



**Cyfoeth
Naturiol
Cymru**
**Natural
Resources
Wales**

The State of Natural Resources Report (SoNaRR): Assessment of the Sustainable Management of Natural Resources.

Annex.

Technical Annex for Chapter 7 Part 2.

Natural Resources Wales

Final Report

About Natural Resources Wales

We look after Wales' environment so that it can look after nature, people and the economy.

Our air, land, water, wildlife, plants and soil – our natural resources - provide us with our basic needs, including food, energy, health and enjoyment.

When cared for in the right way, they can help us to reduce flooding, improve air quality and provide materials for construction. They also provide a home for some rare and beautiful wildlife and iconic landscapes we can enjoy and which boost the economy.

But they are coming under increasing pressure – from climate change, from a growing population and the need for energy production. We aim to find better solutions to these challenges and create a more successful, healthy and resilient Wales.

Evidence at Natural Resources Wales

Natural Resources Wales is an evidence based organisation. We seek to ensure that our strategy, decisions, operations and advice to Welsh Government and others are underpinned by sound and quality-assured evidence. We recognise that it is critically important to have a good understanding of our changing environment.

We will realise this vision by:

- Maintaining and developing the technical specialist skills of our staff;
- Securing our data and information;
- Having a well resourced proactive programme of evidence work;
- Continuing to review and add to our evidence to ensure it is fit for the challenges facing us; and
- Communicating our evidence in an open and transparent way.

The State of Natural Resources Report (SoNaRR) Report Contents

This document is one of six annexes to the State of Natural Resources Report.

Chapter 1	Introduction to the State of Natural Resources Report (SoNaRR): An assessment of sustainable management of natural resources
Chapter 2	Understanding drivers of change in natural resource use
Chapter 3	Summary of extent, condition and trends of natural resources and ecosystems in Wales
Chapter 4	Resilient Ecosystems
Chapter 5	Well-being in Wales
Chapter 6	Identifying Unsustainable Management
Chapter 7	Towards sustainable management of natural resources
Chapter 8	Assessment of the sustainable management of natural resources
Annex	Technical Annex for Chapter 3
Annex	Technical Annex for Chapter 7 (Part 1)
Annex	Technical Annex for Chapter 7 (Part 2)
Annex	Method for assigning confidence to evidence presented
Annex	Record of confidence assessments
Annex	Acronyms and Glossary of terms

All of the SoNaRR documents can be downloaded from the NRW website:
www.naturalresources.wales/sonarr.

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Evidence Sources for Assessment of Risks to Benefits and Well-being

The following table includes a summary of the evidence that helps to demonstrate the links between the resilience of ecosystems, and the benefits they provide used in assembling the risk register. This is *not* a comprehensive list of all evidence sources that link natural resources and ecosystems to their benefits. It draws heavily upon the UK National Ecosystem Assessment to describe some of the many ways in which broad habitats contribute to our well-being – particularly framed around the Well-being Goals, in order for us to begin to make an assessment of risk, and consider where further evidence may be required to develop the risk register further. This supporting evidence, along with the evidence presented in the bulk of the report supports our initial risk assessment to help describe what is considered to be the main risks to well-being, given the current extent, condition and trends of natural resources in Wales. However it is important to consider the limitations of this exercise, as set out below and in the introduction to the risk register in the main text of the report.

Method Statement

This first SoNaRR was developed by NRW with input from NRW specialists and external experts. The methodology used to collate evidence follows the ‘Expert Consultation’ methodology outlined in Tables 1 and 2 of Pullin *et al.* (2016)¹. Future SoNaRRs will draw on the other methodologies outlined in the paper to ensure the most appropriate methodology is adopted going forward.

Experts in NRW carried out a concise time-limited exercise to review the literature available and known to them on the relationships between ecosystem services and well-being, based on their current knowledge as specialists.

The NRW specialists pulled out the main key messages that provided a good representation of the known and reported relationships between natural resources and ecosystems, and well-being based on the best available evidence, and using UK examples wherever possible. The risks compiled in Chapter 7 are generally already well-known and widely published but part of the purpose of this exercise was to collate them to show the whole picture alongside the Well-being Goals.

Baseline

Chapter 7 Annex Part 2 is the evidence base of the reported relationship between ecosystems and well-being, but is no means a comprehensive list of all academic research in these fields. It is predominantly based on, and recognises, the work of the UK NEA. It is recognised that whilst the annex includes associated references, it is not always clear from reading the risks which report the evidence relates to. As part of NRW’s plan going forward, we aim to improve this evidence base so that there is something we can use in future SoNaRRs to assess the strength of relationship, likelihood and impact of risk, and specific areas of Wales where risks are more likely to occur – if or when further evidence becomes available.

Evidence Gaps

The evidence gaps highlighted in Chapter 7 are not comprehensive, are not all focussed at the same level and do not necessarily reflect the priorities between subject areas. They are specific to the natural resources and broad habitats being discussed in the relevant section. In future, they will be reviewed, set out at similar levels and prioritised according to the outcomes of the National Natural Resources Policy (NNRP).

Annex Table 7.2.1. A Prosperous Wales: Risks to benefits and well-being – evidence sources.

PROSPEROUS WALES: RISKS TO BENEFITS AND WELL-BEING		
Evidence sources		
Broad Habitats	Description of risk	How we made the assessment
<p>Mountains, moorlands and heaths</p>	<p>If the resilience of mountains, moorlands and heaths decline there is potentially a risk of increased costs of water treatment, flood management, and carbon capture, as well as potentially losing the value of recreation and tourism</p>	<p>Risk to benefits and well-being is assumed because there are significant risks to the resilience of mountains, moorlands and heaths habitats – particularly extent and condition of lowland heath and condition of upland heath and grassland (from evidence in Chapters 3 and 4) – and ongoing pressures (e.g. climate change). The condition of the most extensive semi-natural habitats of mountains, moorlands and heaths ranges is between 63% and 73% unfavourable, though with some signs of recovery since the 1990s². There is evidence to support the relationship between mountains, moorlands and heaths and prosperity, a selection of which is set out below.</p> <p>Evidence in support of links to Well-being</p> <p>“Mountains, Moorlands and Heaths are a significant source of water supply”³. “An increase in dissolved organic carbon concentrations would represent a treatment challenge (and a major additional cost) for water companies”⁴.</p> <p>“The most significant potential gains in flood control from upland systems come from the restoration of degraded systems, for example, through the re-vegetation of bare peat or the afforestation of slopes, which both reduce erosion and enhance vegetation cover”⁵.</p> <p>“In an active, peat-forming state, mountains, moorlands and heaths soils represent net sinks of carbon dioxide and, in the case of waterlogged soils, sources of methane. Changes in climate, notably in rainfall and temperature, are likely to influence the net flux of both gases and hence affect the capacity of ecosystems to store carbon.</p>

PROSPEROUS WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence sources

Broad Habitats	Description of risk	How we made the assessment
		<p>Therefore, mountains, moorlands and heaths represent both a threat to the global carbon cycle and an opportunity in terms of climate change mitigation policies that encourage adaptive land management to safeguard carbon stores and, to a lesser degree, further carbon sequestration⁶.</p> <p>“Mountains, Moorlands and Heaths provide tourism and recreational opportunities for climbing, mountaineering, rock scrambling, walking, fell running, skiing, orienteering, riding and mountain biking⁷. While no figures exist for visitor use solely of mountains, moorlands and heaths habitats, overall, the 3 National Parks attract 12 million visitors per year spending £1 billion on services⁸. The consequences of habitat change on visitor numbers is not known.</p> <p>Mace <i>et al.</i> (2015)⁹ considers the relationship between condition of bog and cost of water treatment as a significant or “priority relationship”. Priority relationships were determined to be those where society can, or does, have influence (e.g. we can realistically control conditions to influence the level of benefits) and where the level of benefits involved is non-trivial. A moderate relationship indicates where there is some level of influence but this may be more limited, or where there is a high level of influence but the benefits are more trivial.</p> <p>The relationship between blanket bog and flooding is considered to be moderate, although there is uncertainty around the role of blanket bog and flooding. The relationship between peatland soils and carbon capture is significant, although need to keep carbon locked in soils more prevalent than potential as carbon sink (see section 3.4 Soils in Chapter 3). Strong relationship between upland landscapes and tourism (see Chapter 5 – landscape contribution to well-being).</p>

