



The well-being and human health benefits of exposure to the marine and coastal environment

Summary

The UK marine environment covers all areas that are permanently immersed in seawater or are inundated with saline water at some stage in the tidal cycle. This includes estuaries, beaches, coasts and all subtidal habitats out to the 200 mile limit of the UK's marine area. Over a third of the UK population live within 5 km of the coast and approximately 17% live in coastal communities. Large numbers of people visit UK coastlines each year. In England, an estimated 271 million recreational visits were made to coastal environments annually. Evidence shows that living near to or visiting the marine and coastal environment affects human physical and mental health and well-being.

Benefits of the marine and coastal environment to human well-being and mental health:

- The coast has been shown to play a role as a therapeutic and restorative landscape for promoting well-being and mental health.
- People living by the coast report better mental health compared to those living further inland. There is no evidence to suggest that living by the coast influences people's reports of subjective well-being (happiness, anxiety and worthwhileness).
- Individuals report increased happiness when spending time in marine and coastal margins, compared to green spaces and urban environments.

Benefits of the marine and coastal environment to human physical health:

- People living by the coast report better general health and more recreational physical activity, compared to those living further inland.
- There is a positive effect of coastal proximity on the prevalence of childhood obesity. But this effect is dependent on the type of coastal area.
- There is no effect of living closer to blue spaces (such as the coast) on physical functioning in older adults.
- Vitamin D levels are higher within populations living within 1km of the coast.
- People undertaking coastal visits expend higher amounts of energy, compared to visits to non-coastal environments, such as green spaces (e.g. urban parks).
- There is a paucity of economic valuation evidence. Initial estimates suggest that marine recreation in England may provide £195 million worth of savings to the National Health Service through non-occurring health care expenditure.

Risks to the benefits associated with marine and coastal environments:

- Environmental change now and in the coming decades may result in loss to some of the benefits associated with living close to or visiting marine and coastal environments.
- Loss of these benefits may result from reduced visits to marine and coastal environments, inadequate planning and coastal community fragmentation.
- Risk factors to human physical and mental health and well-being include: (i) pollution, (ii) climate change and exposure to extreme weather and (iii) socio-economic and cultural change.

Interventions:

- There is some evidence of positive health outcomes for nature-based interventions in marine and coastal environments, related to taking part in surfing programmes, school-visits and mindfulness courses.
- The designation status of marine and coastal environments appears to influence the well-being benefits gained.
- There are a lack of studies using robust designs which have evaluated the impact of interventions such as designation or improved access to marine and coastal environments.

Context

The 25 Year Environment Plan reaffirmed the UK government's position that the natural environment underpins human health and well-being¹. Over a third of the UK population live within 5 km of the coast and approximately 17% live in coastal communities².

There are also large numbers of visitors to UK coastlines each year. For example, in England, it was estimated that 271 million recreational visits are made to coastal environments annually. Recreational visits to the seas and coasts are made by all groups in society, which contrasts with visits to other natural environments (e.g. woodlands)³.

This Evidence Statement presents evidence on the benefits of the marine and coastal environment for human health. Human health is described as a state of physical, mental and social well-being and not merely the absence of disease or infirmity⁴. This review focuses on the well-being, mental and physical health benefits from exposure to marine and coastal environments and the risks associated with or to these benefits. Two routes of exposure are examined. The first is neighbourhood exposure, i.e. whether living closer to the coast benefits human health, in comparison to living further inland. The second is linked to the use of marine and coastal environments, i.e. whether visits to the marine and coastal environment are linked to improved health. The review does not include the benefits or risks for consumption of seafood or working on or close to the sea. This Evidence Statement was compiled using pre-defined search terms, and as a result there will be omissions in the evidence presented. The Evidence Statement draws on studies from the UK (see Method Summary). The evidence reported from individual studies should not always be considered transferable to other locations and timescales. The evidence gaps are identified from the reviewed literature and do not represent new analysis or recommendations.

Benefits of the marine environment for well-being and mental health

Therapeutic effect

The coast has been shown to play a role as a therapeutic landscape for promoting well-being and mental health and may help to cater for varied needs⁵⁻⁷. People may use the coast to progress towards personal goals (achieving experiences), to lose themselves (immersive experiences) and to connect with others (social experiences) and the sea (symbolic experiences).

