The Second State of Natural Resources Report (SoNaRR2020)

Assessment of the achievement of sustainable management of natural resources: Coastal Margins

Natural Resources Wales

Final Report

About Natural Resources Wales

Natural Resources Wales's purpose is to pursue sustainable management of natural resources. This means looking after air, land, water, wildlife, plants and soil to improve Wales's well-being, and provide a better future for everyone.

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- 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.

Title: **SoNaRR2020** Assessment of the achievement of Sustainable Management of Natural Resources: Coastal Margins

Lead Author: **H Lewis, J Creer**

Contributors: **J Briggs, M Charlesworth, D Crook, J Dickinson, M Howe, P Lindley, R Park, L Pennington, J Ratcliffe, N Rimington.**

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Version 2.0	Page 45 – Added text to Table 10 title “Area figures (ha) = total area of Annex I habitats (except shingle) from Article 17 for coastal habitat types”.

The Second State of Natural Resources Report (SoNaRR2020) contents

This document is one of a group of products that make up the second State of Natural Resources Report (SoNaRR2020). The full suite of products are:

Executive Summary. Foreword, Introduction, Summary and Conclusions. Published as a series of webpages and a PDF document in December 2020

The Natural Resource Registers. Drivers, Pressures, Impacts and Opportunities for Action for eight Broad Ecosystems. Published as a series of PDF documents and as an interactive infographic in December 2020

Assessments against the four Aims of SMNR. Published as a series of PDF documents in December 2020:

SoNaRR2020 Aim 1. Stocks of Natural Resources are Safeguarded and Enhanced

SoNaRR2020 Aim 2. Ecosystems are Resilient to Expected and Unforeseen Change

SoNaRR2020 Aim 3. Wales has Healthy Places for People, Protected from Environmental Risks

SoNaRR2020 Aim 4. Contributing to a Regenerative Economy, Achieving Sustainable Levels of Production and Consumption

The SoNaRR2020 Assessment of Biodiversity. Published in March 2021

Assessments by Broad Ecosystem. Published as a series of PDF documents in March 2021:

Assessment of the Achievement of SMNR: Coastal Margins

Assessment of the Achievement of SMNR: Enclosed Farmland

Assessment of the Achievement of SMNR: Freshwater

Assessment of the Achievement of SMNR: Marine

Assessment of the Achievement of SMNR: Mountains, Moorlands and Heaths

Assessment of the Achievement of SMNR: Woodlands

Assessment of the Achievement of SMNR: Urban

Assessment of the Achievement of SMNR: Semi-Natural Grassland

Assessments by Cross-cutting theme. Published as a series of PDF documents in March 2021:

Assessment of the Achievement of SMNR: Air Quality

Assessment of the Achievement of SMNR: Climate Change

Assessment of the Achievement of SMNR: Energy Efficiency

Assessment of the Achievement of SMNR: Invasive Non-native Species

Assessment of the Achievement of SMNR: Land use and Soils

Assessment of the Achievement of SMNR: Waste

Assessment of the Achievement of SMNR: Water Efficiency

Updated SoNaRR evidence needs. Published as a data table on web in March 2021

Acronyms and Glossary of terms. Published as a PDF in December 2020 and updated in 2021 as a data table on the web

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Contents

Tables and figures

1. Headline Messages

Land management

Confined to a narrow, and increasingly fragmented, strip between land and sea, coastal habitats are vulnerable to numerous pressures. Currently, intensive agriculture and under-management are impacting coastal habitats and species and there are ongoing losses and threats from development.

Climate change and associated effects **such as coastal squeeze and sea-level rise**.

The coastal environment is expected to undergo significant change in the next 10 to 20 years and beyond as a result of sea-level rise and increased erosion driven by climate change. A changing shoreline will also impact coastal communities that in many cases, are not aware of or prepared for these changes.

Constraints to coastal processes

Coastal defences such as sea walls and groynes prevent the natural function of the dynamic coastal habitats essential for maintaining extent and condition.

Air and water quality

Both air and water pollution impact the condition of the coastal margins ecosystem. Contaminants originate from sources such as industry, transport, agriculture, and litter derived plastics.

Delivery of sustainable agriculture is key **to achieving overall good condition of habitats, both within protected sites and the wider countryside**.

Continuing to work with farmers and land managers by providing incentives and support will ensure sustainable agricultural management. Multiple benefits would include biodiversity gains, improvements in air and water quality, carbon storage, and flood protection alongside support for agriculture.

Protect, enhance, and restore coastal margin habitats **to improve resilience**.

Resource actions to deliver good condition on protected sites and landscape scale initiatives to restore overall extent, condition, connectivity, and biodiversity within the coastal margins. Ensure understanding and implementation of the Sustainable Management of Natural Resources (SMNR) approach in assessing ecological value and ecosystems services provided by coastal habitats in development planning and Environmental Impact Assessment regulations (Agriculture).

Raise awareness of the benefits of planning for a changing shoreline, including opportunities to deliver nature-based solutions at the coast.

Address the barriers to achieving sustainable coastlines set out in the Marine Area Statement and support communities facing change. Multiple benefits of nature-based solutions include flood defence, erosion control, habitat restoration, increased carbon storage, and improved well-being of coastal communities.

Address the numerous sources of contamination affecting air and water quality.

An integrated approach is required which addresses the drivers of exceedance of established environmental quality standards and tackles the sources of contamination which originate both away from the coastal zone and within it.

2. Introduction

Ecosystem services provided by the coastal margins ecosystem make significant contributions to well-being such as in contributing to natural flood protection. The Welsh coastline also has strong cultural associations and is celebrated for its iconic scenery, proving a draw for recreation and tourism, with positive effects for both the economy and personal well-being.

Livestock production occurs over a significant proportion of the coastal margin habitats. Historically, significant losses have occurred due to land claim, agricultural intensification, and development. Habitat loss, at a slower rate, and declines in condition continue due to a range of human impacts, such as agricultural abandonment, intensive agricultural management, development, and pollution.

The coastal environment is expected to undergo significant change in the next 10 to 20 years and beyond, as a result of sea-level rise and increased erosion driven by climate change. The coastal margin habitats are reliant on coastal physical processes. Constraints to physical processes, such as sea defences, are affecting habitat extent, condition, and overall resilience, by impeding their ability to move inland in response to sea level rise.

Without significant intervention, prospects for many of these habitats will continue to be poor. Delivery of sustainable agriculture and integrated coastal zone management, including coastal adaptation and source to sea catchment management, are amongst the potential management options which could address long-term decline and deliver sustainable shoreline management.

3. State and Trends (Aim 1)

Summary assessment of state and trends

The following tables (Table 1 to Table 3) give a brief description of the past trends and future prospects for Coastal Margins. These are assessed to be:

- Improving trends or developments dominate, in green;
- Trends or developments show a mixed picture, in amber, or
- Deteriorating trends or developments dominate, in red.

Further information is provided to put this in context.

Table 1 Key messages – past trends and future prospects for extent and connectivity of coastal margins ecosystems

Time period	Indicative assessment	Description
Past trends (1900 – 2019)	Deteriorating	Large scale losses in **extent** and **connectivity** are mostly historical however, loss and fragmentation continue particularly outside of protected sites. The linear nature of the coastal zone makes it vulnerable to fragmentation. **Saltmarsh:** There have been losses due to historical land claim, however, in some estuaries, saltmarsh has expanded often on the outside of sea walls. In the short term, since 2007, the habitat is thought to have been stable in Wales due to the balance of losses and gains (Lewis, 2019b and c). **Sand dune**: Development, forestry, and accelerated succession (Rhind et al., 2008; Rhind and Jones, 2009) has resulted in loss of extent of sand dune constituent habitats. **Sea cliffs**: Extent of cliff top coastal grassland and heathland has declined primarily due to agricultural intensification and abandonment on the coastal slopes and cliff tops. **Shingle**: Extent has declined in the long term due to shoreline structures constraining physical processes. **Coastal lagoons**: The physical extent of lagoons has declined marginally; however, range is stable.

Time period	Indicative assessment	Description
Future Prospects (To 2100)	Deteriorating	Loss in extent is likely to continue due to ongoing pressures. Climate change is an overwhelming concern for the future. Where coastal habitats cannot migrate inland due to the presence of a sea defence, sea-level rise, and increased erosion would be likely to lead to 'coastal squeeze'. **Saltmarsh**: Considerable losses of saltmarsh due to coastal squeeze have been predicted. Shoreline management plans estimate losses of 3,485ha of **intertidal habitat,** which includes saltmarsh, from Special Areas of Conservation (SAC)s in Wales by 2100. **Sand dune**: Projected sea level rise figures suggest an 8% loss of UK sand dune area by 2080. **Sea cliffs**: Sea cliffs, particularly soft cliffs are likely to erode more rapidly, causing loss of cliff top grassland and heath as it is squeezed against intensively managed farmland and developed land. **Shingle**: Shoreline structures are affecting shingle extent, especially where these are restricting sediment transport. Without an influx of new material, the extent of the habitat is likely to reduce in the future (Creer, 2019a and b). **Coastal lagoons**: The overall extent of coastal lagoons is likely to decline over the long-term due to slow retreat of barriers (Green and Lindenbaum, 2019). There is also potential for catastrophic loss due to breaches of barriers (MCCIP, 2018).

Robustness: Extent figures are derived from several sources. Some are relatively old. However, there is reasonable confidence that the broad extent of saltmarsh and sand dune habitats are correct. Estimates for the future extent of saltmarsh rely on both sea level rise predictions and sediment supplies around which there are uncertainties. Extent maps of sea cliffs are incomplete. Trends in extent relating to sea cliff habitat is based largely on expert opinion; there is limited quantitative data on which to base an assessment of the scale and rate of decline, particularly outside of protected sites. There is a lack basic extent data for vegetated shingle in Wales. This lack of contemporary data coupled with the relatively dynamic nature of the habitat makes assessing the trend in habitat area difficult. It is difficult to predict the rate of loss in extent of coastal lagoons. The available outlook information is limited to that available mostly from Article 17 reporting for all coastal margin habitats.

Table 2 Key messages – past trends and future prospects for condition of coastal margins ecosystems

Time period	Indicative assessment	Description
Past trends (2004 – 2019)	Deteriorating	**Saltmarsh**: The majority of saltmarsh is in 'unfavourable condition' and has a decreasing trend. Poor condition is primarily due to intensive grazing and under-grazing. However, the pioneer saltmarsh communities are classed as being in favourable condition (Lewis, 2019b to 2019d). **Sand dune**: Overall the trend in condition is decreasing. Declining condition is mostly attributable to increased vegetation cover and over-stabilisation because of agricultural abandonment, crashes in rabbit populations, air pollution, scrub encroachment, and a lack of dynamic conditions (Creer, 2019c to 2019h). **Sea cliffs**: The majority of the sea cliff habitat is in unfavourable condition however, there is a lack of evidence relating to recent trends. Poor condition relates primarily to cliff top land management pressures; both agricultural intensification and abandonment, and air pollution (Lewis, 2019a). **Shingle**: Condition is unknown for about 95% of shingle habitat and there is uncertainty over short-term trends. Shoreline structures, for example groins and sea walls, are disrupting coastal processes and causing sediment starvation in places. Local damage occurs from trampling and parking. **Coastal lagoons**: There is current uncertainty over short-term trends in condition. However, eutrophication of lagoon water bodies as a result of pollution including, agricultural run-off to groundwater will contribute to decline in condition if water quality remains poor.

Time period	Indicative assessment	Description
Future Prospects (Outlook to 2030)	Deteriorating	**Saltmarsh**: Ongoing pressures including climate change and grazing issues mean that saltmarsh condition is likely to remain negative (Lewis, 2019b to 2019d). **Sand dunes**: Large scale projects to address sand dune stabilisation have the potential to mitigate or reverse some of the negative effects of stabilisation on condition over significant areas of Welsh sand dunes. If successful, this should provide a more optimistic outlook for the habitat in the medium term. However, air pollution remains an issue. **Sea cliffs**: Ongoing land management pressures such as agricultural abandonment and encroachment of intensive agriculture means that poor condition is likely to continue unless these issues are addressed (Lewis, 2019a). **Shingle**: Increased storminess may remove significant proportions of shingle and vegetation associated with shingle, which if sustained consecutively over several years, is likely to have a negative effect on the condition of the habitat in the future (Creer, 2019a, 2019b). **Coastal lagoons**: The outlook for condition is negative as pressures affecting condition, such as climate change and pollution, are likely to remain in the future.

Robustness: There is a large variation in data availability across each of the habitats making up the coastal margin habitats broad ecosystem. Many data gaps remain. The available outlook information is limited to that available mostly from site specific scientific survey, Water Framework Directive assessments, for saltmarsh and coastal lagoons, and Article 17 reporting, all coastal margin habitats.

Table 3 Key messages – past trends and future prospects for drivers of change

Time Period	Driver of change	Indicative Assessment	Description
Past trends (1900-Present)	**Management and land use**	Deteriorating	Many coastal vegetation communities are dependent on appropriate grazing levels grazing to maintain condition. Where the focus of agricultural management is solely on livestock production, the result has been intensification or abandonment of marginal land. Leisure and tourism, and associated development pressures are widespread on the coast and are likely to increase and change in distribution and type in the future.
Past trends (2004-2019)	**Climate change**	Deteriorating	Impacts are mainly associated with loss in extent of habitats due to sea level rise, increases in storminess, and increased erosion. However, changes in temperature and rainfall will also lead to impacts. Climate change is beginning to affect coastal habitats. However, because of the naturally dynamic nature of coastal habitats there is little empirical evidence of change across Wales.
Past trends (1800-2019)	**Constraints to physical processes**	Deteriorating	Historically there has been large scale modification of the majority of Welsh estuaries and over a quarter of the Welsh coastline has been modified by coastal defences. Coastal modification is constraining physical processes impacting sediment budgets, natural erosion, and accretion. This ultimately compromises the ability of coastal habitats to adapt to sea level rise.