PROSPEROUS WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence sources

Broad Habitats	Description of risk	How we made the assessment
		<p>Further evidence required:</p> <ul style="list-style-type: none"> • Characteristics of mountains, moorlands and heaths ecosystems that provide greatest benefits • Spatial distribution of benefits – in relation to where the risks are
<p>Semi-natural grasslands</p>	<p>If we do not manage the decline of our semi-natural grasslands there is potentially a risk of increased costs for soil restoration and carbon capture</p>	<p>Risk to benefits and well-being is assumed due to the significant risks to resilience of semi-natural grasslands, but it must be acknowledged that the relative extent of semi-natural grasslands in Wales is low. As the impacts of any future decline in extent or condition is likely to be localised, there is need to consider the implications of cumulative impacts. There is evidence to support the relationship between semi-natural grasslands and prosperity, a selection of which is set out below.</p> <p>Evidence in support of links to well-being:</p> <p>“Soil compaction in grasslands is caused by high stocking rates, winter grazing and the use of heavy machinery. A Defra review showed that compaction can decrease water infiltration and increase runoff, increase emissions of nitrous oxide and ammonia, decrease uptake of methane, reduce the abundance of soil fauna, decrease plant growth and yield, and limit food availability for some birds”¹⁰.</p> <p>“Semi-natural grasslands have the potential to provide services for farming, in particular, pollination and pest control. It is suggested that both services should be delivered by the spread from semi-natural grassland to farmed land of species which pollinate crops or which attack pests—so-called ‘spillover’”¹¹.</p>

PROSPEROUS WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence sources

Broad Habitats	Description of risk	How we made the assessment
		<p>“While grassland is often perceived as storing little carbon, it should be noted that acid grassland is on organomineral soils and has the highest carbon stock of any UK broad habitat”¹².</p> <p>“Increased soil nutrients in semi-natural grassland due to agricultural improvement or nitrogen deposition might be expected to affect soil carbon, but effects on soil chemical processes are complex”¹³.</p> <p>Mace <i>et al</i> (2015)⁹ considers the relationship between semi-natural grasslands and equitable climate to be priority (see definition above) - Poor management of the habitats could lead to a release of this stored carbon e.g. soil erosion – requiring greater inputs to restore soil productivity.</p> <p>Further evidence required:</p> <ul style="list-style-type: none"> • Ecosystem services and benefits of semi-natural grasslands in particular in relation to functioning of adjacent ecosystems
Enclosed Farmland	If we do not conserve and enhance soil quality and function there is potentially a risk to the ability of those ecosystems to continue to deliver important provisioning services such as food.	<p>There is risk to the resilience of enclosed farmland habitats in general associated with the potential impacts of climate change, and further risks to the diversity of improved grassland species (see Chapter 4). There is evidence to support the relationship between Enclosed Farmland and prosperity, a selection of which is set out below.</p> <p>Evidence to support link to Well-being</p> <p>“Threats to soil formation include: organic matter loss due to climate warming; erosion and compaction caused by intensive agriculture; and soil-sealing due to urbanisation.</p>

PROSPEROUS WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence sources

Broad Habitats	Description of risk	How we made the assessment
		<p>There are many consequences of loss of soil for supporting, regulating and provisioning services¹⁴.</p> <p>Our detailed knowledge of soil quality is relatively poor, but given the uncertainty of the relationship between soils, enclosed grassland, and the level of our ability to influence, this has been included for further consideration in the risk register.</p> <p>Further evidence required:</p> <ul style="list-style-type: none"> • Spatial distribution of soils “at risk”
Woodlands	<p>If we do not improve the diversity of woodlands then there is potentially a risk of future tree health issues which will impact on the ability to produce timber and other woodland products now and in the future.</p>	<p>There is a risk to resilience mainly around the diversity of coniferous forest, given recent tree-health concerns and the uncertainty of longer term impacts of climate change on woodland productivity (see Chapter 3). There is evidence to support the relationship between Woodlands and prosperity, which is summarised in the main report.</p> <p>As a productive resource, Welsh woodlands contribute a GVA of £499.3 million per annum to the Welsh economy and employs between 8,500 and 11,300 people¹⁵.</p> <p>Further evidence required:</p> <ul style="list-style-type: none"> • Better understanding of the relationships between diversity and productivity
Urban	<p>If we do not maintain and enhance urban ecosystems there is potentially a risk to quality of life, health and</p>	<p>Risk to benefits and well-being is assumed as quality of life is dependent on a number of wider determinants of health¹⁶ – local environmental quality being a contributing factor. It is more difficult to associate risk to prosperity of towns and cities as a <i>consequence</i> of poorly managed urban environments as there are a number of</p>

PROSPEROUS WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence sources

Broad Habitats	Description of risk	How we made the assessment
	<p>well-being, local economic investment and desirability of places to live. Areas of particular concern include air quality and green spaces and the connectivity between and within these areas). These risks, and their wider impacts on anti-social behaviour and health, could put added pressure on public services.</p>	<p>contributory socio-economic drivers. There is evidence to support the relationship between Urban environments and prosperity, a selection of which is set out below.</p> <p>Evidence to support links to well-being “Well-planned and managed parks, gardens and squares have a positive impact on the value of nearby properties, attracting inward human and capital investment. Increases in property values range between 0–34%, with a typical increase of about 5%”¹⁷.</p> <p>In terms of its impact on human health, environmental noise has been linked to various non-auditory effects including increased risk of hypertension^{18, 19}, impaired cognitive development in children²⁰ and psychological stress^{21, 22}. All of these things have a cost implication to business through staff absence, and the health service, for treatment.</p> <p>Nearly 32,000 fly-tipping incidents were recorded in Wales during 2014-15 costing the Welsh tax payer an estimated £1.8 million to clear²³.</p> <p>Further evidence required:</p> <ul style="list-style-type: none"> • Relationships between urban environments and prosperity and ways of optimising economic benefits of urban greenspace.
<p>Freshwaters – openwaters, wetlands and floodplains</p>	<p>If we do not sustainably manage our freshwater systems and water use, then there is potentially a risk of increased costs of</p>	<p>Risk assumed, despite the condition of freshwater environments improving over recent years, as there are still concerns with condition and particularly connectivity of floodplains as part of the wider hydrological system, as well as physical modifications. UK-wide demand for water is also a key consideration. There is evidence to support</p>

PROSPEROUS WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence sources

Broad Habitats	Description of risk	How we made the assessment
	<p>provision of new water supply, treatment, and flood risk management measures.</p> <p>Loss of natural flood protection is likely to increase costs of providing coastal flood defences.</p>	<p>the relationship between Freshwaters and prosperity, a selection of which is set out below.</p> <p>Development, growth and land use change is placing additional pressure on our water resources, an ageing sewer and drainage network, our flood defences and our water environment²⁴.</p> <p>The availability of water resources in the future may be adversely affected by pressures associated with climate change, population increase and changes in people's behaviour²⁵.</p> <p>Evidence to support links to well-being</p> <p>“The ability of Freshwater ecosystems to trap, breakdown, process and transform pollutants, especially those derived from diffuse agricultural pollution, means they perform the services of waste breakdown, detoxification and purification to a significant degree and with an associated high societal value that is often overlooked.</p> <p>The capacity of naturally occurring wetlands to improve water quality depends on them occupying locations that intercept polluted waters such as agricultural runoff²⁶.</p> <p>“The use of constructed wetlands for water treatment has seen enormous growth over the past 50 years and, in some cases, they are now seen as a more sustainable and cost-effective solution to the problem of treating various types of polluted water than their engineering counterparts. Appropriate planning and management of the wetland is necessary to ensure lasting, effective treatment²⁶.”</p>