Restorative effect

Visits to marine and coastal environments have been shown to have a restorative effect on people. Restoration refers to emotional responses, including calmness, relaxation, refreshment and revitalisation. Environments, including beaches, rocky shores and coastlines are perceived to increase well-being, as they provide opportunities for stress reduction, for individuals to lose themselves (escapism and immersive experience), relax and reflect⁸⁻¹¹. People visiting coastal environments report greater recalled feelings of restoration, in comparison to urban environments (e.g. urban parks and green spaces). They have similar restorative potential to other non-urban environments, including woodlands and mountains¹².

Subjective well-being

Subjective well-being is an umbrella term for how we think and feel about our lives. It includes positive and negative emotional states (e.g. happiness and anxiety) and people's overall assessments of their lives (e.g. life satisfaction and worthwhileness of life).



Visits to marine and coastal environments have an influence on people's reports of happiness, after controlling for confounding factors (e.g. related to the individual and area). People are happiest when spending time in marine and coastal margins, in comparison to other natural environments in the UK¹³.

Living by the coast does not appear to have a beneficial effect on subjective well-being in England. People's reports of happiness, anxiety, life satisfaction and worthwhileness (how worthwhile individuals think their behaviours or activities are) are similar for people living close to the coast, compared to people living further inland, after controlling for confounding factors^{14,15}.

Mental health

Mental health has been measured using the General Health Questionnaire (GHQ-12). There is a link between mental health and neighbourhood exposure to coastal areas. Relocating to coastal areas with beaches is associated with lower mental distress¹⁶. People living within 5km of the coast are also reported to have lower mental distress, in comparison to people living over 5km away^{15,17}. This coastal effect on mental health was observed after controlling for confounding factors.

Benefits of the marine environment for physical human health

Obesity

No studies were found which focused on the links between obesity in adults and marine environments.

There is a small but unclear effect of coastal proximity on the prevalence of obesity in children¹⁸. Childhood obesity is 0.68% lower in children living within 1km of the coast compared to more inland areas (over 20km from the coast). But this relationship is dependent on the type of coastal area. The coastal proximity effect was identified for children living in coastal rural areas and smaller cities and towns. But, it was not observed for children living in larger urban conurbations, despite their residential proximity to the coast. The study speculated this may be due to challenges of accessing coastal environments in larger urban areas.

Other physiological outcomes

There is a coastal effect on Vitamin D levels. People living within 0-1km of the coast experience higher UV exposure and greater mean annual temperatures than people living inland (around 50km from the coast) in England¹⁹. Coastal climates provide more favourable conditions for Vitamin D synthesis. There is a 3-5nmol/l difference in Vitamin D levels between



coastal residents and those living at around 50km inland, after accounting for confounding factors (e.g. factors associated with Vitamin D synthesis, metabolism and diet).

There does not appear to be a coastal effect on physical functioning in older adults. Physical functioning was measured in older adults, working in the UK civil service and aged 50-74 years. They were sampled over an 11-year period and assessed for walking speed and grip strength. There was no observed association between blue space proximity and physical functioning in older adults²⁰. However, the effect of distance to the coast was not separated from that of other types of blue space, therefore, results are inconclusive.

There is interest in understanding whether coastal visits have a role in reducing the prevalence of non-communicable diseases. It has been proposed that people may be exposed to specific chemicals and particles at the coast which may inhibit the activities of cell signalling pathways linked to cancer, diabetes and immunosuppression. However, there is a paucity of primary research in this area²¹.



Self-reported health

There are positive links between coastal environments and self-reported health. People living close to the coast (less than 5km) in England report higher levels of general health, compared to people living further away (5-50km)^{15,17,22}. Living in areas with higher coastal land cover (i.e. higher density of coastal environment) is associated with higher prevalence of good health²³. This coastal effect is observed after controlling for a range of confounding factors and have been shown to be greater among socio-economically deprived communities.

Physical activity

People living closer to coastal environments engage in higher rates of physical activity, compared to individuals living further inland. This is coined the 'Blue Gym Effect'²⁴. People living closer to the coast (within 5km) participate more in moderate-intensity walking and water-sports, compared to those living

further inland (over 5km)¹⁷. Living near the coast is associated with a higher likelihood of achieving physical activity guidelines through leisure and travel (based on English coasts)²⁵. People living within 1km of the coast are 15 times more likely to visit the coast, and are more likely to achieve recommended levels of physical activity, in comparison to people living more than 20km away.