Time Period	Driver of change	Indicative Assessment	Description
Past trends (2004-2019)	**Poor air and Water Quality**	Deteriorating	Atmospheric nitrogen and ammonia deposition lead to increases in competitive grasses and loss of sensitive lichens and stress tolerant and open ground species, and is a factor contributing to accelerated succession in dunes. Elevated nutrient levels and chemical contaminants within water bodies are detrimental to the functioning of the overall system, and to condition of specific habitats and species. Greatest impacts relate to elevated nutrient levels within lagoons, but saltmarsh is also associated with water bodies with poor water quality.
Future Prospects (2019 – 2100)	**Climate change and constraints to physical processes**	Deteriorating	Predicted impacts in terms of loss in extent are severe. Responses which help mitigate these impacts and improve outlook include: The timely implementation of Shoreline Management Plans and delivery of habitat creation to offset losses. Nature-based solutions and coastal adaptation.

Time Period	Driver of change	Indicative Assessment	Description
Future Prospects (2019 – 2100)	**Changes in management and land use**	Mixed picture	Without changes bringing land use pressures under control both within protected sites and the wider coastal zones, loss of extent is likely to continue. This would improve if: • Sustainable agriculture is extended throughout the coastal zone. • Management is secured to deliver good environmental status within protected sites. • Ecological networks are restored at the coast and terrestrial transitions are reconnected.
Future Prospects (2019 – 2100)	**Air and Water Quality**	Deteriorating	Air pollution emissions are falling. However, nitrogen and ammonia deposition are likely to exceed critical levels and accumulate for significant areas of coastal margin habitats for some time and will continue to have detrimental effects on the habitats condition in the long term (APIS [online] and Lewis 2019a). Overall Phosphorus is decreasing in UK waters, but the elevated levels of dissolved inorganic nitrogen (DIN) are currently stable and are therefore likely to continue to exceed environmental quality standards in coastal waters. Tackling the numerous sources of contaminants with integrated approaches including improving source to sea catchment management of nutrients, chemicals, and pathogens would improve prospects.

Robustness: Evidence and data availability are variable. It is not possible to numerically quantify change, of coastal habitat extent due to climate change, due to the inherent uncertainties related to coastal change, shoreline evolution, and associated impacts due to projected future sea level rise (Halcrow, 2012b).

Extent, Condition, Connectivity and Diversity

Wales has 2,700 km of coastline. The coastal margins ecosystem has been reduced in overall extent relative to its past distribution and connectivity and represents about 3% of the semi natural habitats in Wales (Blackstock et al., 2010). The coastal margins are made up of five component habitat types saltmarsh, sand dune, sea cliff, shingle, and coastal lagoons which vary widely in extent (Figure 1 andFigure 2, Figure 3, Figure 4, Figure 5 and Figure 6).

Historic large-scale loss of extent was primarily due to land claim, development, and agricultural intensification. For example, approximately 30% of the original sand dune area in Wales has been lost to development and erosion since 1900 (Pye et al., 2017). Smaller scale losses continue across the coastal margins due to numerous pressures.

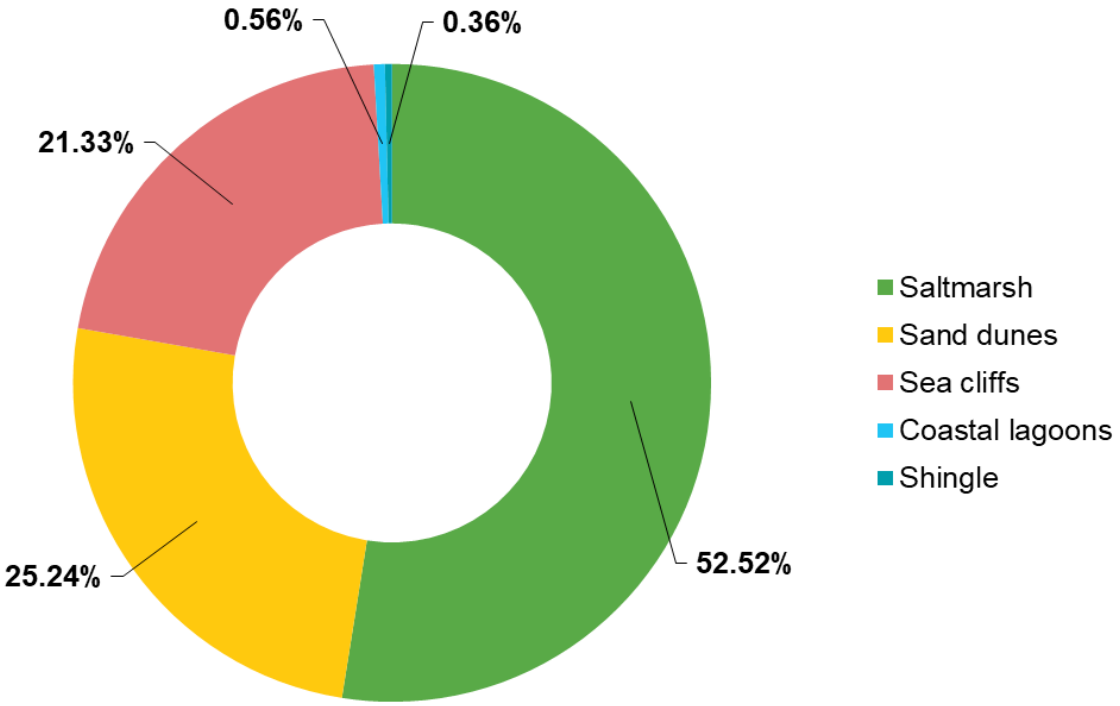

Figure 1 Coastal margin habitats proportional area. Source: NRW Article 17 GIS Habitat Extent layers (Unpublished).

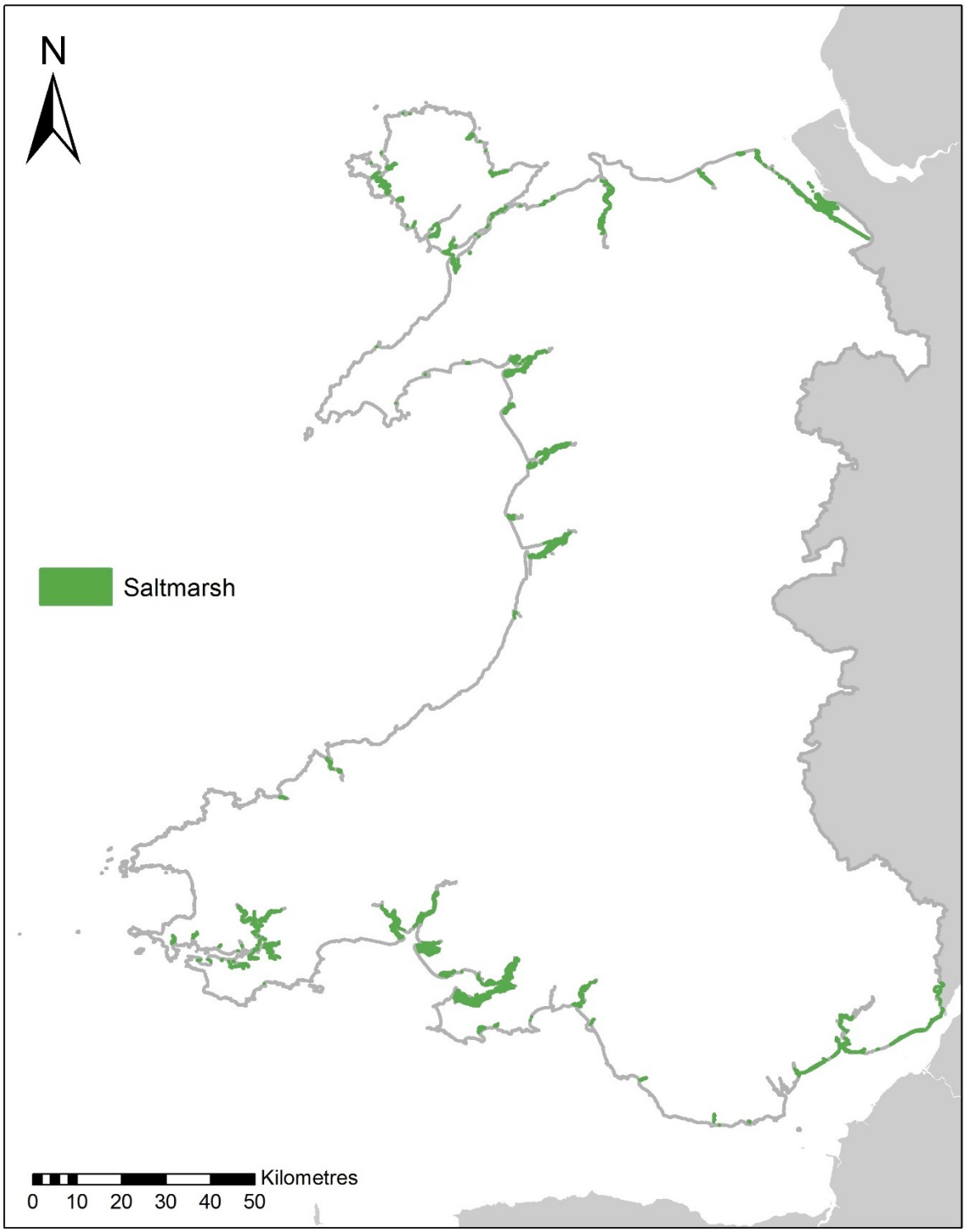

Figure 2 Map showing location of Saltmarsh habitats. Source: Map based on unpublished NRW Annex 1 saltmarsh habitat GIS layers.

Figure 3 Map showing location of Sand dune habitats. Source: map based on NRW Annex 1 sand dune habitats GIS layers

Figure 4 Map showing location of Sea cliff habitats. Source: Map based on the unpublished NRW Annex 1 sea cliff habitat GIS layer.

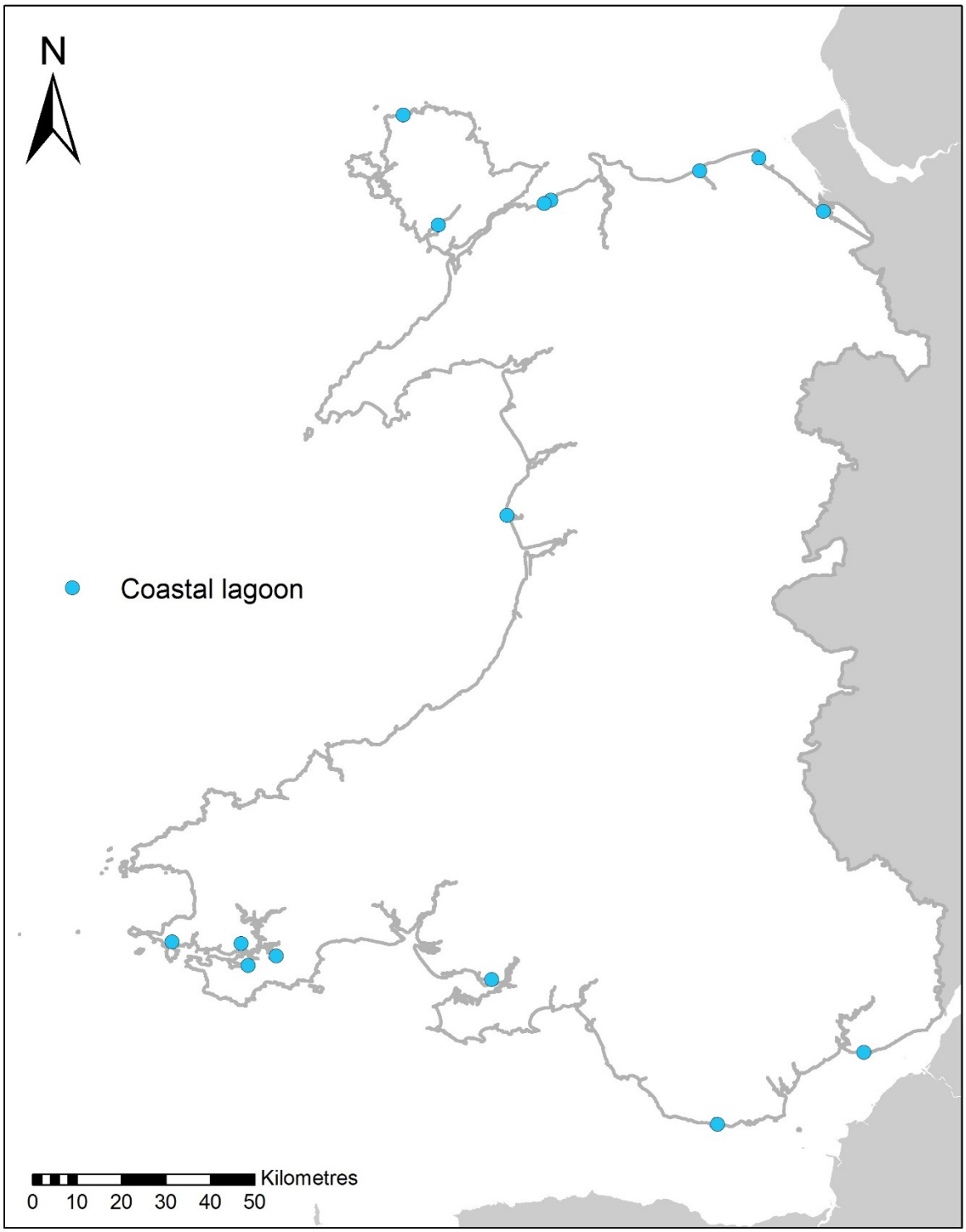

Figure 5 Map showing location of Coastal lagoon habitats. Source: Map based on NRW Annex 1 saline lagoon Annex 1 habitat GIS layer.

