The Second State of Natural Resources Report (SoNaRR2020)

Assessment of the achievement of sustainable management of natural resources: Marine

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.

Evidence at Natural Resources Wales

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

We will realise this vision by:

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

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

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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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Figures and Tables

1. Headline Messages

Issue 1: Marine Protected Area (MPA) feature condition and management. At 69% of inshore seas, the MPA network represents our best understanding of the resilience and diversity of the marine ecosystem. 46% of MPA network features are in favourable condition, but we have evidence that others are not and more needs to be done to secure effective and consistent MPA management.

Issue 2: Climate change. The changing climate is having physical, ecological, social, and economic impacts on UK coasts and seas. There is clear evidence that warming seas, reduced oxygen, ocean acidification, and sea-level rise are already affecting marine ecosystems, and further impacts are predicted.

Issue 3: Pollution and water quality including marine litter. Water quality issues (nutrient levels and chemicals) are impacting the marine ecosystem in a number of ways. Impacts are demonstrated through Water Framework Directive water body statuses, Article 17 reporting and indicative marine site condition reporting.

Issue 4: Evidence base to support planning, management, and decision making. There are various evidence gaps across social, economic (including development) and environmental uses of the marine environment that restrict our ability to ensure sustainable management of marine natural resources.

Response (Issue 1): Understanding and improving feature condition and management. We need to improve our ability to assess MPA feature condition and deliver improved site management in order to restore and improve the condition of marine ecosystems in Wales over the long term.

Response (Issue 1, 2, 3): Building resilience. Building the resilience of the marine ecosystem through the restoration of habitats, maximising carbon sequestration potential, completing the contribution to an ecologically coherent network of MPAs, developing low-carbon energy potential.

Response (Issue 1, 3): Improved catchment management. Improved management of activities and pressures that impact water quality in marine and coastal ecosystems, through River Basin Management Plans measures; agricultural land management; Opportunity Catchments; MPA Network Management Framework and Action Plan; collaboration across Area Statements.

Response (Issue 1, 2, 3, 4): Improving evidence capability and collection. Improving our understanding of the activities and impacts in the marine environment, through the Welsh Marine Evidence Strategy; NRW Marine Evidence Priorities; and the Welsh National Marine Plan, including the Sustainable Management of Marine Natural Resources project.

2. Introduction

The Welsh inshore marine area extends from the mean high-water mark to 12 nautical miles, covering just under 15,000 km^2 or 41% of the territory of Wales. The area of Wales relevant to the SoNaRR assessment is defined by the Government of Wales Act, which includes the sea adjacent to Wales out as far as the seaward boundary of the territorial sea. This assessment of the marine ecosystem encompasses marine water quality, intertidal and subtidal habitats and the species found within them.

Wales has a rich and diverse marine ecosystem, with 69% of inshore waters designated as part of the network of 139 Marine Protected Areas (MPAs). These MPAs and wider seas contain a variety of habitats, benthic invertebrates, fish, extensive algal communities, and important populations of marine mammals and birds. Welsh waters are particularly important for habitats and species at the edge of their geographic range, such as horse mussel beds.

These marine natural resources deliver a range of benefits and opportunities, supporting economic activities including aggregate extraction; ports and shipping; aquaculture and fishing; and marine renewable energy. The marine environment in Wales provides critical services to human health and well-being, including carbon sequestration by marine habitats, natural flood defence and mitigation, and the potential for habitat restoration and associated benefits. The intrinsic value of the marine environment links directly to social opportunities and well-being benefits from recreation, tourism, and other activities.

Marine ecosystems are under pressure from a range of influences such as climate change, some human activities, non-native species and inputs from freshwater catchments. Pressures are impacting variably on the status, extent, condition, and diversity of components of the marine environment. There are, however, multiple opportunities to improve the resilience of marine ecosystems, and for society to continue to benefit widely from Welsh seas.

At sea there are fewer opportunities to directly intervene to manage the environment. Instead, Wales can reduce or better manage the different pressures to allow ecosystems to function and recover naturally. There is a range of legislation, policy and regulation already in place to manage the marine area that can support the Sustainable Management of Natural Resources (SMNR).

3. State and Trends (Aim 1)

Achieving SMNR in the marine environment is reliant on:

- Welsh seas being healthy and resilient, supporting a sustainable and thriving economy.
- The achievement of Good Ecological Status of estuarine and coastal water bodies.
- Welsh waters contributing to the achievement of Good Environmental Status under the UK Marine Strategy.

Key tools to help achieve this are:

- An effective marine planning process that ensures natural resources are sustainably managed.
- An MPA network that is ecologically coherent and under effective and consistent management, guided by the MPA Network Management Framework and Action Plan.
- Effective delivery of River Basin Management Plans.
- A robust and transparent evidence base to support effective decision making, guided by the Welsh Marine Evidence Strategy.

Summary assessment of state and trends

Table 1 to 8 give a brief description of the past trends and future prospects for Marine. These are assessed to be:

- improving trends or developments dominate
- trends or developments show a mixed picture
- deteriorating trends or developments dominate

Further information is provided to put this in context.