PROSPEROUS WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence sources

Broad Habitats	Description of risk	How we made the assessment
		<p>“Modelling by South West Water has shown that a £10 million investment could save £650 million in costs of treating nutrient and topsoil-laden water over a 30-year period”²⁶.</p> <p>Mace <i>et al.</i> (2015) considers a priority relationship between freshwater systems and provision of clean water. Wetland habitats have a role in purification – through trapping and filtering particulates⁹.</p> <p>“The frequency and magnitude of floods from freshwater systems are influenced by human uses of land in their wider catchments including urbanisation, increased drainage and other conversions that alter hydraulic retention, such as embankments that separate rivers from their floodplains.</p> <p>Although these alterations can provide part of the solution to flood risk management, maintenance of such engineered solutions is expensive. Floodwater retention occurs where water is retained in catchment soils or wetlands, and where flood storage capacity is enhanced by green roofs, permeable surfaces, channels, lakes, [uplands] wetlands and floodplains functioning in natural ways”²⁷.</p> <p>“The extensive modifications to river channels and floodplains undertaken in the recent past for flood control and land drainage purposes have had serious consequences for habitats and their inhabitants. At the same time, when carried out sensitively and in conjunction with natural processes, flood defence works offer a major potential route for river rehabilitation and restoration, including the restoration of important ecosystem functions. However, to judge whether the overall costs and benefits of flood defence are positive or negative for ecosystem services or functions requires further, careful evaluation of the evidence in order to guide action”²⁷.</p>

PROSPEROUS WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence sources

Broad Habitats	Description of risk	How we made the assessment
		<p>Further evidence required:</p> <ul style="list-style-type: none"> • Role of natural freshwater systems in providing clean water • Spatial distribution of opportunities for natural solutions for flood attenuation and water purification.
Coastal margins	<p>If we do not build resilience into our coastal habitats there is potentially a risk of increased costs from disruption to transport infrastructure and property damage from coastal flooding.</p>	<p>Risk assumed due to overriding risks from sea level rises (CCRA, Shoreline Management Plans), and the capability of existing systems to be adapted to manage those risk. There is accompanying evidence to support the relationship between coastal margins and prosperity, a selection of which is set out below.</p> <p>Evidence to support links to well-being</p> <p>“Saltmarsh vegetation attenuates wave energy: pioneer saltmarsh has been shown to reduce incident wave energy by 82%, compared with 29% over bare tidal flats”²⁸.</p> <p>One study estimated that “an 80 m saltmarsh width results in capital cost savings of £2,600–4,600 per metre of seawall”²⁸.</p> <p>“Sand Dunes and Shingle provide direct protection, often replacing the need for artificial sea defence structures providing the dune or shingle system is wide enough, or the primary dune ridge is large enough. Sand and shingle beaches are dissipaters of energy, absorbing, rather than reflecting, wave attack”²⁸.</p>

PROSPEROUS WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence sources

Broad Habitats	Description of risk	How we made the assessment
		<p>Mace <i>et al.</i> (2015) considers the potential contribution of coastal margins to flood defence to be high, and it is assumed that a poor quality habitat would not have the structural integrity to provide effective flood protection⁹.</p>
<p>Marine</p>	<p>If action is not taken to increase the resilience of marine ecosystems, we will not be able to optimise the opportunities to sustain or increase the economic benefits we get from our seas. For example, poor coastal water quality can have a knock on impact on shell fisheries businesses in Wales, as well as on health and well-being of local communities who rely on the resource to support recreation based tourism..</p>	<p>Risk assumed as drawn from evidence presented in Chapter 3. We already experience closures of shellfisheries events due to poor water quality (<i>E. coli</i>, etc).</p> <p>Evidence to support links to well-being</p> <p>“The Fisheries sector covers the activities of inshore and offshore commercial fishing, including the harvesting of molluscs and crustaceans, as well as other marine organisms, e.g. algae, sponges, and seaweed. Other activities associated with the sector include fisheries enforcement agencies, boat building and boat maintenance. It also includes the manufacturing and maintenance or repair of fishing gear. Other secondary activities include the processing, distribution and sale of fish for consumption”²⁹. The Wales Marine Evidence Report states:</p> <ul style="list-style-type: none"> • Cockle fisheries are some of the most valuable fisheries in Wales and often of great local and cultural importance. • Crustaceans are the mainstay of much of the Welsh fishing fleet with crab and lobsters traditionally targeted via fishing with pots. • Bass is an important species for the industry in South and West Wales as well as a mainstay of the recreational fleet. <p>Coastal Tourism was estimated to be worth £602 million for Wales in 2013 and generated 3.594 million trips (Great Britain Visitor Survey)²⁹</p>

PROSPEROUS WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence sources

Broad Habitats	Description of risk	How we made the assessment
		<p>Mace <i>et al.</i> (2015) considers the relationship between quality of the marine environment and provision of food to be strong – In a poor quality environment e.g. acidified ocean, high salinity levels, low phytoplankton, the numbers of fish etc. that could be harvested would be very low, and considerable effort and inputs would be required to harvest this low number⁹.</p> <p>Mace <i>et al.</i> (2015) also recognised a link between quality of marine and coastal habitats and recreation – i.e the quality of marine and coastal margins could significantly affect the active enjoyment of them e.g. litter, poor bathing water standards⁹.</p> <p>“Waste water treatment has reduced our need to make use of the capacity of marine ecosystems to degrade sewage waste. There still remain local issues, however, where the presence of human faecal bacteria and pathogens is affecting other uses of the coastal seas”³⁰.</p> <p>Further evidence required:</p> <ul style="list-style-type: none"> • In general further evidence is needed on the interrelationships between marine ecosystems and the impacts of human activities, including any spatial variability.

Annex Table 7.2.2. A Resilient Wales: Risks to benefits and well-being – evidence sources.

A RESILIENT WALES: RISKS TO BENEFITS AND WELL-BEING		
Evidence Sources		
Broad Habitats	Description of risks	How we made the assessment
<p>Mountains, moorlands and heaths</p>	<p>If we do not maintain and enhance the resilience of mountains, moorlands and heaths then there is potentially a risk that we will not be able to capitalise on the opportunities they provide for equitable climate, clean water, hazard protection, wildlife and access and recreation.</p>	<p>Risk assumed as the current extent and condition of mountains, moorlands and heaths poor. There is a significant relationship assumed between the extent and condition of the ecosystem and its performance in delivery of services. There is accompanying evidence to support the relationship between mountains, moorlands and heaths and well-being, a selection of which is set out below.</p> <p>Evidence to support the links to well-being</p> <p>“Increased soil erosion has a number of negative environmental consequences including the degradation of perceived landscape quality, a reduction in water quality due to release of heavy metals and POPs, and the loss of water storage capacity in reservoirs”³¹.</p> <p>“£The restoration and effective management of peatlands to safeguard their vast carbon store, and potentially enhance their carbon sequestration potential, thus represent important opportunities”³².</p> <p>Mace et al (2015) states “peat accumulation immobilises nutrients i.e. when not degraded, organic carbon, nitrogen, etc., is held in place which would otherwise be released into water. Conversely the impact of degraded peatland on clean water is considered to be significant. Furthermore, blanket bog will only form under certain conditions so management has to be right”³³.</p> <p>“The most significant potential gains in flood control from upland systems come from the restoration of degraded systems, for example, through the re-vegetation of bare peat or the afforestation of slopes, which both reduce erosion and enhance vegetation cover”³⁴.</p>

A RESILIENT WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
		<p>“Potential links between well managed habitats and resistance to wildfires. With predicted climatic changes, wildfire risk is expected to rise as the result of a greater accumulation of potential fuel load following warmer and wetter springs, and a greater ignition risk from increased visitor pressure in hot dry summers”³⁵.</p> <p>“Although mountains, moorlands and heaths are characterised by their species-poor habitats, they are known for the species indicative to these habitats, i.e. charismatic, flagship species. Visitors include those seeking specific experiences, such as bird-watching, which links biodiversity with recreation and tourism”³⁶.</p> <p>“Appropriate management of the habitats e.g. heath, can also be considered to enhance views, with degraded habitats not offering the same 'scenery' as good or pristine habitats. However there is large variation in how people value changes in given landscape attributes”³⁷.</p> <p>Further evidence required:</p> <ul style="list-style-type: none"> • Relationships between ecosystem services and benefits of mountain moor and heath habitats in particular in relation to functioning of (and benefits for) adjacent ecosystems. (Extent and condition of the resource needed).
Semi-natural grasslands	If we continue to lose semi-natural grassland then there is potentially a risk of releasing stored carbon through soil erosion which will also	Although there is a high risk to the extent, condition and connectivity of semi-natural grassland (Chapter 4), risk is assumed by virtue of its limited extent, and therefore limited benefits, in relative terms to other habitats.