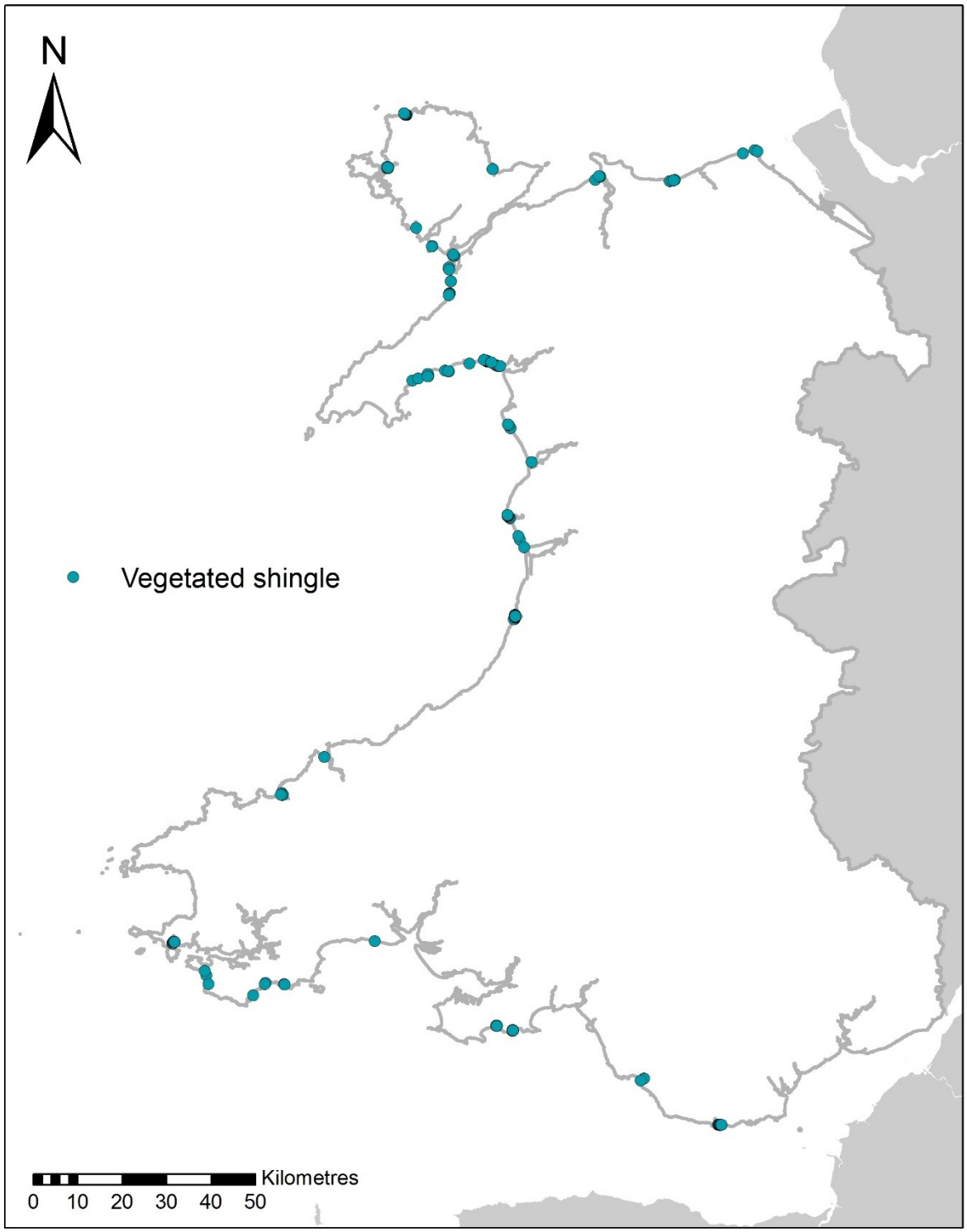

Figure 6 Map showing location of Vegetated shingle habitats. Source: Map based on unpublished NRW Annex 1 shingle habitat GIS layers.

The historic decline and naturally linear distribution of the coastal margin habitats makes them vulnerable to fragmentation, particularly where this coastal zone is narrow. Transitions to terrestrial semi natural habitats are scarce because coastal habitats generally abut intensively managed farmland, developed land, or flood defences.

Since SoNaRR2016 Habitats Directive, Article 17, reporting data (JNCC, 2019) has showed that many of the coastal margin habitats continue to decline in extent and condition and that the future prospects for many features are poor (Table 4 and Table 5). This is due to a range of pressures (Table 6) resulting from human activities and has led to inevitable declines in biodiversity supported by coastal margin habitats (Table 7). Saltmarsh is also assessed as an element of the overall condition of water bodies for Water Framework Directive (WFD) reporting which differs from Article 17 assessments. Of the 17 water bodies where saltmarsh was assessed for the 2018 WFD interim classification, 13 of those were assessed as 'good' or 'high'.

Biodiversity

Note: Sea birds and overwintering water-birds are assessed in the Marine Chapter.

Within the last 50 years there have been several extinctions of invertebrates, lower plants and higher plants as well as further species on the brink of being lost from Wales. The Habitats Directive Reporting revealed the UK conservation status for all of the coastal species listed in Table 8 as 'Unfavourable', although the short term trends for a number of these species shows populations increasing. However, the coastal margin habitats still support nationally and internationally important, if fragile, species populations. Examples include:

- The invertebrate faunas of the Welsh coastal soft cliffs are significant in a UK context (Howe, 2002). The large mason bee *Osmia xanthomelana* is restricted in the UK to coastal soft cliff and dunes on the Llŷn peninsula where populations are very small and vulnerable to extinction.
- Welsh pioneer dune habitats are of high importance for invertebrates, bryophytes, and low growing annuals (Howe et al., 2012). They support numerous vulnerable species such as the liverwort Petalwort *Petalophyllum ralfsii* and Dillwyn's dung beetle *Onthophagus nuchicornis*. UK populations of Dilwyn's dung beetle are now mostly restricted to Welsh dune systems.
- Welsh sea cliffs support numerous populations of scarce and vulnerable higher plants such as spotted rockrose *Tuberaria guttata* and yellow Whitlow-grass *Draba aizoides* which is restricted in the UK to the Gower. They are also of critical importance for a wide range of grassland and heathland species adversely affected by agricultural intensification in the coastal hinterland (Blackstock et al., 2010).
- Wales is the stronghold of the UK and Isle of Man for chough *Pyrrhocorax pyrrhocorax* populations, supporting nearly 80% of the UK breeding population of chough (Hayhow et al., 2018), found primarily along the western coastal fringe.
- The Greenland white-fronted goose (GWfG), *Anser albifrons flavirostris*, over-winters only in Britain and Ireland, feeding on saltmarsh and grazing marsh. In Wales, there remains only one regular over-wintering flock, on the Dyfi Estuary,

which is declining rapidly, from 167 birds in 1998/99 to 26 birds in 2017/18 (Mitchell et al., 2018). There is a real possibility that GWfG could be lost as an over wintering species from Wales within the next couple of decades.

Figure 7 Chough feeding on cliff top habitat, Pembrokeshire. Photo: Heather Lewis

Table 4 and Table 5 set out the short and long-term trends of European Habitats Directive Annex I habitats and Annex II species found in coastal margin habitats which were assessed as part of the Habitats Directive, Article17 reporting 2019 (JNCC, 2019). Assessment categories and evaluation methods are set out in European Environment Agency Guidelines (DG Environment, 2017).

Table 4 Short- and long-term trends in range and extent of European Habitats Directive Annex I (JNCC 2019)

Habitats Directive Annex I Habitat	Coastal Margin Broad Habitat type	Area of Habitat in Wales - Short term trend	Future Prospects in Wales - Extent	Habitat area in good condition in Wales - Short term trend	Future Prospects - Structure and function	UK conservation status
H1210 Annual vegetation of drift lines	Shingle	Uncertain	Unknown	Unknown	Unknown	Unfavourable - Bad
H1220 Perennial vegetation of stony banks	Shingle	Uncertain	Negative	Uncertain	Negative	Unfavourable - Bad
H1230 Vegetated sea cliffs	Sea cliff	Decreasing	Negative	Uncertain	Negative	Unfavourable - Bad
H1310 *Salicornia* and Annuals	Saltmarsh	Uncertain	Negative	Decreasing	Negative	Unfavourable - Bad
H1330 Atlantic salt meadows	Saltmarsh	Uncertain	Negative	Unknown	Negative	Unfavourable - Bad
H1420 Thermo-Atlantic scrub	Saltmarsh	Decreasing	Negative	Stable	Negative	Unfavourable - Bad

Habitats Directive Annex I Habitat	Coastal Margin Broad Habitat type	Area of Habitat in Wales - Short term trend	Future Prospects in Wales - Extent	Habitat area in good condition in Wales - Short term trend	Future Prospects - Structure and function	UK conservation status
H2110 Embryonic shifting dunes	Sand dune	Decreasing	Negative	Decreasing	Negative	Unfavourable - Bad
H2120 Shifting dunes	Sand dune	Decreasing	Negative	Unknown	Negative	Unfavourable - Bad
H2130 Fixed dunes	Sand dune	Decreasing	Negative	Unknown	Negative	Unfavourable - Bad
H2150 Atlantic decalcified dunes	Sand dune	Increasing	Unknown	Stable	Unknown	Unfavourable - Bad
H2170 Dunes with *Salix repens* ssp. *argentea*	Sand dune	Uncertain	Overall stable	Stable	Negative	Unfavourable - Bad
H2190 Humid dune slacks	Sand dune	Unknown	Negative	Uncertain	Negative	Unfavourable - Inadequate
H1150 Coastal lagoons	Coastal lagoons	Unknown	Negative	Unknown	Negative	Unfavourable - Inadequate

Table 5 Short- and long-term trends in range and extent of European Habitats Directive Annex II species, found in coastal margin habitats, in Wales (JNCC 2019)

Habitats Directive Annex II species	Short term trend in range of species in Wales	Short term trend in population size in Wales	Long term trend in population size in Wales	Short term trend in habitats for the species in Wales	UK conservation status
S1014 Narrow-mouthed whorl snail *Vertigo angustior*	Stable	Decreasing	Uncertain	Decreasing	Unfavourable - Inadequate
S6284 Natterjack toad *Epidalea calamita*	Increasing	Increasing	Increasing	Stable	Unfavourable - Bad
S1261 Sand lizard *Lacerta agilis*	Increasing	Increasing	Increasing	Stable	Unfavourable - Inadequate
S1395 Petalwort *Petalophyllum ralfsii*	Stable	Decreasing	Decreasing	Decreasing	Unfavourable - Bad
S1441 Shore dock *Rumex rupestris*	Stable	Increasing	Uncertain	Decreasing	Unfavourable - Inadequate
S1654 Early gentian *Gentianella anglica*	Stable	Uncertain	Uncertain	Uncertain	Unfavourable - Bad
S1903 Fen orchid *Liparis loeselii*	Increasing	Increasing	Decreasing	Increasing	Unfavourable - Bad

Table 6 and Table 7 sets out pressures and threats which have been assessed at a Welsh level for Habitats Directive Reporting 2019 (JNCC, 2019). Only High and Medium pressures are shown below the methods for the ranking of pressures was carried out using European Environment Agency Guidelines (DG Environment 2017), however, the standard individual A17 reporting pressures have been combined to represent general pressures for the broad coastal margin habitat types.

Table 6 Pressues recorded as a high or medium level to Coastal Margins at a Wales level (JNCC 2019). Where pressures are listed as 'not applicable' these pressures may either be present at a low level or absent.

Broad pressure type	**Saltmarsh**	**Sand dune**	**Sea cliffs**	**Shingle**	**Coastal lagoons**
Inappropriate agriculture, including abandonment	High	High	High	Not applicable	Not applicable
Development: Energy production	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Drainage, abstraction, alteration of water courses	Not applicable	High	Not applicable	Not applicable	Not applicable
Constraints to coastal Processes	High	High	Medium	High	Medium
Sports, tourism and leisure activities	Medium	High	Not applicable	High	Not applicable
Pollution	High	High	High	Not applicable	High
Invasive non-native Species	Not applicable	High	Medium	Not applicable	Medium
Succession	Not applicable	High	Not applicable	Not applicable	Not applicable
Climate change	Not applicable	Medium	Not applicable	Medium	Not applicable

Table 7 Threats recorded as a high or medium level to Coastal Margins at a Wales level (JNCC 2019). Where threats are listed as 'not applicable' these threats may either be present at a low level or absent.

