amenity and beauty
- quality of life

Where possible, both quantitative and qualitative evidence is presented.

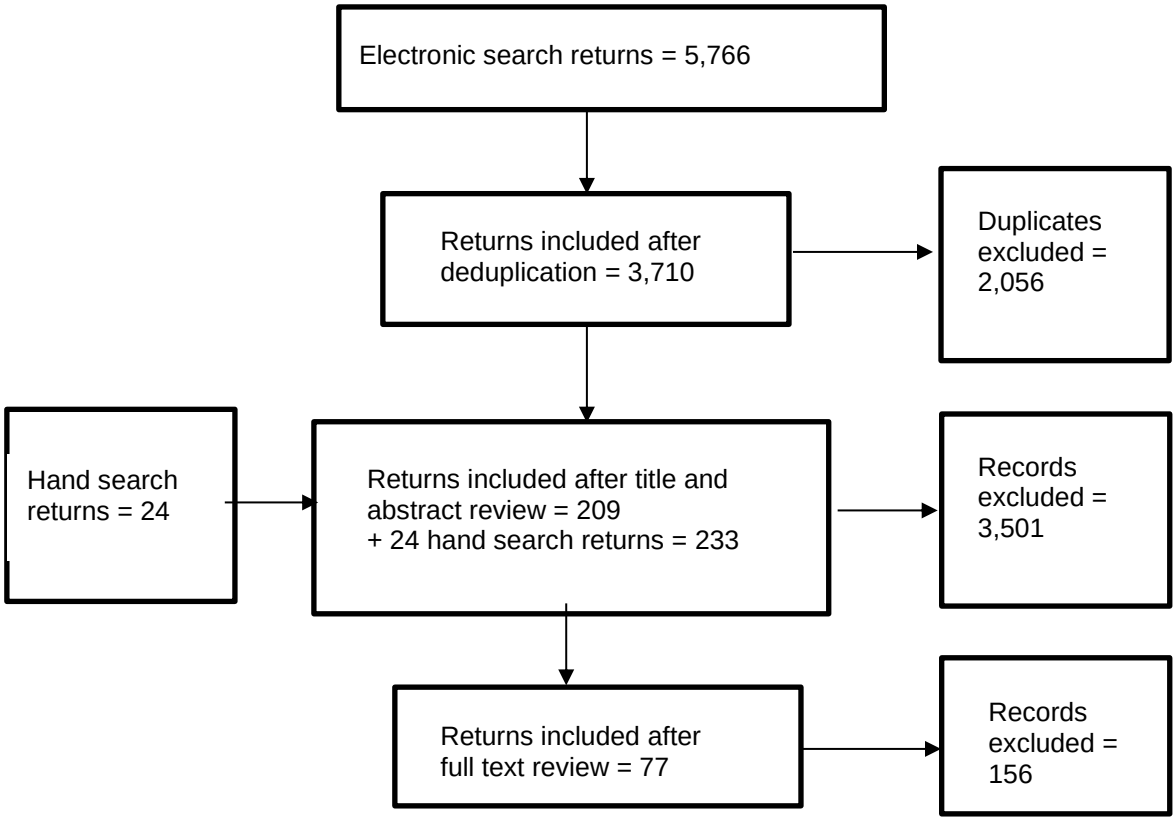


Figure 3.1 Results of the review process

3.1 Recreation

3.1.1 Quantitative evidence

Recreational benefits of Blue Space

Of the 77 records included in the review, 21 provided quantitative evidence of the recreational benefits of Blue Space (Table 3.1). Ten of these records were research studies retrieved from the academic literature and the remaining 11 were reports of evidence generated in other institutional contexts, available as grey literature.

Although the research designs they employed differed in their specific methods and the types of data they generated, 20 of the 21 studies had a cross-sectional structure, creating a relatively homogenous correlation on which to evidence base to draw. The remaining study used a different longitudinal study design based on global positioning system (GPS) tracking (Jansen et al. 2017).

Between them the studies investigated a wide range of different types of Blue Spaces including rivers, canals, lakes and different portions of the coast. In most cases, however, the categories of Blue Space examined differed between studies, as did the mix of Blue Spaces each study included. This made it difficult to reliably group the studies together in terms of the interventions they investigated.

The majority of investigations took place in the UK with 10 being conducted in England, 3 in Wales and a further one across the British Isles as a whole. The 7 remaining studies took place in northern Europe (1 in France, 2 in Finland and 1 in the Netherlands), the USA and Australia.

The majority also investigated the general adult population, with only 4 studies considering a more distinct demographic category. Gundersen et al. (2016) and Natural England (2016) focused only on children, while Ball et al. (2007) considered the use of Blue Space by females only and Jansen et al. (2017) selected an older population (45–65 years-old).

Blue Space as a visited resource

The evidence base generated by the studies supports the claim that, at national scale, Blue Spaces are resources that people visit. Data from the first 5 years of the Monitor of Engagement with the Natural Environment (MENE) survey indicate that:

- 18% of all visits to the natural environment in England in 2009 to 2010 included a visit to some form of Blue Space (Natural England 2010)
- this percentage remained relatively steady up until 2013 to 2014 (Natural England 2011, 2012, 2013, 2015a)[1]

Similarly, the Welsh Outdoor Recreation Survey (WORS) found that 23% of visits to the natural environment in Wales in 2008 were to a Blue Space (CCW/FCW 2009a, 2009b), a proportion that remained roughly consistent across the 2011 and 2014 surveys (CCW/FCW 2011, 2012; Natural Resources Wales 2014, 2015).[2]

[1] The annual MENE survey covered the period from March to the following February.
[2] The 3 rounds of WORS took place in 2008, 2011 and 2014. The 2008 and 2011 surveys were commissioned by the Countryside Council for Wales (CCW) and Forestry Commission Wales (FCW). The 2014 round was commissioned by Natural Resources Wales. WORS was then replaced by the National Survey for Wales.

The size of the surveyed populations and the repetition of the findings over time suggest that these findings from England and Wales are reliable within their national contexts. But there is also some evidence from 2 smaller scale American studies that similar patterns may exist in other national settings and at the sub-national level. Haeffner et al. (2017) demonstrated that 71% of residents living in neighbourhoods with a nearby river or canal in northern Utah had spent time there. Hamstead et al. (2018) used the tweets and Flickr entries of visitors to parks in New York to identify that the number of water bodies in a park was a positive predictor of geo-tagging within its boundary, although the effect size was small.

While there is evidence that Blue Spaces can attract visitors, there is also some evidence from relatively large-scale surveys that visitation patterns vary spatially, temporarily and socially across the UK's population. A study by White et al. (2014) provided evidence that the likelihood of visiting a Blue Space increases for those living near it. In a separate analysis of the MENE data, they found that the odds of people in England visiting the coast were 15 times greater for those whose residence was <1km away compared with those who lived >20km away.

The frequency with which different people visit Blue Spaces has also been shown to vary. De Bell et al. (2017) used data from the Office for National Statistics (ONS) Opinions and Lifestyles Survey to demonstrate that, across Britain:

- 50% of the population said they engaged with Blue Space at least once per month
- 35% said that they did so less frequently
- 15% said they never did

Visits to and activities within Blue Spaces may also have a seasonal pattern. A nationwide survey of parents with children aged between 6 and 12 in Norway demonstrated that there was a reduction in reported children's visits throughout the winter months, both to rivers and streams and the coast (Gundersen et al. 2016). Similarly in Finland, Vesterinen et al. (2010) correlated national recreation data with meteorological data to identify positive relationships between numbers of swimming and boating trips and days of hot weather. This seasonality in visits to Blue Spaces was also evident in England where, in an analysis of MENE data from 2009 to 2014, Natural England identified a strong seasonal pattern in the timing of visits to seaside towns and resorts, and a marginal signal for other seaside locations (Natural England 2010, 2011, 2012, 2014, 2015a).

There is comparably limited evidence regarding the way in which the characteristics of the Blue Spaces themselves can influence rates of visitation. A single study in the Netherlands explored the relationship between the size of Blue Spaces and how frequently they were visited. A GPS tracking method was used to identify which Blue Spaces survey participants living in the neighbourhoods of Rotterdam and Maastricht attended, categorising them according to the area of the Blue Space in hectares. No significant pattern was reported (Jansen et al. 2017).

Only Vesterinen et al. (2010) has reported statistically significant data relating the characteristics of a Blue Space environment to visitation. In an investigation of the effects of water quality on the numbers of trips made for selected recreational activities in Finland, a positive association was found between water quality and going fishing, but there was no correlation between water quality and going swimming or boating.

Blue Space as a recreational resource

As well as providing evidence that Blue Spaces are resources that people visit, the evidence retrieved also gives some insight into the different types of recreational activities people undertake when they get there.

At the national level, the 2009 to 2010 MENE survey examined the specific activities that respondents in England reported taking part in when they visited a seaside town or resort or another part of the coastline. The survey identified 12 different categories of activity varying from dog walking to water sports (see Table 3.1 for the full list) and investigated the percentage of respondents who reported taking part in each type of activity. When considered together, these data can begin to sketch out the outline of the different activity profiles taking place in each space.

In seaside resorts, a higher percentage of respondents reported playing with children, eating and drinking, going sightseeing or having a picnic, visiting an attraction, taking part in an informal game or sport, looking at scenery from the car, or visiting the beach. In other areas of coastline, a higher percentage of people reported taking their dog for a walk, watching wildlife, going fishing or horse riding, or taking part in some form of water sport (Natural England 2010). These patterns of activity remained relatively stable across surveys in subsequent years (from 2010 to 2011 to 2012 to 2013) during which 2 new activities were added: off-road or on-road cycling in 2010 to 2011 and running in 2011 to 2012 (Natural England 2011, 2012, 2013). Both these activities were undertaken by a higher percentage of respondents in areas of other coastline.

Despite these characteristic differences, both areas of coastline had in common the fact that the most often reported activity on each case was overwhelmingly walking, either with or without a dog, followed by use of the beach. In both cases, these activities accounted for 80–90% of all the activity undertaken. As with visitation rates, the sample size of the survey and the consistency of the data over different years suggest that the findings are likely to be robust and reliable within their national context.

There is also evidence that these broad patterns exist in other national settings. Using a public participatory geographical information system (PPGIS), Raymond et al. (2016) investigated the activities of residents of Helsinki in Finland in relation to the Blue Spaces found within the city. They identified that the most common activity was walking on the shore, followed by jogging and spending time with family or friends, and then spending time sitting or sunbathing on the beach. In an Australian context, Ball et al. (2007) looked at the effect of proximity to coastal environments on the amount of walking people do in Melbourne and found that residents living in coastal neighbourhoods were more likely to go walking, both as part of their leisure time but also as a functional way of completing a necessary journey. Only data from a Dutch study provides evidence of a different pattern of use. In another GPS-based study, Jansen et al. (2017) examined the levels of physical activity of residents in Maastricht and Rotterdam as they used Blue Spaces. Approximately 70% of the activity they recorded was categorised as ‘spatially concentrated physical activity’, which could have been sedentary behaviour or active behaviour that excluded any expansive spatial movements, and only 25% was categorised as being either walking or jogging. The remaining 5% was categorised as cycling.

The social content of activities undertaken in Blue Spaces and the way it varied across different types of waterside environment was examined in a Welsh context by the 2008 WORS (CCW/FCW 2009a, 2009b). The survey examined the different activities people undertook in Blue Spaces and grouped them together according to the levels and types of social interaction they afforded. The data generated revealed relatively little difference in the levels of social interaction taking place across different Blue Space settings. The 2011 and 2014 WORS examined the types of recreational activities

people were using Blue Spaces for and the way those activities differed across its various typologies (CCW/FCW 2011, 2012; Natural Resources Wales 2014, 2015). As with the MENE survey in England, the data revealed a wide range of different activities from picnicking to water sports (see Table 3.1 for a full list), and began to highlight characteristic differences in the way Blue Spaces in Wales are being used. Rivers, lakes and canals were more likely to be used by people going cycling, horse riding, wildlife watching, running or off-road driving, while beaches were the most likely to be used by people who went walking, picnicking, outdoor swimming, did non-motorised water sports, or used a children's playground. The sea was most popular for people going fishing or to doing motorised water sports, while other areas of coastline were the most used by people going rock climbing or sightseeing.

White et al. (2016) developed this picture by considering the length of time activities are undertaken for. Using the same MENE data, they made a separate analysis of the how long people engaged in each of the above recreational activities for. They found that, compared with people who reported being active for >30 minutes, people who reported being active for ≤30 minutes were more likely to be walking their dog, running or road cycling. In the case of all other activities, a higher percentage of total respondents were active for ≥30 minutes.

Comparative recreational benefits of Blue and Green Space

Of the 21 records that provided evidence of the recreational uses of Blue Spaces, 15 also provided comparable data on the way Green Spaces were used. Four of those records were academic studies drawn from the academic literature and the remaining 11 were survey reports taken from the grey literature. All but one of these studies demonstrated a cross-sectional research design with only the study by Jansen et al. (2017) employing a longitudinal methodology. The majority of the work was conducted in a British context with 6 of the studies having taken place in England and a further 3 in Wales. Of the remainder, one was from Finland, one was from the Netherlands and one was from the USA.

Comparative benefits of Green and Blue Space as a visited resource

The main body of the Green Space evidence that can be compared with the Blue Space recreation data has been generated at the national scale. The 2009 to 2010 MENE survey generated not only visitation data in relation to Blue Space, but also for a wide range of other natural and urban Green Space settings (Natural England 2010). These data indicate that, like Blue Spaces Green Spaces are locations that people visit; in some cases that they are more visited than the water environments considered. In total a higher proportion of the total visits made to the natural environment as a whole were to Green Spaces and a number of Green Space locations were found to attract a higher percentage of the total amount of visitors than any of the Blue Spaces examined. People were more likely to visit their local park, use a path, cycleway or bridleway, go to an area of woodland or forest, or visit the countryside than they were to visit a river, lake or canal, or go to any part of the coast.

This pattern was broadly repeated in the 2010 to 2011 and 2011 to 2012 MENE surveys (Natural England 2011, 2012), suggesting that it is robust. (1, 2) A similar pattern was also revealed in Wales by the 2008 WORS, where data indicated that people were more likely to visit their local park, go to an area of woodland, use a track or trail, or visit an area of hills or mountains than they were to visit an area of Blue Space (CCW/FCW 2009a, 2009b). Again this pattern was repeated in subsequent WORS rounds (CCW/FCW 2011, 2012; Natural Resources Wales 2014, 2015).

Further insight into the visits people made was provided by the 2009 to 2010 and 2011 to 2012 MENE surveys (Natural England 2011, 2012) and the children's MENE report

(Natural England 2016), which uses data taken from the 2013 to 2014 and 2014 to 2015 surveys to examine the way young people use natural spaces. The latter report divided the data into trips made locally and trips to more distant locations. The results suggested that trips with children to Green Spaces and rivers, lakes and canals were more likely to be made locally over shorter distances whereas visits to the coast were proportionately more likely to be over longer distances (Natural England 2016).

This pattern was found to hold across all of the visits made to natural environments by the wider population (Natural England 2010, 2012). It complements some smaller scale evidence of the different sizes of natural space that people visit. Jansen et al. (2017) provided evidence that residents of Maastricht and Rotterdam were likely to visit smaller parks, and larger areas of agricultural land, forests and moorland. No pattern of spatial discrimination was visible in the Blue Space data reported.

The MENE surveys between 2011 to 2012 and 2013 to 2014 added a temporal dimension to this evidence base by considering the dates of visitation (Natural England 2012, 2013, 2015a). Although a seasonal pattern was discernible to greater or lesser degrees in the data for trips to the seaside, no such seasonal signal was apparent in visit date data for the countryside, perhaps suggesting a difference in the way that the spaces were being used (Natural England 2013).

The relative appreciation of Blue and Green Spaces was examined directly by Hamstead et al. (2018), who conducted an investigation into the characteristics of New York parks associated with geo-tagging on social media platforms. They found that, while the number of Blue Space features in a park such as lakes and fountains was positively associated with geo-tagging within its boundary, the area of Green Space was a negative predictor.

Comparative benefits of Green and Blue Space as a recreational resource

The evidence base allowing comparison of the way Blue and Green Spaces are used for recreation is again comprised mainly of data from the MENE survey in England and WORS in Wales. In the same way that the surveys provide visitation data for a range of natural environments, they also provide data on the way those spaces are used for recreation.

The MENE survey examined the proportion of activity types taking place in 4 different categories of environment: town or city; the countryside; seaside resorts; and along the coast. The data indicate that, like Blue Spaces, walking (both with and without a dog) was by far the most commonly reported recreational activity taking place in Green Spaces. Beyond that, however, it is possible to start to discerning some differences in the types of activity that were taking place in each and to begin to build a characteristic use profile. Towns and cities were the most often reported locations for people playing with their children, taking part in informal games or sport and going running. In contrast, the countryside was visited most often by people who were walking their dog, going horse riding, or going off-road cycling or driving. Seaside towns and resorts were the most often used by people who were eating or drinking out, going sightseeing, visiting an attraction or appreciating scenery from their car, while the coast was most used by people who were going fishing, taking part in water sports, or watching wildlife (Natural England 2010, 2011, 2012, 2013, 2015, 2016).

WORS provides a similar profile of the recreational activities undertaken across different environments in Wales. Blue Spaces were the most selected destinations for people taking part in water sports, going outdoor swimming, having a picnic or going rock climbing, while Green Spaces were used more often by people going walking, cycling, running, horse riding, playing field sports or air sports, taking part in wildlife watching or sightseeing, visiting an attraction or going to a child's playground (CCW/FCW 2009a, 2009b, 2011, 2012; Natural Resources Wales 2014, 2015).

3.1.2 Qualitative evidence

Three qualitative studies provide evidence of the way people use Green and Blue Spaces as a recreational resource (Table 3.2).

- Ashbullby et al. (2013) conducted semi-structured interviews with the parents and children of 15 families in Devon and Cornwall in south-west England to investigate the way that families interact with and use the beach as a space.
- Finlay et al. (2015) used a series of in-depth interviews with older adults in Canada to illuminate the way older people use both Green and Blue Spaces as part of their daily lives.
- Aspe and Jacqué (2015) used semi-structured interviews in combination with a participatory method, where the researcher took part in 6 heritage tours, to investigate the changing uses of the rural canal network in south-western France.

Ashbullby et al. (2013) found that physical activity and active play were central to the way the families they interviewed used the beach, with the children in particular only taking part in sedentary activities for short periods and only then as breaks from more active pursuits. They also found the beach provided a space for individual family members to take part in the activities that they wanted to, separately from the others, and enabled them to avoid activities they did not enjoy. The data highlighted that what was important to the adults was not always important to the children and vice versa.

The investigation by Finlay et al. (2015) of how older adults use Blue and Green Spaces identified that, for them, interacting with Blue and Green Spaces connected to a need for enjoyment and to life fulfilment. To that end the accessibility of Blue Space was considered to be a core concern in the face of increasing challenges to physical health and mobility.

From their interviews with the users of canal paths, Aspe and Jacqué (2015) identified much larger themes of social and cultural change that shaped the way these particular Blue Spaces were being used and regarded by contemporary populations. They highlighted the way spaces that were once considered to be solidly agricultural were then considered to be recreational through the lens of a more urbanised population that sought respite from its daily working life. In that sense, their analysis contextualises the examination of Blue Spaces in processes that have a much broader spatial and temporal scale.

Table 3.1 Quantitative studies providing evidence of recreational benefits

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
Haeffner et al. (2017)	This cross-sectional study used multivariate regression to investigate the association between a sample of households in northern Utah, USA, living in neighbourhoods with a nearby river or canal, and positive household impacts; the likelihood of households spending time at them; being familiar with them.	1,450 randomly sampled households from 13 neighbourhoods in northern Utah: 7 with rivers and 6 with major irrigation canals as their local waterway	River Irrigation canal	Visiting	% of residents who spent time at river or canal	Total neighbourhood score = 71.3 ($p \leq 0.001$)
White et al. (2014)	This cross – sectional study used MENE data to conduct a spatial analysis that correlated distance from the coast with reported coastal visits.	183,755 participants in Natural England's MENE survey (2009 to 2012)	Coast	Visiting	Coastal visits (odds ratio (OR) with confidence intervals, CI)	'In both the unadjusted and adjusted models the odds of visiting the coast within the last week were 15 times greater among those living <1km versus. >20km from the coast.'

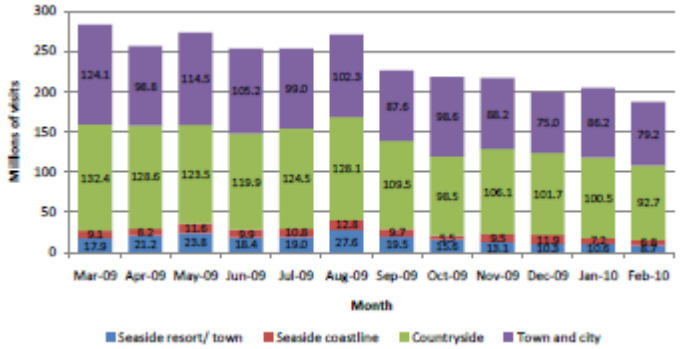
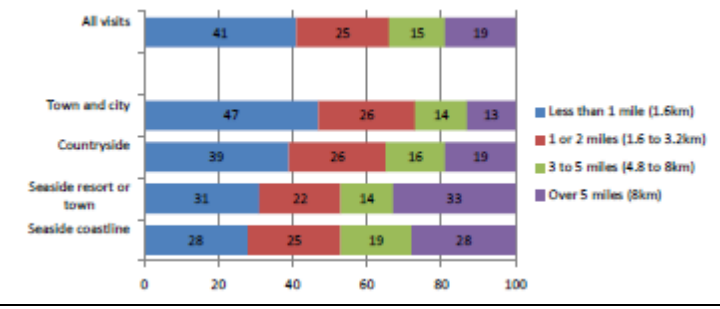
Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
Raymond et al. (2016)	This cross-sectional study used PPGIS to spatially identify the diversity and spatial distribution of PPGIS clusters based on the activities undertaken in urban Blue Space.	Residents of Helsinki, Finland, who marked their activity on Maptionnaire. 109 activity clusters contained a total of 3,356 respondents (one respondent could mark activities in several clusters).	Lake River Coast	Recreational activities (see outcome)	Activity type (N)	Walks on the shore: 2,181 Spending time, sitting, sunbathing on the beach: 1,695 Use of a coffee shop, terrace, etc. by the water: 1,264 Picnics by the water: 935 Skiing on ice or on the shores: 635 Swimming in natural waters: 616 Taking the kids swimming: 439 Taking the dog swimming: 233 Fishing: 228 Canoeing or rowing: 210 Ice skating, tour skating on natural ice: 153 Sailing: 144 Enjoying sauna by the water: 129 Motor boating: 120 Winter swimming: 79 Water area reconditioning or other environmental management work: 34 Diving, snorkelling: 25 Jet skiing, water skiing, or other motorised water sport: 14 Riding snow mobiles on the shore or ice: 3 Jogging: 1,971 Spending time with family or friends: 1,894 Other nature observation: 891 Hiking: 692 Birdwatching: 334 Hunting: 13 Total points: 14,932
White et al. (2016)	This cross – sectional study estimated annual adult levels of physical activity occurring in natural environments across England,	280,790 English adults	Inland waters Beach Other coastline	Recreational activities (see outcome)	Activity for visits <30 minutes, ≥30 minutes (% of total respondents in each duration category (standard deviation, SD)	Beach, sunbathing or paddling = 0.2 (0.0), 0.9 (0.1) Fishing = 0.3 (0.0), 2.6 (0.2) Water sports = 0.1 (0.0), 0.6 (0.1) Swimming outdoors = 0.1 (0.0), 0.3 (0.0) Appreciate scenery from car = 0.1 (0.0), 0.5 (0.1) Eat or drinking out = 0.6 (0.1), 4.3 (0.5) Picnicking = 0.1 (0.0), 0.7 (0.0) Wildlife watching = 0.2 (0.0), 0.6 (0.1)

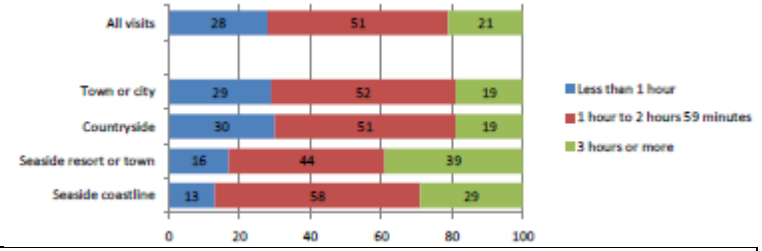
Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
	using 6 waves (2009 to 2010 to 2014 to 2015) of MENE survey data.					Walking with a dog = 67.8 (0.7), 44.1 (0.5) Walking without a dog = 21.1 (0.6), 25.9 (0.2) Visiting an attraction = 0.0 (0.0), 0.8 (0.0) Playing with children = 1.5 (0.1), 7.1 (0.3) Allotment/gardening = 0.1 (0.0), 0.2 (0.0) Off-road driving/motorcycling = 0.5 (0.1), 0.6 (0.1) Informal games and sport (for example, Frisbee/golf) = 0.3 (0.0), 4.6 (0.3) Horse riding = 0.3 (0.1), 1.6 (0.1) Field sports (that is, hunting) = 0.0 (0.0), 0.3 (0.0) Running = 4.2 (0.2), 1.8 (0.1) Road cycling = 2.3 (0.1), 1.6 (0.1) Off-road cycling/mountain biking = 0.5 (0.0), 1.0 (0.0)
					% of total population visiting a type of environment for moderate intensity visits, vigorous intensity visits (SD)	Inland waters = 5.7 (0.1), 5.5 (0.5) Beaches = 4.4 (0.2), 2.5 (0.3) Other coast = 2.4 (0.1), 1.6 (0.2) Town parks = 23.4 (0.4), 20.7 (0.9) Play areas = 3.7 (0.1), 3.9 (0.2) Open space towns = 5.1 (0.1), 5.1 (0.8) Allotments = 0.4 (0.0), 0 (0) Country parks = 6.5 (0.2), 6.7 (0.3) Woodlands = 8.8 (0.2), 7.0 (0.4) Open countryside = 7.2 (0.6), 5.8 (0.3) Farmland = 4.0 (0.1), 2.9 (0.4) Uplands = 1.5 (0.1), 2.6 (0.5) Pathways = 4.5 (0.1), 14.9 (0.7)
Gundersen et al. (2016)	This cross-sectional study aimed to describe the availability and use of nearby outdoor spaces along a nature continuum by Norwegian children. The	3,160 parents with children aged 6–12 from across Norway. The sample frame was derived from a survey panel consisting of about 60,000	Lake, sea and shore Stream and river	Children playing or visiting	Reported frequency of use (% of total study population)	Lake, sea and shore Summer Never = 2.1 Less than once a month = 21.6 1–2 times per month = 34.1 Weekly = 34.8 Almost daily = 7.5 Winter Never = 25.5 Less than once a month = 48.6

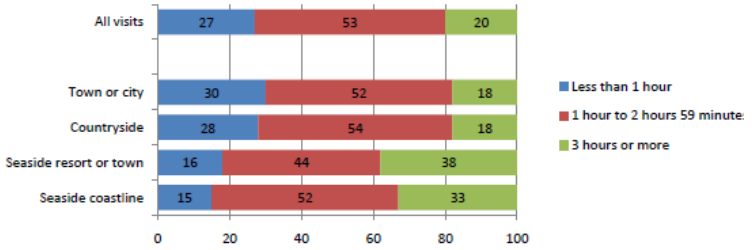
Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
	authors carried out a nationwide survey of 3,160 parents with children aged 6–12. A comprehensive web-based questionnaire used a set of different numeric, category and open-ended questions and was completed in December 2012 and January2013.	volunteers who are continuously tested by the polling company to be representative of Norway's general population. The sample represented adults that more commonly had their own garden.				1–2 times per month = 18.6 Weekly = 5.8 Almost daily = 1.4 Stream, river Summer Never = 12.1 Less than once a month = 37.0 1–2 times per month = 29.0 Weekly = 17.3 Almost daily = 4.6 Winter Never = 32.2 Less than once a month = 43.6 1–2 times per month = 15.3 Weekly = 6.8 Almost daily = 2.2
Hamstead et al. (2018)	This cross-sectional study used geo-tagged 'tweets' (Twitter) and photographs (Flickr) within the boundary of 2,143 designated parks in New York City (NYC), and correlated them against park characteristics broken down into: (1) park facilities and characteristics; (2) park accessibility; and (3)	54,330 unique Flickr users 24.4% were 'residents' of NYC (their geocoded home location was within a one-mile buffer of the city boundary. 75.6% 'tourists' home location outside of buffer. Twitter users who posted 51.3 million geo-tagged tweets between 2012 and 2014 from within a	Water bodies Beaches	Visiting and geo-tagging on social media	Predictors of Flickr user days and Twitter user days	'Positive predictors for both models include area of park, number of water bodies in park, proximity to water bodies, the presence of a Wi-Fi hotspot, community park, length of bike routes, number of subway stops and proximity to nearest bike route, bus stop and subway stop. Negative predictors include area of Green Space, the park type being a playground and neighbourhood-level minority race.'

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
	neighbourhood characteristics.	rectangle bounding the study area.				
Jansen et al. (2017)	This longitudinal study randomly selected participants and asked them to wear an Actigraph GT3X+ accelerometer (Actigraph, Pensacola, Florida) and a BT-Q1000XT GPS-device (QStarz International Co) for 7 consecutive days during waking hours.	Dutch general population adults aged 45–65 (N = 279) recruited from 4 neighbourhoods in Rotterdam and Maastricht. Mean age was 57.1 years, and a little more than half of the sample was female. Almost half of participants were overweight or obese, and most had a middle or higher education.	'Blue Space' (for example, lakes, rivers, water in parks, seas)	Visiting	Total no. of visits (%) by destination size: 0–3ha, 3–7ha, 7–27ha, ≥27 ha	Blue Space: 17.4, 11.4, 17.9, 19.7 Parks: 58, 65, 27.4, 12.8 Recreational areas: 3, 1.1, 12.6, 5.5 Agricultural green: 19, 19.3, 38.1, 51.1 Forest & moorland: 2.5, 3.2, 3.9, 10.8
					Physical activity modality by destination (% mean): spatially concentrated physical activity, walking and jogging, cycling	Blue Space: 69.9, 25.8, 4.3 Parks:74.3, 23.7, 2.0 Recreational areas: 82.3, 16.9, 0.7 Agricultural terrain: 65.7, 31.4, 2.9 Forest & moorland: 55.8, 42.8, 1.4
Ball et al. 2007	This cross-sectional survey correlated likelihood of self-reported walking with neighbourhood proximity to coast (bay side). Models incorporated social, personal and educational mediators.	1,282 female participants (435 from high, 491 from mid and 356 from low socioeconomic position neighbourhoods) recruited using a stratified random sampling procedure from 45 Melbourne neighbourhoods	Coast	Walking	Likelihood of leisure time walking OR (95% CI).Coastal versus non-coastal neighbourhood	Not coastal neighbourhood: 1.0 Coastal neighbourhood: 1.46 (1.02–1.90)
					Likelihood of walking for transport OR (95% CI).Coastal versus non-	Not coastal neighbourhood: 1.0 Coastal neighbourhood: 2.74 (2.20–3.28)

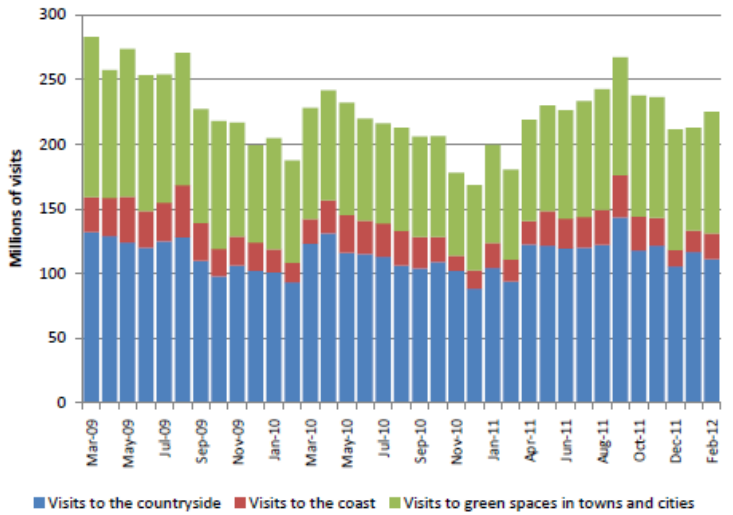
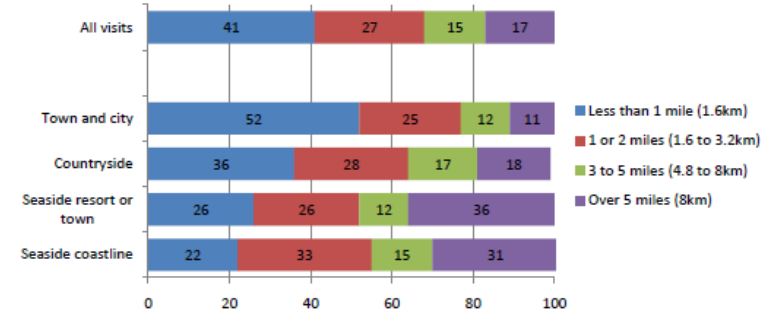
Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
					coastal neighbourhood	
MENE 2009 to 2010 survey (Natural England 2010)	This cross-sectional survey undertook home interviews with a representative sample of the English adult population (aged 16 and over) between March 2009 and February 2010. A sample of at least 800 was achieved across at least 100 sample points per week.	800 English adults (over 16 years) per week.	River, lake, canal Beach Other coastline	Visiting	% of total visits made	Seaside resort or town = 7 Other seaside coastline = 4 Countryside = 48 Green Space in town and city = 41
					% of total visits made (sum of totals is more than 100% as visits could have included more than one type of place)	River, lake, canal = 9% Beach = 6% other coastline = 3% An allotment = 1 Mountain, hill, moorland = 2 Children's playground = 3 A village = 6 Playing field/other recreation area = 7 Country park= 7 Farmland = 7 Another open space in town or city = 8 Woodland or forest = 11 Another open space in countryside = 11 Path, cycleway, bridleway = 13 Park in a town or city = 24
					% of visitors who visited a place by type of activity undertaken (town or city, countryside, seaside resort or town, seaside coastline)	Walking with a dog: 40, 58, 36, 46 Walking not with a dog: 28, 23, 31, 31 Playing with children: 11, 6, 9, 6 Eating or drinking out: 8, 4, 12, 8 Sightseeing, picnic, drive: 3, 3, 7, 6 Visiting an attraction: 4, 3, 7, 6 Wildlife watching: 2, 4, 2, 4 Informal games and sport: 3, 3, 3, 1 Horse riding: *, 2, *, 1 Off-road cycling or mountain biking: 1, 2, 1, 1 Picnicking: 2, 2, 3, 3

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
					* Not applicable (NA)	Road cycling: 2, 2, 2, 2 Running: 3, 2, 2, 2 Appreciating scenery from your car: 1, 2, 4, 3 Field sports: 1, 1, *, * Fishing: *, 1, *, 2 Visits to a beach, sunbathing or paddling in the sea: *, *, 16, 12 Off-road driving or motorcycling: 1, 2, 1, 1 Swimming outdoors: *, *, 2, 2 Water sports: *, *, 2, 3
					Millions of visits per month (March 2009 to February 2010)	
					Distance travelled by place visited (%)	

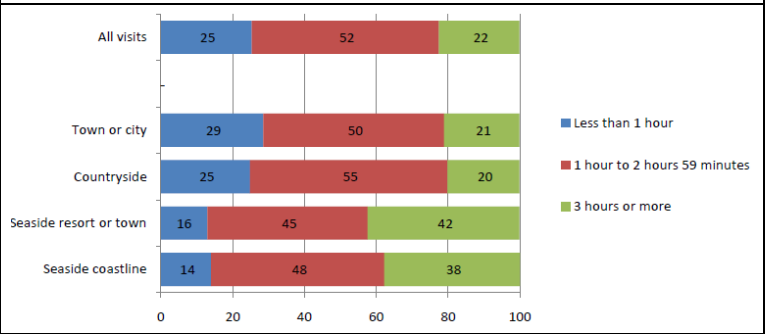
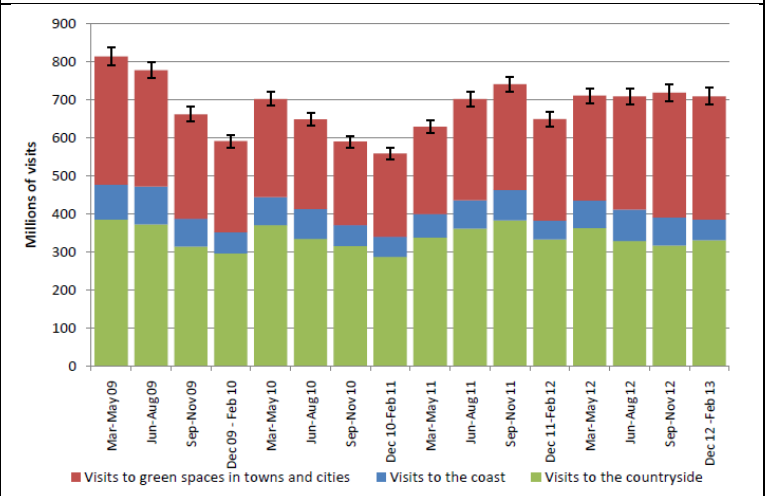
Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
					Duration of visit by place visited (%)	
MENE 2010 to 2011 survey (Natural England 2011)	This cross-sectional survey undertook home interviews with a representative sample of the English adult population (aged 16 and over) between March 2010 and February 2011, with a sample of at least 800 achieved across at least 100 sample points per week.	800 English adults (over 16 years) per week.	River, lake, canal Beach Other coastline	Visiting	% of total visits made	Seaside resort or town = 7 Other seaside coastline = 4 Countryside = 53 Green Space in town and city = 37
					% of total visits made (sum of totals is more than 100% as visits could have included more than one type of place)	River, lake, canal = 9% Beach = 6% Other coastline = 4% An allotment = 1% Mountain, hill, moorland = 3% Children's playground = 3% A village = 6% Playing field/other recreation area = 8% Country park= 7% Farmland = 9% Another open space in town or city = 7% Woodland or forest = 13% Another open space in countryside = 12% Path, cycleway, bridleway = 13% Park in a town or city = 22%
					% of visitors who visited a place by type of activity undertaken (town or city, countryside,	Walking with a dog: 43, 59, 36, 42 Walking not with a dog: 29, 24, 34, 32 Playing with children: 12, 6, 11, 7 Eating or drinking out: 7, 3, 13, 8 Sightseeing, picnic, drive: 3, 3, 8, 7 Visiting an attraction: 4, 3, 6, 4 Wildlife watching: 1, 4, 3, 4