A RESILIENT WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
	<p>have implications for freshwater environments. Loss of these habitats will lead to significant decline in biodiversity that depend on those habitats (such as butterflies and moths).</p>	<p>Evidence to support links to well-being</p> <p>“Water storage is less than under more woody vegetation, such as trees or even bracken . Conversely, conversion to intensive grazing and the resulting compaction of the soil causes decreased infiltration and increased runoff, which both increases the risk of flooding and reduces the recharging of aquifers”³⁸.</p> <p>“Soil compaction in grasslands is caused by high stocking rates, winter grazing and the use of heavy machinery. A Defra review showed that compaction can decrease water infiltration and increase runoff, increase emissions of nitrous oxide and ammonia, decrease uptake of methane, reduce the abundance of soil fauna, decrease plant growth and yield, and limit food availability for some birds”³⁹.</p> <p>There is a particular risk to semi-natural grasslands dependent species such as butterflies, moths and other pollinators (Chapter 3). “Higher plant species richness in grasslands, whether in Semi-natural Grassland compared to Improved Grassland, or among Semi-natural Grasslands, is linked to increased pollinator species richness. There may also be a reverse influence, such that declines in pollinators may cause plant losses”⁴⁰.</p> <p>Further evidence required:</p> <ul style="list-style-type: none"> • Farm management systems that utilise semi-natural grasslands and can contribute to restoring, maintaining and enhancing their resilience.

A RESILIENT WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
Enclosed Farmland	<p>If we do not sustainably manage our productive farmland then there is potentially a risk that we will create further pressures on our ability to sustainably manage other ecosystems to build resilience and optimise benefits for well-being.</p>	<p>Risk assumed given the strategic importance and relationship of activities within enclosed farmland to other adjacent ecosystems – (both potential positive and negative – Chapter 2 and 3). “The major supporting services provided by Enclosed Farmland include soil formation, nutrient cycling and primary production. These all contribute to provisioning, regulating and cultural services”⁴¹.</p> <p>Evidence to support links to Well-being</p> <p>Historically one of the significant causes of habitat loss has been from pressures for food production (Chapter 3, Chapter 6) whereas perhaps the consequences on other ecosystems and well-being were not fully considered. Now whilst there is continued demand for provisioning services there is better opportunity to deliver these in ways that maintain and enhance ecosystem services – as recognised in more recent agri-environment programmes (Glastir, RDP SMS).</p> <p>“Permanent grassland soils are already close to carbon saturation, making them important carbon stores rather than potential sinks”⁴².</p> <p>“The management of Enclosed Farmland has large impacts on the management of water, pollutants and waste products, not least because of the large areas of land involved. Farmland can be both a source and a sink for waste and toxins. As these functions are interlinked through hydrological and biogeochemical processes”⁴³.</p> <p>“Agricultural use of water can have both positive and negative contributions to flooding, soil erosion and the recharge of aquifers”⁴³.</p>

A RESILIENT WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
		<p>“The loss of field margin vegetation can lead to increased loss of sediment to watercourses, reducing habitat quality for biodiversity (including economically important salmonids), blocking channels and increasing flood risk”⁴³.</p> <p>“Diffuse pollution from agricultural land remains the biggest threat to recreational waters through reductions in water quality caused by contaminated runoff water. Contaminants include nitrogen, phosphorus, sediments and pesticides, as well as parasites that impact on human health”⁴³.</p> <p>“Enclosed Farmland can provide waste breakdown services if the farmer imports waste biological material for anaerobic digestion or composting”⁴³.</p> <p>Pollinators - declines in our pollinators have multiple causes, but a key driver is the loss of flower-rich, semi-natural landscape elements in farmland such as flower-rich field margins, species-rich meadows and arable plants in crops. The loss of grass and clover leys, and the legumes they contain, has also been important, and pesticides have been shown to have lethal and sub-lethal effects on bees, resulting in local losses in bee diversity. However the impacts of declines in pollinators on food production are not known⁴⁴.</p> <p>Further evidence required:</p> <ul style="list-style-type: none"> • Management regimes for improved grasslands that support / optimise productivity and minimise negative impacts on other systems. • Farm management systems that can contribute to restoring, maintaining and enhancing ecosystem resilience – and spatial variations that respect cultural and geological differences of practice in Wales.

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Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
Woodlands	<p>If we do not sustainably manage our woodlands then there is potentially a risk that we miss opportunities to build resilience of these and other ecosystems to optimise benefits for well-being.</p>	<p>Risk assumed given the significant opportunities woodlands offer across the wider landscape, and across a broad spectrum of ecosystem benefits³³. However this risk reflects the constraints and long-term planning required to design, maintain and optimise benefits from new or “repositioning” of woodlands, (e.g.) the difficulty in delivering new woodland planting (Chapter 3 of this report).</p> <p>Evidence to support links to well-being</p> <p>“Forests can reduce some of the effects of climate change, notably in dampening temperatures in the soil and beneath the canopy, and in providing shade and shelter for animals and human visitors. Woodland cover can provide shade, reducing overheating and the need for air conditioning, and shelter from strong winds, reducing heat loss and soil erosion. Increasing temperatures will increase the shade and shelter value of trees in towns, and also for livestock in the country. Shading of streams can aid thermal regulation and fish survival”⁴⁵.</p> <p>“The presence of trees can also contribute to water quality by maintaining cool temperatures for fish, intercepting pollution from point sources and capturing diffuse pollution. Trees and woodland can contribute to water management, for example, more sustainable surface drainage in urban areas”⁴⁶.</p> <p>“Woodland biodiversity, including genetic diversity, can be regarded as another supporting service. In particular, below-ground fauna and flora (including mycorrhizal relationships) promote essential biogeochemical processes that, in turn, lead to the renewal of soil, plant nutrients and fertility”⁴⁷.</p> <p>Further evidence required:</p>

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Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
		<ul style="list-style-type: none"> Forestry management systems that encourage diversity and can contribute to restoring, maintaining and enhancing the resilience of woodland ecosystems.
Urban	<p>If we do not maintain and enhance urban systems for multiple benefits, then there is potentially a risk that our ability to adapt to the impacts of climate change will be hindered.</p> <p>If we continue to lose soil surfaces through compaction and soil sealing, then there is potentially a risk for increased surface water related flooding, as well as other extremes such as drought.</p>	<p>Risk assumed due to combined pressures on urban environments from a wide range of potentially competing demands, (including development), the potential impacts of climate change, and the concentration of the population in urban areas who are beneficiaries of the service.</p> <p>Evidence to support the links to well-being:</p> <p>“Large areas of heat-absorbing surfaces, and high-energy use within city environments, contribute to an increased Urban Heat Island, which all natural surfaces can help to reduce”⁴⁸.</p> <p>“Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead. By limiting the use of non-permeable surfaces and changing the type of building materials, ecosystem services associated with Urban climate, such as temperature and flood regulation, could be substantially increased”⁴⁹.</p> <p>“Vegetation roots help to bind and stabilise the soil which, combined with the effect of leaves and branches on reducing the impact of rainstorms, helps to lessen the rate of soil erosion and downstream sedimentation. Gardens play a key role in providing habitats for pollinators, such as solitary and social bees, and this is reflected in the subsequent pollination service”⁵⁰.</p> <p>The Green Infrastructure for Future Generations report provides a good summary of the benefits of green infrastructure: http://www.wtwales.org/sites/default/files/green_infrastructure.pdf</p>