Broad Threat type	**Saltmarsh**	**Sand dune**	**Sea cliffs**	**Shingle**	**Coastal lagoons**
Inappropriate agriculture, including abandonment	High	High	High	Not applicable	Not applicable
Development: Energy production	Medium	Not applicable	Not applicable	Not applicable	Medium
Drainage, abstraction, alteration of water courses	Not applicable	High	Not applicable	Not applicable	Not applicable
Constraints to coastal Processes	High	High	Medium	High	Medium
Sports, tourism and leisure activities	High	High	Not applicable	High	Not applicable
Pollution	High	High	Medium	Not applicable	High
Invasive non-native Species	Medium	High	Medium	Not applicable	Medium
Succession	Not applicable	High	Not applicable	Not applicable	Not applicable
Climate change	High	Medium	High	Medium	Medium

A high proportion of the coastal habitats are within the protected sites series (Figure 8) and this statutory protection is a key factor in reducing habitat loss. Water bodies associated with saltmarsh and saline lagoons fall under the Water Framework Directive (WFD) which is a mechanism for assessing and managing the water environment, through planning and implementing measures to protect and improve the water environment.

Since SoNaRR2016 the Site of Special Scientific Interest (SSSI) Guidelines for Coastlands (Rees et al., 2019) have been updated to enable the boundaries of any new SSSIs to be drawn to account for 'likely future change' for coastal processes

such as erosion, making the protected sites series more resilient to climate change (Rees et al., 2019).

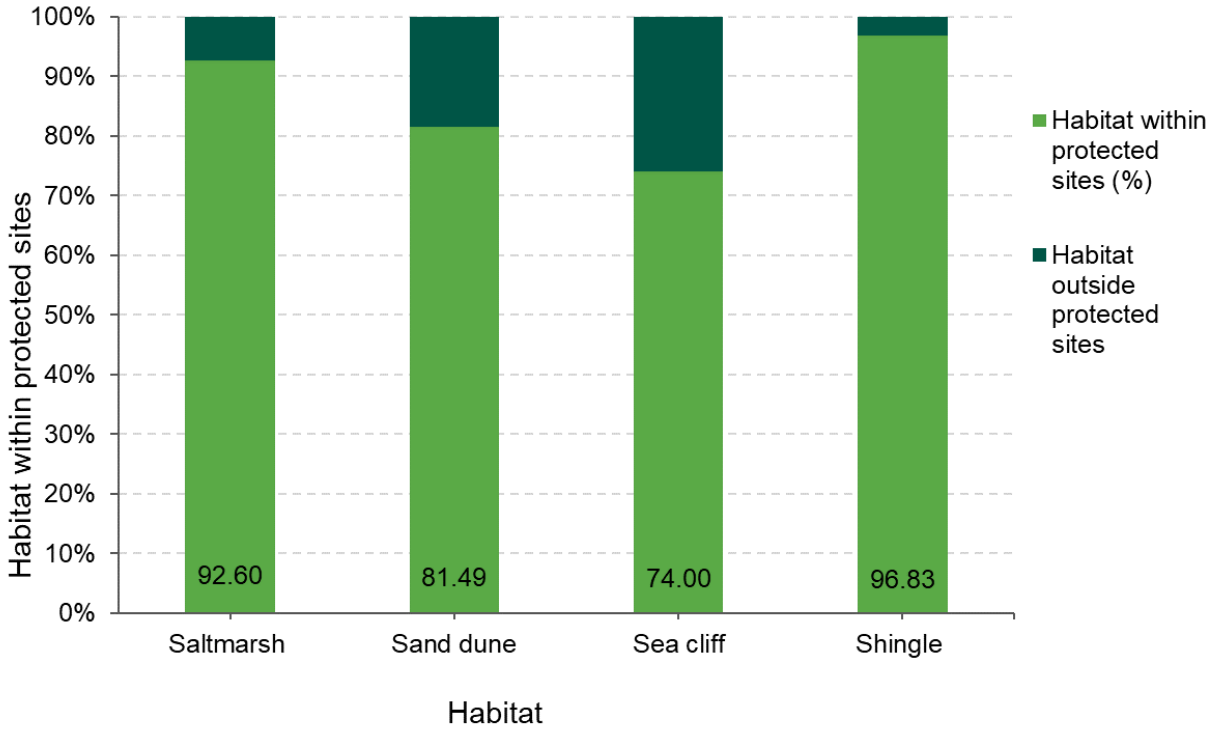

Figure 8 Extent of coastal margin habitat within Wales and the percentage of the coastal habitat under statutory protection (where data exists for broad habitats). Source: Table generated from unpublished NRW Annex 1 GIS Habitat extent layers and protected sites layer.

Pressures and Threats

There are numerous pressures impacting the coastal margin habitats. The prospects for many coastal margin habitats and species will continue to be negative unless these pressures are brought under control, being actively reduced, or mitigated for.

Species examples are given in the text below relating to pressures, however as with habitats, species declines are seldom linked to a single pressure.

Land Management

A significant proportion of Wales's coastal margin habitats are managed for agriculture**,** primarily livestock production on saltmarsh, clifftop grassland and heath, and sand dunes. Many vegetation types are reliant on appropriate grazing levels to maintain good condition. However, agricultural improvement, overgrazing, under-grazing, agricultural abandonment, declines in heavy stock, and timing of grazing are leading to poor condition and species declines.

Agricultural improvement of cliff top habitat has resulted in declines in invertebrate species which are restricted to soft cliffs. Loss of flower rich habitats on cliff tops restricts the nesting and foraging activities to the immediate cliff slopes (Howe, 2015).

Overgrazing typically results in short, uniform swards, the loss of grazing-sensitive species, and restricts the ability plants to flower. Davidson et al., 2020, found that intensively grazed saltmarshes were to be amongst the least valuable habitats for all bee types.

Lowland breeding **common redshank,** *Tringa tetanus,* favour damp habitats including saltmarsh for breeding. In Great Britain, over 50% of saltmarsh breeding redshank have been lost since 1985 (Malpas et al., 2013). Common redshank declines in Wales have been largely driven by agricultural intensification resulting in a lack of available nest sites with recovery hampered by predation. Grazing pressures during the breeding season, even under light grazing levels, can be detrimental (Sharps et al., 2016).

Abandonment of grazing is widespread on clifftops where scrub is replacing coastal grassland and heath, threatening numerous plants such as wild asparagus, *Asparagus officinalis* subsp*. prostratus,* and Goldilocks aster, *Aster linosyris,* and lichens. Chough which feed on clifftop coastal slopes also favour short swards for foraging which enables them to probe the soil for invertebrate prey; favourable foraging conditions are strongly linked to livestock grazing (Johnstone et al., 2011). On the upper saltmarsh, a suite of plant species, including slender hare's-ear, *Bupleurum tenuissimum*, and sea barley, *Hordeum marinum*, rely on short swards and bare ground created by cattle poaching.

Agri-environment schemes are a primary influence on land management in the wider countryside, however less than a third of saltmarsh, sand dune and sea cliff are under the Glastir Advanced scheme, 2018, (

Table 8). Lagoons and shingle are not generally managed for agriculture.

The new Sustainable Farming Scheme for Wales will reflect the following current challenges; sustainable food production, responding to the climate emergency, and reversing the decline of biodiversity (Welsh Government, 2019a). The scheme has the potential to deliver progress towards SMNR across the wider countryside and multiple well-being benefits.

Table 8 Extent of coastal margin habitats within Glastir Advanced agri-environment scheme agreements 2018. Source: Table from unpublished NRW Annex I habitat layers and Welsh Government Glastir GIS layers, 2018.

Coastal margin habitat	Area in agri- environment scheme in hectares	% of habitat covered
Saltmarsh	1,740	22%
Sand dune	1,289	35%
Sea cliff	126	4%
Shingle	0	0%
Coastal lagoon	Not applicable	Not applicable

Currently, site level conservation management is leading to significant localised improvements in the condition of coastal margin habitats; this is often achieved through SSSI management agreements (Figure 9) with conservation agencies and private landowners. The majority of these agreements relate to agricultural practices, or practical management works such as scrub clearance, therefore relate mainly to saltmarsh, sand dune, and sea cliff.

Since SoNaRR2016, several landscape scale initiatives have been implemented or continued to provide benefit to coastal margin ecosystems:

- Sands of LIFE; which will restore over 2400 hectares of sand dunes on 10 separate Welsh sites.
- Dynamic Dunescapes; partnership project which aims to rejuvenate some of the most important dune systems in the UK.
- Farming for the Future on Llŷn; led by the Llŷn Partnership on the Llŷn Peninsula, is a project which includes work to maintain and expand the coastal corridor and trialing a ‘payment on outcomes’ farming model (National Trust, no date).
- Conserving the Park, established in 2002; addresses the decline of traditional agriculture, tackling under-grazing and restoring land which has been intensively managed within Pembrokeshire Coast National Park (Pembrokeshire Coast National Park, 2019).

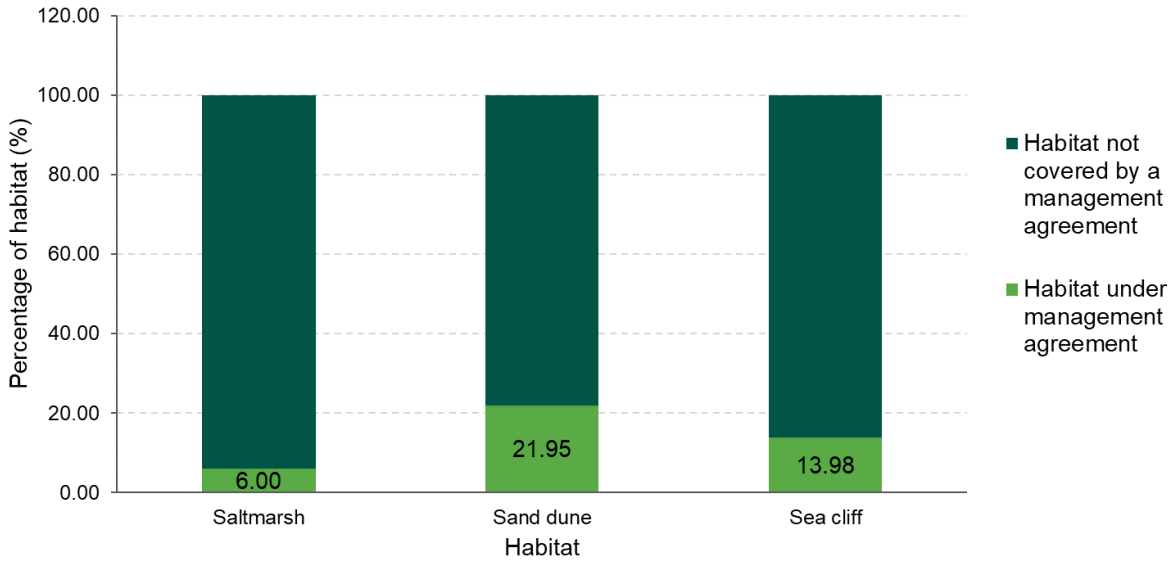

Figure 9 Percentage of saltmarsh, sand dune and sea cliffs within SSSI Management Agreements. Source: Table generated from NRW Annex 1 habitat layers and NRW Management Agreement Layer, 2018.

Forestry affects 1680 hectares of sand dunes in Wales (Howe et al., 2012), causing significant loss of extent of dune vegetation and condition due to lowering of the dune aquifer and sand stabilisation (Provoost et al., 2011; Pye et al., 2014; Rhind et al., 2008; Rhind and Jones, 2009). Afforested sand dunes lose natural dynamism and become 'fossilised relics' of former biodiverse systems. There has been limited felling in order to restore functionality of dune processes at several sites including Morfa Harlech and Newborough Warren where monitoring has shown this to be successful (Wallace and Jones, 2020).

Current development pressures on the coast are primarily related to tourism and leisure, such as holiday parks, golf courses and associated car parks, and in many places, **tourism** and **leisure activities** have led to localised impacts from trampling vehicle access and caused disturbance to wildlife. For example, on the Dee Estuary, car parking at Talacre on the dune saltmarsh transition has led to habitat loss, about 0.5 ha. More controlled parking at this site is now leading to habitat restoration.

The sand lizard, *Lacerta agilis,* and natterjack toad, *Bufo calamita*, both became extinct in Wales by the 1960s (Howe, 2019a, Howe 2019b), as a result of development and sea defence work which led to loss and fragmentation of sand dune habitat. The sand lizard and natterjack toad Recovery Project 2011-2014 carried out successful reintroductions of these species as part of the Species Recovery Project and the UK Biodiversity Action Plan.

The **management and maintenance of man-made structures** is important for the majority of coastal lagoons in Wales. Many of these are sluiced lagoons and have a limited connection with the sea via man-made structures such as culverts and valved sluices.

Climate change

The most recent UK Climate Projections (UKCP18) predict a greater chance of hotter, drier summers and warmer, wetter winters, with an increased likelihood of more intense and frequent rainfall and storm events, which will inevitably result in increased wave action (Met Office Hadley Centre, 2018). All of these changes will impact coastal habitats (Burden et al., 2020).

Climate change projections also show increasing sea-level rise, which we expect to lead to some major changes to these dynamic habitats on the Welsh coast in the next 10 to 20 years and beyond. At many locations in the UK, extreme sea levels that exceed critical flood-thresholds are being experienced more frequently than in the past, due to mean sea-level rise (MCCIP, 2020). The coastal erosion rate in the UK is expected to increase in the future due to a combination of relative sea-level rise, reduced nearshore sediment supply, and impacts resulting from human activities and management (MCCIP, 2020).

The impacts of changes to temperature, rainfall and storminess are uncertain, but climate change is likely to exacerbate the effects of existing pressures and lead to changes in species distribution in the coastal margin habitats (Burden et al., 2020). There is also an increased risk of the spread of invasive species (Barrow, 2020).

Changes in weather patterns are already beginning to affect biodiversity, for example the loss of oysterplant, *Mertensia maritima*, from shingle in North Wales has been attributed to a warming climate (Jones et al., 2013).