Table 1 Key messages - past trends and future prospects for MPA feature condition.

Time period	Indicative assessment	Description
Past trends (2006 to 2018)	Mixed picture	Indicative marine site-level feature condition assessments published in 2018 show that 46% of features were in favourable condition, 45% in unfavourable condition and 9% were unknown. The confidence levels are a vital component of the assessments. Previous assessments were carried out between 2005 and 2007 under a very different process, and the network of MPAs has increased considerably since then. As such, it is difficult to provide an overall trend for feature condition.
Future prospects (outlook to 2030)	Improving	Improvements in management of MPAs are expected as part of the Welsh Government's MPA Network Management Framework and Action Plans, which set out the priority network-level actions to improve the management of the network of MPAs in Wales. A key action for NRW is to lead a project that will develop indicators and an improved feature condition reporting method to enable timely assessments of MPAs. This should lead to a better understanding of condition of MPAs in Wales which will inform management and focus priorities.

Note on robustness: The term 'indicative condition assessment' describes the use of readily available evidence and expert judgement in an intensive, collective workshop process to provide an indication of feature condition at the site level. The confidence rating associated with the assessments is an integral part of the indicative assessment. 57% of indicative assessments were made with high confidence; 21% with medium confidence; 13% with low confidence; and 9% were unknown.

Table 2 Key messages – past trends and future prospects for marine fish and shellfish.

Time period	Indicative assessment	Description
Past trends (1950 to present)	Mixed picture	Many stocks of commercially targeted fish and shellfish species are assessed and managed over large geographic scales (such as International Council for the Exploration of the Sea (ICES) sub-region) and it is not always feasible or appropriate to attempt to assess extent/condition/trends at a Welsh level. Additionally, whilst the distributions of many such stocks are known to overlap with the Welsh inshore, they are not typically landed by the Welsh fleet in significant numbers due to a lack of quota. Many notable species in a Welsh fisheries context are non-quota – whelk, scallop, lobster, crab, spider crab and prawn and are managed through a combination of European, UK and Welsh legislation. Where Welsh level assessments could be considered appropriate, data deficiencies often present challenges. These data limitations also restrict attempts to assess the extent to which the sustainable management of natural resources, such as fish and shellfish, is being achieved.

Time period	Indicative assessment	Description
Future prospects (outlook to 2030)	Mixed picture	Welsh Government are currently responsible for executive and regulatory functions for inshore fisheries (0 to 12nm) and regulatory functions for offshore fisheries (12nm to median line). Following the UK's departure from the EU, Welsh Government will retain these powers and gain some executive functions for offshore fisheries through the UK Fisheries Act, including powers to license third country vessels. Much of the existing EU derived policy framework is saved by the European Union (Withdrawal) Act 2018. Several initiatives, either in place or planned, will contribute valuable information on the sustainability of marine fisheries activities and their locations in Welsh waters, including: Assessment and management outputs of the Assessing Welsh Fishing Activities project and the potential Assessing Welsh Aquaculture Activities project WG/NRW Marine Evidence Strategy; Ongoing domestic fisheries management reform such as proposed Whelk Management Measures 2020; Stock assessment methods have been developed for razor clam and whelk, and further stock assessments to be commissioned and developed for other commercial fish and shellfish stocks; Welsh Fishermen's Association project to undertake pre-assessments in accordance with the core principles of the Marine Stewardship Council process and develop Fisheries Improvement Plans; Mandatory catch recording for all Welsh licensed fishing boats under 10 metres in length; and Inshore vessel monitoring system (iVMS) for licensed fishing boats under 12 metres in length In addition, a new management regime post-EU Exit could have economic benefits through changes to beneficial ownership and the proportion of fisheries resources landed by Welsh vessels.

Note on robustness: In the absence of stock assessments and a historical baseline, there is uncertainty in assessing the state and trends for fish and shellfish.

Table 3 Key messages – past trends and future prospects for seabirds.

Time period	Indicative assessment	Description
Past trends (2000 to 2019)	Mixed picture	There is a mixed picture for seabirds. Auks, gannet, Manx shearwater, and terns have all shown healthy population increases over the period. However, most gulls, cormorant, shag, and black guillemot have declined (JNCC, 2019a). The publication of full UK Seabirds Count data will demonstrate where Welsh populations have increased at the expense of colonies elsewhere in the UK.
Future prospects (outlook to 2030)	Mixed picture	Future prospects for seabirds are unclear. The underlying reasons for declines in Wales vary species by species and as such, the future prospects also vary. Populations are susceptible to various pressures, including climate change, prey/food availability, habitat loss and predation. Whilst some populations have shown increases in recent years, they remain susceptible to future changes as they are concentrated in a small number of colonies, or single colonies in some cases.

Note on robustness: High confidence in analysis of Welsh data derived from the UK Seabird Monitoring Programme “Seabirds Count” census 2015 – 2020.

Table 4 Key messages – past trends and future prospects for waterbirds.