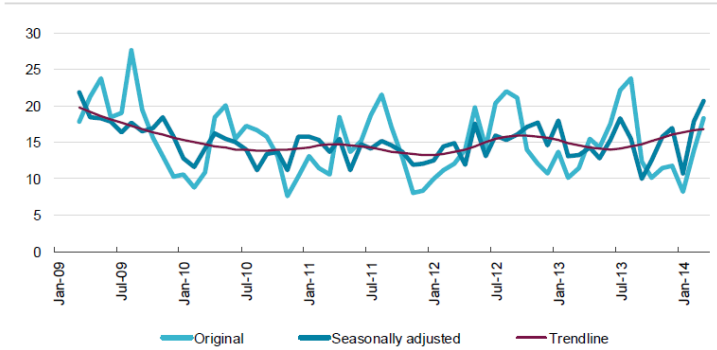
Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
					seaside resort or town, seaside coastline) * NA	Informal games and sport: 3, 2, 2, 1 Horse riding: *, 2, *, 1 Off-road cycling or mountain biking: 1, 1, *, 1 Picnicking: 2, 2, 4, 3 Road cycling: 2, 2, 1, 2 Running: 4, 3, 1, 2 Appreciating scenery from your car: 1, 2, 5, 4 Field sports: *, *, * ,* Fishing: *, 1, 1, 2 Visits to a beach, sunbathing or paddling in the sea: *, *, 19, 16 Off-road driving or motorcycling: *, *, *, * Swimming outdoors: *, *, 2, 2 Water sports: *, *, 1, 3
					Average duration of visit	
MENE 2011 to 2012 survey (Natural England 2012)	This cross-sectional survey undertook home interviews with a representative sample of the English adult population (aged 16 and over) between March 2011 and February 2012 with a sample of at least 800 achieved across	800 English adults (over 16 years) per week	River, lake, canal Beach Other coastline	Visiting	% of total visits made	Seaside resort or town = 6 Other seaside coastline = 4 Countryside = 52 Green Space in town and city = 38
					% of total visits made (sum of totals is more than 100% as visits could have included more than one type of place)	River, lake, canal = 10% Beach = 6% other coastline = 3% An allotment = 1% Mountain, hill, moorland = 3% Children's playground = 3% A village = 7% Playing field/other recreation area = 8% Country park= 7%

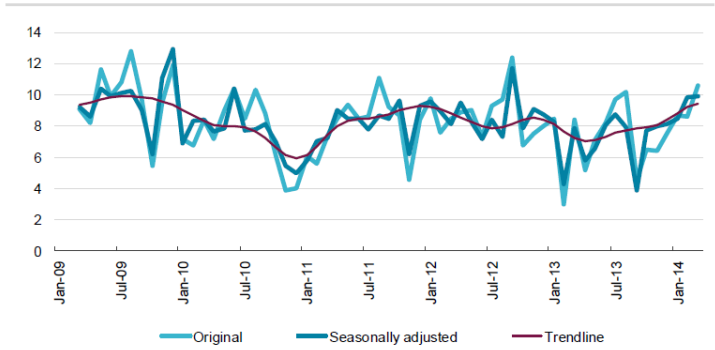
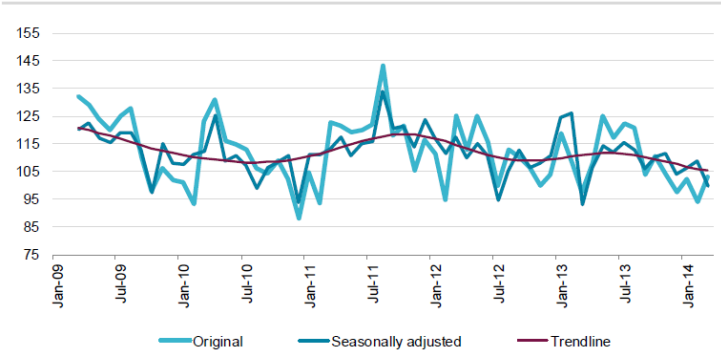
Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
	at least 100 sample points per week.					Farmland = 9% Another open space in town or city = 8% Woodland or forest = 13% Another open space in countryside = 12% Path, cycleway, bridleway = 16% Park in a town or city = 23%
					% of visitors who visited a place by type of activity undertaken (town or city, countryside, seaside resort or town, seaside coastline) * NA	Walking with a dog: 44, 58, 34, 45 Walking not with a dog: 29, 24, 36, 32 Playing with children: 13, 6, 13, 7 Eating or drinking out: 7, 4, 16, 9 Sightseeing, picnic, drive: 2, 4, 9, 8 Visiting an attraction: 3, 3, 6, 3 Wildlife watching: 1, 4, 3, 7 Informal games and sport: 3, 3, 2, 1 Running: 4 , 3, 1, 2 Picnicking: 2, 2, 4, 4 Road cycling: 2, 2, 2, 2 Appreciating scenery from your car: 1, 2, 6, 4 Visits to a beach, sunbathing or paddling in the sea: *, *, 20, 12 Horse riding: *, 2, *, * Off-road cycling or mountain biking: 1, 1, *, 1 Fishing: *, 1, 1, 1 Swimming outdoors: *, *, 2, 2 Water sports: *, *, 2, 3

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
					Estimated visits (millions) to Green Spaces in towns and cities, the countryside and the coast	
					Average duration of visit	
MENE 2012 to 2013 survey (Natural	This cross-sectional survey undertook home interviews with a representative	800 English adults (over 16 years) per week	River, lake, canal Beach Other coastline	Visiting	% of total visits made	Seaside resort or town = 7 Other seaside coastline = 3 Countryside = 47 Green Space in town and city = 43

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
England 2013)	sample of the English adult population (aged 16 and over) between March 2012 and February 2013 with a sample of at least 800 achieved across at least 100 sample points per week.				% of total visits made (sum of totals is more than 100% as visits could have included more than one type of place)	River, lake, canal = 9% Beach = 6% Other coastline = 3% An allotment = 1% Mountain, hill, moorland = 3% Children's playground = 3% A village = 6% Playing field/other recreation area = 7% Country park= 7% Farmland = 9% Another open space in town or city = 9% Woodland or forest = 13% Another open space in countryside = 11% Path, cycleway, bridleway = 16% Park in a town or city = 25%
					% of visitors who visited a place by type of activity undertaken (town or city, countryside, seaside resort or town, seaside coastline) * NA	Walking with a dog: 41, 58, 33, 45 Walking not with a dog: 29, 23, 39, 34 Playing with children: 11, 5, 11, 8 Eating or drinking out: 8, 3, 13, 7 Sightseeing, picnic, drive: 2, 3, 7, 6 Visiting an attraction: 4, 3, 5, 3 Wildlife watching: 1, 4, 2, 5 Informal games and sport: 3, 2, 1 ,1 Running: 4, 3, 2, 2 Picnicking: 1, 1, 3, 4 Road cycling: 2, 3, 1, 1 Appreciating scenery from your car: 1, 2, 4, 3 Visits to a beach, sunbathing or paddling in the sea: *, *, 15, 11 Horse riding: *, 2, *, * Off*road cycling or mountain biking: 1, 2, 1, 1 Fishing: *, 1, 1, 2 Swimming outdoors: *, *, 2, 2 Water sports: *, *, 1, 4

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
					Average duration of visit	
					Estimated visits (millions) to Green Spaces in towns and cities, the countryside and the coast	
MENE 2013 to 2014 survey (Natural England 2015a)	This cross-sectional survey undertook home interviews with a representative sample of the English adult	800 English adults (over 16 years) per week	River, lake, canal Beach Other coastline	Visiting	Total visits made (billions)	Seaside resort = 0.17 Other coastal = 0.09 Countryside = 1.31 Towns and cities = 1.36

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
	population (aged 16 and over) between March 2013 and February 2014 with a sample of at least 800 achieved across at least 100 sample points per week.				% of total visits made (sum of totals is more than 100% as visits could have included more than one type of place)	River, lake, canal = 9 % Beach = 5 % Other coastline = 3% An allotment = 1% Mountain, hill, moorland = 2% Children's playground = 3% A village = 5% Playing field/other recreation area = 8% Country park= 7% Farmland = 8% Another open space in town or city = 9% Woodland or forest = 13% Another open space in countryside = 10% Path, cycleway, bridleway = 16% Park in a town or city = 27%
					Date of visit to seaside towns/resorts (2009 to 2014)	The plot of the original non-seasonally adjusted series (below) shows a series with a slight positive trend, strong seasonality and possibly a level shift12 at December 2009.  A pattern was clearly evident in regard to visits to seaside resorts/towns in the seasonally adjusted data. Visits to this type of destination were more likely to be taken at weekends; therefore months with a higher number of weekend days tended to have higher numbers of visits. There was no discernible trend for visits to other seaside coastal destinations.

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
					Date of visit to other seaside (2009 to 2014)	A plot of the non-seasonally adjusted data shows a slight negative trend for visits to other seaside coastline areas. Some evidence of a seasonal pattern appeared, although it is not immediately obvious with several potential outliers. Mixed results for the presence of seasonality were taken to be an indication of marginal seasonality for this type of location. As with other series, the seasonality will be evaluated further once more data becomes available. 
					Date of visit to the countryside (2009 to 2014)	 The non-seasonally adjusted countryside visit data did not present a discernible trend. Evidence of seasonality is weak/potentially evolving and there has been considerable variation in the data over time.

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
						Seasonality is difficult to discern when looking at the non-seasonally adjusted data. There is evidence that seasonality may exist, however, it is difficult to robustly estimate the seasonality at present.
MENE 2014 to 2015 survey (Natural England 2015b)	This cross-sectional survey undertook home interviews with a representative sample of the English adult population (aged 16 and over) between March 2014 and February 2015 with a sample of at least 800 achieved across at least 100 sample points per week.	800 English adults (over 16 years) per week	River, lake, canal Beach Other coastline	Visiting	Total visits made (billions)	Seaside resort = 0.20 Other coastal = 0.11 Countryside = 1.31 Towns and cities = 1.50
MENE 2015 to 2016 survey (Natural England 2017)	This cross-sectional survey undertook home interviews with a representative sample of the English adult population (aged 16 and over) between March 2015 and February 2016	800 English adults (over 16 years) per week	River, lake, canal Beach Other coastline	Visiting	Total visits made (billions)	Seaside resort = 0.22 Other coastal = 0.10 Countryside = 1.35 Towns and cities = 1.45

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
	with a sample of at least 800 achieved across at least 100 sample points per week.					
MENE – children's report from the 2013 to 2014 and the 2014 to 2015 surveys (Natural England 2016)	This cross-sectional survey undertook home interviews with a representative sample of the English adult population (aged 16 and over) between March 2013 and February 2015 with a sample of at least 800 achieved across at least 100 sample points per week. On one week per month, adults were interviewed about the visiting behaviour of each child in their household in the month prior to interview, with data collected for up to a maximum	10,235 children aged under 16	Seaside/coastal	Beach/coastline River, lake or canal	Types of places visited (% of all children): local, not local	Beach/coastline = 10, 9 River, lake or canal = 11, 4 Park in town or city = 48, 11 Playground = 28, 8 Playing field or other recreation area = 26, 5 Country park = 16, 7 Woodland = 12, 5 A path, cycleway or bridleway = 11, 3 Farmland/ other open space in countryside = 7, 3 Visitor attraction = 8, 6 A village = 7, 3 Nature reserve/ other place for nature = 6, 3 Shared/ community green = 6, 1 Historic/ heritage site = 5, 4 Mountain/hill/ moorland = 3, 2 Other open spaces in a town or city = 5, 2 Other open spaces in countryside = 3, 1 Allotment/ community garden = 2, 1

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
	of 3 children per household.					
WORS 2008 (CCW/FCW 2009a, 2009b)	This cross-sectional telephone survey was undertaken by Ipsos between 21 January 2008 and 21 January 2009. Interviewing was conducted throughout the year with a minimum of 500 interviews completed in every month.	5,273 randomly selected telephone contacts in each of 6 regions of Wales who had visited the outdoors in the last 4 weeks, with numbers screened to ensure the exclusion of those registered with the Telephone Preference Service and those likely to be non-residential.	River, lake or canal Beach Other coastline Sea	Visiting	Which of these was the main place you visited (on your last visit to the outdoors)? % of all surveyed (5% risk level)	River, lake or canal = 8% Beach = 7% Other coastline = 6% Sea = 2% Local park = 15% Woodland or forest = 14% Roadside pavement/track = 12% Hills, mountains or moorland = 11% Farmland = 8% Other local open space = 8% Village = 5% Other = 2%
					Which of these was the main place you visited (on your last visit to the outdoors?) by % of activity grouping (group active activities, lone active activities, rural activities, passive activities, play activities) (5% risk level)	River, lake or canal = 10%, 11%, 10%, 8%, 8%, Beach = 9%, 8%, 7%, 7%, 8% Other coastline = 6%, 4%, 4%, 6%, 6% Sea = 2%, 2%, 2%, 2%, 2% Local park = 13%, 11%, 9%, 15%, 18% Woodland or forest = 12%, 16%, 19%, 14%, 14% Roadside pavement/track = 10%, 11%, 8%, 12%, 10% Hills, mountains or moorland = 12%, 13%, 16%, 11%, 12% Farmland = 9%, 8%, 14%, 8%, 7% Other local open space = 9%, 9%, 6%, 8%, 7% Village = 4%, 4%, 2%, 5%, 4% Other = 5%, 4%, 4%, 5%, 4%

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
WORS 2011 (CCW/FCW 2011, 2012)	This cross-sectional telephone survey was undertaken by Ipsos between 7 January 2011 and 16 January 2012. Interviewing was conducted throughout the year with a minimum of 500 interviews completed in every month.	5,626 randomly selected telephone contacts in each of 6 regions of Wales who had visited the outdoors in the last 4 weeks. Numbers were screened to ensure the exclusion of those registered with the Telephone Preference Service and those likely to be non-residential.	River, lake or canal Beach Other coastline Sea	Visiting	Main place visited – most recent visit. % of all surveyed (5% risk level)	River, lake or canal = 8% Beach = 11% Other coastline = 5% Sea = 2% Woodland or forest = 18% Farmland = 10% Local park = 12% Other local open space = 8% Roadside pavement/track = 9% Hills, mountains or moorland = 11% Village = 5% Other = 2%
					Main place visited during most recent visit by % of activity grouping:(1) walking, (2) road cycling, (3) off-road cycling or mountain biking, (4) horse riding, (5) fishing, (6) rock climbing or caving, (7) motorised water sports, (8) other water sports, (9) outdoor swimming, (10) snow sports, (11) field sports, (12) air sports, (13) wildlife watching, (14) running, (15) sightseeing or	River, lake or canal = (1) 8%, (2) 13%, (3) 12%, (4) 10%, (5) -% , (6) -% (7) 7%(8) 18%, (9) 8% , (10) -% , (11) -% , (12) -% , (13) 9%, (14) 10%, (15) 8%, (16) 6%, (17) 3%, (18) 3% Beach = (1) 11%, (2) 11%, (3) 5%, (4) 2%, (5) 11%, (6) -% (7) 27%(8) 44%, (9) 42% , (10) -% , (11) -% , (12) -% , (13) 7%, (14) 9%, (15) 12%, (16) -%, (17) 30%, (18) 13% Sea = (1) 2%, (2) 2%, (3) 1%, (4) 1%, (5) 12%, (6) -% (7) 51%(8) 24%, (9) 12% , (10) -% , (11) -% , (12) -% , (13) 2%, (14) -% , (15) 3%, (16) -%, (17) -%, (18) 4% Other coastline = (1) 5%, (2) 6%, (3) 3%, (4) -% , (5) 7%, (6) 63%(7) 2%(8) 2%, (9) -% , (10) -% , (11) -%, (12) -% , (13) 6%, (14) 2%, (15) 13%, (16) -%, (17) 6%, (18) 1% Woodland or forest = (1) 19%, (2) 3%, (3) 48%, (4) 27%, (5) 6%, (6) -%, (7) -%, (8) -%, (9) 1%, (10) 32%, (11) 25%, (12) 49%, (13) 18%, (14) 21%, (15) 10%, (16) 35%, (17) 4%, (18) 5% Farmland = (1) 9%, (2) 4%, (3) 2%, (4) 46%, (5) 7%, (6) -% (7) 2%(8) -% , (9) -% , (10) -% , (11) 63%, (12) -% , (13) 25%, (14) 3%, (15) 6%, (16) 28%, (17) 17%, (18) 3% Local park = (1) 9%, (2) 9%, (3) 1%, (4) 1%, (5) 23%, (6) -% (7) -% (8) -% , (9) -% , (10) 6%, (11) 4%, (12) -% , (13) 5%, (14) 8%, (15) 7%, (16) -%, (17) 8%, (18) 57% Other local open space = (1) 8%, (2) 2%, (3) 2%, (4) 6%, (5) 2%, (6) -% (7) -% (8) -% , (9) -% , (10) 35%, (11) 5%, (12) -% , (13) 13%, (14) 4%, (15) 13%, (16) 2%, (17) 1%, (18) 8%

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
					visiting an attraction, (16) off-road driving or motorcycling, (17) picnicking, (18) visiting children's playgrounds) - = no significant data (5% risk level)	Roadside pavement/track = (1) 11%, (2) 21%, (3) 2%, (4) 9%, (5) -% , (6) -% (7) -% (8) 2%, (9) -% , (10) -% , (11) -% , (12) -% , (13) 1%, (14) 19%, (15) 4%, (16) 3%, (17) 1%, (18) -% Hills, mountains or moorland = (1) 11%, (2) 13%, (3) 25%, (4) 6%, (5) -% , (6) 37%(7) 12%(8) -% , (9) -% , (10) 15%, (11) 3%, (12) 51%, (13) 8%, (14) 21%, (15) 9%, (16) 26%, (17) 22%, (18) 1% Village = (1) 5%, (2) 24%, (3) -% , (4) -% , (5) -% , (6) -% (7) -% (8) 10%, (9) 21% , (10) -% , (11) 1%, (12) -% , (13) 3%, (14) 4%, (15) 6%, (16) -%, (17) 5%, (18) 6% Other = (1) 1%, (2) %1, (3) 1%, (4) 3%, (5) -% , (6) -% (7) -% (8) -% , (9) 16% , (10) 11%, (11) -% , (12) -% , (13) 3%, (14) -% , (15) 8%, (16) -%, (17) 3%, (18) -%
WORS 2014 (Natural Resources Wales 2014, 2015)	This cross-sectional telephone survey was undertaken by Ipsos between January 2014 and January 2015. Interviewing was conducted throughout the year with a minimum of 500 interviews completed in every month.	4,941 randomly selected telephone contacts in each of 6 regions of Wales who had visited the outdoors in the last 4 weeks. Numbers were screened to ensure the exclusion of those registered with the Telephone Preference Service and those likely to be non-residential.	River, lake or canal Beach Other coastline Sea	Visiting	Main place visited – most recent visit. % of all surveyed (5% risk level)	River, lake or canal = 7% Beach = 10% Other coastline = 4% Sea = 2% Woodland or Forest = 15% Farmland = 11% Local park = 16% Other local open space = 5% Roadside pavement/track = 13 % Hills, mountains or moorland = 10 % Village = 4% Other = 2%
			River, lake or canal Beach	Multiple (see outcomes)	Main place visited during most recent visit by % of activity grouping (1) walking, (2) road cycling, (3) off-road cycling or mountain biking, (4) horse riding, (5) fishing, (6) rock climbing or	River, lake or canal = (1) 8%, (2) 2%, (3) 8%, (4) 1%, (5) 16% , (6) -% (7) -% (8) 26%, (9) 8% , (10) -% , (11) -% , (12) 5% , (13) 12%, (14) 6%, (15) 5%, (16) 1%, (17) 16%, (18) 4% Beach = (1) 10%, (2) 8%, (3) 2%, (4) 4%, (5) 6%, (6) -% (7) -%(8) 39%, (9) 57% , (10) -% , (11) -% , (12) -% , (13) 6%, (14) 2%, (15) 24%, (16) 3%, (17) 23%, (18) 6% Woodland or forest = (1) 16%, (2) 3%, (3) 23%, (4) 22%, (5) 35%, (6) -%, (7) -%, (8) -%, (9) -%, (10) 12%, (11) 55%, (12) -%, (13) 26%, (14) 14%, (15) 5%, (16) 20%, (17) 5%, (18) 5%

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
					caving, (7) motorised water sports, (8) other water sports, (9) outdoor swimming, (10) snow sports, (11) field sports, (12) air sports, (13) wildlife watching, (14) running, (15) sightseeing or visiting an attraction, (16) off-road driving or motorcycling, (17) picnicking, (18) visiting children's playgrounds) - = no significant data (5% risk level)	Farmland = (1) 9%, (2) 35%, (3) 1%, (4) 25%, (5) 4%, (6) 15% (7) -%(8) -% , (9) -% , (10) -% , (11) 35%, (12) 25% , (13) 16%, (14) 7%, (15) 3%, (16) 68%, (17) 7%, (18) 6% Local park = (1) 13%, (2) 9%, (3) 12%, (4) 9%, (5) 1%, (6) -% (7) 8% (8) -% , (9) 4% , (10) -%, (11) 4%, (12) -% , (13) 1%, (14) 11%, (15) 8%, (16) 1%, (17) 29%, (18) 65% Other Local Open Space = (1) 6%, (2) 2%, (3) 1%, (4) 4%, (5) -%, (6) -% (7) -% (8) 4% , (9) -% , (10) -%, (11) *%, (12) 15% , (13) 8%, (14) 2%, (15) 10%, (16) -%, (17) 10%, (18) 5% Roadside pavement/track = (1) 15%, (2) 17%, (3) 17%, (4) 15%, (5) 9%, (6) 17% (7) -% (8) -%, (9) -% , (10) -% , (11) -% , (12) -% , (13) 7%, (14) 24%, (15) *%, (16) 3%, (17) 1%, (18) 3% Hills, mountains or moorland = (1) 10%, (2) 10%, (3) 30%, (4) 12%, (5) 1% , (6) 28% (7) -% (8) -% , (9) -% , (10) 36%, (11) 4%, (12) 28%, (13) 6%, (14) 24%, (15) 9%, (16) 3%, (17) 5%, (18) 1%
de Bell et al. (2017)	Cross-sectional study based on ONS Opinions and Lifestyle Survey Each month, 2,010 addresses are selected and one person over 16 in each household is interviewed. Response rates	1,043 British people over the age of 16	Rivers, canals and lakes and their immediate surroundings, including river paths, canal paths and lakeside walks	Visiting	Frequency of visits (% of total respondents)	Frequently (≥once a month): 50.0 Infrequently (≤once a month): 34.8 Never: 15.2 Missing: 3

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
	are typically between 50% and 60%. The survey runs for 8 months of the year; a module was commissioned by the authors in the May 2015 survey for which the response rate was 56%, resulting in a sample of 1,043.					
Vesterinen et al. (2010) (3)	This cross-sectional Finnish study utilised national recreation inventory data combined with water quality data to model recreation participation and estimate the benefits of water quality improvements. Using hurdle models, they analysed the association of water clarity in individuals' home municipalities with the 3 most	3,536–3,749 Finns aged 15–74	All water	Swimming, fishing, boating	Increase in activity trips undertaken per unit increase of independent variable: swimming; fishing; boating. (Logit coefficient (t-ratio)). NS = Not Significant p = < 0.01 * p = < 0.05 **	Water clarity in home municipality: NS; 0.107** (2.335); NS Number of hot days: 0.041* (10.198); NS; 0.012* (3.405)

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
	common water recreation activities – swimming, fishing and boating.					

Table 3.2 Qualitative studies providing evidence of recreational benefits

Reference	Study design/ theoretical framing	Population	Type of Blue Space	Mode of interaction	Themes identified and summary passages
Aspe and Jacqué (2015)	Observation survey (772 observations) followed up with semi-structured interviews (62) and participation in 6 outings and activities organised by leisure, heritage and tourism associations. No explicit theoretical framing reported. Bourdieu used in analysis.	Users of 7 canals in the Durance Network in the south of France during the observation survey period (772). Outing participants (136)	Canals	Use of the banks and paths of the canals	'Traditional uses unique to rural ways of life ceding way to urban uses of irrigation canals' 'During the interviews conducted with people who used the canals in their youth, it became clear that until the late 1960s, users were mostly from the rural working class. People got together for fun activities, children learned to swim or gathered in groups to 'go down the canal on a raft'. The waterways were also used for predation: picking berries, fishing and hunting. People continue to swim and fish today, but these activities are relatively marginal compared to other, more prominent ones still gaining in popularity: brisk walking, mountain biking, jogging, horseback riding, hiking, as well as kayaking and inner tubing, but also outings to explore the local heritage or biodiversity. Unlike previous uses these new practices are historically and socially connected with urban uses of rural and natural areas.' 'From the culture of water to enjoying the banks: the cultural amnesia of new users' 'For this new population, the relationship with rural space is based on a lifestyle choice rather than on their place of work or on a productive relationship with the area. Strong cultural amnesia accompanies the way this population uses the banks of the canals in the sense that most of these people do not systematically associate the existence of paths with farming. It is mainly older people with rural roots that note the agricultural value of such facilities and see them as connected to water control.' 'The joy of slowness' 'The agricultural role of the canals, like the management of their water for productive purposes has been replaced by the promotion of the aesthetic and landscaped aspects of

Reference	Study design/ theoretical framing	Population	Type of Blue Space	Mode of interaction	Themes identified and summary passages
					flowing water. The presence of water is one of the main reasons that individuals choose to frequent the banks of the canals…The value placed on canals as garden spaces is connected to the quest for calm and a break at the root of which the presence of water and its aesthetic aspects (colours, sounds) are factors that define the landscape. Such aspects appear disconnected from contemporary lifestyles, and notably the hustle and flow of daily 'home-work' commutes which have not stopped increasing over the past decade… Using the banks of the canals therefore also represents a break from the rhythm associated with travelling to work, notably due to the canals' proximity to people's homes and, even more so, the peaceful environment they offer users.'
Finlay et al. (2015)	In-depth, qualitative interviews with participants of a larger cross-sectional study over 2 time points (2012 and 2013). A sit-down interview was followed by a walking interview during which observations were also made. Data was analysed using framework analysis.	27 community-dwelling older adults (65–86 years0old) from a range of neighbourhoods in Metro Vancouver, Canada	Lakes and the ocean	'Mundane everyday contact' Walking	'Everyday contact with Green and Blue Spaces' 'Many participants referred to an array of settings where they could engage in healthful activities like walking and gardening, observe pleasant scenes and feel spiritual peace. Many participants associated green and blue landscapes with enjoyable activities that provided both active and passive opportunities to 'get out' and 'enjoy life'.'…. 'These experiences were integral to many participants' efforts to build and maintain a fulfilling daily routine in retirement.'…' 'Accessibility is also based upon individual perceptions and ability levels that may influence how older people utilise outdoor spaces. Green and Blue Spaces might pose a challenge for older adults if activities in these spaces require a high level of strength, agility and stamina.' 'Proximity of resources was a major factor as many participants were not physically capable and/or financially able to drive. Many participants used public transit to access everyday services (for example, grocery stores, medical facilities, community organisations, parks). Convenience of access by walking and bus were major factors participants

Reference	Study design/ theoretical framing	Population	Type of Blue Space	Mode of interaction	Themes identified and summary passages
					associated with participation in Green and Blue Spaces, as well as quality of life.'
Ashbullby et al. (2013)	This study investigated how families engaged with beach environments in their local areas and used them in health-promoting ways. Families with children living in coastal regions of Devon and Cornwall participated in individual semi-structured interviews during the summer and early autumn of 2011. Parents and children were interviewed separately.	15 families with children between 8 and 11 years-old. They included 15 mothers and 9 fathers with 20 children (10 girls and 10 boys).	Beach	Visiting	'Physical activity and active play were key features of family beach visits for children and parents.' 'Activities that were salient for the child were not always important to the adults and vice versa. Children only took part in sedentary activities for short periods of time as breaks from other more active pursuits. ' 'The beach provided opportunities for individual family members to do different activities they enjoyed separately and conversely to avoid activities they did not enjoy. '

3.2 Physical health

3.2.1 Quantitative evidence

Physical health benefits of Blue Space

Of the 77 studies included in the review, 16 provided quantitative evidence of the physical health benefits of Blue Spaces (Table 3.3). All were academic studies retrieved from the academic literature, of which 14 had a cross-sectional research design, one had a longitudinal research design and one was a case control study. All the findings reported by the research were generated in a more economically developed context, with 6 of the investigations having taken place in England, one in Great Britain more widely, and a further one taking place across the whole of the UK. Of the remaining 9 studies, 4 took place in the Netherlands, one in Finland, one in China, one in Australia, and one in New Zealand.

Blue Space as a setting for physical activity

Collectively the data reported by the included studies provide some evidence that, in addition to being used for recreational purposes, Blue Spaces are used for physical exercise that has the potential to provide physical health benefits. In an analysis of data collected as part of the ONS Opinions and Lifestyle Survey, de Bell et al. (2017) found that 17.1% of 1,040 people surveyed in Britain indicated that exercising and keeping fit was a benefit that they had gained through the use of Blue Space.

Further case-specific evidence of the potential for Blue Spaces to support physical activity is provided in an Australian context by Koss and Kingsley (2010), who evaluated the effects of a marine survey programme on volunteers and Agency staff in Victoria. The data indicated that all of the respondents agreed that taking part in the survey had allowed them to be physically active.

There is some evidence of the intensity and duration of the physical activity that can take place in Blue Spaces. Elliot et al. (2015) used data from the 2013 to 2014 MENE survey to calculate the energy expended by visitors to different parts of the English coast. Visitors to seaside resorts were on average estimated to expend 454 MET minutes per visit,[3] while visitors to other parts of the coast were estimated to expend slightly less energy at 435 MET minutes per visit. The authors attributed this difference to people spending longer in seaside resorts while only paying shorter visits to other parts of the coast.

White et al. (2016), who also used MENE data (2009 to 2015), extended this analysis by calculating the percentage of ‘active’ visits to different Blue Spaces that included moderate and vigorous physical activity. They found that, of the 6.9% of active visits to the natural environment that took place at the beach, 4.4% involved moderate intensity activity and 2.5 % included some vigorous physical activity. Of the 4% of visits to other coastal environments, 2.4% involved moderate physical activity and 1.6% involved more vigorous exercise. And of the 11.2% of active visits to inland waters, 5.7% included moderate physical activity and 5.5% included vigorous physical activity. The majority of visits to the natural environment, however, were not defined as ‘active’, with 80.5% of them being for <30 minutes or expending <3 METS.

Further evidence that the majority of visits to Blue Space are not physically active is provided at a smaller scale and in a Dutch context by Jansen et al. (2017), who asked

[3] METs were used to examine the intensity of the activities people undertook on visits.

older residents of Maastricht and Rotterdam to wear an accelerometer for 7 days. The data generated indicate that nearly 60% of the visits that took place in Blue Spaces over that period were sedentary, while 30% included some light physical activity and just over 10% included some moderate or vigorous physical activity.

Among the population that do use Blue Spaces to be physically active there is some evidence that living close to Blue Spaces is associated with increased levels of activity. Again using MENE data, White et al. (2014) examined the relationship between people in England making active visits to the coast with the distance they lived from it. Their analysis showed a small but significant decay in the active visits made to the coast as distance to it increases.(4) Similarly, de Vries et al. (2007) undertook a neighbourhood level analysis among Dutch school children, correlating the time they spent engaged in physical activity recorded through diary entries with the built and natural characteristics of the neighbourhood they lived in. The data indicated that living in a neighbourhood that contained water features was associated with an increase in physical activity of 2.7 hours per week.

Association of Blue Space with health outcomes

Eight studies provided evidence of the effects of Blue Space on health outcomes. Of these, 4 generated data describing the relationships between Blue Space and overall health.

Using data from the nationally representative British Household Panel Survey (BHPS), White et al. (2013a) assessed the way self-reported levels of general health changed with distance to the coast. They found a small but statistically significant increase in the levels of health reported by people living within 5km of the coast compared with those living between 5km and 50km away.

This pattern of decay was repeated in findings by Wheeler et al. (2012) who, using a similar research design, used data from the 2001 Census to examine the correlation between self-reported good levels of health and proximity to the coast in England. The findings corroborated those of White et al. (2013a) by indicating that self-reported levels of good health increased with coastal proximity, although again the size of the effect was small. Despite this, the pattern also remained visible when separated out across different types of living environment. People who lived closer to the coast in an urban area, an urban fringe area or rural environment were all more likely to report higher levels of good health than those living further away in the same environment.

In a separate investigation, Wheeler et al. (2015) updated the analysis of their earlier study with data from the 2011 Census, correlating self-reported health levels against the type of natural environment people were living in as defined by land classification types. They found further small but significant associations between the levels of ‘good/very good health’ reported by people and those living close to saltwater (normally estuaries) and the coast. This pattern was matched by decreases in the levels of ‘bad/very bad health’ reported in relation to the coast, but not in people living close to saltwater.(5)

The size of the datasets used in these analyses and the reproduction of the findings by different authors using different survey data collected at different points in time suggests that the findings are likely to be robust within their national contexts.

Patterns of decline in the level of self-reported health with distance from the coast may also hold in other settings. De Vries et al. (2016) used data from a nationally representative survey sample in the Netherlands to examine the association between self-reported general health and living within 1km of the coast. The findings again demonstrated that higher levels of health were strongly correlated with living in proximity to the sea.

Three of the 8 studies considering the relationship between Blue Space and different health outcomes provided some evidence of the association between living close to an area of Blue Space and being overweight.

In a longitudinal study looking at public sector workers in Finland over a period of 10 years, Halonen et al. (2014) examined the comparative likelihood that, at the end of an eight-year follow-up, workers living at different distances from lakes, rivers or the sea would be overweight. They found that workers living between 250m and 750m away were more likely to be overweight than those living within 250m.

In an analysis that focused on the prevalence of childhood obesity in England, Wood et al. (2016) used data from the National Child Measurement Programme from 2010 to 2011 to 2012 to 2013 to identify the percentage of children at different distances from the coast who were obese. They found that the proportion of obese children living within 1km of the coast was nearly 3% lower than the mean number of obese children living more than 20km away, although no comparably significant association was found for those living between 1– 5km away and 5–20km away.

Taking a slightly different approach, Witten et al. (2008) examined the relationship between the body mass index (BMI) of respondents to the New Zealand Health Survey, the prevalence of sedentary behaviour and the likelihood that they regularly completed recommended levels of physical activity, with the length of the drive in minutes to the nearest beach. They found that, compared with people living less than 9.2 minutes' drive from the beach, there was an incremental increase in the BMI of people who lived further away. They also found an increase in the levels of sedentary behaviour reported as drive time lengthened and a decrease in the proportion of individuals completing recommended levels of physical activity.

There is some evidence of a relationship between proximity to Blue Space and the incidence of lung cancer. In a case control study conducted in Shanghai in China, Wang et al. (2016) examined the association of confirmed diagnoses of lung cancer with the characteristics of the surrounding residential environment. They found that having water within the residential area significantly reduced the likelihood of a lung cancer diagnosis.

Comparative physical health benefits of Blue and Green Space

Of the 16 studies that provided evidence of the physical health benefits of Blue Space, 12 also provided comparable evidence of the physical health benefits of Green Space. All were academic studies drawn from the academic literature, with 10 demonstrating a cross-sectional research design, one using a case control structure and one taking a longitudinal approach. Five of the 12 included studies took place in England, 4 took place in the Netherlands, one took place in China, one took place in Finland and one in New Zealand.

Comparative association of Blue and Green Space with physical activity

The majority of the evidence on which the comparison of the association Blue and Green Space with physical activity can be based has been generated at the national scale and in an English context.

White et al. (2014) used data from the MENE surveys (2009 to 2012) to compare the physical activity of participants living at different distances from both the coast and other Green Spaces. They found that while there was a small but significant increase in the levels of exercise people undertook in proximity to the coast, they were unable to identify a similar statistically significant gradient in relation to Green Space.

A more detailed examination of the characteristics of the physical activities taking place in each environment was provided by Elliot et al. (2015) who analysed data taken from the 2012 to 2013 MENE survey to determine the intensity, duration and total energy consumption of the activities people engaged in. They found that, while the intensity of activities undertaken in Green Spaces was in fact greater than that in Blue Spaces, visits to Blue Spaces were more likely to be longer and therefore more likely in total to consume a greater amount of energy.

The different types of Blue and Green Space that physical activities took place in and the proportions of different intensities of activity were examined by White et al. (2016) using data from the MENE surveys between 2009 to 2010 and 2014 to 2015. They found that all of the environments in which people were more likely to engage in moderate to vigorous physical activity, as opposed to light physical activity, were Green Spaces. These included pathways, uplands, country parks and play areas. The environments in which people were more likely to engage in light physical activity than more vigorous physical activity were farmland, open countryside, wetlands, town parks, urban open spaces, areas of inland water, beaches and other coastline.