Where coastal habitats cannot migrate inland due to the presence of a sea defence, sea-level rise and increased erosion would be likely to lead to ‘coastal squeeze’. Shoreline management plans (SMPs) (Atkins, 2010; Halcrow, 2012a and b; Royal Haskoning, 2012) estimate significant losses of intertidal habitat due to coastal squeeze, including saltmarsh (Table 9), the highest predicted losses being from the Severn Estuary.

Average loss of sand dune area of 2% over 20 years and 8% by 2080 due to sea-level rise is projected (Jones et al., 2013). Saline lagoons are one of the most vulnerable habitats to climate change, with their physical, chemical, and ecological characteristics all likely to be affected (MCCIP, 2018). The overall extent of coastal lagoons is likely to decline in the long-term; sea level rise and increases in storminess will lead to the slow retreat of barriers and, in some cases, catastrophic breaches (MCCIP, 2018). Sea-level rise may present opportunities for the creation of new lagoonal habitat, where sea water inundates low-lying land and freshwater areas (Jones et al., 2011).

Numerous species are threatened by habitat loss due to coastal squeeze and changes to the tidal range. For example red hemp-nettle, *Galeopsis angustifolia,* which has only two native populations in Wales, situated on shingle on the south coast, and Baltic bryum, *Bryum marratii*, one of Wales’s rarest and most threatened mosses, which occupies the transitional zone between upper saltmarsh and sand dune, are under threat from sea-level rise. (Callaghan and Farr, 2018).

While many plants have mechanisms to allow seed dispersal by the sea, for example buoyant seeds such as sea kale, *Crambe maritima*, (Sanyal and Decocq, 2015) which grows on shingle, there is a risk that the fragmented nature of shingle systems may reduce the ability of species to migrate in response to climate change impacts (Burden et al., 2020). Rare species typical of isolated coastal lagoons, for example Lagoon cockle *Cerastoderma glaucum*, are likely to have limited adaptation options (Brown et al., 2016).

Table 9 Predicted loss of intertidal habitats, which includes saltmarsh, from Natura 2000 sites in Wales in hectares

Designated Natura 2000 site	**2005 – 2025**	**2025 – 2055**	**2055 – 2105**	**2005 – 2105**
Severn Estuary SAC (Welsh section only)	226	463	1,223	1,912
Burry Inlet / Carmarthen Bay SAC	59	163	411	636
Pembrokeshire Marine SAC	2	4	5	11
Pen Llŷn a'r Sarnau SAC	40	150	111	300
Glannau Môn Cors Heli SAC	1	4	11	16
Menai Strait and Conwy Bay SAC	3	12	1	16
Dee Estuary SAC	0	140	454	594
Total	331	936	2,216	3,485

These predicted losses are derived from the EU Habitats Regulations Assessments for the four SMPs which partially or wholly cover Wales. The figures for predicted losses have not been adjusted to allow for estuary infilling, which drives marsh expansion, or morphological response to sea level rise and in that context, are seen as a worst-case scenario. Figures included in the calculations from the Severn Estuary have been adjusted to reflect the proportion of the intertidal habitat within Wales.

Saltmarsh can respond to sea level rise by vertical accretion, given adequate sediment supply (Jones et al., 2011) therefore, short-term losses due to sea level rise may not be as great as predicted by basic topographic models. However, in the long-term, there are uncertainties surrounding sediment supplies. Without increases in sediment supply to the coast, trends of lateral marsh erosion are likely to continue and may reverse trends in expansion in the northern regions of Great Britain (Ladd et al., 2019).

The National Habitat Creation Programme (NHCP) has been set up to create compensation habitat to offset loss due to coastal squeeze caused by coastal defences owned and maintained by Risk Management Authorities in Wales, as

defined in the Flood and Water Management Act 2010. It is intended to help meet the requirements of the Habitats and Water Framework Directives.

To date, one scheme, at Cwm Ivy on North Gower of 39 hectares, has been implemented in partnership with the National Trust, and further projects are at the planning stage. However, creating like-for-like habitat is unlikely to be achievable in most cases; a study of saltmarsh development by Garbutt and Wolters, 2008, found that restoration efforts may never fully replace natural wetland functions.

Constraints to coastal processes

The coastal margins habitats, particularly sedimentary systems, such as saltmarsh, dunes and soft cliffs, are reliant on coastal physical processes to maintain dynamic conditions and to drive biological succession. Much of the Welsh coastline, almost 28%, has been modified by coastal defences and groynes which protect land claimed for agriculture and development, including housing, industry and transport links (Brazier et al., 2007; Welsh Government 2012). These have changed the shape of the coastline and caused hydromorphological pressures, constricting natural physical processes such as tidal inundation, channel movements, and natural erosion.

Constraints to coastal processes compromise the ability of the dynamic coastal habitats to adapt to both natural change and now, critically, to climate change (Burden et al., 2020), decreasing their ability to function as natural coastal defences.

Figure 10 Coastal defences, North Wales. Photo: Heather Lewis

Sediment supply, made available through natural coastal erosion on one part of the coast, is essential for the maintenance of coastal habitats at other locations, as it is transported and deposited by the sea. Natural erosion and sediment deposition on

soft coasts provide the dynamic conditions for the development of pioneer habitats. Coastal defences, such as rock armour and breakwaters preventing erosion and groynes interrupting sediment transport, are causing declines in sediment supplies. Stabilisation of soft cliffs has caused loss of exposed bare ground, seepages, and pioneer plant communities upon which many of these specialist soft cliff invertebrates depend on for their survival (Howe, 2015).

The coastal zone is narrow, usually bordered by development or land managed intensively for agriculture or forestry, leaving no space for 'rollback' of coastal habitats as a response to erosion or sea-level rise, causing habitat loss and fragmentation. The National Trust's coastal adaptation policy 'Shifting Shores' (National Trust, 2015) includes creation of space for rollback of habitats. The National Trust has begun to implement this policy at its Welsh coastal properties.

Provided that coastal margin habitats have adequate sediment supply and room to adjust in line with sea level rise and erosion, then adaptation could occur. However, with climate change, the pressure for improved coastal defences will inevitably increase. Challenges will arise where sea defences, which interrupt sediment supply and transport, are necessary for protection of property and infrastructure.

The use of nature-based solutions is encouraged in the National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in Wales 2020. The FCERM Business Case guidance for flood defence projects requires at least one nature-based option to be taken through to the shortlist of options. However, for wider use of nature-based solutions in Wales, risk management authorities will require incentives, information, guidance and increased awareness, to make the shift from static concrete and rock defences to nature-based solutions.

Succession

Succession from early pioneer habitats to mature stabilised communities is a natural process; however, dune systems in particular have become increasingly dominated by late successional communities, with a significant loss of the pioneer open habitats and species (Pye and Blott, 2017; Van der Biest et al., 2017; Pye et al., 2014; Provoost et al., 2011; Howe et al., 2010). Accelerated succession in sand dunes is a result of numerous pressures. These include agricultural abandonment, crashing rabbit populations, atmospheric nitrogen and ammonia deposition, anthropogenic activities to stabilise dunes, and natural processes.

Populations of plant species such as fen orchid, *Liparis loeselii* (Woodman, 2018), specialist dune bryophytes (Callaghan et al., 2020) including petalwort, *Petalophyllum ralfsii*, and several invertebrate species (Howe et al., 2012) have all suffered with the decline in area of early successional and pioneer sand dune habitats.

Since the late 1980s, the fen orchid has been lost from three out of five sand dune systems in Wales where it was previously recorded and there has been a huge long-term decline in the numbers of individual plants (Woodman, 2018). The population at Kenfig declined from an estimate of more than 20,000 plants between 1987 and 1992 (Jones, 1995) to about 1000 in 2017 (Wilkinson and Hayes, 2018).

Since 2012 there has been significant improvements in **fen orchid** numbers at Kenfig (Table 5 and Figure 11) and a very small population has been re-established at Whiteford Burrows. These improvements have been driven by a programme of site management at Kenfig to create early successional slacks to increase the area of suitable habitat.

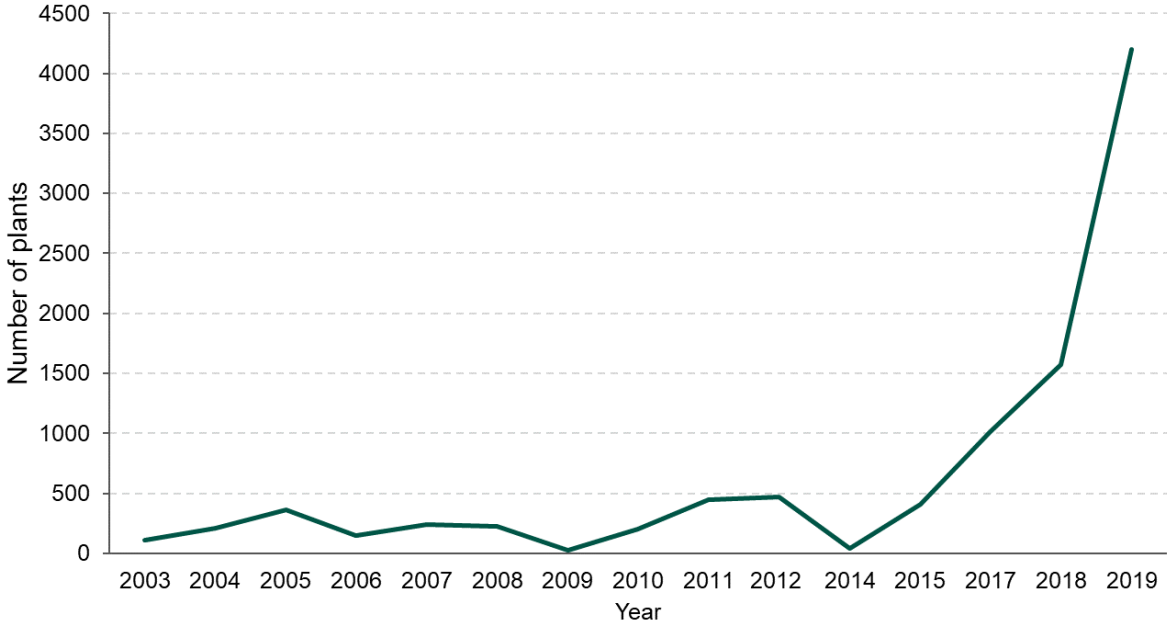

Figure 11 Fen orchid numbers at Kenfig from 2003 – 2019. Source: Graph generated from NRW monitoring data. Source: Graph generated from NRW monitoring data

Figure 12 Fen orchid, Kenfig. © Mike Clark

Four of the Welsh dune systems have lost more than 50% of their notable moss and liverwort species and three dune mosses have become extinct in Wales since 2000: *Bryum calophyllum*, *Catoscopium nigritum* and *Meesia uliginosa* (Callaghan et al., 2020). Recent work has shown that some dune bryophytes can survive as buried spores, and the conservation works undertaken by the Sands of LIFE project may facilitate some notable mosses and liverworts to recolonise on some sites.

Pioneer habitats support up to 75% of the dune specialist invertebrate fauna; however, these pioneer specialists have declined markedly with increased sand dune stabilisation and loss of early successional habitat. The ground beetle *Broscus cephalotes* was once widespread across the Newborough Warren system, but is now restricted to the strandline (Loxton, 2014). 34 invertebrate species associated with pioneer slacks (Howe et al., 2012) have been particularly affected and lost from some systems as this habitat has become scarce (Bratton, 2012).

The Sands of Life and Dynamic Dunescapes dune restoration projects, have the potential to mitigate or reverse some of the negative effects of stabilisation, over significant areas of Welsh sand dunes, and if successful, should provide a more optimistic outlook for the habitat in the medium term.

Air and Water Quality

There are challenges surrounding understanding contaminant pathways, tackling off-site sources of contaminants, and overcoming the consequences of past contamination, such as soil enrichment and sediment contamination. Evidence relating to estuarine and coastal water quality is also covered in the Marine chapter.

Contaminants impacting coastal habitats originate from numerous sources, such as industry, transport, and agriculture. Land managed intensively for agriculture can bring about changes to soil and water courses, particularly through nutrient enrichment.

Air Quality

Atmospheric nitrogen deposition and ammonia pollution are a significant issue. Dunes and cliff top coastal heath which are adapted to nutrient poor conditions are particularly vulnerable, even small levels of inputs can accumulate over time in soils (Aggenbach et al., 2017; Kooijman et al., 2017; Plassmann et al., 2010; Jones et al., 2004). Impacts include increases in competitive grass species, accelerated succession and loss of pioneer, stress tolerant and open ground species.

The Trends Report 2020: Trends in critical load and critical level exceedances in the UK (Rowe et al., 2020) for air pollution, includes assessments for critical loads for saltmarsh and dune grasslands. Despite dune grasslands in Wales displaying the largest reduction in the percentage area exceeded for nutrient Nitrogen of all habitats assessed; from 31.1%, between 1998-2003, to 16.5%, between 2016-2018, the habitat is still being impacted by nutrient Nitrogen leading to accelerated stabilisation and succession. Saltmarsh within Wales has virtually no exceedance of nutrient Nitrogen in any year, due to a combination of its high critical load and the lower deposition of nutrient Nitrogen in coastal areas (Rowe et al., 2020).