Time period	Waterbird group	Indicative assessment	Description
Past trends (1994 to 2019)	Wintering waders	Mixed picture	There is a mixed picture for waders, with declines observed for grey plover, bar-tailed godwit, curlew, oystercatcher, and dunlin, in line with UK-wide population reductions. Increases in the Welsh populations of knot and redshank were observed despite a UK-wide decline, while a large increase in the black-tailed godwit population was in line with the UK trend (Frost et al, 2020).
Past trends (1994 to 2019)	Wintering wildfowl	Improving	Wintering wildfowl species such as wigeon, pintail, teal and great-crested grebe increased on the whole, with the only population reduction in Wales observed for shelduck (Frost et al, 2020).
Future prospects (outlook to 2030)	Wintering waders and wildfowl	Mixed picture	Wader and wildfowling populations will vary with change in climate. We have already seen a shift of wintering populations firstly to the east of the UK and then to continental Europe as winter temperatures have increased opening up once inhospitable wintering areas, closer to their breeding grounds. We have also seen a natural movement of little egret and cattle egret into the UK both for wintering and breeding populations.

Note on robustness: High confidence in analysis of Welsh data derived from the British Trust of Ornithology's Wetland Bird Survey.

Table 5 Key messages – past trends and future prospects for certain marine mammals.

Time period	Type of marine mammal	Indicative assessment	Description
Past trends (2000 to 2017)	Grey seal	Improving	The grey seal population in Welsh waters has shown an upward trend in pup production over the long-term, with an increase in population abundance ((Bull et al 2017a,b; Clarke et al, 2020 in prep; Morgan et al 2018; Mitchell et al, 2018a; Mitchell et al, 2018b; SCOS 2018).
Past trends (2000 to 2017)	Harbour porpoise	Mixed picture	The picture for harbour porpoise is less clear because of the lack of population assessments specifically for the Welsh inshore. For the wider Celtic and Irish Seas Management Unit of which Welsh waters are a part, there is evidence of a significant decline (SCANS II, 2008; Hammond et al, 2017, Rogan et al, 2017).
Past trends (2000 to 2017)	Bottlenose dolphin	Improving	The bottlenose dolphin population in Welsh waters is stable over the longer term (2001 - 2016), although there is some evidence of population shifts within the last decade in the Cardigan Bay Special Area of Conservation (Lohrengel et al 2018).
Future prospects (Outlook to 2030)	Grey seal	Improving	The grey seal population is expected to continue to increase or stabilise.
Future prospects (Outlook to 2030)	Harbour porpoise	Mixed picture	At present, there is no monitoring programme in place for the new harbour porpoise SACs, so condition assessments and trend analysis are not possible.
Future prospects (Outlook to 2030)	Bottlenose dolphin	Mixed picture	There has been no NRW funded monitoring for the last three years, but plans are in place to do so from 2020 onwards. Continued monitoring is vital to determine whether the observed trend in the last decade continues.

Note on robustness: Moderate – based on survey data, evidence reports for example.

Table 6 Key messages – past trends and future prospects for intertidal and subtidal habitats.

Time period	Indicative assessment	Description
Past trends (i. 2006 to 2018; ii. 2013 to 2019; iii. 2015 to 2018)	Mixed picture	There is a mixed picture for intertidal and subtidal habitats based on i. indicative feature condition assessments; ii. Article 17 reporting; and iii. WFD status. Whilst some habitats have been stable over reporting periods, significant proportions of Annex I features remain in unfavourable condition, and the indicative feature condition assessments suggest that there are common issues impacting upon intertidal and subtidal habitats across the MPA network. The WFD assessments of intertidal and subtidal elements shows that the majority of water bodies are meeting the required good status for saltmarsh, seagrass, opportunistic macroalgae, benthic invertebrates, estuarine fish and phytoplankton.
Future prospects (outlook to 2030)	Mixed picture	There are programmes, measures and policies already in place with the aim of improving the management of the MPA network and the condition of its features. These include: • MPA Network Management Framework and Action Plan • MPA Network Condition Improvement project • Welsh National Marine Plan • Improving Marine Site Level Feature Condition Assessment Reporting in Wales project However, more will need to be done to address the underlying causes of poor feature condition. Investigations into failures of WFD elements relevant for intertidal habitats such as saltmarshes and seagrasses will be carried out in 2020 and measures to improve will be identified for the next River Basin Management Plans if technically feasible.

Note on robustness: The assessments included here are largely based on readily available evidence and expert judgement from the indicative assessment process, coupled with assessments of WFD water bodies that do not always completely overlap spatially with MPA habitat features.

Table 7 Key messages – past trends and future prospects for marine and coastal water quality.