Recent evidence suggests that physical activity is a mediator for improvements to self-reported physical and mental health in England. Benefits to physical health and well-being from coastal living is in part due to participation in land-based physical activity, especially walking¹⁷.



Visits to the marine and coastal environment involve less energy intensive activities compared to other types of environment (e.g. countryside and urban green spaces)²⁶. Visits accounted for 6.8% of moderate-intensity physical activity visits (e.g. walking with or without a dog) and 4.1% of vigorous intensity physical activity visits (e.g. swimming, running and road cycling) to natural environments in England. However, visits to marine and coastal environments are associated with the most energy expenditure overall due to their relatively long duration²⁷. On average, people spend approximately 40-52 minutes longer in seaside resorts, compared to the countryside and urban green spaces.

Evidence for the monetary values of marine and coastal environments for physical activity is limited and there is uncertainty over estimates. One study has estimated the contribution of physical activities in the marine environment using Quality Adjusted Life Years (QALY)²⁸. One QALY corresponds with one life year spent in full health. Physical activities in the marine environment provided a total gain of 24,853 QALYs in 2012. In monetary terms, it was estimated that there would be £195 million worth of savings (2018 prices) to the National Health Service, through non-occurring health care expenditure (e.g. coronary heart disease, strokes and type 2 diabetes).

Risks to the benefits associated with marine and coastal environments

The health of the UK seas are inextricably linked to the realisation of human health and well-being benefits²⁹⁻³².

The quality of marine and coastal environments appears to influence the well-being benefits gained from exposure. Experimental evidence has suggested that people feel more restored and happier when there is higher perceived biodiversity, less litter (e.g. fishing and public litter) and more natural conditions (e.g. presence of seaweed)³³⁻³⁵. Litter left or washed up on the coast may also affect people's health and well-being. Litter may reduce recreational opportunities and result in emotional upset, indicated by feelings of sadness and anger and reduce the perceived restorativeness of the area².

The marine and coastal environment is facing unprecedented change as a result of direct human activity and climate change. There are a number of risk factors for the marine environment that may affect human health and well-being^{36,37}. These include: pollution of the sea and air; climate change and exposure to extreme weather; and socio-economic and cultural change. These risks factors may directly affect human health and well-being or may indirectly result in a loss to benefits due to: (1) reduced visits to the marine and coastal environment, (2) inadequate planning for mitigation of health risks and efforts to maximise the health potential of coastal development and (3) coastal community fragmentation (loss of social capital).

Pollution

Public health is affected, both directly and indirectly, by pollution of the sea and air resulting from human activities³⁷.

Water Pollution

Poor water quality remains a threat to public health and is greatest in coastal waters. Human exposure to contaminants can occur through direct skin contact, aerosol contact and incidental ingestion during bathing and recreational water sports³⁷.

Human-mediated contaminants such as industrial, domestic and medical chemicals, include oil, nanomaterials, heavy metals, persistent organic chemicals and plastics. These chemicals can enter marine and coastal environments via various different routes such as waste effluents, atmospheric deposition, agricultural practices or



through product use or discard³⁸. There is some limited evidence of associations between human-mediated contaminants, acute toxicity³⁹ (e.g. headaches and sore eyes and throat) and human disease⁴⁰. Long term effects of the slow accumulation of low concentrations of contaminants within the human body are of growing concern as they have been implicated in chronic disease processes that severely affect people's health.

Naturally-occurring contaminants include: antimicrobial resistant pathogens, microbial pollution (e.g. bacteria, viruses, fungi and parasites)⁴¹ and Harmful Algal Blooms (HABs)⁴². Exposure to microbial pollution and HABs can result in toxicity, acute and chronic illness (e.g. gastrointestinal, respiratory and dermatological diseases). They may also affect well-being and opportunities for physical activity. For example, HABs may reduce the ability of individuals to interact at the sea and coast and decrease the aesthetic appreciation of the environment⁴³. The broader significance of the phenomenon of anti-microbial-resistant pathogens is being evaluated^{44,45}. There are challenges for predicting the impact of naturally-occurring contaminants on human health. The current and projected effects of HABs on human health have been modelled for the UK. However, there is low confidence in these projections, as HAB occurrence is affected by a variety of environmental factors^{30,46}. Also, microplastics may be a vector for microbial pollution, but there is limited information available to assess the risks to human health⁴⁷.