Water Quality

Coastal lagoons are particularly vulnerable to nutrient inputs via run-off from surface waters and groundwater sources, due to limited circulation and exchange. The dominant source of Dissolved Inorganic Nitrogen (DIN) in the Milford Haven Waterway, where a number of Welsh lagoons are situated, was assessed to be from agricultural sources (Green and Lindenbaum, 2019). Saltmarsh is generally associated with quite high levels of Nitrogen (Boorman and Hazelden, 2012) and is therefore believed to be relatively tolerant to nutrient enrichment. Overall Phosphorus is decreasing in UK waters, but the elevated levels of DIN remain stable.

Pollution from shipping and industry is a pressure and a risk; small scale spills and the use of antifoulants contribute to overall pollution. Lagoons around the oil port of Milford Haven are subjected to raised levels of hydrocarbons from small operational incidents (Green and Lindenbaun, 2019). Large scale spills could have catastrophic results and remain a threat.

Marine litter can become trapped within coastal lagoons. Artificial material, mainly plastic, from anthropogenic origin were recorded at all lagoons surveyed in 2017 by NRW at most monitoring stations. Marine litter in the wider marine environment is also covered in the Marine section.

Environmental quality standards (EQSs) set under the Water Framework directive (WFD) are set at levels to ensure there are no impacts to the aquatic environment. Contaminants from marine and freshwater sources, including DIN and chemical contaminants, are exceeding EQSs within numerous water bodies associated with coastal lagoons and saltmarsh.

Water quality has been assessed as ‘not good’ for five of the six lagoons within protected sites (Green and Lindenbaum 2019) using local observations, such as phytoplankton blooms and litter, and WFD assessments (NRW, 2015) from either lagoonal water bodies or surrounding water bodies.

The Water Framework Directive Cycle 2 Interim Classification (NRW, 2018) for the 53 transitional and coastal water bodies associated with saltmarsh revealed that:

- 38% of water bodies assessed for chemicals were assessed as failing; recorded fails were for chemicals including Mercury, Cadmium, Brominated diphenyl ether and Trichlorobenzene.
- 50% of those water bodies assessed for DIN were classified as failing

Saltmarsh is relatively tolerant to heavy metal contamination although, some marine infaunal species may be lost, or reduced in extent (Tyler-Walters, 2004). Saltmarsh is vulnerable to contamination by hydrocarbons and synthetic compounds (Tyler-Walters, 2004).

A significant number of the measures taken in the targeted water bodies in freshwater catchments have contributed to improvements in estuarine and coastal water bodies, although further measures are needed to achieve a change to good status. Wider opportunities provided through area statements and the framework of

marine planning now established, provide additional focus on estuarine, coastal, and marine waters and the link to their freshwater catchments.

‘Opportunity Catchments’ have been selected which represent the best suite of opportunities for addressing WFD objectives, SMNR and well-being outcomes. Those selected have fully applied the ‘source to sea’ approach to catchment management and identified estuarine and coastal water bodies where a sustainable management approach to water will be progressed.

Invasive Non-native Species

Article 17 reporting 2019 identified invasive non-native species (INNS) as a medium pressure for sand dunes, sea cliffs and coastal lagoons (Creer, 2019c-h; Lewis, 2019a; Green and Lindenbaum, 2019). Some of the more common terrestrial INNS are limited within the coastal margins because of the more extreme environmental conditions existing on the coast. However, INNS which are adapted to coastal environments such as sea buckthorn, which is non-native in Wales, threaten biodiversity and mobility of dunes. The Sands of LIFE and Dynamic Dunescapes projects will tackle INNS on several dune sites across Wales.

Control and eradication of marine INNS which may affect coastal lagoons and saltmarsh is technically challenging (NNSS, 2015). The non-native marine seaweed *Gracilaria vermiculophylla* which forms mats in saltmarsh pans has recently been recorded on the Dwyryd Estuary. This species spreads rapidly and has been assessed as a ‘moderate risk’ by the GB Non-native Species Secretariat, 2017.

4. Assessment of Resilience (Aim 2)

Ongoing pressures, particularly the direct and indirect effects of climate change, as well as poor overall prospects of extent and condition will impact resilience.

Generally, diversity is high, however declines and extinctions have occurred throughout the coastal margins. The broad range of species found within the coastal margins reflects the environmental gradient from the marine through to the terrestrial and the harsh and dynamic conditions on the coast.

Figure 13 Species rich dune grassland, Morfa Dinlle. Photo: Heather Lewis

A wide variety of plant communities are represented within the coastal margins however the extent and range of some community types, particularly pioneer habitats, and those on the landward margins of the coastal zone, are much reduced. Sand dunes and clifftops can have high diversity whereas, some coastal vegetation communities such as pioneer saltmarsh are sparse in structure and naturally species poor, but are made up of highly specialised species only found within the coastal zone.

Figure 14 Pioneer saltmarsh dominated by Glasswort / Marsh Samphire Salicornia sp., a salt tolerant species. Photo: Heather Lewis

One of the primary threats to coastal margin habitats is climate-driven sea level rise, along with increases in storminess and wave action. The mobile nature of sand dune, saltmarsh, and shingle means that they are relatively adaptable to such changes; however, constraints to physical processes and sediment supplies and lack of space for rollback of these habitats means that this adaptability is severely compromised.

Table 10 SoNaRR2020 Ecosystem Resilience Assessment: Attributes of resilience of each coastal margins habitat unit.
Area figures (ha) = total area of Annex I habitats (except shingle) from Article 17 for coastal habitat types.

Practical habitat unit	Diversity	Extent	Condition	Connectivity
Saltmarsh	**Medium** Range of variation moderately well maintained, although there have been widespread losses of upper marsh and natural transitions to coastal defences.	**Low** **7782 ha** Major changes have occurred due to historical land claim, although there has been expansion in some estuaries. In the future there are significant predicted losses due to coastal squeeze.	**Medium** Issues: Grazing levels, constraints to physical processes, water quality.	**Medium** There have been habitat losses, but this is a clustered resource and the aquatic element is maintained. Connectivity of upper and transitional marsh is compromised as is connectivity with other semi-natural habitats.
Sand dune	**Medium** High natural diversity of types however, has suffered declines.	**Medium** **3727 ha** Extent generally stable, although some climate related losses, and historic losses to forestry and development.	**Low** Issues: fixation, scrub invasion, air quality, grazing levels, pollution, invasive species, afforestation.	**Medium** Problems with loss of connectivity between sites, although generally a clustered resource.

Practical habitat unit	Diversity	Extent	Condition	Connectivity
Sea cliff	**Medium** High diversity but vulnerable to loss of cliff top vegetation.	**Low** **3161 ha** Losses of cliff top habitat and modification by coastal defences of vertical faces for soft cliffs.	**Low** Issues: intensive agriculture, abandonment, air quality, sea defences, INNS.	**Medium** The clifftops are being progressively squeezed and fragmented, particularly outside protected sites.
Shingle	**Medium** Moderate diversity – largely maintained but vulnerable to loss.	**Medium** **66 ha (vegetated)** **109 ha (total resource)** Extent generally stable although losses through sediment starvation from coastal defences.	**Low** Issues: climate change and sea level rise, anthropogenic damage, INNS, coastal defences.	**Low** Loss of connectivity as a result of coastal defences, however, this is a naturally clustered resource.

Practical habitat unit	Diversity	Extent	Condition	Connectivity
Coastal/Saline lagoon	**Medium** Moderate diversity – but includes species almost or entirely restricted to lagoonal habitats.	**Low** Fifteen saline lagoons, saline ponds, or potential saline lagoons have been identified in Wales covering ~ 84 ha ≡ 1.6% of the UK lagoon resource Extent generally stable although losses are occurring, from seaward barriers (shingle) retreating inland during storm events.	**Low** Issues: poor water quality, physical disturbance from recreation, litter and climate change, poor maintenance of structures, and management of sluices.	**Low** Connectivity is with the adjacent habitats (land and sea) rather than with other lagoons. Lagoons are a limited habitat resource and are in relative isolation from each other.

5. Healthy Places for people (Aim 3)

The Regulating and Cultural ecosystem services for well-being provided by coastal margin habitats are outlined in Table 11 and Table 12 below and use the set of services and definitions of the UK NEA Conceptual Framework (Mace et al., 2011). The Wales assessment is our current interpretation based on expert opinion.

Table 11 Regulating ecosystem services provided by coastal margins ecosystems in Wales.

Regulating Services	Level of Importance
Climate – carbon sequestration	Medium
Hazard – sea defence	High
Disease and Pests	Low
Pollination	Medium
Noise	Medium - High
Water Quality	Medium
Soil Quality	Medium - High
Air Quality	Medium - High
Waste breakdown and detoxification	High

This table is adapted from that in UKNEA synthesis (UK National Ecosystem Assessment, 2011).

Table 12 Cultural ecosystem services provided by coastal margins ecosystems in Wales.

Cultural services	Level of Importance
Local places	High
Landscape	High
Religious, spiritual, cultural heritage, media	High
Aesthetic, inspirational	High
Enfranchisement and Neighbourhood development	High
Recreation/tourism	High
Physical/mental health, security and freedom	High
Education/ecological knowledge	High

This table is adapted from that in UKNEA synthesis (UK National Ecosystem Assessment, 2011).

Coastal ecosystems play an important role in contributing to well-being targets: natural flood protection, contributing to a **Resilient Wales**, providing economic opportunities for a **Prosperous Wales** and by providing some of the most significant opportunities for personal well-being for a **Healthy Wales**. However, the full potential for realising well-being benefits of the coast have yet to be understood or fully developed.

A review was carried out by NRW to determine how and where the 19 Public Service Boards (PSBs) in Wales factor the marine and coastal environment into their individual well-being plans to address social, economic, environmental and cultural well-being (Ibrahim, 2020).

This review highlighted that the coastal environment was valued highest by the PSBs for physical and mental well-being and outdoor activity but was not considered a priority to generate jobs through tourism, recreation, and renewable energy generation. The review revealed the PSBs could address a range of opportunities to maximise benefits from the coastal environment around Wales (Ibrahim, 2020).

Challenges to supporting well-being at the coast include:

- Protecting and supporting communities who will be affected by flooding and coastal erosion.
- Maximising well-being opportunities whilst minimising trade-offs between conservation and well-being activities.

Table 13 Regulating coastal ecosystem services and benefits and the importance of its potential contribution to well-being goals

Benefit	Prosperous Wales	Resilient Wales	Healthier Wales	More equal Wales	Cohesive communities	Vibrant culture and thriving Welsh language	Globally responsible Wales
Climate/carbon regulation	Medium	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Medium
Hazard regulation: sea defences	High	High	High	Not assessed	High	Not assessed	Not assessed
Water quality	Not assessed	Low	Low	Not assessed	Not assessed	Not assessed	Not assessed
Pollination	Low	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
Noise	Not assessed	Low	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
Water Quality	Low	Medium	Medium	Not assessed	Not assessed	Not assessed	Low
Soil Quality	Medium	Medium	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
Air Quality	Not assessed	Medium	Medium	Not assessed	Not assessed	Not assessed	Low
Waste breakdown and detoxification	Medium	Medium	High	Not assessed	Medium	Not assessed	Low

Table 14 Environmental setting for cultural coastal ecosystem services and benefits and the importance of its potential contribution to well-being goals

Benefit	Prosperous Wales	Resilient Wales	Healthier Wales	More equal Wales	Cohesive communities	Vibrant culture and thriving Welsh language	Globally responsible Wales
Local places	High	High	High	High	High	High	Not assessed
Landscape	High	High	High	High	High	High	Not assessed
Religious, spiritual, cultural heritage, media	High	High	High	High	High	High	Not assessed
Aesthetic, inspirational	High	High	High	High	High	High	Not assessed
Enfranchisement and neighbourhood development	High	High	High	High	High	High	Not assessed

Benefit	Prosperous Wales	Resilient Wales	Healthier Wales	More equal Wales	Cohesive communities	Vibrant culture and thriving Welsh language	Globally responsible Wales
Recreation/ tourism	High	High	High	High	High	Medium	Not assessed
Physical/mental health, security and freedom	High	High	High	High	High	High	Not assessed
Education/ ecological knowledge	High	High	High	High	High	High	Not assessed

Regulating Services

Climate change regulation

Carbon sequestration and storage helps to regulate the increased CO_2 contributing to climate change. Coastal margin habitats hold significant stocks of carbon relative to their extent. Saltmarsh in particular is very efficient at carbon sequestration (Chmura et al., 2003); a recent study has shown that Welsh saltmarshes hold up to 50 tonnes of Carbon per hectare in the top 10 cm of soil (Ford et al., 2019) and sequestration rates have been estimated as 6,397 tonnes per year (Armstrong et al., 2020). The report Estimating the Carbon Sink Potential of the Welsh Marine Environment (Armstrong et al., 2020) demonstrated that saltmarsh sequestration should be recognised alongside woodlands for the carbon sequestration service provided.

The sequestration capacity of coastal habitats within the UK, specifically sand dunes, saltmarsh and machair, over the period 2000-2060 is valued to be in the region of £1 billion, a 3.5% discount rate. Discounting is a technique used to compare costs and benefits occurring over different periods of time on a consistent basis. The rate used by Beaumont et al., 2014, is the recommended social discount rate from the HM Treasury Green Book, 2011. The ability of the coastal margin habitats to continue to store and sequester carbon depends on their long-term protection and restoration. If current trends of habitat loss continue, the capacity of the coastal habitats both to sequester and store CO2 will be significantly reduced, with a reduction in value of around £0.25 billion, between 2000-2060 at a 3.5% discount rate (Beaumont et al., 2014).