Time period	Water quality component	Indicative assessment	Description
Past trends (1980 to present)	Bacterial load	Improving	After a long period of improvement, 100% of bathing waters meet the minimum standard and 80% were assessed as excellent (NRW, 2020a). Some issues remain with the standard of shellfish waters protected areas, but improvements have been made.
Past trends (1990 to present)	Nutrients	Deteriorating	Of the 55 estuarine and coastal water bodies around Wales, 24 fail the standard for dissolved inorganic nitrogen, however these failures rarely lead to excessive growth of algae or impacts on the ecosystem (Water Watch Wales, 2018). Since 1990, phosphorus loads have decreased but there is no significant trend in discharges of nitrogen from catchments to the sea.
Past trends (1980 to present)	Contaminants	Mixed picture	Some chemicals, now banned from production, continue to cause failures of standards, and have the potential to bioaccumulate through food chains. There are other chemicals such as tributyltin whereby control measures have been effective and impacts on the ecosystem reduced. Emerging contaminants such as pharmaceuticals remain a concern.

Time period	Water quality component	Indicative assessment	Description
Future prospects (Outlook to 2030)	Bacterial load	Improving	Bacterial load from wastewater treatment is likely to reduce from direct inputs to the sea and from improvements to discharges in the catchment as a result of existing regulation and water company improvement plans. Future prospects for diffuse sources from agriculture are less certain as we aim to better understand the balance between the potential for the intensification of agriculture and the reduction of sources as a result of new regulation and guidance.
Future prospects (Outlook to 2030)	Nutrients	Mixed picture	Nitrogen loads are primarily from diffuse agriculture. Prospects are less certain as we aim to better understand the balance between the potential for the intensification of agriculture and the reduction of sources because of new regulation and guidance.
Future prospects (Outlook to 2030)	Contaminants	Mixed picture	Current source control measures will be effective to ensure decreasing trends for some chemicals that currently pose a risk. Other chemicals may require a local approach to reduce inputs to the water environment. Emerging chemicals will continue to be identified which may require new regulation.

Note on robustness: High where past trends are based on survey data and evidence reports.

Table 8 Key messages – past trends and future prospects for hydrological processes and impacts of climate change.

Time period	Hydrological process	Indicative assessment	Impacts of climate change
Past trends (1900 to present)	Tidal range, tidal currents, and sea levels	Mixed picture	Mean sea level around the UK has risen by about 12–16 cm since 1900. There is variance in sea-level change around the UK partly due to vertical land movement from isostatic rebound following the last Ice Age, with the south of the UK sinking while Scotland is rising. At many locations, 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)
Past trends (1950 to present)	Waves	Mixed picture	Models and observations show an increase in annual and winter mean significant wave heights in the Northeast Atlantic since the 1950s. Over the past 50 years, a poleward shift in mid-latitude depressions is evident during the winter. The strongest mid-latitude depressions may be increasing in intensity but becoming less frequent (MCCIP, 2020).
Past trends (1990 to present)	Temperature	Deteriorating	UK seas show an overall warming trend. Over the past 30 years, warming has been most pronounced to the north of Scotland and in the North Sea, with sea-surface temperature increasing by up to 0.24°C per decade. Warming of UK shelf seas is projected to continue over the coming century. Most models suggest an increase of between 0.25°C and 0.4°C per decade (MCCIP, 2020).

Time period	Hydrological process	Indicative assessment	Impacts of climate change
Past trends (1990 to present)	Salinity	Mixed picture	The salinity of UK shelf seas, and the adjacent Atlantic Ocean, has been highly variable on annual and decadal timescales with no clear long-term trends. In the past five years, salinity of eastern North Atlantic waters west of the UK has dramatically decreased, probably in response to atmospheric changes in the western North Atlantic earlier this decade (MCCIP, 2020).
Past trends (1995 to present)	Acidification	Mixed picture	The North Atlantic contains more anthropogenic CO_2 than any other ocean basin, and ocean surface measurements between 1995 and 2013 reveal a pH decline (increasing acidity) of 0.0013 units per year there (MCCIP, 2020).
Future prospects (present to 2100)	Tidal range, tidal currents, and sea levels	Deteriorating	Based on a medium emissions scenario in UKCP09, relative sea level rise projections for Cardiff, compared with a 1990 baseline, indicate a rise of approximately 0.1m by 2020, 0.22m by 2050 and 0.44m by 2095 (Lowe et al, 2009). The more recent UKCP18 marine report scenario RCP 8.5 predicts a rise of 0.51 to 1.13m in Cardiff by 2100 (Palmer et al, 2018).

Time period	Hydrological process	Indicative assessment	Impacts of climate change
Future prospects (present to 2100)	Waves	Mixed picture	Climate change could affect storms and waves in the North Atlantic, but natural variability will continue to dominate in the near future. Under a high-emissions scenario, there could be an overall reduction in mean significant wave height in the North Atlantic by 2100, although the most severe waves could increase in height. The chance of severe storms reaching the UK during autumn may increase if tropical cyclones become more intense, and their region of origin expands northwards (MCCIP, 2020). Storm surge and increased wave heights at the coast combined with increasing sea level rise are likely to give rise to increased occurrence of coastal inundation.
Future prospects (present to 2100)	Temperature	Deteriorating	Warming of UK shelf seas is projected to continue over the coming century. Most models suggest an increase of between 0.25°C and 0.4°C per decade. There may be some regional differences. For example, warming is expected to be greatest in the English Channel and North Sea, with smaller increases in the outer UK shelf regions (MCCIP, 2020).
Future prospects (present to 2100)	Salinity	Mixed picture	Most 21st Century projections suggest that UK shelf seas, and the adjacent Atlantic Ocean, will be less saline than present, driven by ocean-circulation changes in response to climate change. Greater salinity decreases are projected for the North Sea, than the Irish and Celtic Seas (MCCIP, 2020).