Air pollution

There is a risk of exposure to air pollutants such as sulphur dioxide and nitrogen oxides from coastal shipping and marine industry. This can lead to illness (e.g. respiratory and cardiovascular disease) and premature death³⁷.

Climate change and exposure to extreme weather

Climate change includes ocean warming, sea level rise and ocean acidification⁴⁸. The marine and coastal environment is interconnected with climate change and its impacts on human health and well-being³⁰. The Marine Climate Change Impacts Partnership (MCCIP) and the Committee on Climate Change have projected the impacts of weather and temperature-related impacts on human health now and in the coming decades^{49,50}.

Coastal communities are at high risk from flooding and coastal change. Sea level rise is expected to increase the regularity of coastal flooding, especially when coupled with extreme weather events^{2,51}. In 2017, the Committee on Climate Change stated that the long-term health and well-being impacts of flood events are considerable⁵⁰. The rise in mean sea-level since the beginning of the 20th Century (of approximately 14cm) has significantly increased (as much as doubled) the risk of flooding at many locations. Models project that 910,000 residential properties in England and Wales will be at significant risk of tidal flooding by 2080. This may also result in coastal-flooding induced mental health impacts. Research is needed to better characterise the impacts from sea level rise on coastal communities, thresholds for viability, and what steps should be taken to engage and support affected populations.

The global increase in temperature of 0.85°C since 1880 is mirrored in the UK climate, with higher average temperatures and some evidence of more extreme weather events. There are links between outbreaks of illness caused by bacteria species and warm weather episodes. The Marine Climate Change Impacts Partnership reported that illness caused by bacteria species (e.g. gastro-enteritis and septicaemia) is increasing in bathing waters in Northern Europe⁴⁹. However, there may also be opportunities arising for the UK from climate change.



Warming temperatures and higher emissions are predicted to encourage more physical activity (e.g. cycling and walking) and energy expenditure (in the case of England)⁵².

More research is needed to assess the effects of climate change and exposure to extreme weather to enable management of these impacts^{53,54}. Lack of knowledge limits the ability to predict the potential consequences for other physical health related outcomes (e.g. rates of obesity and non-communicable diseases such as heart disease, diabetes and cancer), in addition to the impacts on well-being and mental health (e.g. stress-related disorders).

Social-economic and cultural change

Inappropriate development of the marine and coastal environment may impact the well-being and health of local communities³⁷. For example, a proposed wind farm development (Llandudno, Wales) was associated with perceived reductions in well-being⁵⁵. It was perceived that the wind farm may threaten aesthetic appreciation and alter people's sense of place (place-attachment) and the socio-cultural identity of the area. Negative outcomes were in the



form of emotional upset, indicated by feelings of sadness and anger and reductions in the perceived restorativeness of the area. Development of the coast (e.g. residential and commercial) may also affect resilience to climate-related future threats. This may have implications for well-being, mental and physical health.

Interventions

Interventions are an act performed for or on behalf of a person or population whose purpose is to assess, improve, maintain, promote or modify physical and mental health and well-being. For example, interventions may encourage access or engagement with the marine and coastal environment or modify access to or the quality of these spaces.

Although limited in extent, evidence suggests that there is a positive effect of interventions which make use of the marine and coastal environment as a setting to promote health and prevent ill-health of individuals. There are indications of a positive effect of surfing programmes on high risk target groups^{56,57}. Vulnerable young people reported increased satisfaction with appearance and a drop in heart rate following the intervention. There was no change in life satisfaction or systolic blood pressure. Veterans with Post-Traumatic Stress Disorder (PTSD) perceived that the surfing programme gave them a sense of respite from their condition and provided opportunities for social interaction. There are also

initial positive indications of benefits from school group visits and mindfulness courses at the beach⁵⁸.

Designation or protection status may be linked to the level of well-being benefits gained from marine and coastal environments. Coastal areas with designation status (e.g. nature reserves, Sites of Special Scientific Interest and Areas of Outstanding Natural Beauty) were associated with greater recalled restoration than locations without designated status⁵⁹. Recreational divers and anglers gain subjective well-being benefits from the network of Marine Protected Areas in the UK⁶⁰. There was a positive correlation between greater subjective well-being and the number of species of conservation interest (e.g. long snouted seahorse and native oyster) and the presence of wrecks and certain habitats (e.g. eelgrass beds).