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Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
		<p>Further evidence required:</p> <ul style="list-style-type: none"> • A better understanding of some of the relationships and critical thresholds in relation to greenspace (e.g. urban canopy cover needed for amelioration of heat island impacts; extent of surface sealing and impact on storm water flows).
<p>Freshwaters – openwaters, wetlands and floodplains</p>	<p>If we do not enhance the resilience of freshwater systems, then there is potentially a risk that we will limit our capability to deal with climate change impacts, extreme flows (flood and drought) and subsequent impact on people and aquatic wildlife (such as migratory fish).</p> <p>If we do not manage diffuse pollution and point-source pollution from abandoned mines then there is a potential risk to the resilience and condition of freshwater systems.</p>	<p>Risk assumed for hydrological reasons given the risks to existing connectivity of rivers and streams (Chapter 4) due to historic physical modifications of water courses.</p> <p>Evidence to support links to well-being</p> <p>The resilience of freshwater habitats and ecology is linked with their ability to deliver benefits, although knowledge is limited (DURESS, etc) It is generally assumed an increase in wetlands could significantly improve water quality, and a decrease in wetlands would reduce water quality³³.</p> <p>Climate change will have far-ranging impacts on freshwater systems. Projected changes in the amount, frequency, intensity and distribution of rainfall will increase the risk of drought and flood events, impacting upon infrastructure, buildings, communities and business. The CCRA17 Evidence Report⁵¹ has identified risks: to infrastructure services from river, surface water and groundwater flooding; of sewer and surface water flooding due to heavy rainfall; and to bridges and pipelines from high river flows and bank erosion. Hydroelectric generation will be affected by low flows in summer / high flows in winter and there are risks to public water supplies from drought and low river flows. While currently not significant in Wales, any requirement for cooling water for energy generation would also be at risk from drought and low river flows. The</p>

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Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
		<p>Evidence Report has highlighted the potential economic impact of changes in the freshwater environment by identifying risks to: business sites from flooding; business operations from water scarcity; and business continuity from disruption to supply chains and distribution networks. On a more positive note, the Evidence Report also identifies opportunities for businesses from changes in demand for goods and services. Flood resilience and water efficiency may provide opportunities here.</p> <p>River Basin Management Plan investigations report the failures for achieving good status in 2015 – physical modifications effect 25% of water bodies. “The extensive modifications to river channels and floodplains undertaken in the recent past for flood control and land drainage purposes have had serious consequences for habitats and their inhabitants. At the same time, when carried out sensitively and in conjunction with natural processes, flood defence works offer a major potential route for river rehabilitation and restoration, including the restoration of important ecosystem functions. However, to judge whether the overall costs and benefits of flood defence are positive or negative for ecosystem services or functions requires further, careful evaluation of the evidence in order to guide action”⁵².</p> <p>“In addition to the support of organisms and internal ecosystem processes, Freshwaters also support other surrounding ecosystems. This includes the export of energy or carbon in the form of emerging insects or exploited fishes which are used as prey by terrestrial organisms; for some birds, bats and spiders, this subsidy can contribute 25–100% of total energy used”⁵³.</p> <p>“Freshwaters have close links with other cycles, for example, through providing nitrogen, phosphorous, carbon and other trace elements into marine environments and other adjacent systems”⁵⁴.</p>

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Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
		<p>Further evidence required:</p> <ul style="list-style-type: none"> • Ground-truthing of existing wetland opportunity maps and wider catchment storage capability. • Spatial opportunities for wetlands to increase habitat connectivity and help manage increases in rainfall intensity.
Coastal margins	<p>If we do not enhance our coastal margins then there is potentially a risk that they would be more vulnerable to erosion and therefore less effective in both flood protection and soil carbon storage, and will result in loss of biodiversity.</p>	<p>Risk assumed as there is a significant risk to the condition of these ecosystems (Chapters 3 and 4 of this report) combined with the importance of their supporting roles in providing other ecosystem services (Chapter 5 of this report).</p> <p>Evidence to support links to well-being</p> <p>“As well as flood protection identified previously (above), a degree of climate regulation is provided by those habitats where rapid soil development or sediment accumulation occurs (primarily Sand Dune, and Saltmarsh)”⁵⁵.</p> <p>“Water quality regulation occurs through the purification of groundwater by Sand Dunes and Shingle and the purification of surface waters by Saltmarsh and Coastal Lagoons. Sand Dunes are used for water purification in the Netherlands, and similar natural filtration processes almost certainly remove nutrients from groundwater in the UK, thus reducing diffuse pollution to the marine environment; however, this is not well studied.”⁵⁶.</p> <p>“The Coastal Margin contains a very wide diversity of ecological niches. The dynamic nature of these habitats means that they provide among the best examples of early successional environments in the UK. They support a wide range of highly specialised and distinctive species due to the harsh environmental gradients associated with their proximity to the sea”⁵⁷.</p>

A RESILIENT WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
		<p>Further evidence required:</p> <ul style="list-style-type: none"> Relationships between ecosystem services and benefits of coastal margin habitats in particular in relation to functioning of (and benefits for) adjacent ecosystems (Extent and condition of the resource needed).
Marine	<p>If action is not taken to increase the resilience of marine ecosystems, it will be more challenging to optimise important benefits derived from the marine environment, such as supporting tourism and recreation, sustainable fisheries, and flood protection.</p>	<p>Risk assumed as we acknowledge there is an important link between marine ecosystems and global ecosystems in particular - further information is needed to better help understand inter-relationships between marine ecosystems.</p> <p>Evidence to support the links to Well-being</p> <p>“Many organisms provide structured space or living habitat for other organisms through their normal growth. These ‘natural’ marine habitats can provide essential feeding, breeding (spawning grounds) and nursery space for other plants and animals, which can be particularly important for the continued recruitment of commercial and/or subsistence fish and shellfish species. Such habitat can also provide a refuge for plants and animals including places to hide from predators. Living habitat plays a critical role in species’ interactions and regulation of population dynamics, and is a pre-requisite for the provision of many goods and services. In the UK, examples of living habitat include kelp and seagrass beds, maerl grounds (calcified red seaweed), mussel patches and cold water coral reefs”⁵⁸.</p> <p>“The chemical composition of the atmosphere and ocean is maintained through a series of biogeochemical processes regulated by living marine organisms. The maintenance of a healthy, habitable planet is dependent on processes such as the regulation of the volatile organic halides, ozone, oxygen and dimethyl sulphide, and</p>

A RESILIENT WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
		<p>the exchange and regulation of carbon, by marine organisms. For example, marine organisms play a significant role in climate control through their regulation of carbon fluxes, by acting as a reserve or sink for carbon dioxide in living tissue, and by facilitating burial of carbon in seabed sediments. Of all the carbon dioxide captured in the world by photosynthesis and stored as living or dead material of biological origin, over half (55%) is captured by living marine organisms. However, there is no readily available data for the UK that quantifies total living biomass in marine and estuarine sediments or the water column⁵⁹.</p> <p>Changes in marine biodiversity influence the biogeochemical cycling of carbon and nutrients within seabed sediments, in the overlying water column, and at the interfaces between sediment and water. This can ultimately result in changes in the capacity of the marine environment to act as a carbon sink and has a strong feedback on the atmosphere and the climate⁵⁹.</p> <p>“The deleterious effects of recently introduced and less well studied environmental contaminants and chemicals, such as nano-particles and pharmaceuticals, which pass through sewage treatment plants is of concern, and the capacity of ecosystems to breakdown and detoxify these products is largely unknown⁶⁰.”</p> <p>Further evidence required:</p> <ul style="list-style-type: none"> • Relationships between ecosystem services and benefits of marine habitats in particular in relation to functioning of (and benefits for) interrelated ecosystems (The extent and condition of the resource needed to support healthy functioning systems).

Annex Table 7.2.3. A Healthy Wales: Risks to benefits and well-being – evidence sources.