Time period	Hydrological process	Indicative assessment	Impacts of climate change
Future prospects (present to 2100)	Acidification	Mixed picture	High-emission scenario models project that the average continental shelf pH could drop by up to 0.366 by 2100. Spatial variability in the rate of pH decline is projected with coastal areas declining faster. Under high-emission scenarios, it is projected that bottom waters will become corrosive to more-soluble forms of calcium carbonate (aragonite). Episodic undersaturation events are projected to begin by 2030. By 2100, up to 20% of the North-west European shelf seas may experience undersaturation for at least one month of each year (MCCIP, 2020)

Note on robustness: Varying degrees in confidence based on long-term modelling and projections.

Baseline position of natural resources:

Evidence on the state and condition of marine natural resources in Wales provides a mixed picture. Some features are in good condition, such as grey seals and some seabirds, while others are highly variable, including intertidal and subtidal habitats.

In some cases, such as coastal and marine water quality, there are significant issues that have ramifications for other aspects of the marine ecosystem. There are complex interactions between the pressures on the marine environment, such as climate change exacerbating the spread of non-native species, periodic high energy storm events that cause large-scale change in marine and coastal habitats, or agricultural practices and land management influencing the condition of marine features. Evidence for this assessment is drawn from a number of key reporting mechanisms, but the baseline evidence they rely on remains variable, meaning that our knowledge – and confidence in our assessments – in some areas remains limited.

At a Welsh seas scale, the MPA network (Figure 1) can be considered as a best available proxy for overall marine ecosystem resilience at a broad scale, and this is an important starting point for the assessment of SMNR. Further detail on the Welsh MPA network can be found in Welsh Government's 2019 report to the Senedd in accordance with Marine and Coastal Access Act 2009 duties. In 2018, NRW published **indicative condition assessments** for the 128 features (the protected habitats and species) of marine Special Area of Conservation (SAC) and Special Protection Area (SPA) (NRW, 2018a). 46% of marine features were assessed to be in favourable condition, 45% were assessed to be in unfavourable condition and 9% were unknown, with underpinning confidence assessment given in Table 9. A 2016 assessment found that Welsh MPAs make a substantial contribution to the UK ecologically coherent network, with only a small number of shortfalls in the protection of habitats and species of conservation interest (Carr et al, 2016).

Table 9 Results of the indicative site-level feature condition assessments for SAC and SPA features, including confidence ratings (NRW, 2018a).

Indicative site-level feature condition assessments	Number of features	Percentage
Favourable / High confidence	40	31%
Favourable / Medium confidence	12	9%
Favourable / Low confidence	8	6%
Unfavourable / High confidence	33	26%
Unfavourable / Medium confidence	15	12%
Unfavourable / Low confidence	9	7%
Unknown	11	9%
Total	128	100%

Note: These assessments made use of readily available evidence and expert judgement to provide an indication of feature condition at the site level. The confidence rating associated with the assessments is an integral part of the indicative assessment. High confidence in an assessment indicates a high degree of certainty that the result is correct, based on the readily available evidence. Low confidence in an assessment indicates that there is a higher degree of uncertainty in the evidence.

Whilst there are many species groups that could be considered in the marine ecosystem assessment for SoNaRR 2020, there is a focus on higher species, such as birds, fish, and mammals. Their inclusion reflects the available data to a large degree, but their position higher up the food chain suggests they are a good indication of the health and condition of other species and habitats. A resilient marine environment is one which can support healthy populations of species and stable marine habitats.

Assessments undertaken for the revised UK Marine Strategy Part One report that non-breeding waterbird and breeding seabird populations are not at Good Environmental Status (GES) in the Celtic Seas (UK MOAT, 2018). However, in Wales, over the last six years many breeding seabird populations have been stable or increasing, contrary to trends elsewhere in the UK, except for storm petrel, cormorant, shag, and some gull species (Table 10) (JNCC, 2019a). Where there have been declines, the underlying cause varies and is often part of a trend at a larger scale: the declines of kittiwake and lesser black-backed gull mirror UK wide decreases (JNCC, 2019a). Indicative condition assessments of SPA features support these findings (NRW, 2018a).