Flooding and Coastal Erosion

Sea-level rise and more frequent storms will increase the likelihood of coastal flooding, erosion, and storm damage, with increased risk to people, properties, infrastructure, agricultural land, and habitats (ASC, 2016). Assets important for well-being and culture, such as heritage sites and the Wales Coastal Path, are also under threat. The Welsh coastline contains over 100,000 historic assets of all periods and types, 16% are at risk from sea level rise (Historic Environment Group, 2020). Defunct, coastal landfill sites could become a serious source of pollution with multiple impacts on well-being.

Saltmarsh, shingle ridges, and sand dune systems play a critical role in protecting the coast by directly dissipating or absorbing wave energy, or indirectly through regulating sediment movement. An 80m width of saltmarsh has been estimated to reduce the height of seawall defence required from 12m to 3m resulting in capital cost savings of £2,600 – £4,600 per metre of seawall (ASC, 2016). Protecting, maintaining, and restoring these natural features and habitats is fundamental to the people, communities, economy, and environment of Wales (Ibrahim, 2020).

Coastal defences help to make coastal communities a safer place to live. Almost a quarter of the Welsh coast is eroding (Eurosion, 2004) and over the next 100 years, 2,126 properties are expected to be at risk from coastal erosion. Currently coastal

flooding is a risk for 62,300 residential properties and 8,750 non-residential properties in Wales. An estimated £3 billion of damages were avoided during the winter of 2013/14 thanks to Wales's network of coastal defence infrastructure. However, over the medium to long term, the on-going maintenance needs of flood defences is a challenge and, in some cases, may be economically and physically unviable.

Shoreline Management Plans (SMPs) set the preferred policy for sustainable management of the coastline of Wales over the next 100 years and take sea-level rise into account. If SMP policies, which integrate the protection of habitats and people, are implemented this will significantly reduce risk from coastal erosion to 145 properties in Wales (NRW, 2014).

Under the SMPs, there are many locations around Wales which will continue to be defended in the future. However, sustainable shoreline management means difficult decisions need to be made about the long-term viability of certain coastal communities (Ibrahim, 2020). There are nearly 100 locations around Wales identified by SMPs where coastal adaptation needs to be implemented which will need detailed planning.

Many people and communities that may be at risk are not aware of the need to adapt or how it might affect them. Working directly and proactively with communities is essential to manage impacts, forge community cohesion and sense of shared ownership (Alexander et al., 2019). Efforts should be sustained, and promoted further, to support the education of children and young adults about flood and coastal erosion risks and climate change, and cultivate a sense of global responsibility (Alexander et al., 2019).

A pilot project 'Coastal Communities Adapting Together' focused on Pembrokeshire and Fingal, Ireland which aims to support coastal communities in understanding climate change and how to adapt to it has been launched. The project will explore how to help young people understand how climate change is affecting their local area and support communities in understanding how they can adapt to make their communities more resilient. The Wales Coastal Monitoring Centre (WCMC) has also been working to develop a series of lessons on climate change and coastal monitoring in line with the new school curriculum for 2022 (WCMC, 2020).

Nature-based solutions can simultaneously provide coastal defence but can also create habitats for wildlife and protect carbon stores. However, this approach to flood defence is not yet common practice in Wales. Valuing the multiple benefits, including well-being benefits, of nature-based solutions so that they can be incorporated into decision-making relating to the use of nature-based solutions rather than hard engineered defences could incentivise delivery of wider well-being goals (Ibrahim, 2020). Recent research shows how less tangible well-being benefits and the inclusion of public perception and value at a local level could be approached (Roberts et al., 2020).

Public Service Boards have the potential to play an important part in supporting the delivery of sustainable coastal management and facilitate joined-up working (Ibrahim, 2020). However, the review of well-being plans found there was no inclusion of adherence to the SMPs, coastal adaptation, or implementing nature-

based solutions into the PSB coastal and flood protection measures, even though the majority of the PSBs recognise that their areas will be at an increased risk of coastal flooding in the future which would impact the health and well-being of coastal communities (Ibrahim, 2020).

New evidence since SoNaRR2016 includes the Resilcoast project. Research focused on integrating ecosystem resilience into coastal planning for the persistence of natural flood protection and wetland ecosystem services.

The CoastWEB project, which is drawing to a close in 2020, has holistically valued the contribution which coastal habitats make to human health and well-being, focusing on the alleviation of coastal natural hazards and extreme events.

Cultural Services:

Many of the cultural services of coastal margins are more clearly understood with reference to the wider coastal landscape and this wider spatial context is therefore needed for managing such services. Man-made changes to the wider coastal landscape can affect the coastal margins. For example, the coast path introduces people to coastal margins; harbours and associated settlements involve significant physical changes to habitats and coastal processes. As coastal margin habitats run along most of the coast, they are an essential component for providing cultural services relating to health and well-being, economy, and culture of the coastal zone as a whole.

LANDMAP (NRW, 2020) indicates a pattern of 'High' and 'Outstanding' landscape evaluations in the coastal zone. Landscape value was recorded in 2020 with 35% being 'Outstanding', 56% being 'High', 8% being 'Moderate' and 0% being 'Low'. The importance that society attaches to conserving the character of the coastal zone to sustain such benefits is reflected in planning policies at national and local level, with over 75% of the coastline being designated or registered. This includes 2 National Parks, 3 Areas of Outstanding Natural Beauty, numerous Registered Historic Landscapes and Heritage Coast, and 4 parts of a World Heritage Site, plus many local designations.

Designated Landscape Management Plans define the special qualities being conserved, which in the coastal zone often refer to coastal and marine areas and their relative wildness, tranquillity, and scenic quality. Assessments of marine and seascape character identify such areas (LUC, 2015).

The coastal zone can provide a shared focus at all levels of society which encourages **community cohesion**. The human desire to be near coastal waters is an innate aspect of both human settlement choices and leisure behaviour (Kelly, 2018). In 2018, visits to "seaside/coast" were 24% of day trips in Wales (Welsh Government, 2019b). The highest individual regions were North and South-West Wales, each at 27%, more than double that of other parts of Great Britain, and Wales had an 11.1% increase in trip volumes compared to 2017-18 (Welsh Government, 2018).

In response to an increasing understanding of the benefits of linking communities and nature are a number of projects to encourage these links have been established, for example:

- Discover the Severn
- Dee Coastliners project

These projects are particularly important where communities are cut off from the coast by infrastructure such as roads and railway lines.

Coastal landscapes provide the greatest financial value in terms of tourism and leisure (Jones et al., 2011). In 2013 Coastal tourism in Wales was worth £602 million (Welsh Government, 2015). Large sections of the Wales Coast Path which provides health and economic benefits run along the coastal margin habitats. However, coastal communities are some of the most deprived in terms of economy, health, and education in the UK. (Corfe, 2017).

The Welsh Governments' Coastal Communities Fund encourages the economic development of coastal communities by giving funding to create sustainable economic growth and jobs.

Since the start of the Coastal Communities Fund in 2012, grants have been awarded to 74 projects in Wales to the value of £16.1 million, creating over 350 direct jobs, 580 indirect jobs, and safeguarding over 700 existing jobs.

The Severn Estuary Partnership (SEP) was set up in 1995 as an independent initiative, hosted by Cardiff University, to work with local stakeholders in promoting a sustainable approach to the planning, management, and development of the estuary for all who live and work here, and for future generations

The majority of Wales's largest settlements are within 10km of the coast. Close contact with nature brings benefits to human health and well-being, but the mechanisms and associations are still not well understood (Nieuwenhuijsen et al., 2014). Results of research have implied that people are less likely to suffer from anxiety or depression if they live within 1km of the coast, compared to those living further inland (Garrett et al., 2019). The benefits of 'nature prescribing' for health at the coast in Wales could potentially be high. A successful pilot was carried out in Shetland assessing the success of 'nature prescribing' (Nutt, 2018). The Dynamic Dunescapes project is working with people living with dementia, enabling visits to the dunes as sensory environments.

Educational activities on the coast are common for members of the public, schools, and universities. However, there remains more potential 'for coastal place-based learning and fun based sea programmes for both well-being and positive environmental behaviour' (Kelly, 2018).

The review of well-being plans (Ibrahim, 2020) found that at least 50% of the PSBs recognise the importance of community engagement with nature and 40% of the PSBs value marine renewable energy to generate new jobs. However, only 25% of the PSBs recognise the contribution that the coastal and marine environments can make to generating jobs through recreation and tourism. Only two of the 19 PSBs

recognise the value of the Wales Coastal Path to their economy and social well-being.

6. Regenerative Economy (Aim 4)

The Provisioning ecosystem services for well-being provided by coastal margin habitats are outlined below and use the set of services and definitions of the UK NEA Conceptual Framework (Mace et al., 2011). The Wales assessment is our current interpretation based on expert opinion.

Table 15. Ecosystem services provided by coastal margins ecosystem in Wales.

Provisioning Services	**Level of Importance**
Crops	Low
Livestock and Aquaculture	Medium
Fish	Medium
Trees, Standing Vegetation, Peat	Medium, standing vegetation
Water Supply	Low
Wild Species Diversity	High

This table is adapted from that in UKNEA synthesis (UK National Ecosystem Assessment, 2011).

The main provisioning services of relevance to the circular economy for the coastal margins are agriculture, livestock production, and fish. There are also examples of the contribution of the beneficial use of dredged materials to the circular economy. Renewable energy, specifically tidal lagoons, have the potential also to contribute to the regenerative economy however, these could also impact coastal habitats (see the Synergies and Trade-offs of this chapter and section 6 of the Marine chapter).

Livestock grazing is carried out, primarily on saltmarsh, cliff top habitat and sand dune. Saltmarsh can provide productive, valuable grazing including the production of ‘saltmarsh lamb’, a premium product for Wales. However, there can also be trade-offs for biodiversity where focus is primarily on production; agricultural improvement and intensive grazing is occurring at some locations, impacting the coastal margins.

Sustainable and restorative agricultural management, where the level of livestock production does not deplete the natural resources on which it relies on, would benefit both biodiversity and long-term production. Practically, this means grazing habitats at appropriate levels and taking account of local biodiversity requirements.

Saltmarshes in the UK play an important nursery role for some species of fish, including several commercially important species (Laffaille, 2000; Green et al., 2009), for example, sea bass: in 2018, landings into the UK by UK vessels were valued at £4.3 million (MMO, 2019). The existing extent of UK saltmarsh is probably insufficient to fulfil demand for certain fish types, if however, either the extent or condition of this habitat declines further, and fish stocks are not managed sustainably, the future integrity of this natural capital stock may be compromised (UK National Ecosystem Assessment, 2014). The role that Welsh saltmarshes play in contributing to this ecosystem service within this UK context is not known.

Natural flood defences are provided by coastal habitats, for example sand dunes and shingle banks provide barriers to flooding. Saltmarsh fronting sea defences reduces the erosive forces of the sea by absorbing some of the wave energy (Möller et al., 2014). Natural flood defence helps reduce the need for hard engineered sea defences and flood defence maintenance.

The use of nature-based solutions, such as green infrastructure, to manage coastal erosion and flood risk can have multiple benefits in terms of cost effectiveness. See the marine area statement for more information. An example of a nature-based solution is the use of dredged materials for coastal recharge schemes. In 2003 sand obtained from dredging in the Dee Estuary was placed at the toe of the nearby Talacre dunes to help prevent erosion and dissipate wave energy. A report reviewing this recharge scheme, Coastal Engineering UK Ltd, 2011, concluded that it had proved a cost effective and sustainable way of providing a multi-functional solution, providing benefits for, flood protection, dune habitat and amenity value.

There is further potential for the beneficial use of dredged materials, however, not all locations will be appropriate, and success will depend on local conditions and availability of appropriate sediments.

Hybrid approaches to flood protection where hard engineered sea walls and other flood protection are enhanced for biodiversity can have multiple benefits. The ‘Greening the Grey’ research project found that even though costs for these hybrid approaches tend to be higher, there can be additional returns compared to traditional hard engineering which include; enhanced ecosystem services, helping to meet statutory mitigation requirements and social benefits (Naylor et al., 2017).

7. Synergies and Trade-offs

There are clear synergies between several important ecosystem services provided by the coastal margin habitats and numerous trade-offs. Primary trade-offs for coastal ecosystems include:

- Factors leading to stabilisation in naturally dynamic coastal habitats
- Intensive agriculture
- Tourism and recreation
- Renewable energy production

There can also be trade-offs between different user groups.

Table 16. High level synergies and trade-offs for coastal margin habitats.

Activity	Synergy	Trade-off
Sea defence (hard engineered)	Protect homes, businesses, transport links and industry. Protection of terrestrial and freshwater habitats.	Disrupts sediment transport. Reduces resilience. Fragments habitats. Landscape and tourism.
Construction of infrastructure	Piers, slipways, breakwaters, quays, and harbours provide services to the public, private and industrial sectors. Provide a degree of flood protection.	Constraints on the natural evolution of the coastline. Disrupts sediment transport. Reduces resilience. Fragments habitats.
Agriculture	Appropriate agricultural management is essential for maintenance of good condition of some coastal margin habitats. Food production. Economic benefits. Cultural benefits.	Optimal management for biodiversity may decrease economic returns and may not be economically viable without subsidies. Enrichment from fertilizers and dunging. Nitrogen and ammonia deposition.