A HEALTHY WALES: RISKS TO BENEFITS AND WELL-BEING		
Evidence Sources		
Broad Habitats	Description of risks	How we made the assessment
Mountains, moorlands and heaths	If condition and extent of mountains moor and heath decline then there is potentially a risk that they will be less favoured for access and recreation with potential consequences for health	<p>Assumed indirect relationship with the resilience, especially extent and condition of habitats but it is difficult to directly quantify the variance in health benefits associated with the state of particular ecosystems.</p> <p>Evidence to support links to well-being</p> <p>“Mountains, Moorlands and Heaths provide health benefits through the activities undertaken within them, while also providing more ‘passive’ benefits for mental and emotional health. Climbing and walking in mountains, moorlands and heaths, for example, provide both physical and mental health benefits. The openness and remoteness of such landscapes has been linked to feeling calm and relaxed, although other emotions, such as exhilaration, anxiety and fear, can be associated with particular landscape features”⁶¹.</p> <p>Further evidence required:</p> <p>We cannot say with any confidence what the implications of degraded ecosystems would have on people’s preference for outdoor recreation and knock-on benefits for health.</p>
Semi-natural grasslands	If extent and condition of semi natural grassland declines there is potentially a risk that they are less favoured for access and recreation with consequences for health	<p>Assumed indirect relationship with the resilience, especially extent and condition of habitats but it is difficult to directly quantify the variance in health benefits associated with the state of particular ecosystems.</p> <p>Evidence to support links to well-being</p> <p>Whilst there is limited direct evidence of the health benefits of semi natural grasslands, evidence of public use of semi-natural grassland comes from the Welsh National Parks,</p>

A HEALTHY WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
		<p>which are valued for recreation, green-space, education, and other services, and which all contain significant areas of semi-natural grassland.</p> <p>Further evidence required.</p>
Enclosed Farmland	<p>If technological advances in farming develop, to capitalise on climatic changes and growing global populations, there is potentially a risk that they could result in subsequent and unknown impacts on food and health.</p>	<p>Assumed indirect relationship with the resilience, especially extent and condition of habitats but it is difficult to directly quantify the variance in health benefits associated with the state of particular ecosystems.</p> <p>Additional risk assumed, as there are potentially a variety of relationships – both positive and negative - between food production and health.</p> <p>Evidence to support links to well-being</p> <p>“Enclosed Farmland provides a vital health benefit to the UK’s population by providing safe, nutritious food; UK foodstuffs are monitored to ensure pesticide residues are kept well below safety levels. Enclosed Farmland also provides health benefits associated with exercise and recreation in the countryside”⁶².</p> <p>“Health risks arise to users of bathing waters but in practice, it is hard to distinguish between microbial pollution arising from agricultural diffuse and domestic point sources, in particular, septic tanks”⁶².</p> <p>The major impacts of the management of Enclosed Farmland on air quality are the emissions of methane and ammonia. “Primary airborne particulates arising from intensive livestock housing and field operations can cause human respiratory problems – but less is known about the risks”⁶².</p>

A HEALTHY WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
Woodlands	<p>If we do not create more resilient woodlands then there is potentially a risk that opportunities for access and recreation could be reduced, having a consequence on recreation and health.</p>	<p>Risk assumed because of the importance of woodland for recreation and informal leisure activities is significant.</p> <p>Evidence to support links to well-being</p> <p>“Most visitors undertake various forms of physical activity, such as horse riding, cycling, walking or jogging, and thus, enhance their general health. A range of pilot initiatives have begun where members of the public with certain ailments will be referred to local woods or forests in order to take physical exercise”⁶³. One such example in Wales is the Actif Woods project.</p> <p>Woodlands for Wales indicators show that:</p> <ul style="list-style-type: none"> • In 2015, 64% of adults surveyed in Wales had visited woodland in the last 12 months. • About half (52%) of all outdoor visits include time spent in woodland. • The most popular activity reported in 2014 was walking. • Woodlands were the second most favoured main outdoor destination. <p>Impacts on closures of forest for recreation for tree-felling for phytophthora have been observed (e.g. Cwmcarn).</p>
Urban	<p>If there is a decline in the condition and extent of urban greenspace (including tree canopy cover), there is a potential risk that opportunities to support health and to</p>	<p>Risk identified due to the connection between urban greenspace and health^{64, 65}. Most studies reported findings that generally supported the view that green space have a beneficial health effect. Establishing a causal relationship is difficult, as the relationship is complex</p> <p>Evidence to support links to well-being</p>

A HEALTHY WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
	<p>help mitigate and adapt to impacts of climate change will be lost, with negative consequences for health.</p> <p>If we do not manage emissions (particularly of ammonia and particulate matter) then there is a potential risk that air quality will not improve with subsequent impacts on health.</p>	<p>Climate change heatwaves are likely to become more frequent in the future in the UK. Heat-related mortality, which is currently around 2,000 premature deaths per year, is projected to increase steeply in the UK throughout the 21st century, from around a 70% increase in the 2020s to around 540% in the 2080s.</p> <p>There are many sources set out the benefits of green infrastructure. The following is drawn from UK NEA Chapter 10:</p> <p>“Poor air quality is a major factor influencing health in Urban environments, with the extent of vegetation and open spaces having a large impact on dispersion, deposition and even the formation of certain pollutants”⁶⁶.</p> <p>“In terms of its impact on human health, environmental noise has been linked to various non-auditory effects including increased risk of hypertension, impaired cognitive development in children and psychological stress”⁶⁷.</p> <p>“Large areas of heat-absorbing surfaces, and high-energy use within city environments, contribute to an increased Urban Heat Island, which all natural surfaces can help to reduce. One large tree can transpire 450 litres of water per day, consuming 1,000 megajoules of heat energy to drive the evaporation process. In this way, city trees can lower summer temperatures and, combined with their ability to provide shade and reduce wind speeds, reduce the need for summer air conditioning and winter heating”⁶⁸.</p> <p>“Epidemiological research has found strong links between health and greenspace in large conurbations, with access to walkable greenspace linked to longevity in the elderly. Living in close proximity to greenspace has been shown to promote physical exercise. Good quality open spaces encourage people to make short journeys on foot or by bike. Associations between greenspace and a reduced risk of anxiety and depression are well-documented.</p>

A HEALTHY WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
		<p>Healthy childhood development is associated with greenspace. Children with access to safe, green areas are more likely to be physically active and less likely to be overweight⁶⁹. The benefits of regular outdoor play continue into later life. There is evidence to show that a child's attitude towards exercise lays the foundation for their habits as an adult⁷⁰.</p>
<p>Freshwaters – openwaters, wetlands and floodplains</p>	<p>If we do not continue to improve the quality and connectivity of freshwater ecosystems then there is a potential risk to health through restricted access to water-based recreation, alongside risks of flood events.</p>	<p>Risk assumed from indirect consequences from risks to connectivity of freshwater systems (Chapter 4; a resilient Wales above) particularly on fish and associated recreational activities, also indirect threat from colonisation of invasive non-native species (Chapter 2). Flood risk already poses risk to human health.</p> <p>Evidence to support links to well-being</p> <p>Angling contributes to health and well-being in three ways:</p> <p>Its range of physical activity levels are suitable for the inactive, people recovering from illness and older age groups who may not participate in other sports.</p> <p>It incorporates contact with the natural environment which helps maintain positive mental health, combat stress and can support programmes for people suffering from mental illness.</p> <p>It encourages the relationship building, connection and participation in social life essential to well-being and active ageing⁷¹.</p> <p>INNS – “examples of the damaging effects of invasive, non-native species are already well-known, such of the impact of introduced crayfish species on the UK’s native white-clawed crayfish. There are expectations that problems will increase in future as environmental change progressively favours non-native species, but the consequences for ecosystem services have yet to be fully evaluated⁷²”.</p>

A HEALTHY WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
Coastal margins	<p>If we do not make appropriate plans for coastal management, then there is a potential risk to human health from sea-level rise and coastal erosion. If the condition of coastal margins deteriorates there is a potential risk that it will be less favourable for recreation activities with a potential consequence for health.</p>	<p>Assumed indirect relationship with the resilience, especially extent and condition of habitats but it is difficult to directly quantify the variance in health benefits associated with the state of particular ecosystems.</p> <p>Evidence to support links to Well-being</p> <p>The rate of coastal erosion in Wales is generally low compared with some parts of England. However, evidence from our emerging Shoreline Management Plans suggests that in the next 100 years we could see an increasing number of our coastal communities at risk from rising sea levels and eroding land⁷³.</p> <p>The coast is highly valued by the public as: living space for coastal communities; a symbol of identity; a place for rest and relaxation; somewhere that provides a sense of freedom; a place where people can enjoy scenery and wildlife; and a site for specific activities including boating, swimming, walking, birdwatching, climbing and wildfowling⁷⁴.</p>
Marine	<p>The marine environment is an important source of recreational space. Coastal water quality issues, when they occur, can have a direct impact on the health of recreational visitors.</p>	<p>Difficult to quantify the health benefits but risk assumed due the significant number of people that live close to the marine environment in Wales and that use it for recreational activities.</p> <p>Evidence to support links to well-being</p> <p>Specific research into the health benefits of the marine environment is not extensive, but suggests that people prefer to see and be near water over both urban and green environments⁷⁵, and that people in coastal communities tend to enjoy better overall health than people who live further inland⁷⁶. The Blue Gym research project⁷⁷ has found that we associate blue spaces with greater feelings of happiness. Blue spaces also promote exercise</p>

A HEALTHY WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
	<p>If the condition of the marine environment deteriorates, there is a potential risk that it will be less favourable for recreation activities. with a potential consequence on health.</p>	<p>and make us healthier (more vitamin D especially in the autumn and winter). In particular, the benefits of living close to the coast were the greatest in the poorest communities.</p>

Annex Table 7.2.4. An Equal Wales: Risks to benefits and well-being – evidence sources.