However, there are a lack of studies which have evaluated the impact of designations and improved access to marine and coastal environments, using before-after studies. However, impact assessments for the Marine and Coastal Access Act in 2010 projected that the public would gain significant well-being benefits from visiting better protected marine and coastal areas and additional visits to coastal environments per year⁶¹. The impact of improved access to marine and coastal environments on physical health, mental health and well-being is an area for upcoming research⁶².

Evidence gaps

There are a number of evidence gaps in our understanding of the benefits of the marine and coastal environment for well-being, mental health and physical health and risks to these benefits. Some of these evidence gaps are the focus of ongoing research.

The majority of studies use cross-sectional surveys to examine the benefits of marine environments in England on well-being and physical and mental health. There are evidence gaps for Northern Ireland, Wales, Scotland and at the UK-scale. There is uncertainty as to whether findings for England are transferable to other locations and at the UK-scale. Few studies used cohort data and there was limited use of quantitative experimental studies (e.g. randomised control trials and natural experiments). This limits the ability to draw causal inferences and therefore the explanatory mechanisms for effects remains unclear.

The literature search for this Evidence Statement revealed that there is a paucity of economic evidence on the value of marine environments for physical health, mental health and well-being.

There are few studies that have evaluated the effectiveness of interventions (physical and nature-based) on physical and mental health and well-being. Interdisciplinary quantitative and qualitative research⁶³ will help to better understand what factors or interventions are effective in promoting different health and well-being outcomes at an individual and population level. There is also a lack of evidence investigating the life stage at which these interventions are most effective and how the impact of interventions may vary among groups in the population.

There is also limited evidence on the risks and pathways which may affect the benefits associated with marine and coastal environments. Also, there is a scarcity of information on the effectiveness of strategies which mitigate the effects of environmental change (e.g. climate and extreme events) and how they affect well-being, mental health and physical health. These represent areas which are poorly understood.