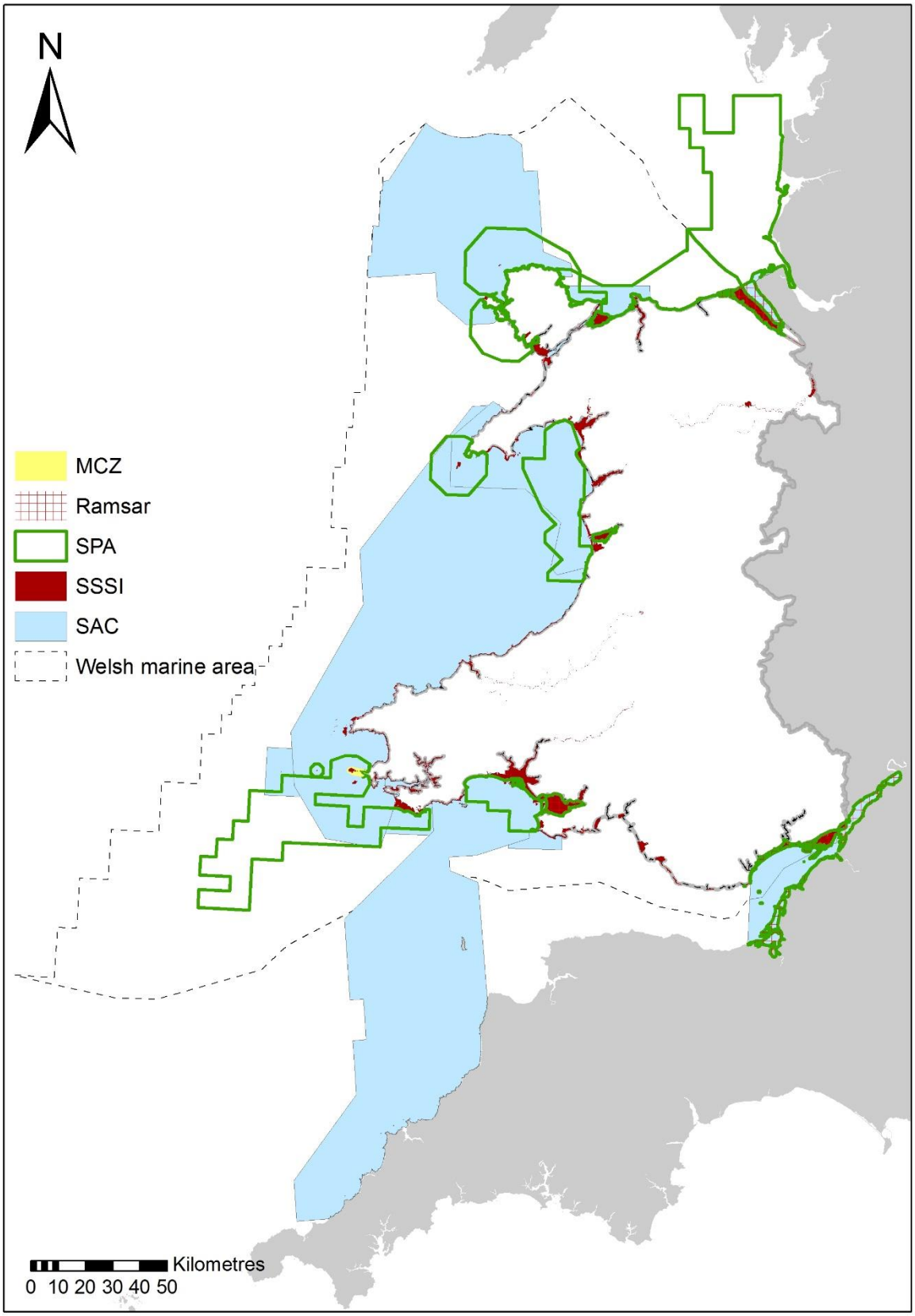

Figure 1 The network of Marine Protected Areas in Wales.

Table 10 Welsh seabird population change from 2000 to 2019 (JNCC, 2020a).

Species	Group	Population size in Seabird 2000 Census 1998-2002 (individuals)	Population size in Seabirds Count Census 2015-2020 (individuals; 2018/19 preliminary results)	Population change (%)	Percentage of Seabird 2000 Census (1998-2002) sites monitored for Seabirds Count Census (2015-2020)
Guillemot	Auks	58334	96802	66	98
Razorbill	Auks	12058	21233	76	100
Puffin	Auks	10328	27831	163	99.6
Black guillemot	Auks	28	19	-32	100
Manx shearwater	Petrels & Shearwaters	168133	487471	190	100
Storm petrel	Petrels & Shearwaters	2805	2475	-12	100
Fulmar	Petrels & Shearwaters	3474	2193	-37	100
Gannet	n/a	30688	36011	17	100
Cormorant	n/a	1699	1491	-12	100
Shag	n/a	914	502	-45	99

Species	Group	Population size in Seabird 2000 Census 1998-2002 (individuals)	Population size in Seabirds Count Census 2015-2020 (individuals; 2018/19 preliminary results)	Population change (%)	Percentage of Seabird 2000 Census (1998-2002) sites monitored for Seabirds Count Census (2015-2020)
Kittiwake	Gulls	7293	4527	-38	100
Black-headed gull	Gulls	1986	827	-58	76
Lesser black-backed gull	Gulls	20722	11070	-47	98
Herring gull	Gulls	13974	7988	-43	90
Greater black-backed gull	Gulls	427	504	18	89
Little tern	Terns	75	171	128	100
Sandwich tern	Terns	450	1980	340	100
Common tern	Terns	674	858	27	100
Arctic tern	Terns	1705	3994	134	100
Roseate tern	Terns	2	2	0	100

Similarly, the UK has not achieved GES for non-breeding waterbirds in the Celtic Seas. However, the recent Waterbirds in the UK 2018/19 report shows that in Wales the majority of wildfowl and wader species have increased in population size over a 25 year period, contrary to the UK trend (Table 11 and Table 12) (Frost et al, 2020).