Further evidence of the comparative intensity of the activities in which people engage in the Green and Blue Spaces they visit is provided in a Dutch context by Jansen et al. (2017), who compared the proportions of different intensities of activity by participating residents of Rotterdam and Maastricht. Approximately 60% of people's activity in Blue Spaces was categorised as sedentary, 30% was categorised as light physical activity and 10% was categorised as vigorous. In comparison, 56% of the activity recorded in recreational areas, 53% of the activity recorded in forest or moorland areas and 47% of the activity recorded in agricultural areas was categorised as sedentary. These activities were replaced by comparatively higher levels of vigorous activity. In recreational areas, approximately 12% of the activity recorded was categorised as vigorous, where as in forested or moorland areas, the proportion of vigorous activity was 18% and in agricultural areas it rose to 22%. Only parks were found to have a higher proportion of sedentary activity than was recorded in Blue Spaces, with 61% of the total activity recorded being categorised as sedentary and only 9% being categorised as vigorous activity.

Some evidence of inconsistencies in this pattern across different demographic groups is provided in a neighbourhood scale study in the Netherlands by de Vries et al. (2007), who considered the physical activity of children in different Green and Blue Spaces. They examined the correlation between the hours of physical activity undertaken by children from 20 schools with characteristics of their residential environment. Their findings revealed a level of complexity in the way spaces are used that is not so far evident in the larger scale national surveys. The data suggest that the availability of Blue Spaces was associated with a larger increase in the time the children spent engaged in physical activity than the availability of areas of Green Space generally, but that sports fields specifically were associated with a higher increase in the time spent being physically active than either of those more general types.

Comparative association of Blue and Green Space with health outcomes

Evidence of the comparative association between Green and Blue Spaces and health outcomes is reported by studies that conducted analyses across a range of different scales. In a national scale analysis of the relationship between different types of environment and self-reported good health in England, Wheeler et al. (2012) used data from the 2001 Census to compare the outcomes reported at different proximities to the coast with increasing levels of Green Space in a residential environment. The data demonstrated that there was a higher percentage increase in the number of people reporting good health with increased proximity to the coast than with increased amounts of Green Space.

This national scale pattern was also identified in the Netherlands where de Vries et al. (2016) used a nationally representative survey sample to examine the association between self-reported general health and Green and Blue Spaces. They found a stronger association with self-reported health among people living within 1km of a Blue Space than they did for people living within 1km of a Green Space.

In an update to their analysis, Wheeler et al. (2015) used data from the 2011 Census to separate out the effects of the natural environment on self-reported health levels by specific types of Green and Blue Space. The data pointed to a more complex relationship than that of the 2 previous surveys. While living in proximity to an environment categorised as saltwater was associated with the highest increase in self-reported good health, living close to a wooded or forested area was more highly associated with increases in self-reported good health than living in proximity to the coast.

Two further studies investigated the relationship between Blue and Green Spaces and being overweight. Witten et al. (2008) conducted an analysis of the association between the drive time of residents in a New Zealand neighbourhood to both the beach and the nearest park. They found that, while residents who lived less time away from the beach were more likely to have a lower BMI, less likely to engage in sedentary behaviour and more likely to complete recommended levels of physical activity, there was no comparable statistically significant relationship with drive time to the park.

Similarly, in a longitudinal analysis of Finnish public sector workers, Halonen et al. (2014) examined the relationship between living in proximity to Blue Space and being overweight. They found that, at the eight-year follow-up point, of those workers that had not moved during the study period, there was an increased likelihood of being overweight among those living between 250m and 750m away than there was for those living less than 250m away. By comparison, no statistically significant relationship was found among workers living at different distances from a park, sports area or nature conservation area. In further evidence of the complex patterns that may exist in this area, however, the data for workers who had moved during the study period showed an increased likelihood of being obese among those who had moved to a distance greater than 250m from a park, sports area or nature conservation area compared with those who had moved to within 250m. Conversely no comparable statistically significant association was found with Blue Spaces.

There is also some evidence of the association between Green and Blue Spaces and other health outcomes. Wang et al. (2016) compared the correlation between incidences of lung cancer in Shanghai residents and both Green and Blue Spaces. They found that, while having Blue Space in a residential neighbourhood was associated with a drop in the cases of lung cancer, having trees was associated with a greater decrease.

In a separate investigation into the effects of different natural spaces on the rate of suicide in the Netherlands, Helbich et al. (2018) examined the differences in the suicide rate at different distances from Green and Blue Spaces. They found that, while there was a statistically significant reduction in the rate of suicide in areas with higher levels of Green Space, there was no comparable statistically significant trend in the case of Blue Space, although a reduction was visible in the data that were collected.

3.2.2 Qualitative evidence

Qualitative evidence of the interaction between Blue Spaces and physical health was provided by 5 studies (Table 3.4). Together these studies draw on a range of qualitative methods from a variety of epistemological positions to generate a diverse body of evidence.

Finlay et al. (2015) conducted 27 in-depth interviews with the older residents of a neighbourhood of Vancouver in Canada in an enquiry that aimed to draw out the way older people make use of Green and Blue Spaces during their everyday lives. A key theme to emerge from the data was that the participants viewed both Blue and Green Spaces as environments that offered them the opportunity to take part in physical activities that they might otherwise not have access to.

This theme was also present in the data of Ashbullby et al. (2013) who conducted semi-structured interviews with the children and parents of 15 families in southwest England to consider the way they used the spaces provided by beaches. They found that the opportunities beaches afforded families were crucial to the children's ability to run around and take part in physical activities.

Völker and Kistemann (2013, 2015) considered the way Green and Blue Spaces might be used differently by people engaged in physical activity. In an analysis of over 100 semi-structured interviews with the users of both the Rhine promenade and green parks in Dusseldorf and Cologne in Germany, they found that comparatively the users of the promenade spent more time looking around and appreciating their environment than the users of the parks, who tended to be more intensely focused on the task in hand and less distracted by the scenery around them.

Taking a different methodological approach, Foley (2015, 2017) considered the embodied experiences of 20 open water swimmers in Ireland, adopting an oral history approach to interviewing them. One of the key findings to emerge from the conversations was the way the swimmers perceived the physical health benefits of the activity they were engaged in. The swimmers considered that swimming had beneficial physical health effects for them, including one individual who perceived that it had made a difference to the severity of their arthritis. But these claims were tempered by an understanding of the potential health dis-benefits of going swimming in the sea, particularly in relation to the effects of the cold.

Table 3.3 Quantitative studies providing evidence of physical health benefits

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
White et al. (2014)	This cross – sectional study used the MENE dataset to conduct a spatial analysis to correlate distance from coast with survey answers.	183,755 English participants in Natural England's MENE survey (2009 to 2012)	Coast	30 or more minutes of physical activity	Physical activity (OR) with CIs)	'The associations for both <1km (OR = 1.08, 95% CI 1.03, 1.14) and 1-5km (OR = 1.04, 95% CI 1.00, 1.08) in the adjusted models were significant.' 'There was no equivalent Green Space gradient although the most and third greenest areas were associated with slightly higher odds than the least green area.'
de Vries et al. (2007)	This cross – sectional study correlated hours of activity undertaken per week (assessed by diary entries) against neighbourhood characteristics.	422 Dutch children aged 6–11 years living in the selected neighbourhoods were recruited from 20 elementary schools (2 schools per neighbourhood)	Water	Play	Change in the number of hours per week of physical activity with an increase of one unit in the particular factor of the built environment, adjusted for other factors in the model (95% CI) (p = < 0.05 – non-significant results excluded)	Water = 2.662 (1.453, 3.871) Sports fields = 2.804 (1.555, 4.052) Proportion Green Space/buildings = 0.075 (0.024, 0.125)
Elliott et al. (2015)	This cross – sectional study used MENE data (2013 to 2014) to determine intensity of physical activity during visits to Green and Blue Spaces.	71,603 randomly selected English adults over the age of 16	Seaside resort Other coast	Various activities	Change in intensity of activity (MET minutes) compared with urban Green Space as reported in Fully Adjusted Model 1 (regression coefficients and 95% CIs)	Seaside resort: -0.17 (-0.20, -0.14) Other coast: -0.09 (-0.13, -0.05) Countryside: 0.04 (0.03, 0.06) p < 001
					Change in visit duration compared to urban greenspace as reported in Fully Adjusted Model 1 (regression	Seaside resort :14.87 (12.41, 17.34) Other coast: 9.80 (6.31, 13.30) Countryside: 3.39 (2.05, 4.74) p < 001

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
					coefficients and 95% CIs)	
					Physical activity undertaken by location: activity intensity (METs), duration (minutes); energy expenditure (MET minutes) (mean average (SD)	Seaside resort: 3.32 (1.07); 140.37 (112.24); 454.41 (403.22) Other coast: 3.41 (1.16); 127.17 (107.19); 434.56 (426.06) Urban greenspaces: 3.52 (1.14); 98.88 (88.98); 342.24 (336.21) Countryside: 3.58 (1.18); 106.99 (99.14); 394.11 (416.64)
White et al. (2016)	This cross-sectional study analysed 6 waves (2009 to 2010 – 2014 to 2015) of MENE survey data to determine the intensity of physical activity undertaken in different natural environments.	280,790 English adults	Inland waters Beach Other coastline	Various activities	Type of environment visited (moderate intensity visits, vigorous intensity visits (% total population (SD))	Beaches = 4.4 (0.2), 2.5 (0.3) Other coast = 2.4 (0.1), 1.6 (0.2) Inland waters = 5.7 (0.1), 5.5 (0.5) Town parks = 23.4 (0.4), 20.7 (0.9) Play areas = 3.7 (0.1), 3.9 (0.2) Open space towns = 5.1 (0.1), 5.1 (0.8) Allotments = 0.4 (0.0), 0 (0) Country parks = 6.5 (0.2), 6.7 (0.3) Woodlands = 8.8 (0.2), 7.0 (0.4) Open countryside = 7.2 (0.6), 5.8 (0.3) Farmland = 4.0 (0.1), 2.9 (0.4) Uplands = 1.5 (0.1), 2.6 (0.5) Pathways = 4.5 (0.1), 14.9 (0.7)
Jansen et al. (2017)	Cross-sectional. Randomly selected participants were asked to wear an Actigraph GT3X+ accelerometer (for 7 consecutive	Dutch general population adults aged 45–65 (N = 279) recruited from 4 neighbourhoods in Rotterdam and Maastricht. Mean	'Blue Space' (for example, lakes, rivers, water in parks, seas)	Physical activity	Physical activity intensity per visit (% of total visits to each environment (mean)) (sedentary behaviour, light physical activity, moderate to vigorous physical activity)	Blue Space 59.6, 30.0, 10.4 Parks: 61.4, 29.6, 9.0 Recreational areas: 56.1, 31.5, 12.4 Agricultural green 47.1, 31.1, 21.8 Forest & moorland: 52.9, 29.4, 17.7

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
	days during waking hours).	age was 57.1 years, and a little more than half of the sample was female. Almost half of participants were overweight or obese, and most had a middle or higher education.			Change in light physical activity compared with a park in different natural environments (regression coefficient (B1), CI (lower; upper))	Blue Space: 3.51 (0.59; 6.59) p =-0.020 Recreational areas: 5.32 (0.53; 9.86) p = 0.023 Agricultural green: 3.98 (1.25; 6.62) p = 0.004 Forest & moorland: 4.99 (1.11; 8.99) p = 0.013
de Bell et al. (2017)	Cross-sectional study based on ONS Opinions and Lifestyle Survey. Each month, 2,010 addresses are selected and one person over 16 in each household was interviewed. Response rates are typically 50–60%. The survey runs for 8 months of the year; a module was commissioned in the May 2015 survey for which the response rate was 56%, resulting in a sample of 1,043.	1,040 British people over the age of 16	Rivers, canals and lakes and their immediate surroundings, including river paths, canal paths and lakeside walks	Exercising or keeping fit	Indicated benefit of visits to Blue Space by % of total respondents	Exercise or keeping fit: 17.1%

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
Koss and Kingsley (2010)	This cross-sectional study used questionnaires comprising 90 Likert Scale questions distributed in November 2008 to January 2009 to investigate the attitudes of Sea Search volunteer and Agency staff towards their health and well-being during monitoring sessions. The research aimed to assess if there was a difference in attitude between community volunteers and those who are involved in higher level decision-making.	271 Australian participants responded to both questionnaires. Males in the 46–60 age bracket were the most prevalent for both questionnaires, whereas females in the 18–30 and 31–45 age groups responded most frequently in the national and Victorian questionnaires respectively	Marine environment (sea)	Citizen Science Marine Survey Programme participation	To what extent do you agree that Sea Search participation programme allowed volunteers to be active?	'There was complete agreement that the Sea Search program allowed volunteers to be active specifically in their Marine Protected Area (MPA) ($U = 543.5$, $z = -1.481$, $p = 0.139$, $r = 0.16$, $n = 77$, $Md = 1.00$)'
White et al. (2013a)	This cross-sectional analysis used BHPS data on self-reported health from individuals living at different distances from the coast in	The measure of general health was included in 17 of the 18 waves and analysis is based on an estimation sample of 109,844	Coast	Proximity	Self-assessed general health by proximity to the coast. 'Please think back over the last 12 months about how your health has been.	'Living ≤5km from the coast was associated with better general health ($p = 0.028$) than living between >5 and 50km from the coast. The estimated benefits to general of living ≤5km, rather than >5–50km from the coast is 0.039 scale points, which represent 4.2% of one standard deviation on these scales.'

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
	England. The BHPS was a nationally representative longitudinal survey of households in the UK that ran annually from 1991 to 2008. It contained over 5,000 households and 10,000 individual adults, and used data collection techniques which maintained representativeness over time.	observations from 15,471 individuals. Mental distress was measured in all 18 waves and resulted in an estimation sample of 114,133 observations from 15,361 individuals. Mental well-being, as measured by life satisfaction, was only collected in 12 waves resulting in analysis of 74,121 observations from 12,360 individuals.			Compared to people of your own age, would you say that your health has on the whole been ...', 'very poor' (1) to 'excellent' (5).	
Wang et al. (2016)	This case control study undertook a survey of lung cancer patients and a control group in 2014 and 2015. A total of 472 interviewees are randomly selected within a pool of local residents who had resided in Shanghai for more than 5 years. Data were collected including their sociodemographic	472 participants, including 202 incident cases of lung cancer and 270 controls. Controls are selected among normal people attending the hospital for physical examinations who are unrelated to respiratory disorders. Cases and controls were randomly selected with the entire	Water body	Proximity	Correlation of cases (versus controls) of diagnosed lung cancer with having a water body in a residential area B (standard error, SE) 95% CI	Water body: -1.673 (0.76) 0.04, 0.83 (water body inside residential areas are associated with lower lung cancer prevalence) Tree: -2.427 (1.15) 0.01, 0.85

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
	factors, lifestyle factors, and external and internal residential area factors. Regression models were established based on collected data to analyse the associations between lung cancer and urban spatial factors in 156 case control pairs.	data to conduct a frequency matched case control study by age (±7.5 years) and gender. The final study population comprised a total of 312 samples with 156 matched pairs.				
Wheeler et al. (2015)	This cross-sectional study used data on land cover type, bird species richness, water quality and protected or designated status to create small-area	English population as captured by the 2011 Census	Saltwater Coastal	Living within associated land classification as defined by the UK Land Cover Map for 2007	% change in the directly age/sex standardised 'good/very good health' prevalence associated with a percentage point increase in land cover share of the relevant environment type	Saltwater: B = 0.074 95% Cl = 0.032,0.117 p = 0.001 Coastal: B = 0.019 95% Cl = 0.010,0.027 p = <0.001 Broadleaf woodland: B = 0.032 95% Cl = 0.029,0.035 p = <0.001 Arable and horticulture: B = 0.004 95% Cl = 0.002,0.005 p = <0.001 Improved grassland: B = 0.016 95% Cl = 0.014,0.018 p = <0.001

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
	environmental indicators across Great Britain. Associations between these indicators and age/sex standardised prevalence of both good and bad health from the 2011 Census were assessed using linear regression models. Models were adjusted for indicators of socioeconomic deprivation and rurality, and also investigated effect modification by these contextual characteristics.				% change in the directly age/sex standardised 'bad/very bad health' prevalence associated with a percentage point increase in land cover share of the relevant environment type	Coastal: B. = -0.011 95% CI-0.016,-0.006 p = <0.001 Broadleaf woodland: B. = -0.009 95% CI -0.011,-0.007 p = <0.001 Arable horticulture: B. = -0.001 95% CI -0.002,-0.000 p = 0.001 Improved grassland: B. = -0.006 95% CI -0.007,-0.005 p = <0.001
Halonen et al. (2014)	In this longitudinal study, Finnish public sector workers were surveyed every 4 years since 2000 at all participating organisations. This study used data for those cohort participants who responded to a survey at	Finnish public sector workers in 10 towns and 6 hospital districts employed for a minimum of 6 months in the participating organisations between 1991 and 2005. These employees covered a wide	Lake, river or sea	Proximity	Odds of being overweight at the end of eight-year follow-up period compared with those living <250m from urban blue/green area in 5,820 participants who did not move over the survey period	Distance = 500–750m Lake, river or sea: OR: 1.24 (95% CI 1.01, 1.52) (significant) Neighbourhood with park, sports area or nature conservation area: OR = 0.99 (95% CI 0.84, 1.18) (non-significant) Distance = >750m Neighbourhood with park, sports area or nature conservation area:: OR = 1.50 (95% CI 1.07, 2.11) (significant) Lake, river or sea: OR:1.15 (95% CI 0.94 1.39) (non-significant)

<table>
<tr><th>Reference</th><th>Study design</th><th>Population</th><th>Type of Blue Space</th><th>Mode of interaction</th><th>Outcome(s) assessed</th><th>Main result</th></tr>
<tr><td></td><td>baseline in 2000 (response rate 68%) and at follow-up in 2008 (or in 2009, if participant was no longer employed by a study organisation in 2008) (response rate 69%, N = 535,213).</td><td>range of occupations, from city mayors and doctors to semiskilled cleaners, nurses and teachers forming the largest groups. 15,621 of them did not move residence (non-movers) during the follow-up, and 9,696 did (movers).</td><td></td><td></td><td>Odds of being obese at the end of eight-year follow-up for those who had moved to >250m from urban Blue/Green Space compared with those that had not (1,545 participants who had moved further away (change from <250m to >250m)</td><td>Neighbourhood with park, sports area or nature conservation area: OR1.49 (95% CI 1.08 2.06) (significant)

Lake, river or sea OR: 1.09 (95% CI 0.79 1.50) (non-significant)</td></tr>
<tr><td>Wheeler et al. (2012)</td><td>This cross-sectional study used 2001 Census data for England (N = 48.2 million), to analyse the relationship between rates of self-reported ‘good’ health and residential proximity to the coast for urban, urban fringe and rural residents. To determine coastal proximity, they used a GIS to calculate the linear</td><td>Data were obtained for England’s 32,482 LSOAs indicating the proportion of the population answering ‘good’ to the question ‘Over the last 12 months would you say your health has on the whole been: Good; Fairly good; Not good? Total included populations are 26,455 urban residents, 3,081 town/fringe</td><td>Coast</td><td>Proximity</td><td>% difference in the age/sex standardised number of people reporting good health compared to those living furthest away (>50km) by type of environment.</td><td>
<table>
<tr><th></th><th colspan="3">URBAN (N = 26,455)</th></tr>
<tr><th></th><th>B</th><th>95% CI</th><th>N</th></tr>
<tr><td>Distance to coast (km)</td><td></td><td></td><td></td></tr>
<tr><td>>50</td><td>0</td><td>-</td><td>10,098</td></tr>
<tr><td>>20-50</td><td>0.54</td><td>(0.46, 0.62)</td><td>8,096</td></tr>
<tr><td>>5-20</td><td>0.63</td><td>(0.53 ,0.73)</td><td>3,571</td></tr>
<tr><td>>1-5</td><td>0.96</td><td>(0.85, 1.06)</td><td>3,133</td></tr>
<tr><td><1</td><td>1.13</td><td>(0.99, 1.27)</td><td>1,557</td></tr>
</table>
<table>
<tr><th></th><th colspan="3">TOWN/FRINGE (N = 3,081)</th></tr>
<tr><th></th><th>B</th><th>95% CI</th><th>N</th></tr>
<tr><td>Distance to coast (km)</td><td></td><td></td><td></td></tr>
<tr><td>>50</td><td>0</td><td>-</td><td>1,023</td></tr>
<tr><td>>20-50</td><td>0.04</td><td>(-0.20, 0.28)</td><td>898</td></tr>
<tr><td>>5-20</td><td>0.43</td><td>(0.16, 0.71)</td><td>620</td></tr>
<tr><td>>1-5</td><td>0.89</td><td>(0.54, 1.25)</td><td>303</td></tr>
<tr><td><1</td><td>1.19</td><td>(0.79, 1.59)</td><td>237</td></tr>
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<table>
<tr><th>Reference</th><th>Study design</th><th>Population</th><th>Type of Blue Space</th><th>Mode of interaction</th><th>Outcome(s) assessed</th><th>Main result</th></tr>
<tr><td></td><td>distance from the population-weighted centroid of each Lower Layer Super Output (LSOA) to its nearest coastline. Coastal proximity was divided into bands chosen to represent comparative geographical accessibility and inferring from this potential frequency/intensity of ‘exposure’ to coastal environments: 0–1km; >1–5km; >5–20km; >20–50km; >50km.</td><td>residents and 2,946 rural residents.</td><td></td><td></td><td></td><td>
<table>
<tr><th></th><th colspan="3">RURAL (N = 2946)</th></tr>
<tr><th></th><th>B</th><th>95% CI</th><th>N</th></tr>
<tr><td>Distance to coast (km)</td><td></td><td></td><td></td></tr>
<tr><td>>50</td><td>0</td><td>-</td><td>870</td></tr>
<tr><td>>20-50</td><td>0.22</td><td>(0.01, 0.42)</td><td>990</td></tr>
<tr><td>>5-20</td><td>0.41</td><td>(0.17, 0.64)</td><td>705</td></tr>
<tr><td>>1-5</td><td>0.73</td><td>(0.41, 1.05)</td><td>317</td></tr>
<tr><td><1</td><td>-0.09</td><td>(-0.69, 0.51)</td><td>64</td></tr>
</table>
</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>% difference of people reporting good health by % land area classified as greenspace (quintile 1 = least area of Green Space; quintile 5 = most area of Green Space)</td><td>
<table>
<tr><th></th><th colspan="3">URBAN (N = 26455)</th></tr>
<tr><th></th><th>B</th><th>95% CI</th><th>N</th></tr>
<tr><td>% greenspace by area</td><td></td><td></td><td></td></tr>
<tr><td>Quintile 1a</td><td>0</td><td>–</td><td>5,291</td></tr>
<tr><td>Quintile 2</td><td>-0.02</td><td>(-0.13, 0.08)</td><td>5,291</td></tr>
<tr><td>Quintile 3</td><td>-0.01</td><td>(-0.11, 0.10)</td><td>5,291</td></tr>
<tr><td>Quintile 4</td><td>0.23</td><td>(0.13, 0.33)</td><td>5,291</td></tr>
<tr><td>Quintile 5</td><td>0.36</td><td>(0.26, 0.47)</td><td>5,291</td></tr>
</table>
<table>
<tr><th></th><th colspan="3">TOWN/FRINGE (N = 3081)</th></tr>
<tr><th></th><th>B</th><th>95% CI</th><th>N</th></tr>
<tr><td>% greenspace by area</td><td></td><td></td><td></td></tr>
<tr><td>Quintile 1a</td><td>0</td><td>–</td><td>617</td></tr>
<tr><td>Quintile 2</td><td>0.13</td><td>(-0.17, 0.43)</td><td>616</td></tr>
<tr><td>Quintile 3</td><td>0.15</td><td>(-0.14, 0.45)</td><td>616</td></tr>
<tr><td>Quintile 4</td><td>0.49</td><td>(0.19, 0.79)</td><td>616</td></tr>
<tr><td>Quintile 5</td><td>0.69</td><td>(0.39, 0.99)</td><td>616</td></tr>
</table>
</td></tr>
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Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
						RURAL (N = 2946) B / 95% CI / N % greenspace by area Quintile 1a 0 – 590 Quintile 2 0.14 (-0.12, 0.40) 589 Quintile 3 0.31 (0.04, 0.57) 589 Quintile 4 0.25 (-0.03, 0.52) 589 Quintile 5 0.59 (0.30, 0.88) 589
Witten et al. (2008)	In this cross-sectional study, access to parks and beaches measured in minutes taken by a car, was calculated for 38,350 neighbourhoods nationally using GIS. Multilevel regression analyses were used to establish the significance of access to these recreational amenities as a predictor of BMI, and levels of physical activity and sedentary behaviour in the participants.	12,529 participants, living in 1,178 neighbourhoods, of the New Zealand Health Survey 2002 to 2003.	Beach	Distance to drive	Change in BMI by quintile of time taken to drive to beaches, where closest quartile is the independent variable (B values, 95% CI)	Beaches <9.2 minutes (N = 3,009) = 0 9.2–17.0 minutes (N = 3,101) = 0.06 (0.01, 0.11) 17.0–31.8 minutes (N = 2,897) = 0.11 (0.06, 0.15) >31.8 minutes (N = 2,226) = 0.13 (0.07, 0.18) Parks No significant data
					Change in sedentary behaviour by quintile of time taken to drive to beaches, where closest quartile is the independent variable. (B values, 95% CIs)	Beaches <9.2 minutes (N = 3, 317) = 1 9.2–17.0 minutes (N = 3,428) = 1.37 (1.10, 1.70) Parks No significant data
					Change in completion of recommended levels of physical activity by quintile of time taken to drive to beaches, where closest quartile is the independent variable. (B values, 95% CI)	Beaches <9.2 minutes = 1 9.2–17.0 minutes 0.74 (0.64, 0.85) 17.0–31.8 minutes 0.85 (0.74, 0.98) Parks No significant data

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
Wood et al. (2016)	This cross-sectional study considered childhood obesity in relation to proximity to the coast, using data from England's National Child Measurement Programme (NCMP). The NCMP is run annually by the Health and Social Care Information Centre and measures the weight and height of children between the ages of 4–5 and 10–11 years in England. The latest 3 years of NCMP data were combined (2010 to 2011 (N = 495,353), 2011 to 2012 (N =491,118) and 2012 to 2013 (N =489,146)) and analysed at the Census Middle-Layer Super Output Area level.	The study population (N = 1,475,617) were children aged between 10-11 years, with childhood obesity prevalence (BMI ≥ 95th percentile) as the outcome.	Coast	Proximity	Change in childhood obesity when compared with mean childhood obesity rates > 20km from coast (B values, 95% CI)	0–1km: -2.786 (-4.089, -1.484) (significant) >1–5km: -0.592 (-1.271, 0.086) (not significant) >5–20km: 0.166 (-0.330, 0.662) (not significant)

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
de Vries et al. (2016)	This cross-sectional study sought to investigate whether Green and Blue Space availability is negatively associated with anxiety and mood disorders and positively associated with self-reported mental and general health. Health data were derived from a nationally representative survey (NEMESIS-2, N =6,621), using a diagnostic interview to assess disorders. Green and Blue Space availability were expressed as percentages of the area within 1km from one's home.	6,540 Dutch-speaking people aged 18–64 recruited from the general Dutch population by a multistage, stratified random sampling procedure. The baseline wave was conducted between November 2007 and July 2009 and included 6,646 participants. The sample was nationally representative of a range of sociodemographic variables, although younger people were somewhat underrepresented.	All water	Proximity	% change in self-reported general health (SF-36) per 1% change in population living with 1km of Blue Space (OR, 95% CI) ** significant at $p < 0.01$	Blue Space (%): 0.092** (0.030, 0.153) Green Space (%): 0.051** (0.020, 0.083)

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main result
Helbich et al. (2018)	This study used a cross-sectional, ecological design to analyse officially confirmed deaths by suicide between 2005 and 2014 per municipality in the Netherlands. Indexes are calculated to measure the proportion of Green and Blue Space per municipality and the coastal proximity of each municipality using a GIS. Bayesian hierarchical Poisson regressions were fitted to assess associations between suicide risk, Green Space, Blue Space and coastal proximity, adjusted for risk and protective factors.	16,105 members of the Dutch population who committed suicide between 2005 and 2014	Cells classified as freshwater or saltwater by the Dutch land use database 2007 Shoreline	Registered suicide within the same municipality	Change in number of suicides by index level of Green and Blue Space (medium and high compared to low) (relative risk estimates (95% CI)) NS = not significant	Green Space (versus low) Mid 0.919 (0.846–0.998) High 0.879 (0.779–0.991) Blue Space (versus low) Mid 0.990 (0.927–1.057) NS High 0.937 (0.861–1.019) NS
					Change in number of suicides by index level of coastal proximity (medium and high compared to low) (relative risk estimates (95% CI)) NS = not significant	Coastal proximity (versus low) Mid 0.965 (0.898–1.035) NS High 0.932 (0.823–1.052) NS

Table 3.4 Qualitative studies providing evidence of physical health benefits

Reference	Study design/ theoretical framing	Population	Type of Blue Space	Mode of interaction	Themes identified and summary passages
Finlay. et al. (2015)	In-depth, qualitative interviews with participants of a larger cross-sectional study over 2 time points (2012 and 2013). A sit-down interview was followed by a walking interview during which observations were also made. Data were analysed using framework analysis.	27 community-dwelling older adults (65–86 years-old) from a range of neighbourhoods in in Metro Vancouver, Canada	Lakes and the ocean	'Mundane everyday contact' Walking	'Physical well-being' 'Green and Blue Spaces promoted participation in physical activity for most participants …. 'Blue Space provided opportunities for physical activity alternatives to walking and other weight-bearing activities. This enabled some participants to maintain their activity level in to older age…. 'These places offered multisensory enjoyment, including the sounds of moving water, tranquil surroundings and opportunities in warmer weather to physically experience the water(for example, dipping one's fingers or feet in the water) …. 'Participants used both Green and Blue Space destinations as reasons to 'get out the door'. This was for both social reasons (described later) and a desire to 'keep the joints moving' to combat mobility deterioration.'
Foley (2015, 2017).	The research is drawn from a wider oral historical study of coastal and inland swimming spots. The methodology incorporated a mix of observer participation and responses from swimmers, informed by non-representational theories methods that focused on a witnessing that 'aims to generate data infused with a fidelity or authenticity to happenings, relaying as much as possible of their character and action'. To date 24 interviews with 20 different swimmers, with core empirical material drawn from 4 specific accounts. The interviews were conducted through an oral history approach, which encouraged an open life course narrative of the swimmer's life, that for this paper, draws from the more health and place oriented content.	20 swimmers in Ireland	Sea	Swimming	'Immersive therapeutic practices and outcomes' 'Specific therapeutic benefits are identified or perceived by respondents. Swimming has historically been identified as having active benefits in terms of the treatment of a range of specific chronic conditions, such as rheumatism, arthritis and skin conditions (Author, 2010). Respondent T (Guillemene) stated in a fairly typical comment, 'Since I started coming here around 10 years ago, the arthritis in my legs has gone away, and I think it's the swimming that does that'. Other comments focus on aspects of strength and fitness at different stages of a swimmer's life.' 'Identifiable healing outcomes also emerge from accounts that, while acknowledging potential benefits, do not do so entirely uncritically. There is a counter-intuitiveness to swimming in cold water on cold days, especially when one has a cold. Respondents monitor their swimming in a way that reflects their personal understanding of their own health status. As they note, it doesn't always work and at times, the cold becomes an

Reference	Study design/ theoretical framing	Population	Type of Blue Space	Mode of interaction	Themes identified and summary passages
	Commentaries from secondary sources, including newspapers, radio interviews and social media pages contextualised the sites as presented to a wider public. Observer participation was conducted at the 2 sites from 2012 to 2014. The sites were visited at different daylight hours (depending on the season), an hour at a time, to get a sense of how the spaces themselves were conducive to affective and healthy encounters.				active deterrent as both affective force and potential health risk.'
Völker and Kistemann (2015)	This study conducted qualitative semi-standardised interviews (N = 113) asking which differences in well-being occurred when visiting urban Green Space and Blue Spaces in high density areas of the inner city in Dusseldorf and Cologne, Germany. Visitors to 4 research areas, one Blue Space and one Green Space in each of the cities selected were canvassed in situ with a short questionnaire between 7am and 8pm weekdays from May to September 2011.	113 visitors to Dusseldorf and Cologne, Germany. Interviewees ranged from 17 to 91 years of age and males were slightly over-represented when compared with the city population.	River	Use of the promenade	'Physical activity and active play were key features of family beach visits for children and parents.'
Ashbullby et al. (2013)	This study investigated how families engaged with beach environments in their local areas and used them in health promoting ways. Families with children living in coastal regions of Devon and Cornwall participated in individual semi-structured interviews during the summer and early autumn of 2011. Parents and children were interviewed separately.	15 families with children between 8 and 11 years-old. They included 15 mothers and 9 fathers with 20 children (10 girls and 10 boys).	Beach	Visiting	'Physical activity and active play were key features of family beach visits for children and parents.' 'Physical health benefits' 'The open space of the beach was viewed as crucial to being able to let children run around and take part In a range of physical activities.'

3.3 Mental health

3.3.1 Quantitative evidence

Mental health benefits of Blue Space

Of the 77 studies eligible for inclusion in the review, 20 studies provided quantitative evidence of the Mental Health benefits of being able to access Blue Space (Table 3.5). Sixteen of those studies were academic investigations drawn from the academic literature and 4 were survey reports taken from the grey literature. Seventeen of the included studies adopted a cross-sectional research design, while one presented data from a cohort of individual participants, one presented data from a longitudinal analysis of its participants and one was a meta-analysis of the data presented in 10 other studies, none of which are included separately here.

Association of Blue Space with overall mental health

The data generated by the included studies provide some evidence that interacting with Blue Spaces can have an impact on both people's overall mental health and their sense of how happy they are.

Using data from the ONS Opinions and Lifestyle Survey, de Bell et al. (2017) examined the benefits that people who used Blue Spaces reported gaining from the experience. The data showed that approximately 40% of respondents felt they had gained some form of psychological benefit.

There is also some evidence that this effect may be present within other national contexts. Völker et al. (2018) conducted a questionnaire survey with residents of 2 German cities, one with relatively good Blue Space provision (Gelsenkirchen) and one with much poorer Blue Space provision (Bielefeld). They demonstrated that, while there was a statistically significant relationship between improved mental health and visits to Blue Spaces in respondents from Gelsenkirchen, the same statistically significant relationship was not present in the data of respondents from Bielefeld.

The importance of the accessibility of Blue Spaces to people's mental health has also been considered in an English context. White et al. (2013a) used data from the BHPS to examine the relationship between self-assessed levels of overall mental health and living in proximity to the coast. Their analysis showed that, when compared with those living over 50km away, there was a small but marginally significant association between better levels of self-reported mental health and living within 5km of the coast.

Alcock et al. (2015) used data taken from the same survey to separate out this effect by different types of coastal environment. Specifically, their analysis explored the correlations between mental health as assessed through the General Health Questionnaire (GHQ) score and residence in different land classifications. They found that, while there was an association between improved mental health and living in a coastal environment, there was a negative correlation between mental health and living in proximity to an area of saltwater – normally an estuary.

Association of Blue Space with feelings of happiness and positive and negative moods

Seven of the studies provided evidence that the use of Blue Spaces can have an impact on both people's wider sense of their own well-being in relation to their levels of happiness, and to their moods. Taking a GPS-based methodological approach, MacKerron and Mourato (2013) used a mobile phone application to track the location of

participants across the UK and to prompt them to report their self-assessed levels of happiness at regular daily intervals. Their analysis demonstrated that people's level of self-reported happiness increased substantially when they were in coastal or marine environments and also, to a lesser extent, when they were in a freshwater, wetland or floodplain location.

The MENE surveys between 2009 to 2010 and 2012 to 2013 provide further evidence that, at the national scale in England, visitors to a range of Blue Spaces felt some level of enjoyment during the time that they spent there. However, the levels of enjoyment reported vary considerably across the 4 surveys and demonstrated a mix of trends that make it difficult to draw any firm conclusions from the data (Natural England 2010, 2011, 2012, 2013).

There is also some evidence that the effect of Blue Spaces on people's mood can be connected to the type of activities they use them for. The effect of undertaking exercise in natural environments specifically was considered by Barton and Pretty (2010) who synthesised the data of 10 studies that looked at the effects of Green Exercise in England. They found that participating in exercise in a waterside environment had a significantly positive effect on both people's mood and their self-esteem.

There is some evidence that these findings also hold in different national settings and at different scales. In evidence drawn from a more case-specific investigation, Koss and Kingsley (2010) asked the volunteer and professional participants of a marine-based survey programme in Victoria, Australia, to assess how participating in the programme had made them feel. The data showed that respondents felt that participating in the programme had made them feel good and increased their sense of calmness.

Evidence that this type of effect can also be found in children is provided by Huynh et al. (2013), who examined the relationship between assessed levels of positive emotional well-being in over 17,000 Canadian schoolchildren with the percentage of their neighbourhood classed as Blue Space. The data, presented by quartiles, broadly demonstrated an increase in positive emotional well-being as the proportion of Blue Space increased, although the relationship was not linear.

Association between Blue Space and restoration, relaxation and distress

Eight of the studies provided evidence of the potential for Blue Spaces to have restorative effects on the people who use them, and for it to affect changes in their states of relaxation and distress.

Using data taken from the 2009 to 10 and 2010 to 2011 MENE surveys, White et al. (2013b) investigated the relationship between visits to Blue Space and the levels of recalled restoration among those surveyed. They found a small but significant increase in the levels of restoration among those who had visited the coast and that the size of this effect increased slightly when compared with o those who had visited the countryside.

Data from the 2011 to 2012 and 2012 to 2013 MENE surveys also provide some evidence that people who used Blue Spaces experienced some level of restorative effect. Approximately 30–40% of the people interviewed found it to be either a relaxing and calming experience, and/or a refreshing one (Natural England 2012, 2013).