References

1. HM Government. A Green Future: our 25 year plan to improve the environment. 2018
2. Government Office for Science. Foresight futures of the sea. A Report from the Government Chief Scientific Adviser 128. 2018
3. Elliott LR, et al. Recreational visits to marine and coastal environments in England: Where, what, who, why, and when? *Mar Policy*. 2018;97:305-314
4. World Health Organisation. The Ottawa Charter for Health Promotion. Geneva, Switzerland. 1986
5. Ashbullby KJ, et al. The beach as a setting for families' health promotion: a qualitative study with parents and children living in coastal regions in SouthWest England. *Health Place* 2013;23:138-147
6. Bell SL, et al. Seeking everyday wellbeing: The coast as a therapeutic landscape. *Soc Sci Med* 2015;142:56-67
7. Bell SL, et al. Using geonarratives to explore the diverse temporalities of therapeutic landscapes: Perspectives from "green" and "blue" settings. *Ann Am Assoc Geogr*. 2017;107:93-108
8. Roe JJ, Aspinall PA. Adolescents' daily activities and the restorative niches that support them. *Int J Environ Res Public Health*. 2012;9:3227-3244
9. Wyles KJ, et al. Perceived risks and benefits of recreational visits to the marine environment: Integrating impacts on the environment and impacts on the visitor. *Ocean & Coastal Management*. 2014;88:53-63
10. Willis C. The contribution of cultural ecosystem services to understanding the tourism-nature-wellbeing nexus. *J Outdoor Recreation and Tourism*. 2015;10:38-43
11. White M, et al. Blue space: The importance of water for preference, affect, and restorativeness ratings of natural and built scenes. *J Environ Psychol*. 2010;30:482-493
12. White MP, et al. Feelings of restoration from recent nature visits. *J Environ Psychol*. 2013;35:40-51
13. MacKerron G, Mourato S. Happiness is greater in natural environments. *Global environ chang*. 2013;23:992-1000
14. White MP, et al. Natural environments and subjective wellbeing: Different types of exposure are associated with different aspects of wellbeing. *Health Place*. 2017;45:77-84
15. White MP, et al. Coastal proximity, health and well-being: results from a longitudinal panel survey. *Health Place*. 2013;23:97-103
16. Alcock I, et al. What accounts for 'England's green and pleasant land'? A panel data analysis of mental health and land cover types in rural England. *Landscape Urban Plan*. 2015;142:38-46
17. Pasanen TP, et al. Neighbourhood blue space, health and wellbeing: The mediating role of different types of physical activity. *Environ Int*. 2019;131:105016
18. Wood SL, et al. Exploring the relationship between childhood obesity and proximity to the coast: A rural/urban perspective. *Health Place*. 2016;40:129-136
19. Cherrie MP, et al. Coastal climate is associated with elevated solar irradiance and higher 25(OH)D level. *Environ Int*. 2015;77:76-84
20. de Keijzer C, et al. Green and blue spaces and physical functioning in older adults: Longitudinal analyses of the Whitehall II study. *Environ Int*. 2019;122:346-356
21. Moore MN. Do airborne biogenic chemicals interact with the PI3K/Akt/mTOR cell signalling pathway to benefit human health and wellbeing in rural and coastal environments? *Environ Res*. 2015;140:65-75
22. Wheeler BW, et al. Does living by the coast improve health and wellbeing? *Health Place*. 2012;18:1198-1201
23. Wheeler BW, et al. Beyond greenspace: an ecological study of population general health and indicators of natural environment type and quality. *Int J Health Geogr*. 2015;14:17
24. Depledge MH, Bird WJ. The Blue Gym: health and wellbeing from our coasts. *Mar Pollut Bull*. 2009;58:947-948
25. White MP et al. Coastal proximity and physical activity: Is the coast an under-appreciated public health resource? *Prev Med*. 2014;69:135-140
26. White MP, et al. Recreational physical activity in natural environments and implications for health: A population based cross-sectional study in England. *Prev Med*. 2016;91:383-388
27. Elliott LR, et al. Energy expenditure on recreational visits to different natural environments. *Soc Sci Med*. 2015;139:53-60
28. Papatheanasopoulou E, et al. Valuing the health benefits of physical activities in the marine environment and their importance for marine spatial planning. *Marine Policy*. 2016;63:144-152
29. McGowan F, et al. Oceans and human health. *Journal of the Marine Biological Association of the United Kingdom*. 2016;96:1-3
30. Moore MN, et al. Oceans and Human Health (OHH): a European perspective from the Marine Board of the European Science Foundation (Marine Board-ESF). *Microb Ecol*. 2013;65:889-900
31. European Marine Board. Linking Oceans and Human Health: A Strategic Research Priority for Europe. Position paper 19 of the European Marine Board, Ostend, Belgium. 2013
32. Knap A, et al. Indicators of ocean health and human health: developing a research and monitoring framework. *Environ Health Perspect*. 2002;110:839-845
33. White MP, et al. Marine wildlife as an important component of coastal visits: the role of perceived biodiversity and species behaviour. *Marine Policy*. 2017;78:80-89
34. Wyles KJ, et al. Factors That Can Undermine the Psychological Benefits of Coastal Environments: Exploring the Effect of Tidal State, Presence, and Type of Litter. *Environ Behav*. 2016;48:1095-1126
35. Wyles KJ, et al. Can Beach Cleans Do More Than Clean-Up Litter? Comparing Beach Cleans to Other Coastal Activities. *Environ Behav*. 2017;49:509-535
36. Fleming LE, et al. Fostering human health through ocean sustainability in the 21st century. *People and Nature*. 2019
37. Depledge MH, et al. Future of the Sea: Health and Wellbeing of Coastal Communities. 2017
38. Depledge MH, et al. Changing views of the interconnections between the oceans and human health in Europe. *Microb Ecol*. 2013;65:852-859
39. Lyons RA, et al. Acute health effects of the Sea Empress oil spill. *J Epidemiol Community Health*. 1999;53:306-310
40. Depledge MH, et al. Are marine environmental pollutants influencing global patterns of human disease? *Mar Environ Res*. 2013;83:93-95
41. Bresnan E, et al. Human Health. *Marine Climate Change Impacts Partnership: Science Review*. 2017
42. Berdalet E, et al. Marine harmful algal blooms, human health and wellbeing: challenges and opportunities in the 21st century. *J Mar Biol Assoc U.K.* 2015
43. Willis C, et al. Harmful algal blooms: the impacts on cultural ecosystem services and human well-being in a case study setting, Cornwall, UK. *Marine Policy*. 2018;97:232-238
44. Leonard AF, et al. Human recreational exposure to antibiotic resistant bacteria in coastal bathing waters. *Environ Int*. 2015;82:92-100
45. Leonard AFC, et al. Exposure to and colonisation by antibiotic-resistant *E. coli* in UK coastal water users: Environmental surveillance, exposure assessment, and epidemiological study (Beach Bum Survey). *Environ Int*. 2018;114:326-333
46. Davidson K, et al. Anthropogenic nutrients and harmful algae in coastal waters. *J Environ Manage*. 2014;146:206-216
47. Keswani A, et al. Microbial hitchhikers on marine plastic debris: Human exposure risks at bathing waters and beach environments. *Mar Environ Res*. 2016;118:10-19
48. Whitmee S, et al. Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation-Lancet Commission on planetary health. *Lancet*. 2015;386:1973-2028
49. Marine Climate Change Impacts Partnership. Marine climate change impacts. Report Card. 2013
50. Committee on Climate Change. UK Climate Change Risk Assessment 2017. Synthesis report: priorities for the next five years. 2016
51. European Environment Agency. Environment and human health. Joint EEA-JRC report. 2013
52. Elliott LR, et al. The effects of meteorological conditions and daylight on nature-based recreational physical activity in England. *Urban Forestry & Urban Greening*. 2019;42:39-50
53. Weatherdon LV, et al. Observed and projected impacts of climate change on marine fisheries, aquaculture, coastal tourism, and human health: an update. *Frontiers in Marine Science*. 2016;3:48
54. Fleming LE, et al. Oceans and Human Health: a rising tide of challenges and opportunities for Europe. *Mar Environ Res*. 2014;99:16-19
55. Devine-Wright P, Howes Y. Disruption to place attachment and the protection of restorative environments: A wind energy case study. *J Environ Psychol*. 2010;30:271-280
56. Caddick N et al. The effects of surfing and the natural environment on the well-being of combat veterans. *Qual Health Res*. 2015;25:76-86
57. Hignett A, et al. Evaluation of a surfing programme designed to increase personal well-being and connectedness to the natural environment among 'at risk' young people. *J Adventure Educ Outdoor Learning*. 2018;18:53-69
58. Kelly C. 'I Need the Sea and the Sea Needs Me': Symbiotic coastal policy narratives for human wellbeing and sustainability in the UK. *Marine Policy*. 2018;97:223-231
59. Wyles KJ, et al. Are some natural environments more psychologically beneficial than others? The importance of type and quality on connectedness to nature and psychological restoration. *Environ Behav*. 2019;51:111-143
60. Bryce R, et al. Subjective well-being indicators for large-scale assessment of cultural ecosystem services. *Ecosyst Serv*. 2016;21:258-269
61. Defra. Marine and Coastal Access Act 2009 Impact Assessment. 2010
62. Grellier J, et al. 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*. 2017;7:e016188
63. Bell S L, et al. The "healthy dose" of nature: A cautionary tale. *Geography Compass*. 2019;13:e12415