Wader and wildfowl populations have moved with changes in climate as evidenced by a shift of wintering populations firstly to the east of the UK and then to continental Europe as winter temperatures have increased, opening up once inhospitable wintering areas closer to their breeding grounds.

Table 11 Welsh Wintering wader species 25-year population change from 1993/94 to 2018/19 (Frost et al, 2020).

Wintering wader species	25 year % change Wales	25 year % change UK
Oystercatcher	-1	-23
Curlew	-42	-33
Dunlin	-38	-41
Knot	47	-20
Redshank	13	-17
Grey plover	-53	-36
Bar-tailed Godwit	-40	-17
Black-tailed Godwit	171	228

Table 12 Welsh Wintering wildfowl species 25-year population change from 1993/94 to 2018/19 (Frost et al, 2020).

Wintering wildfowl species	25 year % change Wales	25 year % change UK
Shelduck	-5	-29
Pintail	28	-24
Shoveler	75	68
Wigeon	53	12
Teal	15	34
Gadwall	368	130
Great-crested grebe	123	-3

Welsh waters are home to a wide variety of fin fish and elasmobranch species, but establishing an accurate picture of the baseline position, state, and trends of populations specifically within the Welsh inshore area is difficult, and in some cases inappropriate, due to data deficiencies and the highly mobile nature of many species. Additionally, these species can also be subject to natural cycles and fluctuations over periods of several years, influenced by a complex interrelationship of factors such as climate change, reproductive success, predation and prey availability. Current reporting provides limited insight such as 100% of water bodies assessed for the Water Framework Directive estuarine fish component achieved good status (Water Watch Wales, 2018). Four diadromous species (river lamprey, sea lamprey, Twaite shad and Allis shad) are designated as features of marine SACs due to the importance of marine areas to certain life cycle stages, but all occurrences were assessed to be in unfavourable condition in the indicative condition assessments for these features (NRW, 2018a).

Historical unsustainable fishing practices over the longer term, in the absence of effective management, and other drivers such as pollution and disease are likely to have impacted upon fish and shellfish populations in Wales, for example the decline of native oyster (Woolmer et al, 2011) and crawfish (Seasearch, 2010). Data limitations make assessing the current condition and trends of commercially targeted marine fish and shellfish species at a Welsh level challenging. There is a paucity of stock assessment data for non-quota stocks wholly within Welsh waters. Information on the assessment and reporting of commercially targeted fish species subject to quota and Total Allowable Catch (TAC) at the scale of International Council for the Exploration of the Sea (ICES) areas is provided in the SoNaRR2016 chapter 3 technical annex (NRW, 2016). Since 2015, a fisheries monitoring programme under the EC Data Collection Framework involving monthly sampling of fisheries through port visits and observes trips at sea has ensured that Welsh data have fed into these

ICES assessments. A recent summary for the ICES Celtic Seas ecoregion states that overall fishing mortality for shellfish (*Nephrops norvegicus*), benthic, demersal, and pelagic stocks subject to TAC has reduced since the late 1990s, and mean mortality is now closer to the level that produces maximum sustainable yield (MSY), with 30 of 45 stocks now fished at or below MSY (ICES, 2019). The Celtic Seas ICES ecoregion covers the north western shelf seas of the EU, ranging from north of Shetland to Brittany in the south.

With the exception of scallops which have undergone annual stock assessments since 2014, and certain cockle stocks relating to regulated or permitted fisheries (such as NRW and WG managed fisheries), there are similar data deficiencies for other shellfish species that are commercially targeted in Wales.

Over twenty species of marine mammal (at least 18 species of cetacean and two species of seal) have been recorded in Welsh waters since 1990 (Baines and Evans, 2012). Harbour seals are observed in Welsh inshore waters but there are no records of breeding sites. There are important grey seal pupping and haul-out sites in Pembrokeshire, the Llŷn peninsula and Anglesey (Baines et al 1995; Stringell et al 2014; Clarke et al, 2020 in prep). The grey seal population in Wales (and in wider UK seas) has shown an upward trend in pup production over the longer term (Bull et al 2017a,b; Clarke et al, 2020 in prep; Morgan et al 2018; Mitchell et al, 2018a; Mitchell et al, 2018b; SCOS 2018). Pup production at Skomer Marine Conservation Zone (MCZ) over the past five years has been the highest recorded for the area since records began in 1976, with an average annual pup production between 2014 and 2018 of 374 pups (Büche and Stubbings, 2019; Bull et al 2017a,b; Burton et al, 2019a).