The same pattern is identified in a Finnish context by Korpela et al. (2010), who analysed data from a longitudinal study that examined the association between people's stated favourite places and the levels of restoration they experienced when visiting them. Their analysis found that, among those participants who had cited a favourite place in a waterside environment, there was an identifiable restorative effect.

Investigating a slightly different mode of interaction between Blue Space and people's mental health, Nutsford et al. (2016) examined the association between the visibility of Blue Space from various neighbourhoods in Wellington, New Zealand, and levels of psychological distress. They found that as visibility increased measures of psychological distress decreased.

Association between Blue Space, stress and anxiety and depression

Four of the studies provided evidence of the effects of Blue Space on symptoms of stress, anxiety and depression. De Vries et al. (2016) used data from a nationally representative survey of the Dutch population to consider the relationship between residential proximity to Blue Space and the percentage of the population with an anxiety disorder. They found that people living within 1km were less likely to report having an anxiety disorder than those living further away.

Generaal et al. (2015) used data from the Netherlands Study of Depression and Anxiety to examine the association between diagnosed cases of anxiety and depression with the amount water in an individual's neighbourhood. In contrast to the results of de Vries et al. (2016) described above, they found an increase in the cases of anxiety and depression together and depression on its own as the percentage of land covered by water rose.

Similarly, in a study conducted in the Catalonia region of Spain, Triguero-Mas et al. (2015) used data from the Catalonian Health Survey to examine the relationship between living in proximity to Blue Space and indicators of mental health. They found that living in proximity to Blue Space was more highly associated with a perceived risk of being in poor mental health, more highly associated with a perceived risk of depression and/or anxiety, and more highly associated with visits to see a mental health specialist.

There is some evidence that the effect of Blue Space on people's mental health can vary according to specific sets of circumstances. In a Lithuanian study, Balseviciene et al. (2014) examined the relationship between the distance that parents lived from a natural pond and the levels of parenting stress they experienced. The data demonstrated no significant correlation. However, they also then conducted a secondary analysis that split the participants into smokers and non-smokers. These data demonstrated that, while there was no significant correlation between the distance to a natural pond and parenting stress in non-smoking parents, there was a relationship for those parents that smoked.

Association between Blue Space and behavioural problems

A single study examined the association between Blue Space and the behavioural problems of children. Amoly et al. (2014) conducted a questionnaire survey with the parents of over 2,000 children aged between 7 and 10 years-old in Barcelona, Spain. They found that, as the children's beach attendance increased, the levels of behavioural problems reported in relation to them decreased.

Comparative mental health benefits of Green and Blue Space

Of the 20 studies that provided quantitative evidence of the effects of Blue Space on mental health, 16 also provided comparable evidence of the effects of Green Space. Twelve of those studies were academic investigations drawn from the academic literature and 4 were survey reports taken from the grey literature. Fourteen of the studies used a cross-sectional research design, one was a meta-analysis of 10 studies (none of which are included separately here) and one presented longitudinal data.

Comparative association of Green and Blue Space with overall mental health

Four of the studies presented comparable data of the relationship between Blue and Green Spaces and overall measures of mental health.

Triguero-Mas et al. (2015) used data from the Catalonian Health Survey to investigate the relationship between living in proximity to Blue Spaces, living in proximity to Green Spaces and overall levels of surrounding greenness, with respondent's perceived risk of poor mental health, their perceived levels of anxiety and depression, and the number of visits to a mental health specialist. Their analysis indicated that, although living in proximity to Blue Spaces showed no significant association with any of the 3 indicators, having access to Green Spaces and the overall levels of surrounding greenness were both associated with a significant reduction in all three.

Similar patterns of difference were demonstrated by de Vries et al. (2016), who used data from a nationally representative Dutch survey to consider the associations between self-assessed levels of overall mental health and living in proximity to both Blue and Green Spaces. The data indicate that, while living within 1km of an area of both Blue and Green Spaces is associated with an improvement in mental health, the effect is stronger in relation to Green Space than it is for Blue Space.

Both these sets of findings are in contrast with those of Huynh et al. (2013), who examined the relationship between the positive emotional well-being of over 17,000 Canadian school children with the proportions of Green and Blue Space in their neighbourhoods. They found that, while positive emotional well-being increased in relation to the proportions of Blue Space in a neighbourhood, no comparably significant association was apparent in the relationship with levels of Green Space.

Alcock et al. (2015) considered the way these effects are differentiated across different types of Blue and Green Space. Their analysis spatially correlated data from the BHPS with land classification data to examine the association between mental health and different residential environments. They found a mixed and inconclusive difference between Green and Blue Spaces. Mental health scores increased the most in areas categorised as improved grassland, then areas categorised as coastal and then areas categorised as mountainous. Areas categorised as saltwater (estuarine) demonstrated a reduction in mental health scores.

Comparative association of Green and Blue Space with feelings of happiness and positive and negative moods

Six of the studies provided evidence of the comparative association of Blue and Green Spaces with feelings of happiness and positive and negative moods.

In a UK-based study, MacKerron and Mourato (2013) provided evidence of a complex set of associations using a GPS-based method to track the location of study participants and to ask them to report their levels of happiness at regular intervals throughout the day. The data were correlated against land classifications to identify the way people's reported levels of happiness varied according to the environment they were in. The data showed that people reported being happiest in coastal or marine environments, followed in descending order of the strength of the effect by mountains, woodland, grassland, farmland and then freshwater environments.

Barton and Pretty (2010) revealed a similar order of effects from a meta-analysis of studies examining the effects of Green Exercise in England. The data showed that participants undertaking exercise experienced the greatest degree of improvement in their mood in a waterside environment, followed by people undertaking exercise in forested and wooded environments, wild habitats, areas of urban green and the countryside.

Four MENE surveys conducted between 2009 to 2010 and 2012 to 2013 provide some comparative evidence of the levels of enjoyment people felt during their visits to Blue and Green Space locations in England. However the nature of the data collected, the variability of the data at each data point over the different years of the survey and changes to the categories of natural environment examined across the surveys make it difficult to draw out any reliable trends or patterns without any further data analysis (Natural England 2010, 2011, 2012, 2013).

Comparative association of Green and Blue Spaces with restoration, relaxation and distress

Seven of the studies provided evidence of the comparative effects of Green and Blue Spaces on feelings of restoration, relaxation and distress.

White et al. (2013b) used MENE data to examine the levels of restoration that people recalled experiencing during their visits to both Blue and Green Space settings in England. Their analysis revealed that people who visited the coast recalled experiencing a greater degree of restoration than people who visited an urban Green Space. However when compared with the levels of restoration experienced by those visiting the countryside, the greatest degree of restoration was recalled by those visiting areas of beach and woodland.

A similar pattern was revealed by Korpela et al. (2010), who undertook a longitudinal survey with residents of the 2 largest cities in Finland to examine the levels of restoration people experienced from their favourite places. They found that people who reported having a favourite place located in a waterside environment experienced greater feelings of restoration than people whose favourite place was in an urban green setting.

Nutsford et al. (2016) examined the association between the degree to which Blue and Green Spaces were visible from various locations in the neighbourhoods of Wellington, New Zealand, and the levels of psychological distress experienced by residents. They found that, while increased levels of visibility to Blue Spaces were associated with a reduction in levels of psychological distress, the data revealed no comparable relationship with the visibility of Green Spaces.

Four MENE survey reports provided evidence of the comparative levels of relaxation and refreshment experienced by people during visits to a mixture of both Green and Blue Spaces. However, the nature of the data collected, the variability of the data at each data point over the different years of the survey and changes to the categories of natural environment examined across the surveys make it difficult to draw out any reliable trends or patterns without any further data analysis (Natural England 2010, 2011, 2012, 2013).

Comparative association of Blue and Green Space with stress and anxiety and depression

Four of the studies provided mixed evidence of the comparative effects of Blue and Green Spaces on diagnoses of anxiety and depression and symptoms of stress. De Vries et al. (2016) used data from a nationally representative Dutch survey to examine the relationship between living in proximity to Blue and Green Spaces and having a diagnosed anxiety disorder. They found that, while living in proximity to both Blue and Green Spaces was associated with a reduction in the number of anxiety disorders, the effect was slightly stronger in among those living in proximity to Green Spaces than it was in relation to those living in proximity to Blue Spaces.

Similarly Bezold et al. (2018) considered the association between Blue and Green Spaces and symptoms of depression. Using data from participants in the American Growing Up Today study, they examined the correlation between living in proximity to

Blue and Green Spaces and symptoms of high depression. They found that, while living in proximity to Green Spaces was associated with a reduction in cases of depression, there was no comparably significant relationship among those living in proximity to Blue Spaces.

This effect was demonstrated again in a Spanish context by Triguero-Mas et al. (2015), who used data from the Catalonian Health Survey to examine the relationship between self-perceived risk of depression and living in proximity to Blue and Green Spaces and overall measures of surrounding 'greenness'. They found that, while living in proximity to Green Spaces and in an environment that contained higher levels of green vegetation, were both associated in reduced levels of people's perceived risk of depression and anxiety, living in proximity to Blue Spaces was not associated with any statistically significant pattern.

Data from a study in the Netherlands demonstrated a statistically significant association between living in proximity to Blue Spaces and an increase in the diagnosed cases of depression. Using data from the Netherlands Study of Depression and Anxiety, Generaal et al. (2018) correlated current diagnoses of depression and anxiety together, and anxiety on its own, against the percentage of land covered by water in individual neighbourhoods. Their analysis indicated that, as the percentage of land covered by water increased, the number of currently diagnosed cases of depression and anxiety also increased. The data revealed no comparable pattern in relation to those living in proximity to Green Spaces.

Comparative association between Green and Blue Space and behavioural problems

A single study compared the association of Blue and Green Spaces with the behavioural problems of children. Amoly et al. (2014) conducted a questionnaire survey with the parents of over 2,000 children aged between 7 and 10 years-old in Barcelona, Spain. They found that, while children's beach attendance, time spent in Green Spaces and living in proximity to a Green Space were all correlated with a decrease in the levels of children's behavioural problems, this effect was strongest among those who spent time in Green Spaces then those who spent time at the beach, and then those who lived in proximity to a Green Space.

3.3.2 Qualitative evidence

Five of the studies included in the review provided qualitative evidence of the way interacting with Blue Spaces can affect people's mental health (Table 3.6). In an investigation of the embodied nature of people's experiences in coastal environments in Ireland, Foley (2015, 2017) used an oral history approach to interview 20 older people who regularly went swimming in the sea at 2 coastal locations. The conversations that he had with the swimmers who participated in the study revealed that a number of those who regularly used the area suffered with one or more mental health conditions and that, for them, going swimming in the sea was considered to have beneficial therapeutic effects.

Similar findings were identified by Caddick et al. (2015) in an investigation of the way surfing courses might function as an intervention for ex-service personnel suffering with post-traumatic stress disorder (PTSD) in the USA. Data from 24 semi-structured interviews revealed that a key outcome of the surfing courses was the way in which they allowed the participants to push any traumatic issues that may have been dealing with into the back of their minds, creating a subjective sense of freedom from the condition.

The ability of Blue Spaces to influence the way people were able to manage unwanted thoughts in this way also emerged from a study in Cornwall. Using an interpretive

mixed methods approach to examine the way Blue and Green Spaces might influence people's well-being, Bell et al. (2015) undertook 9 interviews with participants in a range of settings that they considered to be therapeutic. The analysis revealed that, while in proximity to the coast, interviewees felt a greater sense of calmness than they did in other places and that they were able to reduce or control the amount of 'noise' in their minds, allowing them to reflect more deeply than might otherwise have been the case. This sensation was considered to be a part of the wider immersive experience of being in a coastal environment where the dynamic nature of the processes taking place provided constant sensory stimulation. The sound of moving water in particular was linked to the way in which participants were able to feel refreshed and restored through during the time that they were there.

Ashbullby et al. (2013) identified similar feelings of relaxation, calmness and restoration as being important benefits of the use of beach settings by families in Cornwall. Using semi-structured interviews with 15 sets of parents and children, they considered the way families used the beaches they were visiting and whether there might be any health benefits of them doing so. The analysis found that the beach environment had an important restorative effect on the families that took part and that, in common with the findings of Bell et al. (2015) described above, this effect could be connected to the sound of the waves coming onshore. The analysis also identified that the feelings of fun, joy and happiness experienced by different members of the families in the beach environment, both from being within the setting itself but also by utilising the spaces afforded by it to take part in various types of physical activity, were important psychological benefits.

In an examination of the way the residents of Chevington in Suffolk used the coastal environment local to them, Cairns-Nagi and Bambra (2013) identified the importance of being able to use the space for purposes of relaxation and restoration. Their analysis also drew out a strong sense that the respondents valued the coastal environment for the feelings of freedom that they experienced when they were in it.

Table 3.5 Quantitative studies providing evidence of mental health benefits

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
MacKerron and Mourato (2013)	In this cross-sectional analysis prospective participants downloaded the Mappiness app at no charge. They were then signalled (beeped) at random moments during their daily lives from mid-August 2010 to mid-February 2011, at a frequency and during hours they choose (twice a day between 8am and 10pm). They were asked to report the extent to which they were feeling 'happy' on a continuous sliding scale. Each response was associated with 3 key spatial and environmental indicators using the GPS location data.	21,947 UK participants were self-selecting and recruited opportunistically, assisted by coverage in traditional and social media. Participants owned an iPhone and self-selected into the study. This ruled out obtaining a probability sample, or even one that was representative on observable characteristics	Marine and coastal margins Freshwater, wetlands and flood plains	Unknown	Happiness reported. Coefficient of comparison against 'continuous urban' (SD) ** p < 0.01 *** p < 0.001	Marine and coastal margins: 6.02*** (0.68) Freshwater, wetlands and flood plains: 1.80** (0.63) Mountains, moors and heathland: 2.71** (0.87) Woodland: 2.12*** (0.34) Semi-natural grasslands: 2.04*** (0.35) Enclosed farmland: 2.03*** (0.24) Suburban/rural developed: 0.88*** (0.16) Inland bare ground: 0.37 (0.47) NB: The model was re-estimated using only responses received on weekends and public holidays, when the great majority of respondents are 'on vacation' in the sense that they are presumably free to engage in leisure activities. This restriction reduced the response sample size by about two-thirds. All least common multiple (LCM) type coefficients remained positive. Coefficients on all Green and Blue Space types were reduced somewhat in magnitude, and those on the 'mountains, moors, and heathlands' and 'freshwater, wetlands, and floodplains' types were no longer significantly different from zero at the 5% level.
MENE 2009 to 2010 (Natural England 2010)	This cross-sectional survey undertook home interviews with a representative sample of the English adult population (aged 16 and over) between March 2009 and February 2010. A sample of at least 800	800 English adults (over 16 years) per week	River, lake, canal; beach Other coastline	Visiting	Reported outcomes of visits by destination %: I enjoyed it; It made me feel calm and relaxed;	Seaside resort or town: 54; 25; 34; 32; 23; 7 Seaside coastline: 61; 44; 47; 47; 42; 20 Town or city: 42; 32; 27; 26; 21; 10 Countryside: 53; 37; 33; 34; 27; 8

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
	was achieved across at least 100 sample points per week.				It made me feel refreshed and revitalised; I took time to appreciate my surroundings; I felt close to nature I learned something about the natural world.	
MENE 2010 to 2011 (Natural England 2011)	This cross-sectional survey undertook home interviews with a representative sample of the English adult population (aged 16 and over) between March 2010 and February 2011 with a sample of at least 800 achieved across at least 100 sample points per week.	800 English adults (over 16 years) per week	River, lake, canal Beach Other coastline	Visiting	Reported outcomes of visits by destination %: I enjoyed it; It made me feel calm and relaxed; It made me feel refreshed and revitalised; I took time to appreciate my surroundings; I felt close to nature I learned something about the natural world.	Seaside resort or town: 54; 43; 41; 49; 33; 19 Seaside coastline: 48; 43; 35; 39; 37; 15 Town or city: 40; 27; 26; 23; 14; 9 Countryside: 49; 33; 32; 35; 30; 8
MENE 2011 to 2012 (Natural England 2012)	This cross-sectional survey undertook home interviews with a representative sample of the English adult population (aged 16	800 English adults (over 16 years) per week	River, lake, canal Beach Other coastline	Visiting	Reported outcomes of visits by destination %: I enjoyed it;	Seaside resort or town: 58; 39; 41; 45; 34; 10 Seaside coastline: 38; 30; 29; 30; 19; 9 Beach: 49; 34; 38; 33; 23; 4 Other coastline: 46; 30; 30; 44; 23; 16 River lake of canal: 44; 36; 42; 33; 33; 16

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
	and over) between March 2011 and February 2012 with a sample of at least 800 achieved across at least 100 sample points per week.				It made me feel calm and relaxed; It made me feel refreshed and revitalised; I took time to appreciate my surroundings; I felt close to nature I learned something about the natural world.	Town or city: 39; 27; 25; 24; 19; 8 Countryside: 44; 36; 34; 30; 29; 13 Country park: 49; 34; 32; 32; 35; 11 Farmland :51; 30; 40; 36; 21; 10 Mountain or moorland: 68; 53; 55; 52; 45; 10 Other open space in countryside: 52; 44; 39; 40; 39; 15 Other open space in town: 38; 21; 30; 25; 21; 2 Park in town: 34; 29; 21; 21; 16 7 Path; cycleway or bridleway: 38; 32; 33; 33; 22; 8 Children's playground: 57; 41; 27; 21; 17; 29 Playing field/other recreation area: 41; 20; 23; 13; 20; 8 Village: 42; 33; 34; 27; 20; 7 Woodland/forest :56; 43; 45; 47; 33; 16
MENE 2012 to 2013 (Natural England 2013)	This cross-sectional survey undertook home interviews with a representative sample of the English adult population (aged 16 and over) between March 2012 and February 2013 with a sample of at least 800 achieved across at least 100 sample points per week.	800 English adults (over 16 years) per week.	River, lake, canal; beach; other coastline	Visiting	Reported outcomes of visits by destination %. I enjoyed it; It made me feel calm and relaxed; It made me feel refreshed and revitalised; I took time to appreciate my surroundings; I felt close to nature I learned something about the natural world.	Beach: 50; 25; 31; 25; 23; 5 Other coastline: 55; 49; 48; 28; 18; 12 River lake of canal: 49; 28; 31; 28; 25; 5 Country park: 43; 32; 35; 18; 27; 3 Farmland: 63; 32; 28; 30; 29; 12 Mountain or moorland: 85; 65; 52; 62; 46; 23 Other open space in countryside: 58; 45; 31; 20; 26; 8 Other open space in town: 45; 27; 27; 23; 12; 5 Park in town: 37; 26; 22; 20; 11; 5 Path; cycleway or bridleway: 46; 38; 33; 22; 21; 6 Children's playground: 49; 44; 24; 24; 37; 6 Playing field/other recreation area: 42; 26; 29; 22; 19;4 Village: 37; 19; 16; 18; 12; 3 Woodland/forest: 69; 37; 38; 36; 29; 10

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
Koss and Kingsley (2010)	This cross-sectional study used questionnaires with 90 Likert Scale questions distributed in November 2008 to January 2009 to investigate Sea Search volunteer and Agency staff attitudes towards their health and well-being during monitoring sessions. The research aimed to assess if there was a difference in attitude between community volunteers and those who are involved in higher level decision-making.	271 Australian participants responded to both questionnaires. Men in the 46–60 age bracket were the most prevalent for both questionnaires, whereas women in the 18–30 and 31–45 age groups responded most frequently in the national and Victorian questionnaires respectively.	Marine environment (sea)	Participation in Citizen Science Marine Survey Programme	To what extent do you agree that Sea Search participation make you feel good emotionally and mentally?	Sea Search volunteers agreed that they feel good emotionally and mentally during an activity (U = 491, z = - 0.698, p = 0.485, r = 0.08, n = 64, Md = 1.00) (not significant)
					To what extent do you agree that being in the marine environment during an activity is peaceful and gives a sense of calm?	Search volunteers also agreed that being in the marine environment during an activity is peaceful and gives a sense of calm (U = 525.5, z = - 0.666, p = 0.947, r = 0.08, n = 65, Md = 1.00) (not significant)
White et al. (2013a)	This cross-sectional analysis used BHPS data on self-reported health from individuals living at different distances from the coast in England. The BHPS was a nationally representative longitudinal survey of households in the UK that ran annually from 1991 to 2008. It contained over 5,000 households and 10,000 individual adults, and used data collection techniques which	The measure of general health was included in 17 of the 18 waves and analysis is based on an estimation sample of 109,844 observations from 15,471 individuals. Mental distress was measured in all 18 waves and resulted in an estimation sample of 114,133 observations from 15,361 individuals.	Coast	Proximity	Self-assessed mental health by proximity to the coast	Living ≤5 km from the coast was associated with better mental health (p = 0.023) than living between >5 and 50 km from the coast. There was also evidence of a marginally significant association between lower mental health and living over 50km from the coast compared with living >5 to 50 km from the coast (p = 0.059). The estimated benefits to mental health of living ≤5km, rather than >5–50 km from the coast is 0.147 scale points respectively, which represents 5.1% of one standard deviation on these scales.

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
	maintained representativeness over time	Mental well-being, as measured by life satisfaction, was only collected in 12 waves resulting in analysis of 74,121 observations from 12,360 individuals.				
de Bell et al. (2017)	Cross-sectional study based on ONS Opinions and Lifestyle Survey. Each month, 2,010 addresses are selected and one person over 16 in each household is interviewed. Response rates are typically between 50% and 60%. The survey runs for 8 months of the year; a module was commissioned by the authors in the May 2015 survey for which the response rate was 56%, resulting in a sample of 1,043.	1,043 British people over the age of 16	Rivers, canals and lakes and their immediate surroundings, including river paths, canal paths and lakeside walks	Visiting	Indicated benefit of visit to Blue Space (% of total respondents)	Psychological benefits 39.6%
de Vries et al. (2016)	This cross-sectional study sought to investigate the hypotheses that Green and Blue Space availability are negatively associated with anxiety and mood disorders, and	6,540 Dutch-speaking people aged 18–64 recruited from the general Dutch population by a multistage, stratified random sampling	All water	Proximity	% change in population with any anxiety disorder per 1% change in population living with 1km (OR, 95% CI)	Blue Space (%): 0.991* (0.983, 0.999) Green Space (%): 0.983* (0.967, 1.000)

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
	positively associated with self-reported mental and general health. Health data were derived from a nationally representative survey (NEMESIS-2, N = 6,621), using a diagnostic interview to assess disorders. Green and Blue Space availability was expressed as percentages of the area within 1km from one's home.	procedure. The baseline wave was conducted between November 2007 and July 2009, and included 6,646 participants. The sample was nationally representative of a range of sociodemographic variables, although younger people were somewhat underrepresented.			*, **: significant at p < 0.05, p < 0.01 respectively	
					% change in population with any mood disorder per 1 % change in population living with 1km of Blue Space (OR, 95% CI) *, **: significant at p < 0.05, p < 0.01 respectively	Blue Space (%): 0.970** (0.952, 0.989)
					% change in population with any common mental disorder per 1% change in population living with 1km of Blue Space (OR, 95% CI) *, **: significant at p < 0.05, p < 0.01 respectively.	Blue Space (%): 0.984** (0.973, 0.995)

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
					% change in self-reported mental health (SF-36) score per 1% change in population living with 1km of Blue Space (OR, 95% CI) **, ***: significant at $p < 0.01$, $p < 0.001$ respectively	Blue Space (%): 0.082*** (0.037, 0.128) Green Space (%): 0.034** (0.011, 0.057)
Nutsford et al. (2016) (6)	This cross-sectional study investigated whether increased visibility of nature (Green and Blue Space) was associated with lower psychological distress (Kessler Psychological Distress Scale K10 scores) in Wellington, the capital city of New Zealand. Spatial data on Green Spaces and oceanic Blue Spaces were compiled from 3 national datasets. Visibility measures were generated for population-weighted centroids of meshblocks, called viewpoints hereafter, in which study participants	442 Wellington adults 15 years and older	Ocean and some freshwater	Visibility	Change in K10 score for every 10% increase in Green and Blue Space visibility (regression analysis β coefficient, p, 95% CI)	Blue Space: -0.28, p = 0.001 (-0.41 -0.15) Green Space : -0.09, p = 0.455 (-0.32 0.14) (not significant)

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
	resided. K10 scores were obtained for Wellington adults (N = 442, 15 years and older) who participated in the 2011 to 2012 New Zealand Health Survey.					
Völker et al. (2018)	This cross-sectional analysis among 1,041 urban residents examined the associations between self-reported walking distance to and use of freshwater urban Blue Space and health-related quality of life in 2 German cities: a city with 'poor' urban Blue Space supply (Bielefeld; 0.8% Blue Space) and one with 'better' urban Blue Space supply (Gelsenkirchen; 3.0% Blue Space). Individual level data were sourced from a questionnaire mailed in November 2012 to a sample of 6,243 adults aged 18–93 in highly urbanised statistical districts in Bielefeld (N = 3,145) and Gelsenkirchen (N = 3,098).	The sample was drawn randomly from the central register of persons in each city. 1,041 persons or 17% of the original sample answered the questionnaire. Bielefeld N = 625 (20%); Gelsenkirchen N = 416 (14%)	In Bielefeld ponds, lakes and creeks. In Gelsenkirchen ponds, lakes and rivers/canals	Visiting	Association between Blue Space visits and self-assessed mental health scores (OR, SE) * p < 0.05; ** p < 0.01	Gelsenkirchen only:−1.46 (0.50) ** (shows an association of Blue Space use with mental health) Bielefeld only : 0.46 (0.34) (not significant)

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
Alcock et al. (2015)	This cross-sectional analysis linked aggregate land cover classes of the Land Cover Map 2007 to rural residential areas (LSOAs) and then to rural participants (N = 2,020) in the 18-year longitudinal BHPS. Random effects regression of mental health (as measured by GHQ12 scores) against land cover was then conducted.	Sample consisted of 2,020 individuals drawn from the larger BHPS who: (a) were resident in English rural neighbourhoods (that is, areas classified by morphology as 'Village and Dispersed', as opposed to either 'Small Town and Fringe' or 'Urban' by ONS in 2005); and (b) had full data on the outcome and predictor variables, for at least one wave.	Coast	Residence in land cover classification	Change in GHQ score for every 1% increase in land cover, by land cover type	Coastal: 1.463, p = 0.019 Saltwater: -0.346, p = 0.035 Improved grassland: 2.363, p = 0.005 Mountain: 1.116, p = 0.027
Amoly et al. (2014)	This cross-sectional study (BREATHE project) investigated the impact of contact with Green and Blue Spaces on indicators of behavioural development and symptoms of attention deficit hyperactivity disorder in schoolchildren. Data collection was carried out between January 2012 and March 2013.	2,111 schoolchildren (7–10 years of age) from 36 schools in Barcelona	Beaches	Spending time at the beach	Change in SDQ difficulty score with increases in time spent in Green/Blue Space / residential proximity. Residential proximity = living within 300m of a major Green Space	Change in SDQ score Green Space playing time: -4.8 (-8.6, -0.9)** Annual beach attendance: -3.9 (-7.2, -0.4)** Residential proximity: -1.3 (-8.2, 6.2)

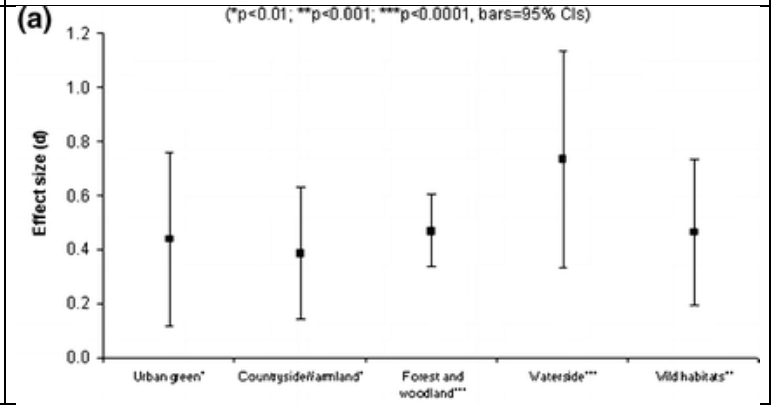
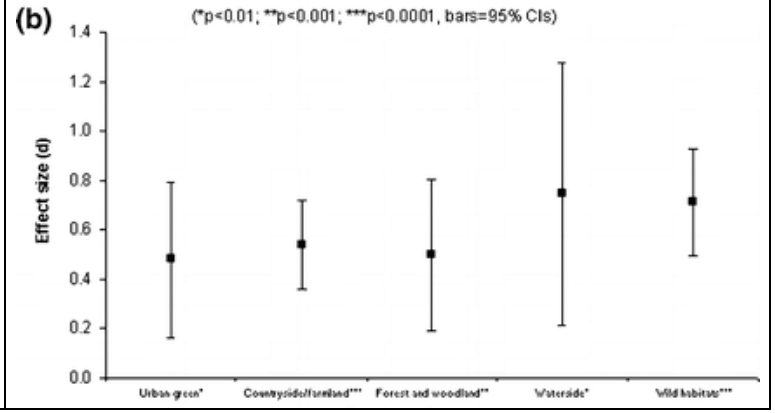
Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
	Parents filled out questionnaires on sociodemographic and household characteristics, time spent playing in Green and Blue Spaces, and behaviour of children. A Strengths and Difficulties Questionnaire (SDQ) total difficulties score (range: 0–40) was calculated with higher scores indicating more behavioural problems.				* p < 0.1, **p < 0.05	
Triguero-Mas et al. (2015)	This cross-sectional study investigated the association between natural outdoor environments and its possible mediators and modifiers. Data from adults interviewed in Catalonia (Spain) between 2010 and 2012 as part of the Catalonia Health Survey were correlated with indicators of surrounding greenness and access to natural outdoor environments within 300m of the residence and degree	8,793 adult residents of Catalonia in Spain	Inland and non-inland water bodies	Proximity	Increase in health indicator per increase in population within 300m Blue Space (Incidence Ratio, 95% CI) *p = <0.05	Perceived risk of poor mental health: 1.13 (0.86, 1.49) Perceived depression and/or anxiety: 1.13 (0.90, 1.41) Visits to mental health specialists: 1.30 (0.92, 1.84) Intake of tranquilisers or sedatives: 0.85 (0.61, 1.17) Intake of antidepressants: 0.84 (0.59, 1.19) Intake of sleeping medication: 0.95 (0.69, 1.31)
					Increase in health indicator per increase in surrounding greenness (Incidence Ratio, 95% CI) *p value = <0.05	Perceived risk of poor mental health: 0.79 (0.71, 0.88)* Perceived depression and/or anxiety: 0.81 (0.75, 0.88)* Visits to mental health specialists: 0.80 (0.69, 0.92)* Intake of tranquilisers or sedatives: 0.88 (0.79, 0.99)* Intake of antidepressants: 0.80 (0.71, 0.91)* Intake of sleeping medication: 0.89 (0.79, 0.99)*

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
	of urbanisation were derived for residential addresses.				Increase in health indicator with increase in access to Green Spaces (Incidence Ratio, 95% CI) *p value = <0.05	Perceived risk of poor mental health: 0.93 (0.79, 1.09) Perceived depression and/or anxiety: 0.86 (0.76, 0.98)* Visits to mental health specialists: 0.79 (0.63, 0.98)* Intake of tranquilisers or sedatives: 0.93 (0.78, 1.11) Intake of antidepressants: 0.87 (0.72, 1.05) Intake of sleeping medication: 1.03 (0.86, 1.24)
Generaal et al. (2018)	This cross-sectional study examined whether objectively obtained socioeconomic, physical and social aspects of the neighbourhood in which persons live are associated with the presence and severity of depressive and anxiety disorders. Data were from the Netherlands Study of Depression and Anxiety including participants (N = 2,980) with and without depressive and anxiety disorders in the past year. Data of neighbourhood factors were retrieved from national registration organisations. Baseline characteristics were compared between subjects with and	At baseline (2004–2007), persons with a range of psychopathology were included: from those without a depressive or anxiety disorder to those with a current, first or recurrent (in the past year) depressive or anxiety disorder and those with a remitted disorder (at baseline, a depressive and/or anxiety disorder was diagnosed in the past, but no diagnoses were present in the year before baseline). Exclusion criteria were not being fluent in Dutch and a primary clinically	Inland water, sea and (large) lakes	Proximity	Association between % water land cover in neighbourhood and current diagnoses of depressive and anxiety disorders. (OR, 95% CI) *p ≤ 0.05	Blue Space: 1.13 (1.02, 1.25)* (Blue Space = more mental health problems) Green Space: 0.97 (0.83, 1.12)
					Association between % water land cover in neighbourhood and current diagnoses of depressive disorders. (OR, 95% CI) *p ≤ 0.05	Blue Space: 1.13 (1.01, 1.26)* (Blue Space = more mental health problems) Green Space: 0.94 (0.80, 1.12)
					Association between % water land cover	1.16 (1.04, 1.29)** (Blue Space = more mental health problems)

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results	
	without depressive and/or anxiety disorders using appropriate statistical tests.	overt diagnosis of other psychiatric (for example, diagnosis of psychotic, obsessive-compulsive, bipolar or severe addiction) disorder.			in neighbourhood and current diagnoses of depressive disorders. (OR, 95% CI) **p ≤ 0.01		
					Association between % water land cover in neighbourhood and the severity of depressive, symptoms. (OR, 95% CI) *p ≤ 0.05	0.04 (0.00002, 0.08)* (Blue Space = more mental health problems)	
Huynh et al. (2013)	This cross-sectional study was based on the Canadian 2009 to 2010 Health Behaviour in School-aged Children Survey with linked GIS data. Features of the natural environment were extracted using GIS within a 5km radius circular buffer surrounding each school. Multilevel logistic regression was used to examine the relationship between the presence of public	Following exclusions, the sample included 17,249 (grades 6–10, mostly ages 11–16) students from 317 schools. Students who lived beyond a one-hour travel distance from school were excluded as the 5km residential space surrounding school had less relevance to their	Water bodies such as oceans, lakes, rivers, streams	Proximity of school attendance	Association between quartiles of % land cover of Blue/Green Space (where quartile 1 has the least %) and positive emotional well-being. Relative risk (95% CI)	Blue Space: All Quartile:1: 1.00 2: 1.02 (0.97-1.07) 3: 1.06 (1.01-1.11) 4: 1.04 (0.99-1.09 P trend = 0.04 Small city: Quartile:1: 1.00 2: 1.11 (1.02-1.20) 3: 1.15 (1.07-1.24) 4: 1.14 (1.05-1.22) p trend = 0.008	Green Space: All Quartile:1: 1.00 2: 0.98 (0.93-1.03) 3: 1.03 (0.98-1.08) 4: 1.01 (0.96-1.06) P trend = 0.34 Small city: Quartile:1: 1.00 2: 1.05 (0.95-1.15) 3: 1.10 (1.01-1.18) 4: 1.07 (0.98-1.15) p trend = 0.11

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results	
	natural space (features include Green and Blue Spaces such as parks, wooded areas, and water bodies) and students' reports of positive emotional well-being, while controlling for salient covariates and the clustered nature of the data.	living environment. Additionally, students attending the 82 schools with missing Green Space information were excluded. This resulted in a total of 22,171 students in 354 schools being available for study. On removal of missing data for other key variables, the final sample was 17,249 students in 317 schools.				Metropolitan Quartile:1: 1.00 2: 1.01 (0.93-1.09) 3: 1.10 (1.02-1.18) 4: 1.07 (0.96-1.18) p trend = 0.02	Metropolitan Quartile:1: 1.00 2: 0.98 (0.87-1.08) 3 1.03 (0.92-1.13) 4: 1.04 (0.92-1.15) p trend = 0.23
Bezold et al. (2018)	This cross-sectional study investigated the association between greenness (vegetation), Blue Space and depressive symptoms among adolescents in the USA. Greenness exposure was characterised using the Normalised Difference	9,385 participants aged 12–18 included in the 1999 wave of the Growing Up Today Study.	Perennial surface water bodies and coasts Swamps were excluded	Proximity	High depressive symptoms associated with the presence of: all water types; coast; interior water (yes/no) (OR, 95% Cl) NS = not significant	All water types = 0.92 (0.66,1.28) NS Coast only = 0.29 (0.04, 2.01) NS Interior water only = 0.99 (0.71, 1.37) NS	

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
	Vegetation Index (NDVI) at a 250m and 1,250m radius around a subject's residence and Blue Space as the presence of Blue Space within 250–1,250m radius. Logistic regression models were used to examine associations with high depressive symptoms.				High depressive symptoms associated with a one interquartile range increase in greenness measured by peak and average annual NDVI at 1,250m (OR, 95% CI) NS = not significant	Peak NDVI = 0.88 (0.79, 0.98) Average annual NDVI = 0.90 (0.83, 0.99)
White et al. (2013b)	This cross-sectional study investigated feelings of restoration (calm, relaxed, revitalised, refreshed) recalled by individuals after visits to different natural environments. Data were drawn from Natural England's MENE survey from 2009 to 2011.	4,255 individuals interviewed as part of the MENE survey who had visited the natural environment at least once in the previous week.	Coast River, lake, canal Beach	Visiting	Increase in recalled restoration associated with visits to different categories of environmental space (β) p = < 0.05*	Coast = 0.04* Urban green = -0.05*
					Increase in recalled restoration associated with visits to different types of environmental space when compared to open countryside (β)	Beach = 0.07** Coast = 0.05* Playing field = -0.05* Farmland = 0.04* Woodlands/forests = 0.07** Hill/moor/mountain = 0.06**