AN EQUAL WALES: RISKS TO BENEFITS AND WELL-BEING		
Evidence sources		
Broad Habitats	Description of risks	How we made the assessment
<p>Mountains, moorlands and heaths</p> <p>Semi-natural grasslands</p>	<p>If these natural resources are not managed in ways that promote hazard regulation (such as flooding) then there is potentially a risk that environmental inequality will be exacerbated.</p>	<p>Risk assumed based on the contribution needed from these natural resources to sustain an equitable climate, to further mitigate climate change, and to store carbon and water – alongside the existing research presented on environmental inequality.</p> <p>Evidence to support links to Well-being</p> <p>“Permanent grassland soils are already close to carbon saturation , making them important carbon stores rather than potential sinks”⁷⁸.</p> <p>“Under waterlogged conditions agriculture is very severely restricted, so much agricultural land is drained in order to shift water off the land surface as quickly as possible; this increases the flood risk downstream, however. In addition, biomass crops are fast growing and consume large amounts of soil water which can, in turn, have a negative impact on groundwater recharge. By contrast, grasses, trees and other waterside vegetation can slow down runoff and help reduce diffuse pollution. Some Enclosed Farmland in floodplain areas is managed through grazing to hold water and contribute to flood management”⁷⁹.</p>
<p>Enclosed Farmland</p>	<p>Risk unknown. There is a need to consider the impact of any changes to agricultural systems on well-being issues such as food poverty, even if the change is to support more ecosystem resilience</p>	<p>“Tree cover can offer protection from soil erosion and slope failure. Forests moderate rainfall, delaying and reducing flood events. Forest and tree cover can help to regulate flows in streams and rivers, and also affects the quality of that water. The effects can be either positive or negative, depending on the context, and are localised. In general, benefits from increased cover are likely in the upland and upland fringes, and may not require very large changes to the land cover of whole catchments. There is likely to be some benefit from increasing tree cover in floodplains”⁸⁰.</p>

AN EQUAL WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence sources

Broad Habitats	Description of risks	How we made the assessment
Woodlands	<p>If we do not promote opportunities for a range of activities in woodland settings, then there is a risk that we do not offer equality of opportunity with the consequence of sub-optimal enterprise, skills and learning benefits.</p>	<p>Further evidence required: there is a need to develop a much wider evidence base to understand the influences land management practices have on the provision of water quantity and quality. This includes furthering our understanding of the relationships between vegetation composition, drainage of upland and enclosed farmland areas and flood risk further downstream. Furthermore, information on environmental inequalities is also needed.</p>
Urban	<p>If natural resources are not managed in ways that promote hazard regulation then there is a risk that environmental inequality will be exacerbated.</p> <p>The potential impacts are greatest in urban environments where the majority of people live. There is a potential risk from a wide range of disbenefits, such as flood and drought risk, heat islands, and health issues associated with poor air quality, access to green space and noise.</p> <p>There are also potential risks in relation to local environmental</p>	<p>Risk assumed due to existing risks and effects of environmental hazards within urban areas which are likely to increase due to the impacts of climate change (CCRA).</p> <p>Evidence to support links to well-being</p> <p>Levels of awareness of flood risk are low among those in the lower socio-economic groups. Residents in deprived neighbourhoods are therefore likely to be less well prepared to cope in the event of a flood and with its aftermath⁸¹.</p> <p>Health impacts of flooding will be more extensive in neighbourhoods already characterised by poor health. Those who suffer the greatest losses – often those on lower incomes and without insurance – may be most susceptible to psychological health effects and, by extension, physical health effects⁸².</p> <p>Physical and cultural access to green space is unequally distributed in Wales. For example, proximity to green-space varies between areas (Various accessible natural greenspace studies), whilst participation in outdoor recreation has been found to have significant differences relating to social and economic factors⁸³. In particular, elderly and disabled people were much less likely to take part in outdoor recreation (and therefore gain the associated health benefits), along with people who lived in</p>

AN EQUAL WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence sources

Broad Habitats	Description of risks	How we made the assessment
	quality, and inequalities in access.	Community First Areas. Cultural difference in ethnic minorities populations mean that they are under-represented in outdoor participation.

AN EQUAL WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence sources

Broad Habitats	Description of risks	How we made the assessment
<p>Freshwaters – openwaters, wetlands and floodplains</p>	<p>If these natural resources are not managed in ways that promote hazard regulation (such as flooding) then there is a potential risk that environmental inequality will be exacerbated.</p>	<p>Risk acknowledged due to existing climate change risk assessment position and acknowledged policy position.</p> <p>Flooding and coastal erosion are two of the biggest natural hazard risks affecting the safety and sustainability of communities across Wales.</p> <p>Current estimates show that one in six properties in Wales are at risk of flooding from rivers, the sea and surface water.</p> <p>Climate change projections suggest that Wales can expect to see different rainfall patterns in the future, along with rising sea levels. These projections suggest that Wales will experience more frequent and more severe flooding in the future, along with increased rates of coastal erosion. Communities at risk of flooding and coastal</p>

AN EQUAL WALES: RISKS TO BENEFITS AND WELL-BEING

Evidence sources

Broad Habitats	Description of risks	How we made the assessment
<p>Coastal Margins</p> <p>Marine</p>	<p>If we do not better understand and optimise the benefits from marine natural resources, then there is a risk that we lose important opportunities to reduce inequality and deprivation within coastal communities</p>	<p>erosion can expect to see those risks realised more frequently and many more communities across Wales will begin to face the risks of flooding and coastal erosion themselves⁸⁴.</p> <p>Evidence to support links to well-being.</p> <p>Changes to hydrological processes from either climate change or at a smaller scale due to developments in the marine and coastal environment can affect seabed and coastal geomorphology and associated habitats and species^{85, 86, 87, 88}. These changes could also increase risks to people, property, infrastructure and protected sites due to the increased risk of flooding from the sea, coastal erosion and coastal squeeze.</p> <p>“Living marine flora and fauna can play a valuable role in the defence of coastal regions by dampening environmental disturbances. A diverse range of species bind and stabilise sediments and create natural sea defences, for example biogenic reefs, seagrass beds, mudflats and saltmarshes. The presence of these organisms in the front line of sea defence can dissipate energy and, therefore, dampen and prevent the impact of tidal surges, waves, storms and floods”⁸⁹.</p> <p>“The marine environment presents a number of educational opportunities; school trips to the beach are common particularly in coastal communities”⁹⁰.</p>

Annex Table 7.2.5. A Wales of Cohesive Communities: Risks to benefits and well-being – evidence sources.