Activity	Synergy	Trade-off
Conservation	Designated site status provides overall protection for habitats and species. Restoration and support for species and habitats. Supports pollinators.	Conflicts arise between habitats which are managed specifically for one species or group of species which may not be compatible for other species dependent on that habitat.
Forestry (sand dunes)	Timber production. Carbon storage. Amenity value.	Impacts extent, condition, connectivity, and biodiversity. Stabilises naturally dynamic dune systems. Can affect level of water table.
Sports Leisure and tourism	Wide application for cultural, amenity, and sport and recreation use. Economic benefits particularly from tourism. Health benefits.	Impacts extent and condition. Disturbance to wildlife. Local communities can be overwhelmed by tourism. Loss of ‘wilderness’.
Sustainable business	Economic benefits. Understanding overlapping interests. Potential to promote environmental sustainability principles.	Environmental interventions that are aimed at benefitting one group, can potentially interfere or harm another group’s interests (such as fishing communities and coastal tourism facilities).
Energy production	Opportunities for low-carbon marine renewable energy development.	Impacts habitats both directly and by affecting coastal processes.

Conservation management of coastal habitats and species, provides numerous other benefits such as, protecting natural flood defences, enhancing coastal environmental settings, which support cultural services and provide a draw for tourism. High species diversity has numerous benefits, for example, within saltmarsh soil erosion rates are lower with increased plant species richness (Ford et al., 2016).

Trade-offs occur between coastal margin habitats and built infrastructure, including housing, business and transport, agricultural land and footpaths where they are protected by hard defences or groynes to prevent coastal flooding or erosion. These defences, impact coastal processes essential to maintain the resilience of coastal margin habitats which themselves often act as natural flood defences to other parts of the coast (Jones et al., 2011; Dawson et al., 2009).

Much of the saltmarsh, sand dunes and cliff coastal grasslands and heath are managed for agriculture, primarily livestock production. Whilst many of the coastal vegetation communities are dependent on grazing for good condition, there can also be trade-offs where the focus is primarily on production for habitat condition, biodiversity, air, water and soil quality, and flood defence protection.

Flood protection trade-offs occur with agriculture where saltmarsh fronts sea defences, protecting those defences by wave attenuation. Taller vegetation is more effective at wave attenuation (Möller et al., 2014) than shorter swards produced by grazing. Modelling within the Tâf Estuary showed that allowing extensive grazing would generate widespread changes in estuarine hydrodynamics; resulting in increases in wave heights and current velocities across the marsh (Bennett et al., 2020). Erosion can also be influenced by livestock management on saltmarsh. Soil compaction by sheep grazing can lead to higher sediment retention on marshes, however, this is a trade-off for soil quality (Pagès et al., 2018).

Economic and well-being opportunities for sports, tourism, and recreation supported by the coastal margin habitats can cause trade-offs at some coastal locations between coastal margin habitats and species. There can also be trade-offs between different leisure users, for example, wildfowling on saltmarsh may trade off against recreational birdwatching (Davidson and Griffin, 2018).

Trade-offs include physical damage from trampling of coastal habitats at popular sites and disturbance to wildlife by people and dogs. Ground nesting birds, such as terns and common ringed plovers, *Charadrius hiaticula,* are particularly prone to disturbance pressure in shingle locations and several areas in Wales have seasonal access restrictions to reduce disturbance.

Recreation has resulted in trade-offs with agriculture where there has been conflict between livestock and people with dogs. The establishment of the Wales Coastal Path has led to many sections of cliff tops being fenced off to separate grazing livestock from walkers. Leading to agricultural abandonment of the cliff edges.

Timber production on sand dunes is creating trade-offs for the extent, condition, connectivity, and functioning of sand dunes (Hunt et al., 2019; Stratford et al., 2013; Provoost et al., 2011; Blackstock et al., 2010; Jones et al., 2003). Conifer plantation reduces dune resilience to adapt to sea level rise. Several sand dunes in Wales have Geological Conservation Review status for their Coastal Geomorphology, which is compromised or destroyed where forestry plantations occur. Sand dune soils are relatively poor, and timber generated from sand dunes is generally of low quality and is mostly used for wood pulp (Jones et al., 2011). Forestry on dunes does provide carbon sequestration and has amenity value. On Newborough warren, the forestry plantation provides a habitat for the re-introduced red squirrel.

Welsh waters are recognised for their potential contribution to renewable energy through tidal range, tidal stream, and wave energy devices (ABPmer, 2008). These developments will support efforts to reduce carbon emissions but could also impact coastal habitats through changes to hydrodynamic and sediment transport processes. In recent years, several tidal lagoon energy projects have been proposed which would impact coastal habitats, sometimes over very significant areas.

Offshore developments also have the potential to alter or diminish the available tidal current and wave energy. For example, it has been demonstrated that tidal stream turbines can lead to a significant effect on flows and sediment dynamics (Neill et al., 2009; Ramos et al., 2014). The Welsh National Marine Plan promotes the responsible deployment of low carbon technologies, so that the Welsh marine area is making a strong contribution to energy security and climate change emissions targets. This is likely to have future implications for coastal margin habitats.

8. Opportunities for action to achieve the sustainable management of natural resources

Opportunities for action to increase the resilience of the coastal margin habitats and the ecosystems services they provide are outlined below. Working with strategic partners and stakeholders is key to achieving long term sustainable management.

Areas of focus for Air Quality, Water Quality and Land Management are also covered in the following chapters: Air Quality, Freshwater, Marine and Land Use and Soils.

Land management opportunities for action

Opportunities for action to safeguard, enhance, and reverse declines in resilience due to habitat loss and land management pressures could include:

- Supporting and resourcing coastal restoration projects which focus on:
  - Landscape scale habitat restoration projects, such as dune and estuary restoration. Other benefits include increasing carbon capture.
  - Restoration of ecological networks. Including broadening the coastal zones on cliff tops one field back from the cliff edge, to restore coastal grasslands and heath and enable adaptation by providing space for rollback of habitats responding to erosion.
  - Restoration of natural transitions with terrestrial and freshwater habitats.
  - Supporting targeted species recovery projects via collaborative projects such as Natur am Byth (Back from the Brink Cymru).
- Delivery of sustainable agriculture could implement beneficial management to a significant proportion of coastal margin habitats by reducing agricultural pollution and delivering nature-based solutions. Support and incentives for farmers and land mangers could include:

  - Maintenance of existing good quality habitat and restoration of degraded habitat.
  - Ensuring appropriate grazing to support biodiversity and agricultural production.
  - Establishment of sympathetically managed buffer zones around coastal habitats, where appropriate to one field back from the coast.
  - Implement coastal adaptation measures, such as managed realignment.
- Working with, and continuing to work with, farmers and land managers could help overcome barriers which prevent landowners from grazing coastal margin habitats where they have been abandoned:
  - Assisting landowners to achieve appropriate stocking levels and to introduce heavy stock grazing where necessary.
  - Resolving issues around livestock disturbance by dogs and people and livestock access to high tide refuges on saltmarsh.
- Ensuring adequate protection and coverage of coastal habitats within the protected sites series.
- Implement strategic landscape scale land management planning, based on outcomes for ecosystems services, in order to deliver multiple benefits across regions Resilcoast, 2018.
  - Management to support priority ecosystem services could be tailored at a local level for example adjusting saltmarsh grazing intensity to protect flood defences.
- Ensuring strategic and local development planning decisions:
  - Are evidence based.
  - Consider and properly value ecosystem services.
  - Are ecologically and physically resilient and are socially and economically adaptable to change driven by a dynamic coastline.
  - Are in line with the revised planning Technical Advice Note 15.
  - Recognise the long-term impacts of developments such as caravan and holiday parks, which have associated pressures from public access and impact the immediate hinterland where rollback could occur.

Climate change opportunities for action

Mitigation for the effects of climate change could be achieved through coastal adaptation and the implementation of nature-based ‘green infrastructure’ solutions, in line with Shoreline Management Plans (SMPs). This would also support resilience, carbon sequestration, and well-being through the alleviation of flood risk to people and property.

A key opportunity is to raise public awareness and participation, particularly in those communities that are likely to be most affected by climate change. The effects of climate change are beginning to impact coastal habitats and communities, therefore timely action is required to support the planning and prioritisation of key work and overcome barriers to the implementation of coastal adaptation and nature-based solutions.

- Improving understanding of barriers to implementation:
  - Scoping and delivering communications at the national, local authority and community level, to help improve understanding of coastal change, and the need to adapt.
  - Scoping and delivering wider communications about coastal adaptation beyond coastal practitioners. These can be extensions of existing channels, for example Public Service Boards, or new routes entirely.
  - Making coastal adaptation and nature-based solutions data available and easily accessible.

- Addressing the complex legal requirements relating to coastal adaptation.
- Identify mechanisms to ensure that inappropriate development does not occur in areas of coastal flood and erosion risk, and that enable at risk communities to relocate to support the aspirations for coastal adaptation.
- Support the development of coastal adaptation strategies along many parts of the Welsh coastline to inform decision making and local strategic planning, alongside SMPs and planning policy.
- Supporting major coastal adaptation schemes to ensure offset habitat is created to compensate for habitat predicted to be lost through coastal squeeze, by assets maintained by risk management authorities, and ensure that compensation habitat is created to offset coastal squeeze caused by assets not maintained by risk management authorities and therefore not covered by the statutory obligations of NHCP.
- Supporting and encouraging hybrid approaches to flood protection where hard engineered sea walls and other flood protection are enhanced for biodiversity.
- Ensuring that protected site boundaries reflect the changing nature of the coastline into the future, allowing for rollback of habitats and coastal realignment.
- Protection and restoration of saltmarsh to increase carbon storage, as part of Wales's efforts to combat the climate emergency.

Coastal physical processes opportunities for action.

Potential opportunities for action related to allowing physical processes to operate unconstrained could occur, outside of areas where coastal defences are essential. Opportunities relating to coastal adaptation and nature-based solutions will also have benefits for coastal physical processes.

- Managing sediment supply is not commonplace but may be critical to mitigate coastal impact from climate change (Ladd et al., 2019). Coastal management aimed at reconnecting sand dunes and shingle structures to their source sediment areas would be likely to have considerable local benefits in vulnerable locations (Jones et al., 2011), as for example, when sediment has been supplied in the past by areas of erosion elsewhere in the same littoral cell.
- Supporting shoreline restoration projects.

Air and water quality opportunities for action

Developing measures to address pollution is challenging, as the sources reflect agricultural practice, lifestyle choices, and the wider economy. Tackling the numerous sources of pollution for example agriculture, transport, and industry requires an integrated approach, as the sources generally originate away from the coastal margin habitats. See also opportunities for action for the Air Quality, Freshwater, Land Use and Soils and Marine chapters.

- Improve source to sea catchment management of nutrients, chemicals, and pathogens.
  - Support 'Opportunity Catchment' measures identified as part of the River Basin Management Plans to manage pressures, put in place improvements and align objectives with SMNR to addressing water quality in the coastal environment.
- Consider making the awarding of farming subsidies dependant on good agricultural practice which will benefit air and water quality.
- Support delivery of strategic programmes, for example, the Clean Air Plan and Sustainable Farming Scheme to reduce and reverse critical level exceedance of ammonia.
- Support opportunities identified in area statements and the Welsh Marine Plan relating to pollution and litter.

Well-being opportunities for action

To maximise well-being on the coast there may be trade-offs in terms of impacts to coastal habitats, therefore it is essential that changes to access in terms of increases in coastal visits, or type of access, is carefully managed. Potential opportunities include:

- Promote and where required evidence the value of the coastal environment to PSBs, to encourage further inclusion of the services provided by the coast into the objectives of individual well-being plans to address social, economic, environmental, and cultural well-being.
- Support 'Placemaking' projects which could benefit coastal communities including some of Wales's most deprived seaside towns. Placemaking is where planning focuses on community assets to promote community cohesion, health, and well-being. The projects could have multiple benefits for both environment and well-being such as building environmental appreciation and awareness, as well as renewing cultural associations with the coast, particularly where communities have been cut off from the coast by large roads and railway lines.
- Investigate and highlight the potential benefits of nature-prescribing at the coast, including preventative health care.
- Support communities living with coastal risk and uncertain futures in their personal resilience and emotional well-being (Alexander et al., 2019).
- Work with partners, businesses, and the education sector to embed environmentally sensitive behaviours within communities.
- Promotion of access to quieter or less sensitive sections of the coast to mitigate trade-offs associated with the impacts of high visitor numbers. Encouragement of the use of public transport for both people from local communities and tourists

visiting the coast by supporting new and existing bus routes which provide a link to the coast.

9. Evidence needs summary

Evidence requirements at the coast are broad because of the diverse and transitional nature of this ecosystem between the marine and terrestrial environment.

There are some fundamental gaps in evidence required to ensure high levels of confidence in the assessment of SMNR within the coastal margins. Basic extent, condition, connectivity and biodiversity data is out of date and incomplete in some areas, providing difficulties with evaluating stocks of natural resources or detecting trends. Fit for purpose evidence relating to stocks of natural resources is essential as it informs many other elements of the SMNR assessment, enables prioritisation and informs focus areas for other evidence needs. To enable key issues to be tackled effectively, further understanding of where pressures are leading to impacts is required and what the drivers behind these pressures are.

More complex is the need to predict future trends to enable preparation and planned response to changing pressures at the coast, for example the impacts of sea level rise. These are areas where there would be a need for strategic research and targeted long-term monitoring. Identification of opportunities for restoration of coastal habitats and nature based solutions are also key evidence needs to respond to the climate and nature emergencies.

The contribution coastal margins make to well-being and the regenerative economy through the regulating, provisioning and cultural ecosystems services such as natural coastal defence, leisure and tourism and fisheries within a Welsh context has not yet been fully evaluated. Better understanding of the range, extent and spatial distribution socio-economic activities at the coast would inform actions to maximise well-being benefits. Tactical research to consider the socio-economic activities and their trade-offs would enable informed policy decisions to be taken to support resilience at the coast

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