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
					p = < 0.05* p = < 0.01**	
Barton and Pretty (2010)	This multi-study analysis assessed the best regime of dose(s) of acute exposure to Green Exercise required to improve self-esteem and mood (indicators of mental health). The research used a meta-analysis methodology to analyse 10 UK studies involving 1,252 participants. Outcomes were identified through a priori subgroup analyses, and dose−responses were assessed for exercise intensity and exposure duration.	1,252 individuals; (individuals choosing to engage in Green Exercise activities; individuals at National Trust sites; visitors to care farms; students; members of local mind association; individuals at urban flower show; young offenders; individuals responsible for allotments)	Waterside	Exercise	Combined intervention effects on self-esteem	
					Combined intervention effects on mood	

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
Balseviciene et al. (2014)	This cohort study examined the associations between parenting stress, children's mental health and Green Spaces for smoking and non-smoking mothers. Data were obtained from the Kaunas cohort study. Participants were sent questionnaires by mail (Parenting Stress index – short form Lithuanian version; SDQ Lithuanian version). Spatial land cover datasets for Kaunas city were obtained from the municipality and were processed using ArcGIS 10 software to produce the Green Space classification.	573 mothers of children of ages between 4 and 7 who did not smoke.	Rivers and natural ponds	Proximity	Association of Parenting Stress with distance to natural water or ponds	Distance to natural water pond β = -0,002 t = -0,056 p = 0,955 Distance to Green Spaces β = 0,050 t = 1,167 p = 0,244 (No associations found)
		72 mothers of children of ages between 4 and 7 who did not smoke Mothers of children of ages between 4 and 7 who smoked.	Rivers and natural ponds	Proximity	Association of parenting stress with distance to natural water or ponds	Distance to natural water pond: β = -0.239 t = -2.131 p = 0.037 (association found)
Korpela, et al. (2010)	This longitudinal study investigated the reliability and stability of favourite place selections and evaluations of place attachment over a 10-month period. A mail questionnaire was used to gain responses around people's favourite places and a follow-up survey 10 months later gauged	1,273 respondents representative of the population of the 2 largest cities in Finland between the ages of 15 and 75.	Beaches and harbour areas	Selection as favourite place	Means of restorative outcomes (ROS) by favourite place type (confidence intervals of the mean are included). Numbers under the bars represent the frequency of mentioning the	Graph removed for copyright purposes

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
	the degree to which these had changed.				favourite place type	

Table 3.6 Qualitative studies providing evidence of mental health benefits

Reference	Study design/ theoretical framing	Population	Type of Blue Space	Mode of interaction	Themes identified and summary passages
Foley (2015, 2017)	The research was drawn from a wider oral historical study of coastal and inland swimming spots. The methodology incorporated a mix of observer participation and responses from swimmers, informed by non-representational theories methods that focused on a witnessing that 'aims to generate data infused with a fidelity or authenticity to happenings, relaying as much as possible of their character and action'. To date 24 interviews with 20 different swimmers, with core empirical material drawn from 4 specific accounts. The interviews were conducted through an oral history approach, which encouraged an open life course narrative of the swimmer's life, which for this paper, draws from the more health and place oriented content. Commentaries from secondary sources, including newspapers, radio interviews and social media pages contextualised the sites as presented to a wider public. Observer participation was conducted at the 2 sites from 2012 to 2014. The sites were visited at different daylight hours (depending on the season), an hour at a time, to get a sense of how the spaces themselves were conducive to affective and healthy encounters.	20 swimmers	Sea	Swimming	Immersive therapeutic practices and outcomes 'In addition, the value for swimming for the recovery of mental health, also emerged from a respondent's comments on swimmers she knew: Well I do know quite a few people who swim at the 40 foot who have sort of mental illness … depressions really and quite a few of those people say they find swimming really beneficial. They often come down and swim and come out and don't really engage or talk to other people and some of the others say, oh they're unfriendly or a bit odd. But I think that's fine. I do talk to one person I know and they say they just like to go into the water and it's like a little rest or a treatment for them.'
Bell et al. (2015)	This study sought to explore the relative contribution of different types of Green and Blue Spaces to individual well-being, examining how these contributions might be shaped by everyday routines, life circumstances and past experiences. The study was conducted from May to November 2013 in 2 towns in Cornwall. An interpretive, mixed method approach was designed for the study. Participants carried a GeneActiv accelerometer (measuring physical	33 individuals aged between 25 and 85 years-old; in full/part-time employment or retired; with or without children; and spanning households earning less than £20,000 year to over £70,000 per year	Coast, sea	Routine everyday use, recall of past experiences; therapeutic; place attachment and identity	'Symbolic therapeutic experiences at the coast' 'reflecting longstanding perceptions of water as 'cleansing' or 'purifying' (Völker and Kistemann 2011), participants in the current study indicated: feeling calmer by the sea, referring to the cleansing nature of the waves in the context of their emotions: 'If I'm kind of upset about anything or if I just need to get away for a bit, I find that being by water and

Reference	Study design/ theoretical framing	Population	Type of Blue Space	Mode of interaction	Themes identified and summary passages
	activity) and a QStarz BT-Q1000XT GPS (measuring location) receiver for one week and the data were used to create personalised maps. Each participant's maps were then used as visual prompts to guide an in-depth interview. This was followed by a series of 9 case study go-along interviews with a subset of participants, in places they deemed therapeutic.				just staring at the waves crashing in kind of washes your emotions away… you can get lost in that'. 'Achieving' therapeutic experiences at the coast' 'Several participants referred to local coastal spaces when discussing their desire for challenge and achievement, appreciating them as both functional and pleasurable environments in which to pursue long-term personally meaningful goals and more immediate feelings of short-term cathartic release….. 'achieving' experiences discussed in this section suggest that, for some participants, being active in coastal environments was able to promote the widely recognised 'eudaimonic' conception of well-being' 'Immersive therapeutic experiences at the coast' 'participants' narratives indicated that by allowing themselves to engage with the captivating multisensory elements of the coastal setting, they were able to clear their mind of everyday cognitive 'noise', creating the mental space needed for deeper processes of reflection (Herzog et al. 1997). The material fluidity and sense of ongoing motion at the coast (Ryan 2012), coupled with the expanse of the oceanic horizon, were frequently highlighted by participants in this regard…. The powerful sense of sound also seemed to contribute to the intensity of participants' restorative experiences at the coast, with many commenting on the duality of the sea's 'moods'. 'Several participants illustrated the importance of internally felt bodily sensations at the coast (Paterson 2009, p. 768), conveying the importance of 'haptic' restorative sensory experiences. In these narratives (for example, Box 8, Figure 1), participants highlighted the feeling of the whole body reacting to different elements

Reference	Study design/ theoretical framing	Population	Type of Blue Space	Mode of interaction	Themes identified and summary passages
					of the setting. This was in terms of the physicality of moving through the environment and the physical sensations of feeling the elements, including the sun, wind, rain or ambient temperature (termed 'elemental haptics' by Allen-Collinson and Leledaki 2014). These findings illustrate the 'wholeness' of embodied restorative coastal encounters and suggest the need to appreciate the 'fullness of our bodily sensibilities' (Ryan 2012, p. 73) when exploring people's therapeutic landscape experiences.' 'In addition to the fluidity and ever-changing nature of the coast, participants also commented on the sense of space and time out engendered by the oceanic horizon (Figure 1, Box 5). The physical extent and broad horizons of the sea afforded a sense of spaciousness, which participants felt helped to 'clear the head', suggesting feelings of cognitive release or 'internal spaciousness' (Conradson 2005). Participants often linked these experiences to feelings of freedom, appreciating the contrasts between such open horizons and the enclosed, indoor environments routinely encountered at home and work' 'For some participants, encountering these open horizons conferred a sense of perspective and feelings of connection to 'something bigger'. This is illustrated in the extract from Sally's interview below, in which she explains how engaging with nature during her weekly coastal walk puts her personal problems into perspective. 'Researcher: What it is about that walk that helps you to switch off? Sally: 'You've got, you know, the fresh air, you've got, it's just space! I mean I think after living in London so many years, you're so enclosed. So to have that space and realise that there's a bigger

Reference	Study design/ theoretical framing	Population	Type of Blue Space	Mode of interaction	Themes identified and summary passages
					thing out there than you, and nature is quite an amazing thing - when you look at the sky and the sea and the birds – just to kind of ((pause)) take it in, you know, and sometimes it's like, well maybe my problems aren't as bad as I perceive them to be, because you've got all of this around you, it kind of puts things into perspective if that makes sense?'
Caddick et al. (2015)	The study sought to answer the question: what effects do surfing and the natural environment have on veterans' well-being? Interviews and participant observations were conducted with a group of combat veterans belonging to a UK-based veterans' surfing charity. The primary analytical approach was dialogical narrative analysis. Interviews were semi-structured life history interviews numbering 24 in total, each lasting between 1 and 4 hours. Participant observation entailed the researcher observing and participating in the daily activities of the veterans during 18 of the charity's twice-weekly surf camps, and during 3 residential weeks in which he actively immersed himself in the group environment and joined in their activities.	15 male combat veterans (aged 27–60) were recruited through purposive sampling from a UK-based veterans' surfing charity. All of the participants referred to themselves as living with PTSD. One additional participant was a former member of the civilian emergency services who was diagnosed with PTSD. On hearing of the study, this man also volunteered to take part, bringing the total number of participants to 16.	Coast, sea	Surfing	'Experiencing respite From PTSD' 'surfing… enabled the veterans to push PTSD into the background and experience a sense of respite from suffering, as exemplified in the following comments: 'It frees you up. It's freedom for those two or three hours, kind of like a bit of respite. It takes your mind off it. Just leave all that away somewhere on the beach and then, we'll deal with that later. But for now, when we're surfing, we're going to have a laugh. And there's not a lot you can do to not have a laugh; it's kind of the antidote to PTSD in a way. You know, get your wetsuit on, go for a paddle, ride a wave, and it's like PTSD doesn't exist for that short time, which is all good in my book.' 'We understood the effects of surfing as being related more to subjective well-being than to psychological well-being. That is, surfing was a vehicle for pursuing pleasure and escaping pain rather than for loftier notions of psychological growth and development.' 'Regular surfing facilitated respite by helping the participants stay focused on experiences in the present and avoid dwelling on the traumatic memories hidden in their past. In addition to keeping participants focused on the present, a second way in which surfing facilitated respite was through relationships with other veterans. Surfing provided a context for veterans to

Reference	Study design/ theoretical framing	Population	Type of Blue Space	Mode of interaction	Themes identified and summary passages
					relate to one another in a positive fashion, which in turn helped to facilitate respite from PTSD.'
Ashbullby et al. (2013)	This study investigated how families engaged with beach environments in their local areas and used them in health-promoting ways. Families with children living in coastal regions of Devon and Cornwall participated in individual semi-structured interviews during the summer and early autumn of 2011. Parents and children were interviewed separately.	15 families with children between 8 and 11 years-old. They included 15 mothers and 9 fathers with 20 children (10 girls and 10 boys).	Beach	Visiting	'Psychological health benefits' 'The primary benefit of visiting the beach was experiencing fun, enjoyment and feelings of happiness.' 'At the same time the natural features of the beach environment, including the perceived space, the sound of the waves and the beauty of the setting were viewed to have psychological benefits in terms of stress relief, relaxation and restoration. '
Cairns-Nagi and Bambra (2013)	Study with mixed methods approach, combining statistical area-level analysis with an in-depth qualitative case study. There were 2 phases to the research: (1) quantitative identification of resilient socioeconomically deprived areas in England using a multi-dimensional operationalisation of 'health resilience' across different geographical scales; and (2) qualitative exploration of potential mechanisms underlying 'health resilience' in one case study area.	354 local authority districts and 7,942 Census Area Statistical Wards were examined in this research.	Coast beach	Place attachment, visiting	'The natural environment emerged as another aspect of Chevington that was prominent in the minds of local residents when considering their health and well-being. This is related to the nostalgia of the past and local heritage, the therapeutic element of being around nature, and their sense of belonging and place attachment as already discussed. The north-east region is home to many national parks, national trails and heritage coastal sites. Northumberland has many local nature reserves, conservation sites and public bridleways. More specifically, the locality of Chevington is surrounded by countryside with public access, there is a country park – Druridge Bay which was restored from an old opencast mine- and the coast is nearby. Some narratives relate the significance of these natural surroundings to the well-being of local residents.' 'The beach is something that I certainly use quite a lot and being able to get to the coast is very important. For playing around or chilling out; it allows you to escape. It's not only health as in fitness and exercise but also freedom and being able to relax is very important.'

3.4 Inequality of access

Of the 77 studies included in the review, 10 provided evidence of the way access to Blue Spaces and the benefits it can have for those who use it, distributed across different social groups (Table 3.7). Two of those studies were investigations drawn from the academic literature and 8 were survey reports taken from the grey literature. All of them had a cross-sectional research design. Three of the studies were conducted in Wales, 2 were conducted in England and one was conducted in the USA.

3.4.1 Visits made to Blue Spaces by different social groups

Eight of the studies provided evidence of the way that visits to Blue Spaces are distributed across different social groups.

In England, the MENE survey and MENE survey for children examined the proportions of adults and children from different ethnic minority and socioeconomic groups that had made visits to different types of natural environment within the last month.

The data revealed that:

- in total 63%, of the children who were from a Black, Asian or other minority ethnic background (BAME) had made a visit to the natural environment
- 3% had made a visit to the beach
- 4% had visited coastline or river/lake or canal

In comparison a total of 77% of the children who were from a non BAME background had made a visit to the natural environment, 12% had visited the beach and 13% had visited coastline or river/lake or canal (Natural England 2016).

A similar pattern was found among the adult population. In the 2009 to 2010 MENE survey, 10.4% of the recorded visits to the natural environment among BAME adults were to either a seaside resort or another place along the coastline compared with 11% of the adults who considered themselves to be white. This difference in patterns of visitation between adult ethnic groups can be clearly identified in subsequent years of the survey up to 2012 to 2013, after which it was no longer reported (Natural England 2010, 2011, 2012, 2013).

The data also revealed patterns of difference in the way that children and adults from different socioeconomic groups visited the natural environment. The MENE children's survey reveals that, in total, 81% of children from a background classed as being AB had made a trip to the natural environment in the last month compared with 76% of children classed as from a C1 background, 74% of children classed as from a C2 background and 70% of children classed as from a DE background. A total of 13% of children from an AB background had visited the beach, compared to 11% of children from a C1 background, 9% of children from a C2 background and 8% of children from a DE background. Similarly 16% of children from an AB background had visited the coastline or a river/lake or canal compared with 11% of children from a C1 background, 10% of children from a C2 background and 8% of children from a DE background (Natural England 2016).

Data collected by the MENE survey on patterns of visitation among the adult population reveal a less consistent difference between socioeconomic groupings (Natural England 2010, 2011, 2012, 2013). A more pronounced pattern is discernible in the proportion of visits to Blue Spaces being undertaken by adults in different deciles of the Index of Multiple Deprivation (IMD). In the 2009 to 2010 survey, 6% of visits to the natural

environment made by adults who were classified as being within the top 10% of the IMD (that is, least deprived) were to Blue Spaces compared with 12% of visits to the natural environment made by adults across the rest of the spectrum. This pattern remained consistent in the 2010 to 2011 survey, but in the 2011 to 2012 and 2012 to 2013 surveys, the proportion of visits to the natural environment that were to a Blue Space made by adults in the bottom 10% of the IMD (that is, most deprived) decreased to 8% and 9% respectively.

The 2008 and 2014 rounds of WORS investigated variations in the way different groups among the Welsh population visited Blue Spaces. Participants in the survey were asked to name the main place they had visited during their last trip to any part of the natural environment. The data were then reported by IMD percentile, age group, gender and ethnic grouping. They indicated that, of the visits made to the natural environment in 2008 by people who were categorised as being among the least deprived 10% of the population, 23% were to Blue Spaces; for those who comprised the bottom 10% of the population interviewed the figure was 18%. These proportions were found to be broadly similar in the 2011 and 2014 rounds. The data also point to some differences in the types of Blue Spaces that different percentiles of the IMD visited. While 4% of the visits to the natural environment by those in the least deprived 10% of respondents were to the sea in 2008, it was the destination of only 1% of the visits made by people categorised as being in the most deprived 10%. This trend was broadly visible in the data collected during the 2011 and 2014 rounds (CCW/FCW 2009a, 2009b, 2011, 2012; Natural Resources Wales 2014, 2015).

Similar lines of difference were revealed by the categorisation of visits according to age group. Data generated by the MENE survey revealed that a higher proportion of visits to the natural environment made by English adults aged 65 or over were to Blue Spaces. In the 2009 to 2010 survey, 14% of the visits made to the natural environment by people over 65 were to a Blue Space compared with 9% of the visits made by 16–24 year-olds, 14% of the visits made by 24–44 year-olds and 14% of the visits made by 44–64 year-olds. This pattern remained broadly consistent in subsequent years of the survey to 2012 to 2013 (Natural England 2010, 2011, 2012, 2013).

Although there was no clear pattern in variations of the total proportion of visits made to Blue Spaces across the spectrum of ages considered by WORS, there was a more consistent difference between the types of Blue Space people over the age of 75 were found to have visited and the types of Blue Space that those between the ages of 16 and 24 had visited. While 4% of the total number of trips made by those aged over 75 was to the sea in 2008, that number was too small to report reliably among those in the age group 16–24. The same trend is visible in the data collected during the 2011 and 2014 rounds (CCW/FCW 2009a, 2009b, 2011, 2012; Natural Resources Wales 2014, 2015).

Analysis of the number of trips made to Blue Spaces by ethnic minority groups in Wales reveals a comparatively strong pattern of difference between the 2 groups, but not one that is repeated consistently over the 3 years of the survey. Data from the 2008 round of WORS indicate that the proportion of trips made to Blue Spaces by people who considered themselves to be BAME was approximately comparable with the proportion of trips made by those who considered themselves to be white. However, data collected during both the 2011 and 2014 rounds of WORS showed a comparatively much smaller percentage of trips being taken to Blue Spaces by BAME individuals (CCW/FCW 2009a, 2009b, 2011, 2012; Natural Resources Wales 2014, 2015).

Categorisation of the trips that people made to Blue Spaces in Wales according to gender indicated that both men and women made a roughly comparable proportion of trips to each of the different waterside environments considered with the exception of the beach. The data suggest that women made a higher proportion of trips to beaches

than men in each of the 3 rounds of the survey (CCW/FCW 2009a, 2009b, 2011, 2012; Natural Resources Wales 2014, 2015).

3.4.2 Benefits of Blue Space for different social groups

Two studies provided evidence of the way the benefits of living in proximity to Blue Space can vary across social parameters. Wheeler et al. (2012) used data from the 2001 Census in England to examine the correlation between living in proximity to the coast and self-reported good health across quintiles of deprivation within the population. The analysis reveals that:

- a gradient of improving health exists as residential proximity to the coast increases
- the gradient becomes less pronounced as levels of deprivation increase

In a substantially different type of analysis, Haeffner et al. (2017) considered the way that the impacts of Blue Space on families living in neighbourhoods of Utah in the USA varied according to levels of education. They found that people's familiarity with the Blue Spaces around them, the likelihood that they had visited that Blue Space, and their appreciation of the sights, sounds and wildlife that it offered, all rose as educational levels increased.

3.4.3 Comparative visits made to Blue and Green Spaces by different social groups

Of the 10 studies included in the review that provided evidence of the way that access to Blue Spaces and the benefits they can bring changes across society, 8 also provided comparable evidence of the way access to Green Spaces can differ.

The 2013 to 2014 MENE survey for children examined the degree to which children in England visited different natural settings according to their ethnic and socioeconomic backgrounds. The analysis demonstrated that both children who considered themselves to be from a BAME background and children who considered themselves not to be BAME (non BAME) were more likely to visit Green Spaces than they were to visit Blue Spaces. Nearly half of both the BAME and the non BAME children participating in the study reported that they had visited their local park in the last month, 14% of BAME children and 29% of non BAME children had visited a playing field, and 11% of BAME children and 18% of non BAME children had been to a country park. This compares to 3% of BAME children and 12% of non BAME children who had visited a beach, and 4% of BAME children and 13% of non BAME children who had visited a coastline, river or canal. The percentage of non BAME children visiting any form of Green or Blue Space was consistently higher than the percentage of BAME children across all of the types of environment examined (Natural England 2015, 2016).

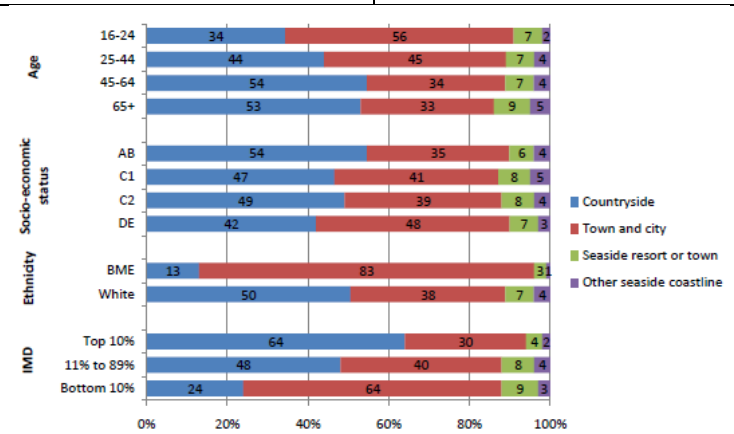
Analysis of MENE visit data by socioeconomic grouping reveals a very similar set of patterns. Children across all of the socioeconomic categories considered were more likely to have visited a Green Space than they were to have visited a Blue Space. Nearly half of all of the children in each group had visited a local park within the last month, between a third and a fifth had visited a playing field and between a fifth and an eighth had visited a country park. Children from the higher socioeconomic categories were consistently more likely than those from the lower groupings to visit any form of Green or Blue Space (Natural England 2016).

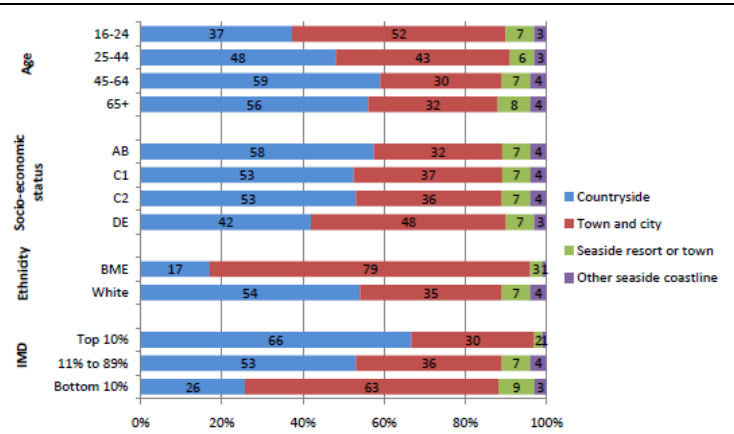
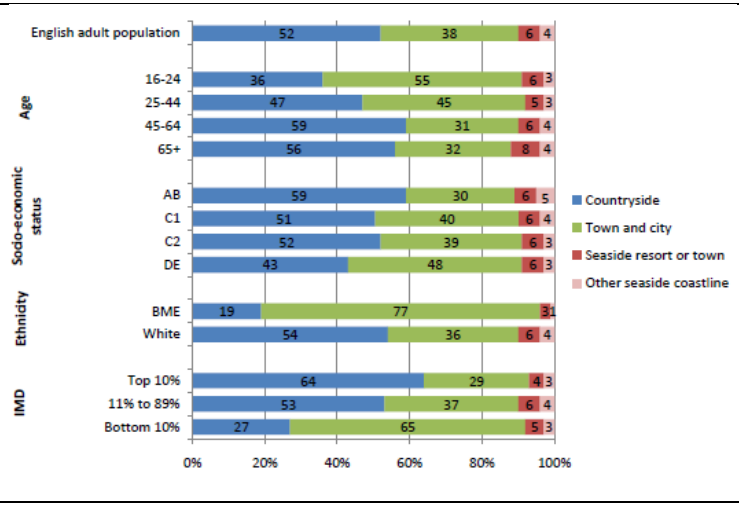
The 2008 and 2014 rounds of WORS considered the way visits to the natural environment among the Welsh population varied according to different social groupings. The analysis considered the distribution of visits to different categories of

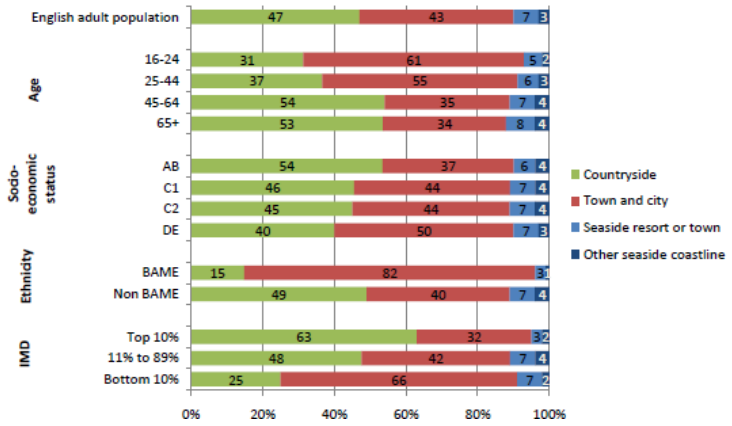
Green and Blue Space across IMD percentiles, ethnic groups, age groups and by gender. The data revealed that people who lived in Wales were more likely to visit their local park than any other form of Green or Blue Space; there were no other consistent patterns of difference in the types of natural environment visited by different percentiles of the Welsh IMD. The data for visits by people who considered themselves to be BME and people who considered themselves to be white demonstrated a similar absence of consistent trends across the 3 rounds of WORS, although a higher percentage of BME respondents had visited their local park than had white respondents in all 3 rounds. Analysis of visit data by age group revealed that across all 3 rounds of survey data collected, women were more likely than men have visited their local park while men were more likely than women have visited areas of woodland or forest and mountains, hills or moorland (CCW/FCW 2009a, 2009b, 2011, 2012; Natural Resources Wales 2014, 2015).

Table 3.7 Quantitative studies providing evidence of equality of access

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results	
Haeffner et al. (2017)	This cross-sectional study drew on a sample of households in northern Utah living in neighbourhoods with a nearby river or canal to ask if local waterways provided positive impacts to households and if proximity to them increased the likelihood of households spending time at them and being familiar with them. Households were asked to fill out a five-point questionnaire querying aspects of the way the used Blue Space. Answers were coded using a five-point scale	1,450 randomly sampled households from 13 neighbourhoods in northern Utah: 7 with rivers and 6 with major irrigation canals as their local waterway	River Irrigation canal	Quality of life	Perceived impact on household of aspects of Blue Space on quality of life by level of education (average Likert Scale Score) ($p \leq 0.001$)	≤ High school diploma Familiarity = 3.43 Visit and walk = 3.79 Play = 3.32 Sights and sounds = 3.35 Wildlife habitat = 3.63 Some college/Vocational Familiarity = 3.69 Visit and walk = 3.80 Play = 3.42 Sights and sounds = 3.50 Wildlife habitat = 3.84	4-year college degree Familiarity = 3.85 Visit and walk = 4.02 Play = 3.61 Sights and sounds = 3.76 Wildlife habitat = 3.98 Graduate school Familiarity = 4.0 Visit and walk = 4.14 Play = 3.69 Sights and sounds = 3.85 Wildlife habitat = 4

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
	ranging from 'strong negative impact' (1) to 'no impact' (3) to 'strong positive impact' (5).					
MENE 2009 to 2010 survey (Natural England 2010)	This cross-sectional survey undertook home interviews with a representative sample of the English adult population (aged 16 and over) between March 2009 and February 2010 with a sample of at least 800 achieved across at least 100 sample points per week.	800 English adults (over 16 years) per week	River, lake, canal Beach Other coastline	Visiting	Visits by social category (% of total)	

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
MENE 2010 to 2011 survey (Natural England 2011)	This cross-sectional survey undertook home interviews with a representative sample of the English adult population (aged 16 and over) between March 2010 and February 2011 with a sample of at least 800 achieved across at least 100 sample points per week.	800 English adults (over 16 years) per week	River, lake, canal Beach Other coastline	Visiting	Visits by social category (% of total)	
MENE 2011 to 2012 survey (Natural England 2012)	This cross-sectional survey undertook home interviews with a representative sample of the English adult population (aged 16 and over) between March 2011 and February 2012 with a sample of at least 800 achieved across at least 100 sample points per week.	800 English adults (over 16 years) per week	River, lake, canal Beach Other coastline	Visiting	Visits by social category (% of total)	

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
MENE 2012 to 2013 survey (Natural England 2013)	This cross-sectional survey undertook home interviews with a representative sample of the English adult population (aged 16 and over) between March 2012 and February 2013 with a sample of at least 800 achieved across at least 100 sample points per week.	800 English adults (over 16 years) per week	River, lake, canal Beach Other coastline	Visiting	Visits by social category (% of total)	
MENE survey: children's report from the 2013 to 2014 and the 2014 to 2015 surveys (Natural England 2016)	In home interviews undertaken with a representative sample of the English adult population (aged 16 and over) between March 2013 and February 2015, with a sample of at least 800 achieved across at least 100 sample points per week. On one week per month, adults were	10,235 children aged under 16	Beach/coastline River, lake or canal	Visiting	Types of local places visited in previous month by ethnicity and socioeconomic group of children (% of children) NB Totals may add up to more than 100% because each child visited more than one type of place.	

<table>
<tr><th>Reference</th><th>Study design</th><th>Population</th><th>Type of Blue Space</th><th>Mode of interaction</th><th>Outcome(s) assessed</th><th colspan="2">Main results</th></tr>
<tr><td></td><td>interviewed about the visiting behaviour of each child in their household in the month prior to interview, with data collected for up to a maximum of 3 children per household.</td><td></td><td></td><td></td><td></td><td colspan="2">
<table>
<tr><th></th><th colspan="2">Ethnicity</th><th colspan="4">Socioeconomic group</th></tr>
<tr><th></th><th>BAME</th><th>Non BAME</th><th>AB</th><th>C1</th><th>C2</th><th>DE</th></tr>
<tr><td>Total local</td><td>63%</td><td>77%</td><td>81%</td><td>76%</td><td>74%</td><td>70%</td></tr>
<tr><td>A path, cycleway or bridleway</td><td>4%</td><td>13%</td><td>18%</td><td>13%</td><td>10%</td><td>7%</td></tr>
<tr><td>A village</td><td>2%</td><td>8%</td><td>13%</td><td>8%</td><td>6%</td><td>4%</td></tr>
<tr><td>Allotment/ community garden</td><td>1%</td><td>2%</td><td>3%</td><td>3%</td><td>2%</td><td>2%</td></tr>
<tr><td>Beach/coastline</td><td>3%</td><td>12%</td><td>13%</td><td>11%</td><td>9%</td><td>8%</td></tr>
<tr><td>Country park</td><td>11%</td><td>18%</td><td>21%</td><td>20%</td><td>15%</td><td>12%</td></tr>
<tr><td>Farmland/ other open space in countryside</td><td>2%</td><td>9%</td><td>13%</td><td>9%</td><td>6%</td><td>5%</td></tr>
<tr><td>Historic/heritage site</td><td>2%</td><td>5%</td><td>9%</td><td>5%</td><td>3%</td><td>3%</td></tr>
<tr><td>Mountain/hill/moorland</td><td>1%</td><td>4%</td><td>6%</td><td>3%</td><td>3%</td><td>2%</td></tr>
<tr><td>Nature reserve/ other place for nature</td><td>3%</td><td>7%</td><td>10%</td><td>7%</td><td>5%</td><td>4%</td></tr>
<tr><td>Other open spaces in a town or city</td><td>3%</td><td>5%</td><td>5%</td><td>5%</td><td>5%</td><td>4%</td></tr>
<tr><td>Other open spaces in countryside</td><td>1%</td><td>3%</td><td>4%</td><td>3%</td><td>3%</td><td>2%</td></tr>
<tr><td>Park in town or city</td><td>46%</td><td>49%</td><td>48%</td><td>50%</td><td>48%</td><td>47%</td></tr>
<tr><td>Playground</td><td>19%</td><td>31%</td><td>37%</td><td>31%</td><td>27%</td><td>24%</td></tr>
<tr><td>Playing field or other recreation area</td><td>14%</td><td>29%</td><td>34%</td><td>28%</td><td>27%</td><td>20%</td></tr>
<tr><td>River, lake or canal</td><td>4%</td><td>13%</td><td>16%</td><td>11%</td><td>10%</td><td>8%</td></tr>
<tr><td>Shared/community green</td><td>3%</td><td>7%</td><td>9%</td><td>7%</td><td>6%</td><td>4%</td></tr>
<tr><td>Visitor attraction</td><td>4%</td><td>9%</td><td>12%</td><td>9%</td><td>7%</td><td>5%</td></tr>
<tr><td>Woodland</td><td>3%</td><td>15%</td><td>19%</td><td>14%</td><td>11%</td><td>8%</td></tr>
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</td></tr>
<tr><td>WORS 2008 (CCW/FCW 2009a, 2009b)</td><td>Cross-sectional survey
A telephone survey was undertaken by Ipsos between 21 January</td><td>5,273 randomly selected telephone contacts in each of 6 regions of Wales who had visited the outdoors in the</td><td>River, lake or canal
Beach
Other coastline
Sea</td><td>Visiting</td><td>‘Which of these was the main place you visited?’ by % of IMD percentile (bottom 10%, bottom 20%,</td><td>River, lake or canal = 3%, 8%, 8%, 7%
Beach = 5%, 6%, 6%, 7%
Other coastline = 6%, 4%, 4%, 6%
Sea = 4%, 3%, 2%, 1%</td><td>Hills, mountains or moorland = *, 1%, 3%, 8%,
Farmland = 4%, 11%, 10%, 9%
Other local open space = 10%, 5%, 4%, 4%
Village = 4%, 3%, 2%, 1%
Other = 4%, 4%, 5%, 8%</td></tr>
</table>

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results	
	2008 and 21 January 2009. Interviewing was conducted throughout the year with a minimum of 500 interviews completed in every month.	last 4 weeks, with numbers screened to ensure the exclusion of those registered with the Telephone Preference Service and those likely to be non-residential.			bottom 30%, top 10%)	Local park = 35%, 26%, 25%, 18% Woodland or forest = 7%, 11%, 11%, 14% Roadside pavement/track = 8%, 9%, 10%, 9%	(5% risk level)
					'Which of these was the main place you visited?' by % of age group (16–24, 25–34, 35–54, 55–74, 75+) * small base	River, lake or canal =14%, 9%, 7%, 6%, 4% Beach = 6%, 8%, 8%, 8%,7% Other coastline = 5%, 2%, 4%, 7%, 11% Sea = *, 3%, 2%, 2%, 4% Local park = 23%, 17%, 13%, 12%, 16% Woodland or forest = 8%, 19%, 16%, 13%, 8% Roadside pavement/track = 15%, 11%, 11%, 11%, 10%	Hills, mountains or moorland = 9%, 9%, 13%, 10%, 10% Farmland = 2%, 9%a, 9%, 13%, 5% Other local open space = 7%, 8%, 10%, 7%, 4% Village = 7%, 2%, 4%, 4%, 9% Other = 2%, 5%, 3%, 6%, 12% (5% risk level)
					'Which of these was the main place you visited?' by % of ethnic group (white, BME) * small base	River, lake or canal =8%, 6% Beach = 7%, 11% Other coastline = 6%, * Sea =2%, 6% Local park = 15%, 19% Woodland or forest = 13%, 19% Roadside pavement/track = 12%, 7%	Hills, mountains or moorland = 11%, 8% Farmland = 8%, 6% Other local open space = 8%, 7% Village = 5%, 7% Other = 5%, 3% (5% risk level)
					'Which of these was the main place you visited?' by % of gender group (male, female) * small base	River, lake or canal =8%, 7% Beach = 6%, 9% Other coastline = 6%, 2% Sea = 2%, 2% Local park = 10%, 20% Woodland or forest = 15%, 12% Roadside pavement/track = 12%, 11%	Hills, mountains or moorland = 13%, 9% Farmland = 10%, 7% Other local open space = 7%, 8% Village = 4%, 5% Other = 7%, 4% (5% risk level)

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results	
WORS 2011 (CCQ/FCW 2011, 2012)	Cross-sectional survey A telephone survey was undertaken by Ipsos between 7 January 2011 and 16 January 2012. Interviewing was conducted throughout the year with a minimum of 500 interviews completed in every month.	5,626 randomly selected telephone contacts in each of 6 regions of Wales who had visited the outdoors in the last 4 weeks. Numbers were screened to ensure the exclusion of those registered with the Telephone Preference Service and those likely to be non-residential.	River, lake or canal Beach Other coastline Sea	Visiting	Main place visited – most recent visit by. % of gender group (male, female)	River, lake or canal = 8%, 7% Beach = 9%, 13% Other coastline = 5%, 4% Sea = 2%, 3% Local park = 11%, 14% Woodland or forest = 18%, 17% Roadside pavement/track = 9%, 10%	Hills, mountains or moorland = 12%, 9% Farmland = 11%, 9% Other local open space = 8%, 7% Village = 5%, 5% Other = 2%, 2% (5% risk level)
					Main place visited – most recent visit by. % of age group (16–24, 25–34, 35–54, 55–74, 75+)	River, lake or canal = 4%, 7%, 8%, 9%, 9% Beach = 10%, 7%, 12%, 12%, 13% Other coastline = 1%, 6%, 4%, 6%, 6% Sea = 3%, 2%, 2%, 3%, 4% Local park = 12%, 18%, 13%, 9%, 11% Woodland or forest = 22%, 19%, 20%, 14%, 10%, Roadside pavement/track = 11%, 12%, 7%, 9%, 8%	Hills, mountains or moorland = 14%, 13%, 10%, 10%, 6% Farmland = 8%, 7%, 11%, 11%, 11% Other local open space = 5%, 5%, 9%, 10%, 8% Village = 10%, 2%, 3%, 6%, 10% Other = 1%, 1%, 2%, 2%, 4% (5% risk level)
					Main place visited – most recent visit by % of ethnic group (white; BME) * small base	River, lake or canal = 8%, 1% Beach = 11%, 4% Other coastline = 5%, -% Sea =2%, *% Local park = 12%, 14% Woodland or forest = 18%, 16% Roadside pavement/track = 9%, 20%	Hills, mountains or moorland = 11%, 3% Farmland = 10%, 21% Other local open space = 7%, 19% Village = 6%, 2% Other = 2%, -% (5% risk level)
					Main place visited – most recent visit by % of IMD percentile (bottom 10%,	River, lake or canal = 6%, 5%, 13%, 8% Beach = 8%, 8%, 9%, 9% Other coastline = 5%, 3%, 5%, 6% Sea = *%, 1%, 1%, 2%	Farmland = 5%, 11%, 10%, 6% Other local open space = 12%, 7%, 6%, 7% Village = 2%, 12%, 4%, 5% Other = 2%, 2%, 2%, 1%

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results	
					bottom 20%, bottom 30%, top 10%)	Local park = 16%, 15%, 17%, 14% Woodland or forest = 16%, 11%, 11%, 22% Roadside pavement/track = 17%, 14%, 13%, 14% Hills, mountains or moorland = 11%, 12%, 9%, 5%	(5% risk level)
WORS 2014. (Natural Resources Wales 2014, 2015)	Cross-sectional survey A telephone survey was undertaken by Ipsos between January 2014 and January 2015. Interviewing was conducted throughout the year with a minimum of 500 interviews completed in every month.	4,941 randomly selected telephone contacts in each of 6 regions of Wales who had visited the outdoors in the last 4 weeks. Numbers were screened to ensure the exclusion of those registered with the Telephone Preference Service and those likely to be non-residential.	River, lake or canal Beach Other coastline Sea	Visiting	Main place visited – most recent visit by. % of gender group (male, female)	River, lake or canal = 6%, 8% Beach = 7%, 12% Other coastline = 4%, 4% Sea = 2%, 2% Local park = 15%, 17% Woodland or forest = 17%, 14% Roadside pavement/track = 12%, 13%	Hills, mountains or moorland = 11%, 9% Farmland = 15%, 8% Other local open space =5%, 6% Village =3%, 5% Other = 3%, 2% (5% risk level)
					Main place visited – most recent visit by. % of age group (16–24, 25–34, 35–54, 55–74, 75+)	River, lake or canal = 4%, 5%, 10%, 7%, 4% Beach = 8%, 7%, 11%, 11%, 9% Other coastline = 1%, 7%, 4%, 5%, 6% Sea = 2%, 1%, 2%, 2%, 3% Local park = 20%, 21%, 14%, 14%, 10% Woodland or forest = 21%, 8%, 16%, 15%, 16% Roadside pavement/track = 15%, 10%, 11%, 14%, 16%	Hills, mountains or moorland = 10%, 13%, 10%, 9%, 6% Farmland = 11%, 22%, 10%, 9%, 5% Other local open space = 4%, 4%, 6%, 6%, 9% Village = 1%, 3%, 5%, 6%, 9% Other = 4%, *, 1%, 3%, 6% (5% risk level)
					Main place visited – most recent visit' by % of ethnic group (white; BME)	River, lake or canal = 7%, 4% Beach = 10%, 7% Other coastline = 4%, * Sea =2%, 2% Local park = 16%, 27% Woodland or forest = 15%, 37%	Hills, mountains or moorland = 10%, 5% Farmland = 11%, 13% Other local open space = 6%, 3% Village = 4%, - Other = 2%, -

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results	
					* small base	Roadside pavement/track = 13%, 2%	(5% risk level)
					Main place visited – most recent visit by % of IMD percentile (bottom 10%, bottom 20%, bottom 30%, top 10%)	River, lake or canal = 10%, 7%, 6%, 8% Beach = 5%, 7%, 9%, 10% Other coastline = 5%, 4%, 3%, 5% Sea = 1%, 2%, 2%, 3% Local park = 20%, 23%, 23%, 19% Woodland or forest = 8%, 10%, 11%, 9% Roadside pavement/track = 26%, 17%, 16%, 8% Hills, mountains or moorland = 5%, 8%, 9%, 8%	Farmland = 5%, 7%, 7%, 13% Other local open space = 3%, 6%, 5%, 11% Village = 4%, 5%, 6%, 4% Other = 7%, 4%, 3%, 2% (5% risk level)
Wheeler et al. (2012)	This cross-sectional study used 2001 Census data for England (N = 48.2 million) to analyse the relationship between rates of self-reported 'good' health and residential proximity to the coast for urban, urban fringe and rural residents. To determine coastal proximity, a GIS was used to	Data were obtained for England's 32,482 LSOAs indicating the proportion of the population answering 'good' to the question 'Over the last 12 months would you say your health has on the whole been: Good; Fairly good; Not good? Total included populations are	Coast	Proximity	Coefficients represent the difference in the age/sex standardised prevalence (percentage) of people reporting good health relative to that in the category of LSOAs furthest from the coast (>50km) stratified by income deprivation quintiles	Graph removed for copyright purposes	

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
	calculate the linear distance from each LSOA's population-weighted centroid to its nearest coastline. Coastal proximity was divided into bands chosen to represent comparative geographical accessibility and inferring from this potential frequency/intensity of 'exposure' to coastal environments: 0–1km; >1–5km; >5–20km; >20–50km; >50km.	26,455 urban residents, 3,081 town/fringe residents and 2,946 rural residents.				