A WALES OF COHESIVE COMMUNITIES: RISKS TO BENFITS AND WELL-BEING		
Evidence Sources		
Broad Habitats	Description of risks	How we made the assessment
<p>Mountains, moorlands and heaths</p> <p>Semi-natural grasslands</p> <p>Enclosed Farmland</p> <p>Woodlands</p>	<p>If these natural resources cannot be managed in a way that contributes to community cohesion (e.g. sustaining local employment opportunities) there is potentially a risk to the viability of rural communities.</p>	<p>Risk assumed due to the complex relationship between land use, land use change, and community cohesion – which is difficult to measure – but important to consider.</p> <p>Evidence to support links to well-being</p> <p>Welsh Farm Business Survey figures show that, despite low profitability, a typical farm can annually contribute between £100,000 and £250,000 to the wider economy⁹¹</p> <p>The Welsh Government’s ‘Woodlands for Wales: Action Plan’ published in March 2010 states that the forestry sector in Wales contributes an estimated £429 million to the national economy and employs nearly 9,000 people. This estimate is based on the production of timber alone and excludes woodland recreation, tourism, energy generation and timber transport.</p>
<p>Urban</p>	<p>If we do not maintain and enhance our urban green spaces, there is potentially a risk that we dilute and potentially remove opportunities for people and communities to create an enhanced sense of place and increase levels of community cohesion. Access to good quality</p>	<p>Risk assumed given the significant role and focus that urban green-space provides for community cohesion, and the pressures on those spaces.</p> <p>Evidence to support links to well-being</p> <p>Green Infrastructure report provides a good summary of the benefits of green infrastructure: http://www.wtwales.org/sites/default/files/green_infrastructure.pdf</p> <p>Benefits associated with different broad habitat types:</p>

A WALES OF COHESIVE COMMUNITIES: RISKS TO BENEFITS AND WELL-BEING

Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
	<p>green space can reduce the effects of poverty, health inequalities and it lowers crime rates</p>	<p>As well as their importance in wider conservation planning, local grasslands are also the subject of more focused and local conservation activities, (e.g. Keep Wales Tidy Natural Buzz pollinators project)</p> <p>“Trees and woodlands can be a focus for community development around both their formation and management—there are a substantial number of volunteer groups utilising woodlands”.⁹²</p>
<p>Freshwaters – openwaters, wetlands and floodplains</p>	<p>If the quality and condition of freshwaters decline then there is potentially a risk to cohesive communities, through reduced access to water based activities and recreation opportunities.</p>	<p>Risk assumed from indirect consequences from risks to connectivity of freshwater systems (Chapter 4; a resilient Wales above) particularly on fish and associated recreational activities (as in the health section)</p> <p>Evidence to support links to well-being</p> <p>“Urban rivers have been linked to a variety of mental and physical health benefits, from promoting environmental consciousness and engendering a sense of well-being, to providing increased opportunity for exercise and fresh air”⁹³</p> <p>Angling can encourage relationship building, connection and participation in social life essential to well-being and active ageing. Numerous community programmes such as Keep Wales Tidy river care / adopt a river which connect people to local river environments.</p>

A WALES OF COHESIVE COMMUNITIES: RISKS TO BENEFITS AND WELL-BEING

Evidence Sources

Broad Habitats	Description of risks	How we made the assessment
Coastal margins	<p>If these natural resources cannot be managed in a way that contributes to employment there is potentially a risk to the viability of coastal communities.</p>	<p>Risk assumed from the inter-relationships between coastal communities and the partial dependency on those natural resources to support them.</p> <p>Evidence to support links to well-being</p> <p>“Welsh seas provide a range of ecosystem goods and services, including: leisure and recreation; cultural and spiritual experiences; climate change adaptation; air and water quality. We know that people see the marine and coastal environment as intrinsically important, for its habitats and species, seascape and landscape features, its beauty, heritage and ‘sense of place’. Taken together, these marine and coastal areas represent hugely important economic, environmental and social assets for the Welsh coastal communities and, more widely, Wales. Over 60% of the population of Wales lives and works on the coast, with all of the major cities and many important towns also located there. The Welsh marine environment supports an important communications and transport network and Welsh ports are vital for international trade; Welsh waters support valuable fishing activity and aquaculture developments and aggregates extraction that feeds local construction projects.</p> <p>As well as the value of Welsh sea-fisheries reported in the main text, Coastal Tourism was estimated to be worth £602 million for Wales in 2013 and generated 3.594 million trips (Great Britain Visitor Survey).” ⁹⁴</p>
Marine	<p>If we do not better understand and optimise the benefits from marine natural resources, such as employment, and health and well-being, then there is a risk we will lose opportunities to support viable coastal communities</p>	

Annex Table 7.2.6. A Wales of Vibrant Culture and Welsh Language: Risks to benefits and well-being – evidence sources.

A WALES OF VIBRANT CULTURE AND WELSH LANGUAGE: RISKS TO BENEFITS AND WELL-BEING		
Evidence Sources		
Broad Habitats	Description of risks	How we made the assessment
<p>Mountains, moorlands and heaths</p> <p>Semi-natural grasslands</p> <p>Enclosed Farmland</p> <p>Woodlands</p> <p>Freshwaters</p>	<p>If traditional management practices decline it may have implications on cultural and heritage assets. If traditional management practices decline, it may have implications on cultural and heritage assets, together with reduced benefits derived from Wales` distinctive landscape, seascapes and historic environment..</p>	<p>Over 52% of Wales is nationally valued for its scenic quality and character, often recognised as iconic landscapes with a clear sense of place and identity – majority of which is Mountain Moor and Heath⁹⁵.</p> <p>Evidence to support links to well-being</p> <p>“Mountains, Moorlands and Heaths are one of the few Broad Habitats that involves the management of common pool resources (e.g. common grazings);Broad Habitats that involves the management of ‘common this generates important cultural traditions and bonds of reciprocity which are essential to maintain social capital”⁹⁶.</p> <p>“Semi-natural Grasslands are part of the cultural landscape of Wales. Semi-natural Grasslands have also probably contributed more than any other ecosystem to the development of the UK’s ecological knowledge”⁹⁷.</p> <p>“Semi-natural Grassland is probably the most benign environment for the preservation of archaeology”⁹⁸. “Peat soils are of considerable archaeological importance as they can preserve records of species, environment, climate and land use for 10,000 years or more”⁹⁹.</p> <p>“The degree to which agricultural landscapes provide meaningful places for individuals varies greatly according to the nature of the landscape itself, its accessibility and the variation in values, attitudes and behaviours of individuals. In Wales, an urban,</p>

		<p>industrial and largely English-speaking identity prevails in the south, but a rural, agricultural and Welsh-speaking one dominates in the north”¹⁰⁰.</p> <p>“Ancient woodland and veteran trees are historic features in their own right and provide a link to past society and culture. There is some association between perceptions of landscape value and woodland characteristics: for example, woodland type (broadleaves tend to be more favoured than conifers), tree age (large, old trees tend to be favoured over young ones), openness (valued more than dense, closed areas) and diversity”¹⁰¹.</p>
Urban	<p>If changes in urban areas through growth and development do not make use of cultural assets there is potentially a risk that existing benefits will be eroded</p>	<p>Risk assumed due to the cultural associations that exist within the urban environment and urban settings, (e.g. register of historic parks and gardens for example), and the ongoing threats to those assets.</p> <p>Increased contact with nature improves the way children learn, both formally and informally. Outdoor learning gives them direct experience of the subject, making it more interesting and enhancing their understanding. It also enables them to develop the vital connections between the outside world and what educationalists call children’s ‘interior, hidden, affective world’¹⁰².</p> <p>“In the UK, ecosystems, habitats and environmental settings are all heavily infused with the cultural values and histories of human use “¹⁰³. “Through their differing heritages, every environmental setting is capable of being interpreted as possessing a distinctive sense of place, including urban areas”¹⁰³.</p>
Coastal margins Marine	<p>If coastal and marine development does not take into account cultural and heritage assets, there is potentially a risk that existing benefits will be eroded together with reduced benefits derived from Wales` distinctive</p>	<p>Risk acknowledged in evidence presented in Wales Marine Evidence Report¹⁰⁴ which states:</p> <p>“The potential future issues that will arise in relation to the protection of heritage assets are likely to include the effects of new infrastructure development or activities on existing coastal, intertidal, and marine heritage assets and the wider historic marine environment. Furthermore, the effects of increased footfall on the coastal historic environment and heritage assets may contribute to the damage of these sites and, in turn, the tourist economy. As stated, the effects of coastal erosion and damage caused by the sea to heritage</p>

	<p>landscapes and seascapes</p> <p>The marine environment is important to the culture and heritage of Wales, including their contribution to Wales` distinctive landscapes and seascapes. Existing benefits could be eroded if we do not sustainably manage marine natural resources.</p>	<p>assets, both positive (in uncovering) and negative (in abrasion) are also a consideration.”</p> <p>“Visual effects result from changes in the landscape or seascape, and are defined as changes in the appearance of the landscape or seascape, and the effects of those changes on people”.</p> <p>“Developments in the inshore planning area are increasingly likely to encroach on the seascape around the Welsh coastline, in particular renewable energy infrastructure. At a strategic level, marine planning has a role to play in guiding development and, therefore, will need to take account of potential impacts of different activities and developments upon Welsh seascapes”.</p>
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