Evidence Statements

Evidence Statements are succinct summaries of evidence from published literature in a defined policy setting that are written for senior policy officials and a general non-expert audience to support decision making. No attempt has been made to make recommendations, but only to summarise the evidence. Evidence Statements are developed using systematic approaches to improve the reliability and confidence in the findings, and improve the ease with which they are updated in light of new evidence. Evidence Statements are therefore designed to be “living” documents that are updated regularly based on consultation with the expert community and when new evidence appears.

Method summary

The following search string was used to find published evidence that summarised literature on the effects of marine environments on physical health, mental health and well-being:

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( TITLE-ABS-KEY ( ( "marine environment" OR "coastal environment" OR "marine and coastal environment" OR coast* OR ocean* OR beach* OR sea OR seas OR bluespace OR "blue space" ) AND ( "wellbeing" OR "well-being" OR "human health" OR "mental health" OR "physical health" OR "physical activity" OR morbidity OR "quality of life" OR "subjective well-being" OR "subjective wellbeing" OR "non communicable disease*" OR "non-communicable disease*" OR "social capital" OR "social contact*" OR "social support" OR restoration OR restorative OR "stress reduction" OR "mental stress" ) ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) )
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Search date: 06/06/2019, Database: Scopus

The search was restricted to articles conducted by institutes in the UK and published in English. The search revealed 1815 peer-reviewed papers, of which 46 were judged to be relevant to the topic. Additional cited references were provided by members of the steering group. The Evidence Statement was reviewed by a steering group of experts from Cefas, Defra, Marine Management Organisation, Plymouth Marine Laboratory, The Calouste Gulbenkian Foundation, University of Aberdeen, University of Exeter, and University of Hull. The work was completed between 29/04/2019 and 23/08/2019