3.5 Social interaction

3.5.1 Quantitative evidence

Of the 77 studies included in the review, 2 provided quantitative evidence of the association between Blue Space and people's social interaction (Table 3.8). Both of these studies were retrieved from the academic literature and used a cross-sectional questionnaire survey based design to generate data from participants based in Australia. Together they provide limited and case-specific evidence of the way people can use Blue Spaces to meet others.

Koss and Kingsley (2010) used a Likert Scale based methodology to assess the extent to which 271 professional and volunteer participants in a marine-based survey programme in Victoria agreed with various statements about how the programme had affected them. They found that the respondents enjoyed the experience of being part of the marine survey group and the opportunity to socialise with the other volunteers.

Wynveen et al. (2012) used a similar methodology to examine the extent to which visitors to the Great Barrier Reef Marine Park in Queensland agreed with a number of statements exploring the benefits of their stay. They found that one of the statements people agreed most strongly with was that spending time in park gave them the opportunity to spend time with their family and friends.

3.5.2 Qualitative evidence

Five of the studies provided qualitative evidence of the way Blue Spaces can have an impact on social interaction (Table 3.9).

Finlay et al. (2015) conducted semi-structured interviews with 27 older residents of Vancouver, Canada, as part of an enquiry that aimed to draw out the way Blue Spaces were used during people's everyday lives. They found that a strong theme to emerge from the data was the way Blue Spaces served as an important meeting place for people who wanted to meet up with friends, neighbours and family. For the older participants of the study in particular, this type of opportunity was considered to be an important contributor to their individual social well-being and a way of avoiding the problems of loneliness and social isolation that can be connected to the aging process.

Bell et al. (2015) took a mixed methods approach to understanding the role that Blue Spaces play in the health and well-being of residents from 2 towns in Cornwall. Following a GPS enquiry that examined people's movement through natural spaces, 33 individual interviews and 9 case study based walking interviews were conducted with selected participants. The data generated demonstrate that an important part of the therapeutic effect people felt they were able to achieve in Blue Spaces was the ability to:

- seek friendly conversation with others
- be in a space that offered a variety of opportunities for family leisure and well-being
- connect with others through shared hobbies and experiences

The opportunities afforded by beaches for social interaction were found to be of particular importance to children in a study by Ashbullby et al. (2013) in Cornwall. In an examination of the way families used their local beaches, interviews were conducted with the parents and children of 15 families. The data generated indicate that the beach

environment allowed parents and children the space and time to interact with each other, something highly valued by the children, but also to meet others and develop wider social connections.

Caddick et al. (2015) considered the effectiveness of participating in a surfing programme as a treatment for the PTSD of a group of ex-service personnel in the USA. One of the key conclusions to emerge from the work was that the programme provided the opportunity for veterans to meet each other and to develop positive relationships that allowed them to achieve a degree of respite from their symptoms.

Völker and Kistemann (2013, 2015) conducted semi-structured interviews with 113 visitors to Dusseldorf and Cologne in Germany as part of a wider investigation that aimed to examine the way in which using Blue and Green Spaces could contribute to people's sense of their own well-being. The interviews all took place on either the Rhine promenade or in one of the city's 2 parks and highlighted a difference in the types of interaction that were taking place in each environment. The promenade was found to be a much greater draw for tourists who had travelled from international origins, and the people using it therefore saw it as a place where conversations with visitors from abroad were more likely take place. In contrast, the parks were found to be places favoured more by domestic tourists, which changed the type of interaction that people expected to become engaged in in those spaces.

Table 3.8 Quantitative studies providing evidence of social interaction benefits

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
Koss and Kingsley (2010)	Questionnaires comprising 90 Likert Scale questions were distributed during November 2008 through to January 2009 to investigate during monitoring sessions the attitudes of Sea Search volunteer and Agency staff towards their health and well-being. The research aimed to assess if there was a difference in attitude between community volunteers and those who are involved in higher level decision-making.	271 Australian participants responded to both questionnaires. Men in the 46–60 age bracket were the most prevalent for both questionnaires, whereas women in the 18–30 and 31–45 age groups responded most frequently in the national and Victorian questionnaires respectively.	Marine environment (sea)	Participation in the Citizen Science Marine Survey Programme	To what extent do you agree that Sea Search participants enjoy being part of the Sea Search group and socialising with other volunteers during the monitoring activity?	Volunteers enjoyed being part of the Sea Search group and socialising with other volunteers during the monitoring activity (U = 580, z= -1.696, p = 0.09, r = 0.198, n = 53, Md = 1.00)
Wynveen et al. (2012)	This study used key informant interviews (N =20) and a questionnaire survey (N =324) based on a five-point Likert Scale (1 = only slightly important; 5 = extremely important) to identify the meanings visitors ascribed to places in the Great Barrier Reef Marine Park. The survey contained 34 statements participants could agree or disagree with based on ideas that emerged from	20 key informants interviewed in July and August 2008, including tourist industry managers, resource managers and recreational visitors. 324 residents living in proximity to the Great Barrier Reef Marine National Park who volunteered to take part in a survey.	Great Barrier Reef Marine National Park	Professional Recreational visitor Living in proximity	Mean Likert Scale response to statements of place meaning	Family and friends I enjoy being there with family and friends = 4.38 I feel a sense of connection to my ancestors = 2.40 I want to pass my family's knowledge about the place to younger generations = 3.83 Being there makes me feel like I'm part of a lifestyle that is unique to the area = 3.94

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
	the key informant interviews.					

Table 3.9 Qualitative studies providing evidence of social interaction benefits

Reference	Study design/ theoretical framing	Population	Type of Blue Space	Mode of interaction	Themes identified and summary passages
Finlay et al. (2015)	In-depth, qualitative interviews with participants of a larger cross-sectional study over 2 time points (2012 and 2013). A sit-down interview was followed by a walking interview during which observations were also made. Data were analysed using framework analysis.	27 community-dwelling older adults (65–86 years-old) from a range of neighbourhoods in in Metro Vancouver, Canada	Lakes and the ocean	'Mundane everyday contact' Walking	'Social well-being' 'A major use of Green and Blue Spaces described by participants was to stimulate contact with friends, family and neighbours. Both Green and Blue Spaces served as places for social interaction amongst participants.' 'Local Green Space in particular enhanced social integration and contributed to social interaction, community building and empowerment.' 'Green and Blue Spaces were intimately linked to participants' social well-being, and helped to relieve perceived aloneness in everyday life. Many participants live alone and implied fears of isolation. These spaces provide opportunities for spontaneous and plan- ned multigenerational social activities'… Thus, local Green and Blue Spaces may represent important sites that provide older people meaningful opportunities to connect with family, friends and neighbours. Social well-being, essential to an enhanced quality of life, may be promoted through the provision of local nearby Green and Blue Spaces.''
Bell et al. (2015)	This study sought to explore the relative contribution of different types of Green and Blue Spaces to individual well-being, examining how these contributions may be shaped by everyday routines, life circumstances and past experiences. The study was conducted from May to November 2013 in 2 towns in Cornwall. An interpretive, mixed method approach was designed for the study. Participants carried a	33 individuals aged between 25 and 85 years-old; in full/part-time employment or retired; with or without children; and spanning households earning less than £20,000 to over £70,000 per year	Coast, sea	Routine everyday use, recall of past experiences; therapeutic; place attachment and identity	Social therapeutic experiences at the coast 'Several participants discussed the importance of the social context and social relations linked to their preferred therapeutic experiences. These included 3 types of social dynamics, each of which were apparent within local coastal spaces: (a) seeking friendly conversation and a convivial atmosphere; (b) engaging with spaces offering varied opportunities for family leisure and well-being; and (c) connecting through shared hobbies and experiences.'

Reference	Study design/ theoretical framing	Population	Type of Blue Space	Mode of interaction	Themes identified and summary passages
	GeneActiv accelerometer (measuring physical activity) and QStarz BT-Q1000XT (GPS, measuring location) receiver for one week and the data were used to create personalised maps. Each participant's maps were then used as visual prompts to guide an in-depth interview. This was followed by a series of 9 case study go-along interviews with a subset of participants, in places they deemed therapeutic.				
Caddick et al. (2015)	The study sought to answer the question: what effects do surfing and the natural environment have on veterans' well-being? Interviews and participant observations were conducted with a group of combat veterans belonging to a UK-based veterans' surfing charity. The primary analytical approach was dialogical narrative analysis. Interviews were semi-structured life history interviews numbering 24 in total, each lasting between 1 and 4 hours. Participant observation entailed the researcher observing and participating in the daily activities of the veterans during 18 of the charity's twice-weekly surf camps, and during 3	15 male combat veterans (aged 27– 60) were recruited through purposive sampling from a UK-based veterans' surfing charity. All the participants referred to themselves as living with PTSD. One additional participant was a former member of the civilian emergency services who was diagnosed with PTSD. On hearing of the study, this man also volunteered to take part, bringing the total number of participants to 16.	Coast, sea	Surfing	'A second way in which surfing facilitated respite was through relationships with other veterans. Surfing provided a context for veterans to relate to one another in a positive fashion, which in turn helped to facilitate respite from PTSD.'

Reference	Study design/ theoretical framing	Population	Type of Blue Space	Mode of interaction	Themes identified and summary passages
	residential weeks in which he actively immersed himself in the group environment and joined in their activities.				
Völker and Kistemann (2013, 2015)	This study conducted qualitative semi-standardised interviews (N =113) asking which differences in well-being occurred when visiting urban Green and Blue Spaces in high density areas of the inner city in Dusseldorf and Cologne, Germany. Visitors to 4 research areas, one Blue Space and one Green Space in each of the cities selected were canvassed in situ with a short questionnaire between 7am and 8pm weekdays from May to September 2011.	113 visitors to Dusseldorf and Cologne, Germany. Interviewees ranged from 17 to 91 years of age; men were slightly over-represented when compared to the city population.	River	Use of the promenade	'Social engagement, behaviour, participation' 'People using the promenades enjoyed observing other people, as did people using the Green Space within the cities, although they were many fewer….Urban Blue Spaces provide somewhere where people can easily participate.' 'We found suggestions that, in contrast to Green Spaces, there is more chance of meeting 'foreign people' and of talking with them in Blue Spaces, whereas in Green Spaces people are more focused on friends or prefer to be alone…. The collective social environment is different; the Green Spaces are where people want to have a rest or conduct activities with one or more personal acquaintances. In Blue Spaces the focus on people and the involvement of other people is clearly in the foreground. '
Ashbullby et al. (2013)	This study investigated how families engaged with beach environments in their local areas and used them in health promoting ways. Families with children living in coastal regions of Devon and Cornwall participated in individual semi-structured interviews during the summer and early autumn of 2011. Parents and children were interviewed separately.	15 families with children between 8 and 11 years-old. They included 15 mothers and 9 fathers with 20 children (10 girls and 10 boys).	Beach	Visiting	'Social and family interaction benefits.' 'Increased social interaction was a benefit of beach visits identified by both families and children. A number of children felt that families spent more time together and were also able to interact socially with other families.'

3.6 Place attachment

3.6.1 Quantitative evidence

Contribution of Blue Space to place attachment

Of the 77 studies included in the review, 2 provided evidence of the way Blue Spaces can contribute to the sense of attachment that people feel towards the communities and places that surround it (Table 3.10). Both of those studies were investigations drawn from the academic literature with one demonstrating a cross-sectional research design and the other reporting a longitudinal analysis.

Wynveen et al. (2012) used a Likert Scale base questionnaire methodology alongside key informant interviews to investigate the meaning that the Great Barrier Reef Marine Park held for both the visitors to the park and the professionals who worked within it. They found that, on average, people attached importance to the statement 'I feel like I'm part of the place', indicating a degree of identification with the park as a place.

Korpela et al. (2009) performed a longitudinal analysis with 1,273 residents of 2 of the largest cities in Finland to investigate the sense of attachment that people had to their favourite places and the degree to which that sense of attachment remained stable over time. They found that 63% of people who identified a favourite place in a beach or harbour area identified the same place as being their favourite in a follow-up questionnaire 10 months later.

Comparative contribution of Blue and Green Space to place attachment

Of the 2 studies that provided evidence of the way Blue Spaces can contribute to people's sense of attachment to a place, only the study by Korpela et al. (2009) also provided comparable evidence of the way Green Spaces can contribute to place attachment.

In their longitudinal analysis undertaken with 1,273 Finnish participants, Korpela et al. (2009) examined the degree to which people's selection of a range of Green and Blue favourite places remained the same during a follow-up survey 10 months later. The proportions of people selecting the same place again as their favourite were as follows:

- 89% of people who had selected an allotment
- 63% of people who had selected a beach or harbour area
- 56% of people who had selected an area of decorative flowerbeds
- 47% of people who had chosen a forested area or built green park
- 37% of people who had chosen an area of fields of meadows

3.6.2 Qualitative evidence

Two of the studies provided qualitative evidence of the way Blue Spaces can interact with people's sense a place and shape the way it comes to be regarded (Table 3.11).

Bell et al. (2015) employed a mixed methods approach to examine the contribution that Blue Spaces made to the well-being of residents in 2 towns in Cornwall. They found that the coastal spaces people interacted with formed an important part of their identity

and engendered a sense of rootedness and belonging that generated a deep sense of attachment to the area. People also considered the coastal environment to be a prominent local feature that set Cornwall apart from other areas of the country.

Research by Völker et al. (2013, 2015) revealed similar feelings in relation to the Rhine as it passed through Cologne and Dusseldorf in Germany. In an investigation of the way both Blue and Green Spaces could contribute to people's sense of well-being, they interviewed over 100 people in situ as they used the promenades and parks in both cities. The promenade in particular was identified by the interviewees as being a key part of the identity of both settlements and felt to represent an important landmark for its residents and visitors.

Table 3.10 Quantitative studies providing evidence of place attachment

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
Wynveen et al. (2012)	This cross-sectional study used key informant interviews (N =20) and a questionnaire survey (N =324) based on a five-point Likert Scale (1 = only slightly important; 5 = extremely important) to identify the meanings visitors ascribed to places in the Great Barrier Reef Marine Park. The survey contained 34 statements participants could agree or disagree with based on ideas that emerged from the key informant interviews.	20 key informants interviewed in July and August 2008, including tourist industry managers, resource managers and recreational visitors. 324 residents living in proximity to the Great Barrier Reef Marine National Park who volunteered to take part in a survey.	Great Barrier Reef Marine National Park	Professional; recreational visitor Living in proximity	Mean Likert Scale response to statements of place meaning	'I feel like I'm a part of the place' = 3.43
Korpela et al. (2009)	This longitudinal study investigated the reliability and stability of favourite place selections and evaluations of place attachment over a 10-month period. A mail questionnaire was used to gain responses around people's favourite places and a follow-up survey 10 months later gauged the degree to which these had changed.	1,273 respondents representative of the population of the 2 largest cities in Finland between the ages of 15 and 75	Beaches and harbour areas	Selection as favourite place	Stability of self-reported favourite places over a period of 10 months (% – calculated by dividing the diagonal frequency of a favourite place by its frequency in the first survey)	Beaches and Harbour Areas = 63 Recreation Trails and sports grounds = 23 Allotment gardens = 89 Built parks (grass, passages, plants) = 47 Scenery fields and meadows = 37 Large forest areas = 47 Small-scale wooded areas = 15 Large green lots = 25 Green areas within housing blocks = 24 Decorative flowerbeds and glorious flowers = 56

Table 3.11 Quantitative studies providing evidence of place attachment

Reference	Study design/ theoretical framing	Population	Type of Slue Space	Mode of interaction	Themes identified and summary passages
Bell et al. (2015)	This study sought to explore the relative contribution of different types of Green and Blue Spaces to individual well-being, examining how these contributions might be shaped by everyday routines, life circumstances and past experiences. The study was conducted from May to November 2013 in 2 towns in Cornwall. An interpretive, mixed method approach was designed for the study. Participants carried a GeneActiv accelerometer (measuring physical activity) and QStarz BT-Q1000XT GPS (measuring location) receiver for one week and the data were used to create personalised maps. Each participant's maps were then used as visual prompts to guide an in-depth interview. This was followed by a series of 9 case study go-along interviews with a subset of participants, in places they deemed therapeutic.	33 individuals aged between 25 and 85 years-old; in full/part-time employment or retired; with or without children; and spanning households earning less than £20,000 to over £70,000 per year	Coast Sea	Routine everyday use, recall of past experiences; therapeutic; place attachment and identity	'Symbolic therapeutic experiences at the coast' 'Reflecting a form of place identity (Kyle et al. 2004), longer term residents felt that having the option to go to the seaside, with scenic coastlines to the north, west and south of home, distinguished Cornwall from elsewhere in the UK, giving it a unique 'coasty feel' 'Whilst participants might not actively engage with the sea on a routine basis (as Danny notes, sometimes taking it for granted), they valued its presence, even if just viewing it through a car window or at work. This presence contributed to feelings of belonging to the locality, reflecting Tuan's (1980, p. 4) notion of 'rootedness'; a feeling of 'being completely at home – that is, unreflectively secure and comfortable in a particular location'.
Völker and Kistemann (2015, 2017)	This study conducted qualitative semi-standardised interviews (N =113) asking which differences in well-being occurred when visiting urban Green Space and Blue Spaces in high density areas of the inner city in Dusseldorf and Cologne, Germany. Visitors to 4 research areas, one Blue Space and one Green Space in each of the cities selected were canvassed in situ with a short questionnaire between 7am and 8pm weekdays from May to September 2011.	113 visitors to Dusseldorf and Cologne, Germany. Interviewees ranged from 17 to 91 years of age; men were slightly over-represented when compared with the city population	River	Use of the promenade	'Emotional significance, identity, atmosphere' 'Symbolically the Rhine and the promenades are considered to be significant for both cities. This place is the landmark of Cologne.'

3.7 Environmental cooling

Eight of the studies included in the review provided evidence of the way Blue Spaces can contribute to environmental cooling (Table 3.12). All of those studies were investigations drawn from the academic literature, and of these 6 adopted a longitudinal research design, one was a cross-sectional analysis and one was a meta-analysis of data presented in 27 other studies (none of which is included separately here).

3.7.1 Contribution of Blue Space to environmental cooling

The evidence base generated by the included studies indicates that Blue Spaces can have a cooling effect on the environment surrounding them, but that the size and extent of this effect can vary considerably depending on the characteristics of each location examined.

In a meta-analysis of 27 studies that measured the difference in temperature between readings taken at a location in proximity to a water body and a reading taken from a separate control point, Völker et al. (2013) found that there was a median cooling effect at the water body of 2.5K over the summer months of May to October in the northern hemisphere.

The distance over which this type of effect can persist spatially was investigated by Hathway and Sharples (2012), who measured the air temperatures in proximity to the River Don in Sheffield. They found that both the reduction in temperature in proximity to the river and the distance from the river at which it was still detectable changed according to the built characteristics of the urban environment adjacent to the bank. Temperatures remained lower at greater distances from the river where the urban form consisted of either an open square (approximately 50–60m) or open streets (approximately 40m).

Three of the included studies considered the way in which the cooling effects measured in proximity to water bodies can vary over the diurnal cycle.

Amani-Beni et al. (2018) investigated the cooling effect of 2 of the manmade water features present in Beijing's Olympic Park – a large area of water near the middle of a river and a smaller area of water at the bottom of the river. The temperature at both areas was measured daily at 3 intervals – in the morning, at midday and in the afternoon – and compared with measurements taken from a nearby control point. The data point to the influence of the size of a water body on environmental cooling effects, indicating that:

- at the larger of the 2 areas of water, the cooling effect was most pronounced during the morning and at midday
- at the smaller water body, the cooling effect was most pronounced in the afternoon

A similar investigation carried out by Xu et al. (2017) in another urban park in Beijing used continuous onsite temperature measurement to investigate the comparative cooling effects of a range of environmental features. The water bodies they examined at different points within the park were found to exert a cooling effect that was most pronounced in the morning and that dissipated as temperatures rose in the afternoon.

However a study by Xiao et al. (2018) indicated that the cooling effect they identified at Suzhou Industrial Park in China remained relatively stable throughout the day, pointing to the influence of case-specific variables on the ability of water bodies to provide

cooling across the day. They collected temperature measurements from 5 different locations in and around the park, each of which was located in proximity to a different set of natural features. The temperatures measured in proximity to water bodies remained lower across the day than the temperatures measured at the control point.

Qiu et al. (2017) took a different methodological approach to examining the cooling effects of water bodies over the diurnal cycle, using satellite data to measure temperatures at the city-wide scale of different categories of land use in Shenzhen, China. The data demonstrated that the land temperatures around water bodies were lower than those both in the commercial district of the city and an area of urban village at every point throughout the day.

Using a similar methodological approach, Sun and Chen (2017) set out to consider much longer term trends by investigating the average temperature differences across different land use classifications within the metropolitan area of Beijing over a period of 5 years. Their analysis found that:

- the cooling effect of water bodies within the city was relatively stable over time
- areas of water were consistently associated with a cooling effect of approximately 3°C across the study period

Mushore et al. (2017) used similar techniques to examine the extent to which changes in the different types of land use found in Harare, Zimbabwe, had exerted a climate forcing effect and contributed to rising temperatures over a 30-year period. They found that between 1984 and 2015 areas classified as water bodies within the city had made an overall negative contribution to temperature rises and exerted a long-term cooling effect.

3.7.2 Comparative contribution of Blue and Green Spaces to environmental cooling

Of the 8 studies that provided evidence of the way water bodies can have a cooling effect on their surrounding environment, 6 also provided comparable evidence of the cooling effect of Green Spaces (Table 3.12). The overall picture they present is of an inconsistent and mixed relationship that depends considerably on the types of Green and Blue Space being considered as well as other local influences on the microclimate.

Three of the studies provided evidence that the environmental cooling effect generated by Blue Spaces is weaker than that provided by comparable local Green Spaces.

In their analysis of the cooling effects of the different features within the Suzhou Industrial Park, China, Xiao et al. (2018) found that:

- the Green Spaces within the park provided a small but consistently greater degree of cooling than the water bodies present
- this pattern held across all 3 of the different areas of the park considered

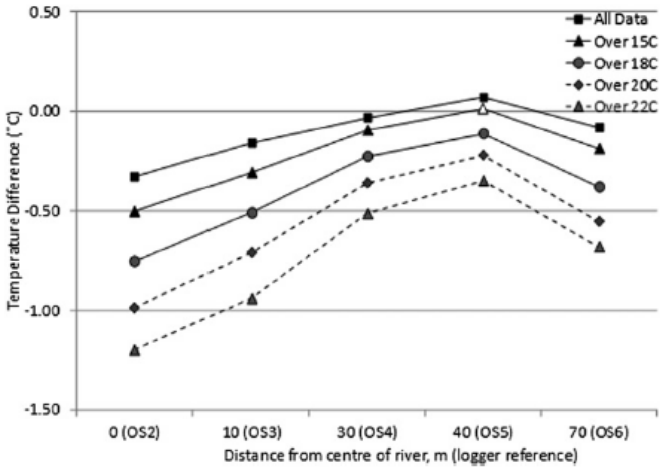
Similarly Qiu et al. (2017) found that, in their analysis of land surface temperatures relating to different categories of land classification across Shenzhen, China, the measurements taken from areas of urban Green Space were consistently lower than those taken from the water bodies within the city.

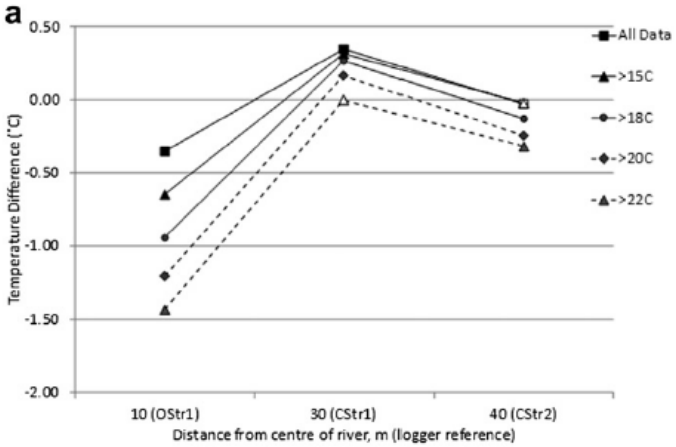
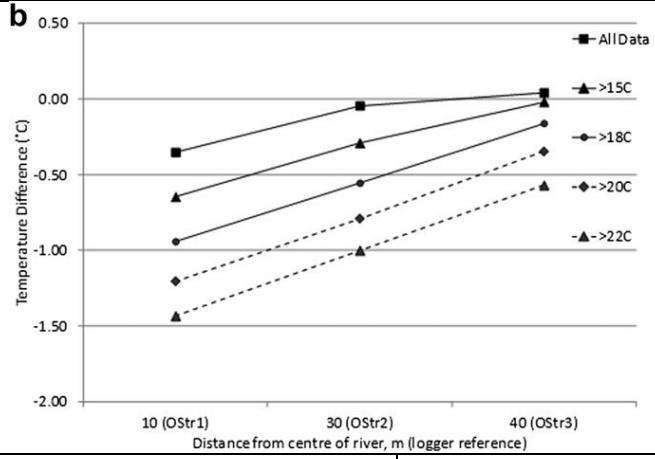
Likewise the analysis by Mushore et al. (2017) of the different contributions made to increasing local temperatures in Harare, Zimbabwe, demonstrated that Green Spaces had made a comparably larger negative contribution to rising temperatures than had areas of water within the city.

A single study provided evidence that water bodies generated a comparably larger cooling effect than the comparable local Green Spaces. In their analysis of satellite temperature data for different land classifications within the metropolitan area of Beijing, Sun and Chen (2017) found consistently lower temperatures connected to the areas of water within the city than for the areas that were either forested or grassed.

The analysis by Amani-Beni et al. (2018) of the cooling effect of the different environmental features within Beijing's Olympic Park provided evidence of a comparable size of effect between the larger of the 2 water bodies and the cooling effect of the Park's trees, but that the grassed areas in the Park provided significantly less cooling.

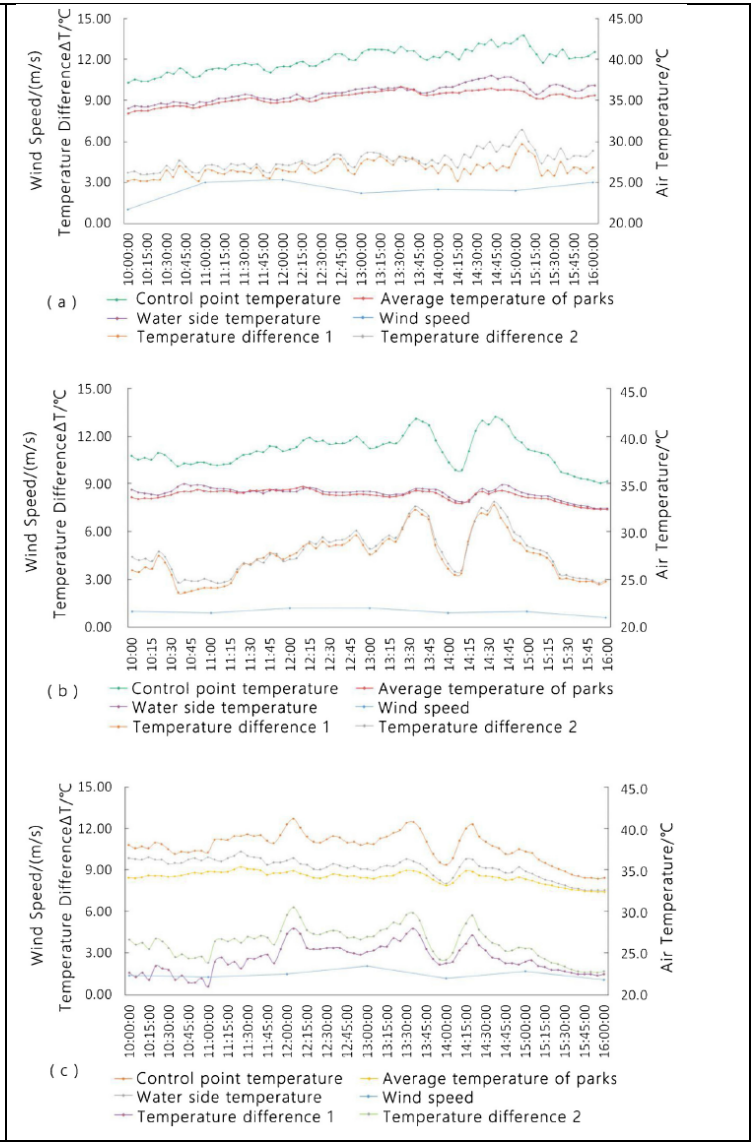
Table 3.12 Quantitative studies providing evidence of environmental cooling benefits

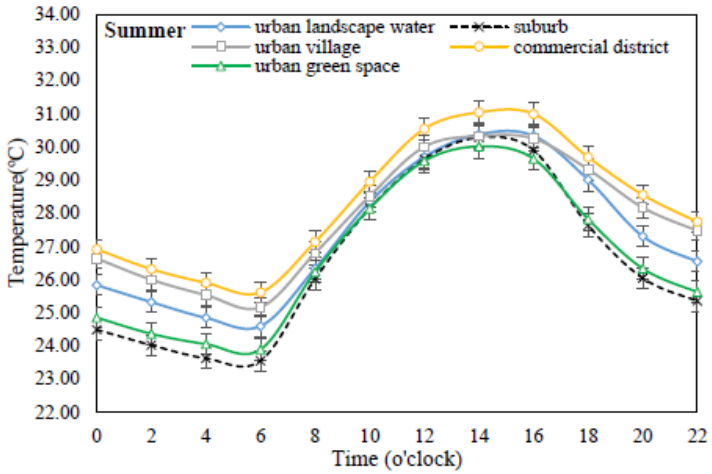
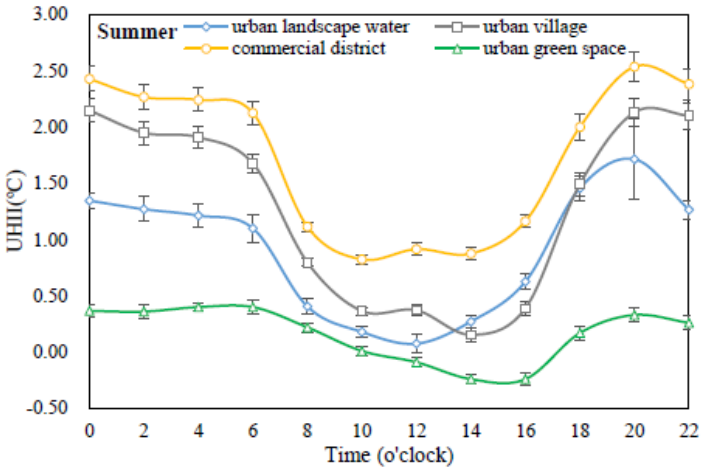
Reference	Study design	Study site	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
Hathway and Sharples (2012)	This study investigated the effectiveness that small urban rivers may have in reducing the urban heat island (UHI) effect. It also examined the role that the urban form on the banks of a river can play in propagating or reducing this potential cooling. A field survey was conducted between 24 April and 12 August 2010 on the River Don in Sheffield. Measurements of temperature and humidity were taken at 12 locations that were either directly adjacent to the river or running perpendicular to the river bank at a selection of sites close to the north of the city centre. These were then compared with an urban reference temperature measurement.	The River Don, flows with an average flow estimated to be 4.7m3 per second through the study site where the channel is ~22m wide. The river passes through rural locations before entering the suburbs and finally the city of Sheffield. Four different types of urban form were chosen for monitoring locations: enclosed (E), open square (OSq), open street (OStr) and closed street (CStr).	River	Water vaporisation (cooling)	Temperature difference with urban reference measurement moving away from the river at the open square site, with the distance from the river centre shown on the x-axis of the graph alongside the individual logger reference. All filled markers are statistically significant ($p < 0.05$); unfilled markers are not.	

Reference	Study design	Study site	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results	
					Temperature difference with urban reference measurement moving away from the river at the closed street. All filled markers are statistically significant ($p < 0.05$); unfilled markers are not.		
					Temperature difference with urban reference measurement moving away from the river at the open streets. All filled markers are statistically significant ($p < 0.05$); unfilled markers are not.		
Amani-Beni et al. (2018)	The study investigated the impact of trees, grass and water on the microclimate inside the	The Beijing Olympic Park was built for 2008 Olympic Games in	Manmade river and lake	Water vaporisation (cooling)	Average temperature reduction compared with	Water body J AM 1.01 Midday 1.11 PM 0.51	Park's grass: 0.62 Park's trees: 1.12

Reference	Study design	Study site	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results	
	Olympic Park, Beijing during the summer days of 2016. The study area included buildings, roads, trees, grass and river, within which 12 measurement sites were selected (in B zone): 5 tree areas; 5 grassed areas; and 2 water bodies. The 2 water body measurements were taken at site J, adjacent to the largest area of water, and site H, next to a smaller lake at the south end of the Park.	the northern part of the city. It has a total area of 1,215ha and has become a hotspot for recreation and tourism. It consists of 3 parts: the northern part (A zone) is the forest park with 760ha; the southern part (C zone) is the stadiums' area of 140ha; and the middle part (B zone) covering 315ha is the core area of Olympic Park. Zone B has been the core of Olympic Park and is distributed with various types and relatively homogeneous Green Spaces, which is why it was chosen as the study area.			reference point at site J and H at 3 times of day. Air temperature reduction (T): T of reference point – T of river site (positive values show temperature reduction)	Average: 0.88 Water body H AM: −0.08 Midday: −0.08 PM: 0.38 Average: 0.08	
Sun and Chen (2017)	This study investigated Green Space dynamics and land surface temperature (LST) of the Beijing metropolis. LST values were extracted from Landsat™ images and	Beijing has experienced rapid development in recent decades and as a result the UHI intensity has increased at a rate of 0.031°C per	Waterbody	Contribution to the thermal environment	Relative land surface temperature (RLST) for the years: 2002, 2009, 2010, 2011, 2012	Impervious land: mean (SD) 0.83 (1.12), 0.89 (1.78), 0.89 (1.72), 0.97 (1.81), 0.92 (1.82) Water: mean (SD) -2.97 (1.61), -3.06 (1.72), -3.09 (1.84), -3.14 (1.67), -3.08 (1.83) Forest land: mean (SD) -0.93 (1.43), -0.65 (1.99), -0.69 (1.79), -0.68 (1.93), -0.6 (2.01) Grassland: mean (SD) -1.46 (1.47), -1.14 (1.99), -1.26 (1.85), -1.17 (1.92), -1.13 (2.07)	

Reference	Study design	Study site	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
	included impervious land, forest land, grassland, water body and bare land.	year (Yu et al. 2005). The mean daily temperature in urban areas is 4.6°C higher than the mean daily temperature in the suburbs. The study targeted the highly urbanised region inside the city's 5th ring road, which covers an area of 667.28km^2. The study area was divided into 4 sub-regions via the ring roads, including the sub-region inside of the 2nd ring road, the sub-region between the 2nd and 3rd ring roads, the sub-region between the 3rd and 4th ring roads, and the sub-region between the 4th and 5th ring roads.			If RLSTj i > 0, then cell j produces a positive contribution to the thermal environment. If RLSTj i < 0, then cell j generates a negative contribution to the thermal environment.	Bare land: mean (SD) -0.05 (1.25), -0.15 (1.48), -0.1 (1.68), -0.11 (1.56), -0.13 (1.81)

Xiao et al. (2018)	This study aimed to understand how plants affect urban surface and air temperature in 15 urban Green Spaces in Suzhou Industrial Park, China. They were divided into small (<4ha), medium (4–10ha) and large (>10ha). Five observation points were selected with different types of land surface and compared with a control point set up in an open field during July 2016. The difference between the temperature recorded by each observation and control point was used to define the cooling effect.	Suzhou is located in the south-eastern part of Jiangsu Province. Suzhou has a subtropical monsoon maritime climate, with 4 distinct seasons and abundant rainfall. According to Suzhou meteorological station statistics, the average temperature of Suzhou City is 15.7°C, with the highest annual average temperature being 17°C and the lowest being 14.9°C. The highest monthly average temperature is in July at 30.3°C and the lowest is in January at 0.3°C.	Water body	Water vaporisation (cooling)	Temperature difference (ºC) between waterfront and control point (Temp diff 1) and waterfront and Green Space (Temp diff 2) in (a) Central Park (large) (b) Zhongtang Park (medium size) (c) Wenxing Plaza (small).	

Reference	Study design	Study site	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
Qiu et al. (2017)	This study focused on quantifying the effects of Green Space on the UHI in Shenzhen, a subtropical megacity in China. Extensive measurements (air temperature and humidity) were taken using a mobile traverse method in an 8km long transect, where a variety of Land Use and Land Cover (LULC) types were included. Measurements were conducted at two-hourly intervals for 2 years (repeated a total of 7,011 times). The transect was divided into 40 observation sections considering vegetation, roads, traffic, buildings and other factors. Five main LULC types through the belt transect, urban landscape water, urban village, commercial area, urban Green Space and suburban forest were studied. The LULC types division was based on an aerial view from satellite and observation data	An 8-km long transect around Xili University Town in Nanshan District, Shenzhen was selected as the experimental site. The entire observation transect shared a similar altitude (~20m). Along the transect, an area 150m wide at each side is used as a buffer zone to mitigate the impact of different landscapes on the measured air temperature.	Pond	Water vaporisation (cooling)	Average air temperature (ºC) for 5 different LULCs in Shenzhen. Data were measured from July to November 2011, with approximately 1,800 repetitions. The bars on the graph represent one standard deviation.	
					Average UHI intensity (ºC) (UHII) for 4 land use types. Data were measured from July to November 2011, with approximately 1,800 repetitions. The bars represent one standard deviation.	

Reference	Study design	Study site	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
Xu et al. (2017)	This study investigated the cooling and energy saving effect of landscape parameters in an urban park of Beijing during a hot summer. Continuous onsite microclimate data of individual parameters including grass, water body, tree and artificial shading device (including a Chinese style pavilion) and certain combinations such as grass + tree, water body + tree and shading device + tree were collected. The thermal perception of people caused by each parameter was studied using both measured data and thermal sensation votes from a questionnaire survey. Based on those field measurements, the heat reduced and thus the energy saved by each parameter were estimated.	The Yuan dynasty relics park is a belt-shaped Green Space located in the northern part of Beijing between the 3th and 4th ring roads. It has a length of 8.68km, a mean width of 118m and a total area of 1,027,876m^2. This park is open, free of charge, for citizens for 24 hours per day and 365 days per year. Five separated locations (A–E) with 3 or 4 sites for each were chosen as the measuring points.	River	Water vaporisation (cooling)	Temperature of the control group (ºC) minus those of the water body measuring sites respectively	Graph removed for copyright purposes
					Humidity of the control group (%) minus those of the water body measuring sites respectively	Graph removed for copyright purposes
Mushore et al. (2017)	This study assessed the microclimate forcing of LULC changes in the heterogeneous Harare Metropolitan City, Zimbabwe, between	This study was conducted in Harare, the capital city of Zimbabwe. The city is experiencing	Water/ wetlands	Water vaporisation (cooling)	Contribution of LULC types and their changes to heating in Harare (HDR: high density residential areas	Graph removed for copyright purposes

Reference	Study design	Study site	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
	1984 and 2015. To achieve this objective, the transformation of major LULCs within the city was determined and the relative brightness temperature used to assess long-term thermal changes in the city. LULC maps for the years 1984, 1993, 2001 and 2015 were derived using the 30m reflective bands of Landsat 5, 7 and 8 images. The average temperature of each class for each year collected from points evenly distributed across the study area was calculated to capture all possible inter- and intra-class variations. The difference between the average temperature in 1984 and 2015 for each land cover was also calculated. In order to determine the change in average temperature, due to change from LULC changes, the normalised difference in temperature was used to correct for the influence of other anthropogenic factors.	growth as evidenced by the increase in population and built-up area. The urban core and industries are found at the centre of the city, while major roads radiate from the city centre. Settlements are more spacious in the north where mostly low and medium density residential suburbs are found. The month of October is the hottest and driest, while the summer season is noted to be warming and experiencing prolonged hot spells – hence the selection of the period.			and LMR: low-medium density residential areas)	

Reference	Study design	Study site	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
Völker et al. (2013)	This meta-analysis examined 27 studies that measured air temperatures at various types of urban Blue Space such as ponds, lakes or rivers and compared them with reference sites at defined distances or to urban reference sites in the same city. Studies were identified though a systematic review that included studies quantifying the temperature-mitigating effects of urban Blue Space compared with other urban sites. The temperature difference ΔT (= effect size) was calculated using the method proposed by Bowler et al. (2010b), which is the median of the differences in K between urban blue and non-blue urban areas:	Multiple	Multiple	Water vaporisation (cooling)	Median temperature difference between urban blue and reference site temperature of 27 included studies (K, 95% Cl)	2.5K (1.9–3.2K, $p < 0.01$)

3.8 Educational

3.8.1 Quantitative evidence

Five of the studies provided quantitative evidence of the way Blue Spaces can function as educational settings and can have an impact on people's educational outcomes (Table 3.13). Four of those studies were survey reports taken from the grey literature, and all had a cross-sectional research design. The fifth study was an academic enquiry taken from the academic literature and also had a cross-sectional design. The 4 survey reports were national scale enquiries conducted in England and the academic enquiry was a city-wide analysis conducted in Twin Cities, Minnesota, USA.

Association between Blue Space and educational outcomes

The MENE surveys conducted in England between 2009 to 2010 and 2012 to 2013 provide some evidence of the extent to which the people who visited Blue Spaces in England considered that their experience had enabled them to learn something about the natural world. In the 2009 to 2010 survey, 20% of those interviewed who had reported visiting an area categorised as 'seaside coastline' said that they had learned something about the natural world during the course of their visit; this percentage declined in the next 2 years of the survey to 16% and then 9%. In comparison 7% of those interviewed in 2009 to 2010 who had visited a 'seaside town or resort' said that they felt as if they had learned something about the natural world, a figure that jumped to 19% in 2010 to 2011 and fell back to 10% in 2011 to 2012. The relationship between the data collected over the different years of the survey may be complicated by the introduction of new categories of environment in later years. Given the degree of variability in the data, it may be necessary to interpret trends with care (Natural England 2010, 2011, 2012, 2013).

In the 2012 to 2013 and the 2013 to 2014 surveys, the categories for which learning outcome data were reported changed to include the beach, areas of other coastline and rivers, lakes and canals. The data indicate that, of those who reported having visited an area of beach in 2011 to 2012, 4% felt they had learned something about the natural world during the course of their visit. In comparison, 16% of people who reported visiting an area of other coastline or a river, lake or canal felt they had learned something (Natural England 2012). These percentages changed to 5%, 12% and 5% respectively in 2012 to 2013 (Natural England 2013).

Comparative association between Blue and Green Space and educational outcomes

The MENE surveys conducted between 2009 to 2010 and 2012 to 2013 also provide comparable evidence of the way that Green Spaces can be used as educational settings in England, and the way that their use can have an impact on educational outcomes. Alongside the evidence presented in relation to Blue Spaces, survey participants who reported visiting the countryside were asked to either agree or disagree with the assertion that they had learned something about the natural world during their visit. In the 2009 to 2010 and 2010 to 2011 surveys, 8% of people who had visited the countryside said they had learned something; this percentage rose to 13% in the 2011 to 2012 survey (Natural England 2010, 2011, 2012).

Further categories of environmental setting were added to the response options in the 2011 to 2012 survey. The data collected indicated that the spaces in which the highest

percentage of people reported learning something about the natural world in that year were children's playgrounds, followed by areas of woodland, areas of other coastline and rivers, lakes or canals (Natural England 2012). In the 2012 to 2013 survey, these locations changed to mountains and moorlands, farmland and areas of other coastline (Natural England 2013).

Hodson and Sander (2017) used a different methodological approach to examine the comparative relationship between learning outcomes and the level of access people had to Blue and Green Spaces in a US context. They examined the reading scores of primary school aged children from 222 schools in the Twin Cities metropolitan area in Minnesota and correlated them against the percentage of land in each school attendance area covered by water, tree canopy and impervious materials. They found that, while there was no significant relationship between either the reading scores children obtained or the number of children that exceeded the basic standard for reading abilities and the percentage of their school attendance areas covered by water, there was a significant relationship between both variables and both the amount of land covered by tree canopy and, significantly, impervious materials. However, the latter relationship implies the presence of a confounding variable. This may mean that the associations found may not imply any beneficial effect that results from a natural setting.

3.8.2 Qualitative evidence

Two of the studies included in the review provided qualitative evidence of the way that Blue Spaces can be used as educational setting and the way that they can have an impact on educational outcomes (Table 3.14).

Kelly (2018) used a case study based approach that employed participant observation and in situ survey questionnaires to examine the way that courses provided by specialist providers of outdoor education programmes in Brighton shaped and contributed to the environmental knowledge of the teachers and school pupils that used them. She found that the classes that took place in a coastal setting were highly effective as a means of engaging children in pro-environmental behaviour.

Selman et al. (2010) used creative writing classes that took place in the environment around the River Don in Sheffield as part of an imaginative engagement approach intended to:

- involve the local community in catchment management debates
- help them grasp the important functions and meanings of those types of conversations

They found that the response to the approach was variable in terms of the way it affected people's behaviours, but that it had a more sustained impact on the way participants engaged cognitively and emotionally with the issues raised.

Table 3.13 Quantitative studies providing evidence of educational benefits

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
MENE 2009 to 2010 survey (Natural England 2010)	In home interviews undertaken with a representative sample of the English adult population (aged 16 and over) between March 2009 and February 2010 with a sample of at least 800 achieved across at least 100 sample points per week.	800 English adults (over 16 years) per week	River, lake, canal Beach Other coastline	Visiting	Reported outcomes of visits by destination %. 'I learned something about the natural world.'	Seaside resort or town: 7 Seaside coastline: 20 Countryside: 8
MENE 2010 to 2011 survey (Natural England 2011)	In home interviews undertaken with a representative sample of the English adult population (aged 16 and over) between March 2010 and February 2011 with a sample of at least 800 achieved across at least 100 sample points per week.	800 English adults (over 16 years) per week	River, lake, canal Beach Other coastline	Visiting	Reported outcomes of visits by destination %. 'I learned something about the natural world.'	Seaside resort or town: 19 Seaside coastline: 15 Countryside: 8
MENE 2011 to 2012 (Natural England 2012)	In home interviews undertaken with a representative sample of the English adult population (aged 16 and over) between March 2011 and February 2012 with a sample of at least 800 achieved across at least 100 sample points per week.	800 English adults (over 16 years) per week	River, lake, canal Beach Other coastline	Visiting	Reported outcomes of visits by destination %. 'I learned something about the natural world.'	Seaside resort or town: 10 Seaside coastline: 9 Beach: 4 Other coastline: 16 River lake of canal: 16 Countryside: 13 Country park: 11 Farmland: 10 Mountain or moorland: 10 Other open space in countryside: 15 Other open space in town: 2 Park in town: 7 Path, cycleway or bridleway: 8 Children's playground: 29 Playing field/other recreation area: 8 Village: 7 Woodland/forest: 16

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
MENE 201 to 2013 survey (Natural England 2013)	In home interviews undertaken with a representative sample of the English adult population (aged 16 and over) between March 2012 and February 2013 with a sample of at least 800 achieved across at least 100 sample points per week.	800 English adults (over 16 years) per week	River, lake, canal Beach Other coastline	Visiting	Reported outcomes of visits by destination %. 'I learned something about the natural world.'	River, lake or canal: 5 Beach: 5 Other coastline: 12 Country park: 3 Farmland: 12 Mountain or moorland: 23 Other open space in countryside: 8 Other open space in town: 5 Park in town: 5 Path, cycleway or bridleway: 6 Children's playground: 6 Playing field/other recreation area: 4 Village: 3 Woodland/forest: 10
Hodson and Sander (2017)	This study investigated the relationship between natural elements of urban landscapes and the third-grade reading and mathematics test scores of 222 primary schools in the Twin Cities Metropolitan Area of Minnesota for the academic year 2010 to 2011. The 2011 Minnesota Comprehensive Assessment score reports by grade and school were used to obtain the mean reading and mathematics scores of third-grade students attending each school in the study sample in addition to the proportion of students exceeding the basic standard for reading ability and mathematics at said schools. Five environmental variables were estimated to indicate the level of greenness and the development intensity of each school attendance area.	Grade 3 students of 222 primary schools in the Twin Cities Metropolitan Area of Minnesota, whose school attendance area exceeded 50% urban land	Water bodies	Residence in a school attendance area	Association between student reading score and % school attendance area covered by water body (B, SE, t-value)	Water body: 0.06087, 0.03586, 1.698 (not significant) Canopy: 0.12107, 0.04029, 3.005 (p = 0.01) Impervious: 0.09980, 0.04117, 2.424 (p = 0.05)
					Association between proportion of students exceeding the basic standard for reading and % school attendance area covered by water body (B, SE, t-value)	Water body: 0.09138, 0.09769, 0.936 (not significant) Canopy:0.26846, 0.10439, 2.572 (p = 0.05) Impervious; 0.23041, 0.10132, 2.274 (p = 0.05)

Table 3.14 Qualitative studies providing evidence of educational benefits

Reference	Study design/ theoretical framing	Population	Type of Blue Space	Mode of interaction	Themes identified and summary passages
Kelly (2018)	This paper used Brighton in south-east England as a case study through which 3 different user groups were studied to investigate costal engagement, well-being, learning and attitudes to coastal environmental sustainability. Using an outdoor/coastal education and well-being provider as the source for sample respondents, the paper assessed the underlying pedagogic discourses of school 'away-days' and their connections to evolving forms of socioenvironmental practice.	School group visits: (teachers and primary age children 7–11) school group visits. These comprised 10 one-day school field trips (N = 460) over a 15-month period and two 10-week afterschool beach school programmes (N = 40). Family beach visits: During the months of June to September 2016, 30 family groups were approached as part of a random sample on the Brighton and Hove seafront. Mindfulness by the Sea class: 30 adult participants (affective well-being).	Coast Sea	School trips; 30 mindfulness class participants	School group visits 'The findings from the school group visits show that situated learning at the beach, preceded by classroom learning content, and post-visit review is a highly effective way of engaging school children in pro-environmental behaviour.'
Selman et al. (2010)	The experience of involving communities in dialogues about choices concerning river catchments was examined through a participatory approach known as imaginative engagement. The study experimented with an approach based on techniques of imaginative engagement in the expectation that it could help people grasp important functions and meanings and identify with possible future catchment management options. These methods use the arts to communicate and help people engage with complex and sometimes abstract issues, by providing icons and metaphors and by giving space to the imagination and emotions. The approach chosen was based on creative writing. The location was a 20km stretch of the valley of the River Dearne, an area that was at the heart of the UKs coal mining and steelmaking industries before their catastrophic decline during the 1980s.	Participants were drawn from local government, government agencies, non-governmental organisations, research groups and the local community. Although 11 individuals were recruited, only 7 participated in ≥3 workshops. A minority of the group had qualifications relevant to environmental science, so there was scope to blend 'lay' and 'expert' knowledge.	River	Creative writing workshops	The effects of imaginative engagement on participants 'Responses indicate variable effects on participants' behaviours, but a more consistent effect on emotional, physical and cognitive engagement with rivers, with all participants noting some change to their attitudes and/or thinking.' One participant said that he now pays more attention to his surroundings and that he is 'more interested in rivers and the role they play in society' and has become 'more interested in local environmental issues.' Another participant reported becoming 'more aware of opportunities for participation in my local area' and joining a local environmental group.

3.9 Tourism, amenity and beauty

3.9.1 Blue Space as a tourist commodity

Of the 77 studies included in the review, 2 provided evidence of the way that Blue Spaces can contribute to the tourism economy (Table 3.15). The relatively low number of studies returned in comparison with the size of the literature on the subject is likely to be a function of the exclusion of studies published before 2004.

In a large-scale international investigation, Onofri and Nunes (2013) correlated the international and domestic coastal arrivals in 160 countries with their national environmental characteristics. These included:

- the length of the beaches
- the total area of coastal wetland
- the area of coastal protection zone
- the area of coastal coral reef

They found that by far the strongest correlation with both international and domestic arrivals was with the length of the beaches. Weaker correlations were also found with the other parameters.

Sijtsma et al. (2012) conducted a much smaller scale and case-specific comparison of the percentage of leisure and tourism jobs in the Wadden Islands World Heritage Site and the economy of the Netherlands as a whole between 1996 and 2007. They found that, while leisure and tourism jobs made up approximately 8.5% of the economy of the Netherlands in 2007 (up from 7.4% in 1996), and around 8.8% of the jobs on the mainland coast adjacent to the Wadden Islands, they made up between 35% and 40% of the total jobs in the Wadden Islands over the same period. In a second phase of the investigation, they compared the spatial distribution of leisure and tourism jobs on the Wadden Islands with markers of attractive places left on the website Hotspotmonitor. No correlation was found.

3.9.2 Attractiveness and beauty of Blue Space

Two of the studies also provided evidence of the way Blue Spaces can be appreciated for their attractiveness and their beauty.

The second phase of the investigation by Sijtsma et al. (2012) compared the spatial distribution of leisure and tourism jobs on the Wadden Islands with markers of attractive places left on the website Hotspotmonitor. No correlation was found. However, an analysis of the specific attractivity tags that people selected when leaving their marker revealed that nearly 80% of those who left a marker selected water as being a key feature of its attractiveness. Similarly the word ‘sea’ was the second most used term people chose to describe their selection.

In a similarly case-specific investigation, Wynveen et al. (2012) examined the benefits of the Great Barrier Marine Park in Queensland, Australia, for both members of the professional community who worked there and people who had come to visit. Using a Likert Scale questionnaire-based methodology, they asked participants the extent to which they agreed or disagreed with statements around the way they evaluated its aesthetic beauty. They found that people ‘agreed’ or ‘strongly agreed’ with the assertion that:

- the park provided a naturally beautiful space
- the sound of the waves and wildlife were important features
- the tropical beaches were special

Table 3.15 Quantitative studies providing evidence of tourism and amenity benefits

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
Onofri and Nunes (2013)	This study correlated national international and domestic coastal tourist arrivals data against national environmental parameters. Data were gathered from a broad set of different sources with the objective of creating a rich, multi-metric worldwide and comprehensive database at country level. The bulk of the dataset is based on the World Tourism Organization's dataset and on the work of Bigano et al. (2004, 2007) which used a methodology based on a geo-climatic algorithm that disentangles coastal from total tourist arrivals worldwide, whenever primary information is not available. (The study's modelling of visitor environmental parameter preference was excluded from the current review.)	160 coastal countries	Beach Coastal wetland Coastal reef Coastal protected area	Flight arrival	Correlation between international coastal arrivals and environmental parameter (descriptive statistic: 1 = perfect correlation)	Beach length: 0.801 Coastal wetland area: 0.014 Coastal reef area: 0.048 Coastal protected areas: 0.026
					Correlation between domestic coastal arrivals and environmental parameter (descriptive statistic: 1 = perfect correlation)	Beach length: 0.398 Coastal wetland area: 0.042 Coastal reef area: 0.044 Coastal protected areas: 0.048
Sijtsma et al. (2012)	The study aimed to ascertain the level of the contribution of tourism to different parts of the rural economy, and to examine which parts and aspects of the natural area are highly appreciated by visitors and thus may serve as immobile resources for the local economy. The analysis compared jobs and industry data taken from the Dutch National Information System for Workplaces (LISA) at the municipality level in the Wadden Islands and across the Netherlands as a whole. Municipal tourist industry employment data was also spatially correlated against mapped attractive places markers on the website Hotspotmonitor.	Wadden Islands and Coast – 18 municipalities 320 respondents on Hotspotmonitor	Sea Coast	Leisure employment	Leisure employment (% of total) in 2007	Netherlands = 8.6 Wadden Coast = 8.8 Wadden Islands = 39
					Spatial correlation between clusters of Hotspotmonitor attractive place markers and tourism employment Cluster share of markers, % total (share of employment, % total)	Texel: 88 (28%) 679 (31%) Vlieland: 17 (5%) 157 (7%) Terschelling: 66 (21%) 291 (13%) Ameland: 22 (7%) 272 (13%) Schiermonnikoog: 40 (13%) 160 (7%) Lauwerslake area: 13 (4%) 25 (1%) Sea: 52 (16%) 0 (0%) Mainland: 22 (7%) 598 (28%) Total: 320 (100%) 2.157 (100%) No significant correlation
					Hotspotmonitor attractive place marker tags	Graph removed for copyright purposes

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome(s) assessed	Main results
					Hotspotmonitor attractiveness descriptors (number of times used)	'nature' (82 times), 'sea' (54) 'beautiful' (51) and 'birds' (48) The words 'space' (40), 'island' (39), 'peace' (35) 'beach' (34), 'quiet' (29), 'Wadden' (24) and 'dunes' (22) 'birds' mentioned 48 times and 'plants' 12 times, but 'seals' were mentioned only 4 times
Wynveen et al. (2012)	This study used key informant interviews (N = 20) and a questionnaire survey (N = 324) based on a five-point Likert Scale (1 = only slightly important; 5 = extremely important) to identify the meanings visitors ascribed to places in the Great Barrier Reef Marine Park in Queensland, Australia. The survey contained 34 statements participants could agree or disagree with based on ideas that emerged from the key informant interviews.	20 key informants interviewed in July and August 2008, including tourist industry managers, resource managers and recreational visitors. 324 residents living in proximity to the Great Barrier Reef Marine National Park who volunteered to take part in the survey.	Great Barrier Reef Marine National Park	Professional Recreational visitor Living in proximity	Mean Likert Scale response to statements of place meaning	Aesthetic beauty The seascapes and landscapes are beautiful = 4.42 I enjoy the sounds of the waves and the wildlife = 4.09 The tropical beaches are very special = 4.08

3.10 Quality of life

Two of the studies included in the review provided evidence of the way Blue Spaces can influence people's overall sense of their own well-being and quality of life (Table 3.16). One was a study drawn from the academic literature and the other was a survey report taken from the grey literature. Both had a cross-sectional design with one taking place in the UK and the other in Utah, USA.

Haeffner et al. (2017) drew on data collected from a questionnaire survey of 1,450 randomly sampled households from 13 neighbourhoods in northern Utah. Participants were asked to indicate the extent to which they felt that local Blue Spaces had an impact on their quality of life using a Likert Scale methodology. The data indicated that the residents who responded felt that the Blue Spaces they had access to improved their quality of life overall and were valuable resources in terms of their habitats and wildlife, the sights and sounds that visiting them afforded and the spaces that they provided for play. In a further analysis, the scores for those families who had been to the Blue Space were separated from those who had not. It was found that those who had visited the Blue Space reported substantially more positive impacts on their quality of life than those who had not.

White et al. (2013a) used BHPS data to consider the way living at different proximities to the coast influenced the overall well-being and sense of life satisfaction of UK residents. The analysis found no significant relationship.

Table 3.16 Quantitative studies providing evidence of quality of life benefits

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome assessed	Main results
Haeffner et al. (2017)	This cross-sectional study drew on a sample of households in northern Utah living in neighbourhoods with a nearby river or canal to ask if local waterways provided positive impacts to households and if proximity to the waterways increased the likelihood of households spending time at them and being familiar with them. Households were asked to fill out a five-point questionnaire querying aspects of the way the used Blue Space. Answers were coded using a five-point scale ranging from 'strong negative impact' (1) to 'no impact' (3) to 'strong positive impact' (5).	1,450 randomly sampled households from 13 neighbourhoods in northern Utah: 7 with rivers and 6 with major irrigation canals as their local waterway	River Irrigation canal	Quality of life	Perceived impact on household of aspects of Blue Space: Total neighbourhood scores (river and canal) ($p \leq 0.001$.) (Likert Scale: 1 = strong negative, 5 = strong positive)	Overall quality of life = 4.10 A place to visit and walk = 3.94 A place to play = 3.53 Sights and sounds = 3.63 Habitat for wildlife = 3.89
					Perceived impact on household of aspects of Blue Space when households: (Likert Scale – 1 = strong negative, 5 = strong positive)	Did not spend time there ($p \leq 0.001$) Overall v = 3.65 A place to visit and walk = 3.34 A place to play = 3.14 Sights and sounds = 3.14 Habitat for wildlife = 3.42 Did spend time there ($p \leq 0.001$) Overall quality of life = 4.29 A place to visit and walk = 4.18 A place to play = 3.68 Sights and sounds = 3.82 Habitat for wildlife = 4.07
White et al. (2013a)	The study analysed BHPS longitudinal data on self-reported health from individuals living at different distances from the coast in England. The BHPS was a nationally representative longitudinal survey of households in	The measure of general health was included in 17 of the 18 waves. Analysis was based on an estimation sample of 109,844 observations from 15,471	Coast	Proximity	Self-assessed well-being as measured by life satisfaction	No significant association with coastal proximity

Reference	Study design	Population	Type of Blue Space	Mode of interaction	Outcome assessed	Main results
	the UK that ran annually from 1991 to 2008. It contained over 5,000 households and 10,000 individual adults, and used data collection techniques that maintained representativeness over time	individuals. Mental distress was measured in all 18 waves and resulted in an estimation sample of 114,133 observations from 15,361 individuals. Mental well-being, as measured by life satisfaction, was only collected in 12 waves resulting in analysis of 74,121 observations from 12,360 individuals				

4 Conclusions

4.1 Contextualisation of findings

The conclusions of the review drawn out in this section are contextualised by the limitations to the process identified in section 2.6, and the claims being made need to be considered in that light. But within those boundaries the review has been able to draw together a useful body of evidence that could inform policy and practice across the Environment Agency and more widely across other government departments.

The evidence base shows that there are variable levels of evidence of the social benefits of Blue Space across the different outcome categories. Some areas of investigation appear to have received substantially more attention than others, such as the examination of how Blue Spaces are used recreationally and the physical and mental health benefits that can arise from using them. Consequently the understanding of the benefits of Blue Space that they provide in relation to those areas seems to be considerably more developed.

The majority of the evidence retrieved across the review as a whole has used quantitative techniques, often in the context of a cross-sectional research design, to generate a largely correlative dataset. Therefore, the review identified no quantitative evidence of causal relationships between areas of Blue Space and the socially beneficial outcomes considered, although the qualitative evidence identified does provide some level of insight into the linkages through which Blue Spaces affect the different outcomes. The studies retrieved in the review also examine these outcomes in relation to some population subgroups, but on the basis of the evidence retrieved there is a considerable further opportunity in this area to expand the evidence base further.

Finally, while a considerable proportion of the evidence base collated by this review has been generated in relation to either a UK population or populations that are broadly similar in socioeconomic or cultural terms, there is a need to consider the applicability of some of the included research to a UK context. A number of the investigations considered by the review took place in countries with substantially different climatic regimes to that of the UK including Australia, the south-western USA and Finland. The availability of water in these environments may therefore be quite different to the UK, as well as the way it is used and regarded by the people who live there.

4.2 Social benefits of Blue Space

The balance of the evidence that Blue Space provides social benefits identified by the review is summarised for the different outcome categories below.

4.2.1 Recreation

- There is national scale evidence in England and Wales that approximately 20% of visits to the natural environment are to Blue Spaces, and that 50% of the population interact with a Blue Space at least once a month.
- There is evidence at the national scale in England that people who live closer to the coast are more likely to visit it.
- There is evidence at different scales from 2 different national contexts that the visits people pay to Blue Spaces have a seasonal pattern.

- There is evidence from a single country that the frequency with which people use Blue Spaces for some activities may be influenced by water quality.
- There is evidence at the national scale in England and Wales that people tend to engage in different recreational activities in different types of Blue Space. The most common activity in all Blue Space settings is walking, often with a dog. The type of interaction people engage in influences how long they spend in a Blue Space.
- Evidence from a single qualitative study highlights how the way Blue Spaces are used can change over time as the result of wider cultural and social shifts.
- Evidence from a single city within one national context indicates that people who live closer to the coast are more likely to go walking.
- Evidence from a 2 qualitative studies demonstrates how Blue Spaces are used by people of different age groups. A study of the way families use beaches points to the way they can facilitate physical activity and give families time to take part in activities separately. A study of the use of Blue Spaces by older people indicates that this can help to maintain physical condition and generate a sense of well-being.

4.2.2 Physical health

- There is evidence at the national scale in Britain that approximately 17% of the population has used a Blue Space for some form of exercise or keeping fit, and that approximately two-thirds of active visits to Blue Spaces involve moderate physical activity and one-third more vigorous physical activity.
- There is evidence at more than one scale and from more than one national context that the majority of visits to Blue Space (approximately 80%) are not active.
- There is evidence at more than one scale and from more than one national context that living closer to Blue Spaces is associated with increased levels of physical activity.
- There is repeated evidence at the national scale in more than one national context of a small increase in levels of overall health with proximity to the coast, and some evidence that this pattern holds across different types of urban and rural residential setting.
- There is evidence at more than one scale and from more than one national setting that living closer to the coast and being less travel time away is associated with lower levels of being overweight or obese, and a lower BMI.
- There is evidence at the city scale in one national context of an association between the amount of water in people's neighbourhoods and a reduction in the diagnosed incidence of lung cancer.

4.2.3 Mental health

- There is evidence at more than one scale and in more than one national context that people who used Blue Spaces said they had gained some form of psychological benefit from the experience.
- There is some evidence at the national scale in an English context that self-reported levels of mental health increase in proximity to the coast.
- There is evidence at more than one scale, in more than one national context and in more than one social group that people report feeling happier when they are in proximity to Blue Spaces.
- There is evidence from 10 studies in England that taking part in exercise in waterside environments was associated with improvements in people's mood and self-esteem.
- There is evidence at more than one scale and in more than one national context that people who interact with Blue Spaces find it to be a restorative experience that can reduce levels of psychological distress.
- There is mixed and inconclusive evidence of the association of Blue Space with depression and anxiety.
- There is evidence at the city scale in a single national context that beach attendance is negatively associated with behavioural problems in children.

4.2.4 Inequality of access

- There is evidence at the national scale in one country that people who consider themselves to be part of an ethnic minority group or who are from a lower socioeconomic category are less likely to access both the natural environment as a whole and the Blue Spaces within it.
- There is consistent evidence at the national scale in a single country that people over the age of 75 are more likely to visit the marine environment than those aged between 16 and 24.
- There is consistent evidence at the national scale in one country that women are more likely to make visits to the beach than men.
- There is evidence at the neighbourhood scale from one national context that the way people interact with Blue Space and the likelihood that they will do so is associated with their level of education.

4.2.5 Social interaction

- There is limited and case-specific evidence in one national context that people who interact with Blue Spaces feel that doing so gives them the opportunity to interact with others.
- There is evidence from 5 qualitative studies that Blue Spaces can play an important role in the ability of people of a range of ages to meet others and sustain or develop social relationships, and that the opportunities to do so can have an impact on individual well-being.

4.2.6 Place attachment

- There is evidence from more than one national context and at more than one scale that people can identify with Blue Spaces and that their sense of identification can remain stable over time.
- There is evidence from 2 qualitative studies that Blue Spaces can form an important part people's place identity and that they can, to some extent, come to define a city, area or region.

4.2.7 Environmental cooling

- There is evidence from multiple national contexts across the northern hemisphere that Blue Spaces can have a cooling effect on their environment during the months of summer.
- There is evidence from a single river in a northern European city that the spatial extent of the environmental cooling effect generated by Blue Spaces varies depending on the thermal characteristics of the environment around them.
- There is evidence from multiple locations in a single national context that the temporal extent of environmental cooling provided by Blue Spaces can vary depending on the characteristics of the water body and the way water bodies interact with the thermal characteristics of the surrounding environment.

4.2.8 Education

- There is inconsistent evidence at the national scale in one national context that a minority of people who visit Blue and Green Spaces felt they learned something about the natural world during their visit.
- There is evidence from 2 qualitative studies that educational classes conducted in Blue Spaces can be effective at engaging people with environmental issues.

4.2.9 Tourism

- There is evidence of a correlation at the international scale between domestic and international arrivals and beach length.
- There is evidence from 2 separate case-specific investigations in different national settings that people can find coastal and marine World Heritage Site environments aesthetically pleasing or beautiful.
- There is evidence from a single case-specific investigation at a coastal World Heritage Site that tourism related employment can increase in proximity to Blue Spaces.

4.2.10 Quality of life

- There is mixed and inconclusive evidence from more than one scale and in more than one national context that Blue Spaces are associated with any change in overall quality of life.

4.3 Comparable social benefits of Green and Blue Space

The evidence of the comparable social benefits of Blue Space when compared to Green Space identified by the review is summarised below.

4.3.1 Recreation

- There is evidence at the national scale in England and Wales that most visits to the natural environment are to Green Spaces.
- There is evidence at the national scale in England that people are prepared to travel further to visit the coast with children than they are to visit other natural settings.
- There is evidence from a city-specific study that parks with more Blue Space are more likely and parks with more Green Space are less likely to be geo-tagged on social media.
- There is evidence at the national scale in England that visits to Green Spaces demonstrate less seasonal patterning than Blue Spaces.

4.3.2 Physical health

- While there is evidence that living in proximity to Blue Spaces is associated with an increase in physical activity, there is no comparable evidence of a relationship with Green Space (possible failing of proximity method).
- There is evidence at more than one scale and in more than one national context that people are more likely to take part in intense physical activity in Green Spaces. Evidence from one qualitative study indicates that visitors to Blue Spaces can spend more time looking around appreciating their surroundings than visitors to Green Spaces.
- There is evidence at the national scale in England that the longer duration of average visits to Blue Spaces means that on average more energy is burnt in those settings.
- There is mixed and inconsistent evidence at the national scale and from more than one national context that there is a greater increase in the number of people reporting overall good health in proximity to Blue Spaces than in proximity to Green Spaces.
- While there is evidence at the national scale in England that living in proximity to Blue Spaces is associated with a reduction in being overweight or obese, there is no comparable evidence that living in proximity to Green Spaces is associated with a reduction in overweight and obesity (possible failing of proximity method).
- There is evidence at the city scale in one national context that living in proximity to a greater number of trees is more strongly associated with reductions in the incidence of lung cancer than the area of water in a neighbourhood.
- There is evidence at the national scale in one national context that, while living in proximity to a Green Space is associated with reductions in the incidence of suicide, there is no comparable relationship with Blue Spaces.

4.3.3 Mental health

- There is mixed and inconclusive evidence across more than one scale and in more than one national context of the comparative associations between Green and Blue Space and overall measures of mental health.
- There is evidence at the national scale in the UK that Blue Space environments can make people feel happier and improve their mood to a greater degree than Green Spaces.
- There is evidence from a single qualitative study that being in a coastal environment can stimulate feelings of freedom.
- There is evidence at more than one scale and in more than one national context that people who interact with Blue Spaces experience greater levels of restoration and greater reductions in psychological stress than people who interact with Green Spaces.
- There is evidence from 3 qualitative studies that the constant sensory stimulation associated with coastal environments can help people control traumatic thoughts, reduce the amount of 'noise' in their minds, and provide the opportunity for restorative experiences.
- There is mixed and inconclusive evidence across more than one scale and in more than one national context of the comparative associations between Green and Blue Space and stress, and diagnoses of anxiety and depression.
- There is evidence at the city scale in a single national context of a stronger association with reduced behavioural problems among children who interact with Green Spaces than those who go to the beach.

4.3.4 Inequality of access

- There is evidence at the national scale in one country that both people who consider themselves to be part of an ethnic minority group and people who do not consider themselves to be part of an ethnic minority group, or people who are from any socioeconomic category, are more likely to access Green Spaces than they are Blue Spaces.
- There is consistent evidence at the national scale in one national context that, while women are more likely to visit beaches, men are more likely to visit areas of woodland or forest and mountains, hills or moorland.

4.3.5 Place attachment comparison

- There is limited and inconclusive evidence of the comparative degree to which people can identify with Blue and Green Spaces.

4.3.6 Environmental cooling

- There is evidence of an inconsistent and mixed comparative relationship between the environmental cooling effects of Green and Blue Space. This depends considerably on the types of Green and Blue Space being considered as well as other local influences on the microclimate.

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TRIGUERO-MAS, M., DADVAND, P., CIRACH, M., MARTÍNEZ, D., MEDINA, A., MOMPART, A., BASAGAÑA, X., GRAŽULEVIČIENĖ, R. AND NIEUWENHUIJSEN, M.J., 2015. Natural outdoor environments and mental and physical health: relationships and mechanisms. *Environment International*, 77, 35-41.

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List of abbreviations

BAME	Black, Asian or other minority ethnic background
BMI	body mass index
BHPS	British Household Panel Survey
CI	confidence interval
GHQ	General Health Questionnaire
GIS	geographical information system
GPS	global positioning system
IMD	Index of Multiple Deprivation
LSOA	Lower Layer Super Output
LST	land surface temperature
LULC	Land Use and Land Cover
MENE	Monitor of Engagement with the Natural Environment
NDVI	Normalised Difference Vegetation Index
ONS	Office for National Statistics
OR	odds ratio
PPGIS	public participatory geographical information system
PTSD	post-traumatic stress disorder
SD	standard deviation
SE	standard error
SDQ	Strengths and Difficulties Questionnaire
UHI	urban heat island
WORS	Welsh Outdoor Recreation Survey

Appendix A: Searches

Science Direct (title, abstract, keyword search; research; review; eds; 2004 to 2018)

("Blue Space" OR "green space" OR "natural environment" OR "green infrastructure") AND ("longitudinal" OR "cohort" OR "randomized controlled trial" OR "observational" OR "RCT" OR "case study" OR "cross-over" OR "systematic review" OR "survey")

("Blue Space" OR "green space" OR "natural environment" OR "green infrastructure") AND ("interview" OR "survey" OR "questionnaire" OR "focus group" OR "ethnography" OR "document analysis")

("Blue Space" OR "blue infrastructure" OR "blue gym") AND ("longitudinal" OR "cohort" OR "randomized controlled trial" OR "observational" OR "RCT" OR "case study" OR "cross-over" OR "systematic review" OR "survey")

("outdoor recreation" OR "green exercise" OR "right to roam") AND ("longitudinal" OR "cohort" OR "randomized controlled trial" OR "observational" OR "RCT" OR "case study" OR "cross-over" OR "systematic review" OR "survey")

("Blue Space" OR "green space" OR "natural environment" OR "green infrastructure" OR "blue infrastructure") AND ("pollution" OR "urban heat island")

("Blue Space" OR "green space" OR "natural environment" OR "green infrastructure" OR "blue infrastructure") AND ("recreation" OR "leisure" OR "tourism" OR "walking" OR "cycling" OR "sport" OR "exercise")

("Blue Space" OR "green space" OR "natural environment" OR "green infrastructure" OR "blue infrastructure") AND ("crime" OR "social safety" OR "safety" OR "perception of crime" OR "violence")

("Blue Space" OR "green space" OR "natural environment" OR "green infrastructure" OR "blue infrastructure") AND ("social isolation" OR "community attachment" OR "social interaction")

("Blue Space" OR "green space" OR "natural environment" OR "green infrastructure" OR "blue infrastructure") AND ("education" OR "children" OR "learning" OR "school" OR "classroom")

("Blue Space" OR "green space" OR "natural environment" OR "green infrastructure" OR "blue infrastructure") AND ("older people" OR "elderly" OR "lifecourse" OR "disabled")

("Blue Space" OR "green space" OR "natural environment" OR "green infrastructure" OR "blue infrastructure") AND ("aesthetic" OR "value" OR "beautiful" OR "sound")

("Blue Space" OR "blue infrastructure" OR "green space" OR "natural environment" OR "green infrastructure") AND ("swimming" OR "sailing" OR "diving" OR "kayaking" OR "boat" OR "canoeing" OR "water sports" OR "adventure")

("Blue Space" OR "blue infrastructure" OR "green space" OR "natural environment" OR "green infrastructure") AND ("justice" OR "inequality" OR "equality" OR "distribution")

PubMed (title, abstract; 2004 to 2018)

("Blue Space" OR "blue infrastructure" OR "green space" OR "natural environment" OR "green infrastructure") AND ("longitudinal" OR "cohort" OR "randomized controlled trial"

OR “observational” OR “RCT” OR “case study” OR “cross-over” OR “systematic review” OR “survey”)

(“Blue Space” OR “green space” OR “natural environment” OR “green infrastructure”) AND (“interview” OR “survey” OR “questionnaire” OR “focus group” OR “ethnography” OR “document analysis”)

(“Blue Space” OR “blue infrastructure” OR “green space” OR “natural environment” OR “green infrastructure”) AND (“pollution” OR “urban heat island”)

(“Blue Space” OR “blue infrastructure” OR “green space” OR “natural environment” OR “green infrastructure”) AND (“recreation” OR “leisure” OR “tourism” OR “walking” OR “cycling” OR “sport” OR “exercise”)

(“Blue Space” OR “blue infrastructure” OR “green space” OR “natural environment” OR “green infrastructure”) AND (“crime” OR “social safety” OR “safety” OR “perception of crime” OR “violence”)

(“Blue Space” OR “blue infrastructure” OR “green space” OR “natural environment” OR “green infrastructure”) AND (“social isolation” OR “community attachment” OR “social interaction”)

(“Blue Space” OR “blue infrastructure” OR “green space” OR “natural environment” OR “green infrastructure”) AND (“education” OR “children” OR “learning” OR “school” OR “classroom”)

(“Blue Space” OR “blue infrastructure” OR “green space” OR “natural environment” OR “green infrastructure”) AND (“older people” OR “elderly” OR “lifecourse” OR “disabled”)

(“Blue Space” OR “blue infrastructure” OR “green space” OR “natural environment” OR “green infrastructure”) AND (“aesthetic” OR “value” OR “beautiful” OR “sound”)

(“Blue Space” OR “blue infrastructure” OR “green space” OR “natural environment” OR “green infrastructure”) AND (“swimming” OR “sailing” OR “diving” OR “kayaking” OR “boat” OR “canoeing” OR “water sports” OR “adventure”)

(“Blue Space” OR “blue infrastructure” OR “green space” OR “natural environment” OR “green infrastructure”) AND (“justice” OR “inequality” OR “equality”)

Appendix B: Records excluded at full text review

Reference	Reason for exclusion
AMBREY, C., BYRNE, J., MATTHEWS, T., DAVISON, A., PORTANGER, C. AND LO, A., 2017. Cultivating climate justice: Green infrastructure and suburban disadvantage in Australia. *Applied Geography*, 89, 52-60.	No intervention of interest
AMIRI, R., WENG, Q., ALIMONAMMAMADI, A. AND ALAVIPANAH, S.K., 2009. Spatial–temporal dynamics of land surface temperature in relation to fractional vegetation cover and land use/cover in the Tabriz urban area, Iran. *Remote Sensing of Environment*, 113 (12), 2606-2617.	Green Space only
ARBILLAGA-EXTRILLA, A., GIMENO-SANTOS, E., BARBERAN-GARCIA, A., BENET, M., BORRELL, E., DADVAND, P., FORASTER, M., MARÍN, A., MONTEAGUDO, M., RODRIGUEZ-ROISIN, R., VALL-CASAS, P., VILARÓ, J., GARCIA-AYMERICH, J.; URBAN TRAINING STUDY GROUP, 2017. Socio-environmental correlates of physical activity in patients with chronic obstructive pulmonary disease (COPD). *Thorax*, 72 (9), 796-802.	Does not disaggregate between Green and Blue Space
ARNBERGER, A. AND EDER, R., 2012. The influence of green space on community attachment of urban and suburban residents. *Urban Forestry & Urban Greening*, 11 (1), 41-49.	Contains data on perception
ARNBERGER, A., ALLEX, B., EDER, R., EBENBERGER, M., WANKA, A., KOLLAND, F., WALLNER, P. AND HUTTER, H.-P., 2017. Elderly resident's uses of and preferences for urban green spaces during heat periods. *Urban Forestry & Urban Greening*, 21, 102-115.	Perceptions only No outcomes of interest
ASAKAWA, S., YOSHIDA, K. AND YABE, K., 2004. Perceptions of urban stream corridors within the greenway system of Sapporo, Japan. *Landscape and Urban Planning*, 68 (2), 167-182.	Perceptions of stream corridors only No outcome of interest
AULIA, D.N., 2016. A framework for exploring liveable community in residential environment. Case study: public housing in Medan, Indonesia. *Procedia - Social and Behavioral Sciences*, 234, 336-343.	No intervention of interest
BARBIERI, C. AND SOTOMAYOR, S., 2013. Surf travel behavior and destination preferences: an application of the Serious Leisure Inventory and Measure. *Tourism Management*, 35, 111-121.	Preference data only
BENMARHNIA, T., KIHAL-TALANTIKITE, W., RAGETTLI, M.S. AND DEGUEN, S., 2017. Small-area spatiotemporal analysis of heatwave impacts on elderly mortality in Paris: a	No outcome of interest

Reference	Reason for exclusion
cluster analysis approach. *Science of The Total Environment*, 592, 288-294.	
BERGOVEC, M., REINER, Ž., MILICIC, D. AND VRAŽIC, H., 2008. Differences in risk factors for coronary heart disease in patients from continental and Mediterranean regions of Croatia. *Wiener Klinische Ochenschrift*, 120 (21-22), 684-692.	No intervention of interest Looks at regional differences and is not specifically investigating Blue Space
BIEDENWEG, K., SCOTT, R.P., AND SCOTT, T.A., 2017. How does engaging with nature relate to life satisfaction? Demonstrating the link between environment-specific social experiences and life satisfaction. *Journal of Environmental Psychology*, 50, 112-124.	Does not disaggregate between Green and Blue Space
BIELING, C., PLIENINGER, T., PIRKER, H. AND VOGL, C.R., 2014. Linkages between landscapes and human well-being: an empirical exploration with short interviews. *Ecological Economics*, 105, 19-30.	Perception data Contains aesthetic values Does not disaggregate between Green and Blue Space
BOYD, F., WHITE, M.P. BELL. S.L. AND BURT, J., 2018. Who doesn't visit natural environments for recreation and why: a population representative analysis of spatial, individual and temporal factors among adults in England. *Landscape and Urban Planning*, 175, 102-113.	No outcome of interest
BRANIŠ, M. AND KOLOMAZNÍKOVÁ, J., 2010. Year-long continuous personal exposure to PM2.5 recorded by a fast responding portable nephelometer. *Atmospheric Environment*, 44 (24), 2865-2872.	Does not define 'nature' No outcome of interest
BRERETON, F., CLINCH, J.P. AND FERREIRA, S., 2008. Happiness, geography and the environment. *Ecological Economics*, 65 (2), 386-396.	Economic study
BUCHECKER, M. AND DEGENHARDT, B., 2015. The effects of urban inhabitants' nearby outdoor recreation on their well-being and their psychological resilience. *Journal of Outdoor Recreation and Tourism*, 10, 55-62.	No outcome of interest
CASEY, J.A., JAMES, P., RUDOLPH, K.E., WU, C.-D. AND SCHWARTZ, B.S., 2016. Greenness and birth outcomes in a range of Pennsylvania communities. *International Journal of Environmental Research and Public Health*, 13, 311.	Green Space only
CASPERSEN, O.H. AND OLAFSSON, A.S., 2010. Recreational mapping and planning for enlargement of the green structure in greater Copenhagen. *Urban Forestry & Urban Greening*, 9 (2), 101-112.	Does not disaggregate between Green and Blue Space
CHANG, C.-Y., 2008. Psychophysiological responses and restorative values of natural environments in Taiwan. *Landscape and Urban Planning*, 85 (2), 79-84.	No intervention of interest Perception data

Reference	Reason for exclusion
CHEN, H., LIU, Y., ZHU, Z. AND LI, Z., 2017. Does where you live matter to your health? Investigating factors that influence the self-rated health of urban and rural Chinese residents: evidence drawn from Chinese General Social Survey data. *Health and Quality of Life Outcomes*, 15 (1), 78.	No outcome of interest
CHIBUIKE, E. M., HAMMITT, W.E., CHEN, P.-K., MACHNIK, L., AND SU, W.-C., 2018. Assessment of green parks cooling effect on Abuja urban microclimate using geospatial techniques. *Remote Sensing Applications, Society and Environment*, 11, 11-21.	Does not disaggregate between Green and Blue Space
DADVAND, P., DE NAZELLE, A., FIGUERAS, F., BASAGAÑA, X., SU, J., AMOLY, E., JERRETT, M., VRIJHEID, M., SUNYER, J. AND NIEUWENHUIJSEN, M.J., 2012. Green space, health inequality and pregnancy. *Environment International*, 40, 110-115.	Green Space only
DEFRA, 2014. *Elwick Community Partnership. Paths for Communities – Project summary sheet.* York: Natural England.	No data reported
DOHERTY, S.T., LEMIEUX, C.J. AND CANALLY, C., 2014. Tracking human activity and well-being in natural environments using wearable sensors and experience sampling. *Social Science & Medicine*, 106, 83-92.	Green Space only
DONAHUE, M.L., KEELER, B.L., WOOD, S.A., FISHER, D.M., HAMSTEAD, Z.A. AND MCPHEARSON, T., 2018. Using social media to understand drivers of urban park visitation in the Twin Cities, MN. *Landscape and Urban Planning*, 175, 1-10.	Shows park characteristics correlated with visits No outcome of interest
DU, H., CAI, W., XU, Z., WANG, Y. AND CAI, Y., 2017. Quantifying the cool island effects of urban green spaces using remote sensing Data. *Urban Forestry & Urban Greening*, 27, 24-31.	No significant outcomes of interest
DZHAMBOV, A.M. AND DIMITROVA, D.D., 2014. Elderly visitors of an urban park, health anxiety and individual awareness of nature experiences. *Urban Forestry & Urban Greening*, 13 (4), 806-813.	No outcome of interest
EBISU, K., HOLFORD, T.R. AND BELL, M.L., 2016. Association between greenness, urbanicity, and birth weight. *Science of the Total Environment*, 542, 750-756.	No outcome of interest
EL-BIALY, R. AND MULAY, S., 2015. Two sides of the same coin: factors that support and challenge the wellbeing of refugees resettled in a small urban center. *Health & Place*, 35, 52-59.	Does not disaggregate between Green and Blue Space
FAIVRE, N., FRTIZ, M., FREITAS, T., DE BOISSEZON, B. AND VANDEWOESTIJINE, S., 2017. Nature-based solutions in the EU: innovating with nature to address social, economic and environmental challenges. *Environmental Research*, 159, 509-518.	Review

Reference	Reason for exclusion
FOREST RESEARCH, 2008. *Forests for recreation and nature tourism –European COST Action E33*. Research summary. Farnham, Surrey: Forest Research.	Green Space only
FOREST RESEARCH, 2010. *Benefits of green infrastructure.* Report for Defra project WC0807. Farnham, Surrey: Forest Research.	Review
FOREST RESEARCH, 2010. *Heat amelioration. Adaption Strategies for Climate Change in the Urban Environment: the ASCCUE project.* Benefits of green infrastructure case study 010. Farnham, Surrey: Forest Research.	Green Space only
FOREST RESEARCH, 2010. *Improving levels of physical activity and health.* Active England: the woodland projects. Benefits of green infrastructure case study 029. Farnham, Surrey: Forest Research.	Green Space only
FOREST RESEARCH, 2010. *Physical activity and health.* Benefits of green infrastructure evidence note 007. Farnham, Surrey: Forest Research.	Review
FOREST RESEARCH, 2010. *Physical activity and health. Walking the Way to Health Initiative and Paths to Health Project.* Benefits of green infrastructure case study 034. Farnham, Surrey: Forest Research.	Green Space only
FOREST RESEARCH, 2010. *Promoting psychological health and mental well-being*. Blarbuie Woodland: evaluating the benefits. Benefits of green infrastructure case study 030. Farnham, Surrey: Forest Research.	Green Space only
FOREST RESEARCH, 2010. *Promoting psychological health and mental well-being. Branching out: greenspace and conservation on referral.* Benefits of green infrastructure case study 031. Farnham, Surrey: Forest Research.	Green Space only
FOREST RESEARCH, 2010. Psychological Health and Mental Well-Being. Benefits of green infrastructure evidence note 008. Farnham, Surrey: Forest Research.	Review
FORESTRY COMMISSION, 2005. *Dog walkers.* Edinburgh: Forestry Commission.	Green Space only
FORESTRY COMMISSION, 2008. *The Chopwell Wood Health Project. Research summary*. Farnham, Surrey: Forest Research.	Green Space only No data reported
FORESTRY COMMISSION SCOTLAND, 2015. *Green ways to health - Ayr and Ailsa Hospitals case study*. Edinburgh: Forestry Commission Scotland.	No data reported
FRANGOS, C.C., KARAPISTOLIS, D., STALIDIS, G., CONSTANTINOS, F., SOTIROPOULOS, I. AND MANOLOPOULOS, I., 2015. Tourist loyalty is all about prices, culture and the sun: a multinomial logistic regression of tourists visiting Athens. *Procedia - Social and Behavioral Sciences*, 175, 32-38.	No intervention of interest

Reference	Reason for exclusion
FRANKE, T., TONG, C., ASHE, M.C., MCKAY, H., SIMS-GOULD, J.; WALK THE TALK TEAM, 2013. The secrets of highly active older adults. *Journal of Aging Studies*, 27 (4), 398-409.	Green Space only
FRISCHENBRUDER, M.T.M. AND PELLEGRINO, P., 2006. Using greenways to reclaim nature in Brazilian cities. *Landscape and Urban Planning*, 76 (1), 67-78.	No outcome of interest
FUERTES, E., MARKEVYCH, I., VON BERG, A., BAUER, C.P., BERDEL, D., KOLETZKO, S., SUGIRI, D. AND HEINRICH, J., 2014. Greenness and allergies: evidence of differential associations in two areas in Germany. *Journal of Epidemiology and Community Health*, 68 (8), 787-790.	Green Space only
GATERSLEBEN, B. AND ANDREWS, M., 2013. When walking in nature is not restorative – the role of prospect and refuge. *Health & Place*, 20, 91-101.	No intervention of interest
GIDLOW, C.J., JONES, M.V., HURST, G., MASTERON, D., CLARK-CARTER, D., TARVANIANEN, M.P., SMITH, G. AND HIEWNEHUIJSEN, M., 2016. Where to put your best foot forward: psycho-physiological responses to walking in natural and urban environments. *Journal of Environmental Psychology*, 45, 22-29.	Does not disaggregate between Green and Blue Space
GIDLOW, C.J., SANDALL, J., GILLMAN, J., SMITH, G.R. AND JONES, M.V., 2016. Natural environments and chronic stress measured by hair cortisol. *Landscape and Urban Planning*, 148, 61-67.	Does not disaggregate between Green and Blue Space
GILL, T., 2006. *Growing adventure.* Final report to the Forestry Commission. Bristol: Forest Enterprise.	Secondary analysis and review
GINLEY, S. AND WILSON, M., 2006. *Schools Education Service Survey 2005/2006.* Ponterwyd, Caredigion: Forestry Commission Wales.	Green Space only
GINTING, N., NASUTION, A.D. AND RAHMAN, N.V., 2017. More attractive more identified: distinctiveness in embedding place identity. *Procedia Environmental Sciences,* 37, 408-419.	No outcomes of interest Perception data
GOEMINNE, P.C., NAWROT, T.S., DE BOECK, K., NEMERY, B. AND DUPONT, L.J., 2015. Proximity to blue spaces and risk of infection with *Pseudomonas aeruginosa* in cystic fibrosis: A case-control analysis. *Journal of Cystic Fibrosis*, 14 (6), 741-747.	No outcome of interest
GRELLIER, J., WHITE, M.P., ALBIN, M., BELL, S., ELLIOTT, L.R, GASCÓN, M., GUALDI, S., MANCICIN, L., NIEUWENHUIJSEN, M.J., SARIGIANNIS, D.A., VAN DEN BOSCH, M., WOLF, T., WUIJS, S. AND FLEMING L.E., 2017. BlueHealth: a study programme protocol for mapping and quantifying the potential benefits to public health and well-being from Europe's blue spaces. *BMJ Open*, 7 (6), e016188.	Not a primary study

Reference	Reason for exclusion
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HYSTAD, P., DAVIES, H.W., FRANK, L., VAN LOON, J., GEHRING, U., TAMBURIC, L. AND BRAUER, M., 2014. Residential greenness and birth outcomes: evaluating the influence of spatially correlated built-environment factors. *Environmental Health Perspectives*, 122, 1095-1102.	Green Space only
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IVES, C.D., OKE, C., HEHIR, A., GODRON, A., WANG, Y. AND BEKESSY, S.A., 2017. Capturing residents' values for urban green space: mapping, analysis and guidance for practice. *Landscape and Urban Planning*, 161, 32-43.	Values data No outcome of interest
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KERR, J.H. AND HOUGE MACKENZIE, S., 2012. Multiple motives for participating in adventure sports. *Psychology of Sport and Exercise*, 13 (5), 649-657.	No outcome of interest

Reference	Reason for exclusion
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KORPELA, K.M., YLÉN, M., TYRVÄINEN, L. AND SILVENNOINEN, H., 2008. Determinants of restorative experiences in everyday favorite places. *Health & Place*, 4 (4), 636-652.	No outcomes of interest
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LAATIKAINEN, T.E., PIIOINEN, R., LEHTINEN, E. AND KYTTÄ, M., 2017. PPGIS approach for defining multimodal travel thresholds: Accessibility of popular recreation environments by the water. *Applied Geography*, 79, 93-102.	No outcome of interest Same study as Laatikainen et al. (2015)
LAFFAN, K., 2018. Every breath you take, every move you make: visits to the outdoors and physical activity help to explain the relationship between air pollution and subjective wellbeing. *Ecological Economics*, 147, 96-113.	Does not disaggregate between Green and Blue Space MENE data
LARSON, S., DE FREITAS, D.M. AND HICKS, C.C., 2013. Sense of place as a determinant of people's attitudes towards the environment: Implications for natural resources management and planning in the Great Barrier Reef, Australia. *Journal of Environmental Management*, 117, 226-234.	Does not disaggregate between Green and Blue Space
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Reference	Reason for exclusion
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MODESTI, P.A., BAMOSHMOOSH, M., RAPI, S., MASSETTI, L., AL-HIDABI, D., AL GOSHAE, H., 2013. Epidemiology of hypertension in Yemen effects of urbanization and geographical area. *Hypertension Research*, 36 (8), 711-717.	No intervention of interest 'Coast' is defined as a region and is not a Blue Space
MONAMED ALI, S., ROSTAM, K. AND HAIR AWANG, A., 2015. School landscape environments in assisting the learning process and in appreciating the natural environment. *Procedia - Social and Behavioral Sciences*, 202, 189-198.	No outcome of interest
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NATURAL ENGLAND, 2007. *Green infrastructure and the urban fringe: learning lessons from the Countryside In and Around Towns programme*. Natural England Report NE33. Sheffield: Natural England.	Does not report data
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NATURAL ENGLAND, 2012. *What impact did Walking for Health have on the physical activity levels of participants*. Natural England Commissioned Report NECR075. York: Natural England.	No outcome of interest
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O'BRIEN, L. AND LOVELL, R., 2011. *A review of the Forest Education Initiative in Britain.* Farnham, Surrey: Forest Research.	Green Space only
O'BRIEN, L. AND MURRAY, R. 2016. *A marvellous opportunity for children to learn. A participatory evaluation of Forest School in England and Wales.* Farnham, Surrey: Forest Research.	Green Space only
O'BRIEN, L., MORRIS, J. AND STEWART, A., 2012. *Exploring relationships between peri-urban woodlands and people's health and well-being*. Farnham, Surrey: Forest Research.	Green Space only
O'DONOVAN, G., CHUDASAMA, Y., GROCOCK, S., LEIGH, R., DALTON, A.M., GRAY, L.J., YATES, T., EDWARDSON, C., HILL, S., HENSON, J., WEBB, D., KHUNTI, K., DAVIES,	Does not disaggregate effect of water from Green Space

Reference	Reason for exclusion
M.J., JONES, A.P., BODICOAT, D.H. AND WELLS, A., 2017. The association between air pollution and type 2 diabetes in a large cross-sectional study in Leicester: the CHAMPIONS Study. *Environment International*, 104, 41-47.	
ODE SANG, Å., KNEZ, I., GUNNARSSON, B. AND HEDBLOM, M., 2016. The effects of naturalness, gender, and age on how urban green space is perceived and used. *Urban Forestry & Urban Greening*, 18, 268-276.	Does not disaggregate effect of river from park
PADILLA, C.M., KIHAL-TALANKIT, W., PEREZ, S. AND DEGEUN, S., 2016. Use of geographic indicators of healthcare, environment and socioeconomic factors to characterize environmental health disparities. *Environmental Health*, 15 (1), 79.	Does not disaggregate between Green and Blue Space
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PEARSON, A.L., BOTTOMLY, R., CHAMBERS, T., THORNTON, L., STANLEY, J., SMITH, M., BARR, M. AND SIGNAL, L., 2017. Measuring blue space visibility and 'blue recreation' in the everyday lives of children in a capital city. *International Journal of Environmental Research and Public Health*, 14 (6), 563.	Quantifies exposure only No beneficial outcome.
PILAT, M.A., MCFARLAND, A., SNELGROVE, A., COLLINS, K., WALICZEK, T.M. AND ZIJICEK, J., 2012. The effect of tree cover and vegetation on incidence of childhood asthma in Metropolitan Statistical Areas of Texas. *HortTechnology*, 22 (5), 631-637.	Green Space only
RASIDI, M.H., JAMIRSAH, N. AND SAID, I., 2012. Urban green space design affects urban residents' social interaction. *Procedia - Social and Behavioral Sciences*, 68, 464-480.	No outcomes of interest
ROCA, E. AND VILLARES, M., 2008. Public perceptions for evaluating beach quality in urban and semi-natural environments. *Ocean & Coastal Management,* 51 (4), 314-329.	Preferences, no beneficial outcomes
RUPPRECHT, C.D.D., BYRNE, J.A., UEDA, H. AND LO, A.Y., 2015. 'It's real, not fake like a park': Residents' perception and use of informal urban green-space in Brisbane, Australia and Sapporo, Japan. *Landscape and Urban Planning*, 143, 205-218.	No outcome of interest. Includes cross cultural data on perception of Green Space.
SARAJEVS, V., 2011. *Health benefits of street trees.* Research note. Farnham, Surrey: Forest Research.	Review
SCHAEFFER, Y., CREMER-SCHULTE, D., TARTIU, C. AND TIVADAR, M., 2016. Natural amenity-driven segregation:	Economic study

Reference	Reason for exclusion
evidence from location choices in French metropolitan areas. *Ecological Economics*, 130, 37-52.	
SCHIPPERIJN, J., BENTSEN, P., TROELSEN, J., TOFTAGER, M. AND STIGSDOTTER, U.K., 2013. Associations between physical activity and characteristics of urban green space. *Urban Forestry & Urban Greening*, 12 (1), 109-116.	No outcome of interest Includes data on perception of importance of Blue/Green Space characteristics
SCHÜLE, S.S., FROMME, H. AND BOLTE, G., 2012. Built and socioeconomic neighbourhood environments and overweight in preschool aged children. A multilevel study to disentangle individual and contextual relationships. *Environmental Research,* 150, 328-336.	Green Space only
SEELAND, K. AND NICOLÈ, S., 2006. Public green space and disabled users. *Urban Forestry & Urban Greening*, 5 (1), 29-34.	Perceptions of disabled users on specially designed Green Space provision No outcomes of interest
SHEPHARD AND MOYES LTD AND TRILEIN, 2016. *Come Outside! Headline results and key learning.* Cardiff: Natural Resources Wales.	Does not differentiate between effects of different outdoor environments
SHEPHARD AND MOYES LTD AND TRILEIN, 2016. *The value of community gardening to residents of a women's refuge.* Come Outside! Case study. Cardiff: Natural Resources Wales.	Green Space only
SLANEY, G., SALMON, J AND WEINSTEIN, P., 2012. Can a school based programme in a natural environment reduce BMI in overweight adolescents? *Medical Hypotheses*, 79 (1), 68-70.	No outcomes of interest
SNOWDON, H., 2006. *Evaluation of the Chopwell Wood Health Project.* Newcastle upon Tyne: Primary Care Development Centre.	Green Space only
SOGA, M., COX, D.T., YAMAURA, Y., GASTON, K.J., KURISU, K. AND HANAKI, K., 2017. Health benefits of urban allotment gardening: improved physical and psychological well-being and social integration. *International Journal of Environmental Research and Public Health*, 14 (1), 71.	Green Space only
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SWANWICK, C. (2009). Society's attitudes to and preferences for land and landscape. *Land Use Policy*, 26, S62-S75.	Review Information on perceptions and attitudes

Reference	Reason for exclusion
THE FUTURES COMPANY, 2010. *Understanding what people want from the natural environment using customer segmentation*. Report for Defra project WC0806. London: Department for Environment, Food and Rural Affairs.	No outcome of interest Values and attitudes data
THOMAS, F., 2015. The role of natural environments within women's everyday health and wellbeing in Copenhagen, Denmark. *Health & Place*, 35, 187-195.	Does not disaggregate effects of blue space from green space
TRIGUERO-MAS, M., DONAIRE-GONZALEZ, D., SETO, E., VALENTÍN, A., MARTÍNEZ, D., SMITH, G., HURST, G., CARRASCO-TURIGAS, G., MASTERSON, D., VAN DEN BERG, M., AMBRÒS, A., MARTÍNEZ-ÍÑIGUEZ, T., DEDELE, A., ELLIS, N., GRAZULEVICIUS, T., VOORSMIT, M., CIRACH, M., CIRAC-CLAVERAS, J., SWART, W., CLASQUIN, E., RUIJSBROEK, A., MAAS, J., JERRET, M., GRAŽULEVIČIENĖ, R., KRUIZE, H., GIDLOW, C.J. AND NIEUWENHUIJSEN, M.J., 2017. Natural outdoor environments and mental health: stress as a possible mechanism. *Environmental Research*, 159, 629-638.	Does not disaggregate effects of Green and Blue Space Same as Zijlema et al. (2017) (phenotype study)
TRIGUERO-MAS, M., DONAIRE-GONZALEZ, D., SETO, E., VALENTÍN, A., MARTÍNEZ, D., SMITH, G., HURST, G., CARRASCO-TURIGAS, G., MASTERSON, D., VAN DEN BERG, M., AMBRÒS, A., MARTÍNEZ-ÍÑIGUEZ, T[12], DEDELE A[13], ELLIS N[14], GRAZULEVICIUS T[15], VOORSMIT M., CIRACH, M., CIRAC-CLAVERAS, J., SWART, W., CLASQUIN, E., RUIJSBROEK, A., MAAS, J., JERRET, M., GRAŽULEVIČIENĖ, R., KRUIZE, H., GIDLOW, C.J. AND NIEUWENHUIJSEN, M.J., 2017. Natural outdoor environments and mental health: stress as a possible mechanism. *Environmental Research*, 159, 629-638.	Does not disaggregate between Green and Blue Space
VILLENEUVE, P.J., JERRETT, M., SU, J.G., BURNETT, R.T., CHEN, H., WHEELER, A.J. AND GOLDBERG, M.S., 2012. A cohort study relating urban green space with mortality in Ontario, Canada. *Environmental Research*, 115, 51-58.	Green Space only
WANG, X., RODIEK, S., WU, C. CHEN, Y. AND LI, Y., 2016. Stress recovery and restorative effects of viewing different urban park scenes in Shanghai, China. *Urban Forestry & Urban Greening*, 15, 112-122.	No intervention of interest
WELDON, S. AND BAILEY, C., 2007. *New pathways for health and well-being in Scotland: research to understand and overcome barriers to accessing woodlands.* Report for Forestry Commission Scotland.	Green Space only Has separate summary document
WHITING, J.W., LARSON, L.R., GREEN, G.T. AND KRALOWEC, C., 2017. Outdoor recreation motivation and site preferences across diverse racial/ethnic groups: a case study of Georgia state parks. *Journal of Outdoor Recreation and Tourism*, 18, 10-21.	Preference/motivation data No outcome of interest

Reference	Reason for exclusion
WINDHORST, E. AND WILLIAMS, A., 2015. 'It's like a different world': natural places, post-secondary students, and mental health. *Health & Place*, 34, 241-250.	Does not disaggregate between Green and Blue Space
WU, Y.T,. PRINA, A.M., JONES, A., MATTHEWS, F.E., BRAYNE, C.; MRC CFAS, .2015. Older people, the natural environment and common mental disorders: cross-sectional results from the Cognitive Function and Ageing Study. *BMJ Open*, 5 (9), e007936.	Does not disaggregate between Green and Blue Space
WÜSTEMANN, H., KALISCH, D. AND KOLBE, J., 2017. Accessibility of urban blue in German major cities. *Ecological Indicators*, 78, 125-130.	No outcomes of interest
'YOTTI' KINGSLEY, J., TOWNSEND, M., PHILLIPS, R. AND ALDOUS, D., 2009. 'If the land is healthy … it makes the people healthy': the relationship between caring for country and health for the Yorta Yorta Nation, Boonwurrung and Bangerang tribes. *Health & Place*, 15 (1), 291-299.	PhD thesis containing resulting publications Does not disaggregate between Green and Blue Space
YOUNAN, D., TUVBLAD, C., LI, L., WU, J., LURMANN, F., FRANKLIN, M., BERHANE, K., MCCONNELL, R., WU, A.H., BAKER, L.A. AND CHEN, J.C., 2016. Environmental determinants of aggression in adolescents: role of urban neighbourhood greenspace. *Journal of the American Academy of Child and Adolescent Psychiatry*, 55 (7), 591-601.	Green Space only
YU, R., WANG, D., LEUNG, J., LAU, K., KWOK, T. AND WOO, J., 2018. Is neighborhood green space associated with less frailty? Evidence from the Mr. and Ms. Os (Hong Kong) Study. *Journal of the American Medical Directors Association*, 19 (6), 528-534.	No outcomes of interest
ZHANG, Y., YIYUN, C., QING, D. AND JIANG, P., 2012. Study on urban heat island effect based on normalized difference vegetated index: a case study of Wuhan City. *Procedia Environmental Sciences*, 13, 574-581.	No outcomes of interest
ZHANG, X., ESTOQUE, R.C. AND MURAYARNA, Y., 2017. An urban heat island study in Nanchang City, China based on land surface temperature and social-ecological variables. *Sustainable Cities and Society*, 32, 557-568.	Does not disaggregate effects of Green and Blue Space
ZHU, C. AND ZENG, Y., 2018. Effects of urban lake wetlands on the spatial and temporal distribution of air PM10 and PM2.5 in the spring in Wuhan. *Urban Forestry & Urban Greening*, 31, 142-156.	No outcome of interest
ZIJLEMA, W.L., TRIGUERO-MAS, M., SMITH, G., CIRACH, M., MARTÍNEZ, D., DADVAND, P., GASCON, M., JONES, M., GIDLOW, C., HURST, G., MASTERSON, D., ELLIS, N., VAN DEN BERG, M., MAAS, J., VAN KAMP, I., VAN DEN HAZEL, P., KRUIZE, H., NIEUWENHUIJSEN, M.J. AND JULVEZ, J., 2017. The relationship between natural outdoor	Does not disaggregate effects of Green and Blue Space Same as Triguero-Mas et al. 2017 (phenotype study)

Reference	Reason for exclusion
environments and cognitive functioning and its mediators. *Environmental Research*, 155, 268-275.	
ŽLENDER, V. AND WARD THOMPSON, C., 2017. Accessibility and use of peri-urban green space for inner-city dwellers: a comparative study. *Landscape and Urban Planning*, 165, 193-205.	Does not disaggregate effects of Green and Blue Space

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2. Natural England. Monitor of Engagement with the Natural Environment: The national survey on people and the natural environment - Annual Report from the 2011-12 survey 2012 [Available from: https://webarchive.nationalarchives.gov.uk/20140712070213/http://www.naturalengland.org.uk/ourwork/evidence/mene.aspx.
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4. White MP, Wheeler BW, Herbert S, Alcock I, Depledge MH. Coastal proximity and physical activity: Is the coast an under-appreciated public health resource? Preventive Medicine. 2014;69:135-40.
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