The five regular and relatively common cetacean species occurring in Welsh waters are harbour porpoise, bottlenose dolphin, Risso's dolphin, short-beaked common dolphin and minke whale. All five species were given an unknown conservation status at a UK level due, to data limitations and a change in the approach used to assess populations (JNCC, 2019b). In Wales, the coastal bottlenose dolphin population centred around Cardigan Bay is considered to be stable over the long term and in favourable condition (NRW, 2018b), although abundance is thought to have possibly declined in the last decade (Lohrengel et al 2018). The harbour porpoises in Welsh waters are considered to be part of the Celtic and Irish Seas Management Unit (CIS MU) population (IAMMWG, 2015), which is thought to have declined from approximately 98,000 individuals in 2005 to approximately 62,000 individuals in 2016 (SCANS II, 2008; Hammond et al, 2017, Rogan et al, 2017). Estimated bycatch of harbour porpoise in net fisheries in the ICES Celtic Seas ecoregion may be above environmental limits defined by ASCOBANS (ICES 2018). However, the bycatch within the CIS MU, occurs almost entirely in the Southwestern approaches and Celtic Sea (ICES subarea 7h), which are areas outside of the Welsh zone, in net fisheries generally not associated with the predominantly inshore Welsh fleet.

Subtidal and intertidal habitats are characterised in the SoNaRR 2016 chapter 3 technical annex (NRW, 2016) and these accounts remain accurate. Assessing the state of subtidal and intertidal habitats is challenging due to the resources required to effectively monitor their condition over a suitable timescale. The Water Framework Directive Cycle 2 Interim Classification 2018 (Water Watch Wales, 2018) of estuarine

and coastal water bodies assessed biological quality elements that correspond with some subtidal and intertidal habitats as part of the overall assessment of WFD classification. The majority of water bodies achieved good or high status for these biological quality elements, but several failed to achieve the required standard, as shown in Table 13.

Table 13 Number of Water Framework Directive water bodies assessed and their status for each of the intertidal and subtidal biological quality elements, derived from 2018 interim assessment. (Water Watch Wales, 2018).

Biological element	Habitat	Water bodies assessed	High (pass)	Good (pass)	Moderate (fail)	Poor (fail)
Seagrass	Intertidal	7	2	4	1	n/a
Saltmarsh	Intertidal	17	4	9	4	n/a
Opportunistic macroalgae	Intertidal	40	28	9	3	n/a
Benthic macro-invertebrates	Subtidal	30	6	17	7	n/a
Estuarine fish	Intertidal, Subtidal	7	n/a	7	n/a	n/a
Phytoplankton	Subtidal/ Pelagic	24	13	7	3	1

Many habitats are subject to protection under the EU Habitats Directive or have been identified as habitats of principal importance under the interim section 7 list of the Environment Wales Act, 2016. Assessments carried out under Article 17 reporting represent the most recent record, but do not provide a conservation status for each habitat in Wales. However, some information on trends in the range and extent of each habitat at a Welsh level is available (see Table 14 and Table 15) (JNCC, 2019b). In addition, indicative condition assessments are available for each occurrence of each marine SAC habitat feature, spanning intertidal and subtidal areas. These indicative assessments found that 60% of habitat features were in unfavourable condition, 28% in favourable condition and the remainder were in unknown condition (NRW, 2018a). These sources of information represent the best available assessments of these important habitats at a national scale.

Localised reporting indicates that the *Zostera marina* seagrass bed within Skomer MCZ has shown a slight increase in extent in recent years (Burton et al, 2019a; 2019b), although losses of the pink sea fan *Eunicella verrucosa* within the MCZ have been reported (Newman et al, 2018). There is evidence of a significant decline in

Wales's only maerl bed in Milford Haven due to multiple pressures from human activities and invasive non-native species (JNCC, 2019b).

Plankton monitoring has taken place at Skomer MCZ since 2009 and provides some insight into pelagic habitats, recording both zooplankton and phytoplankton at stations within the site (Burton et al, 2019a).

Table 14 Short- and long-term trends in range and extent of Annex I intertidal habitats in Wales. UK conservation status included for reference. All information from 2019 Article 17 reporting (JNCC, 2019).

Habitats Directive Annex I habitat	Range of habitat in Wales - Short term trend	Range of habitat in Wales - Long term trend	Area of habitat in Wales - Short term trend	Area of habitat in Wales - Long term trend	Habitat condition (km2) - Good	Habitat condition (km2) - Bad	Habitat condition (km2) - Not known	Short term trend	UK condition assessment
Estuaries	Stable	n/a	Stable	Decreasing	11.19	506.26	72.99	Stable (2007 – 2018)	Unfavourable - bad
Mudflats and sandflats not covered by seawater at low tide	Stable	n/a	Decreasing (1% or less/year)	Decreasing	62.97	337.9	15.12	Uncertain (2010 – 2018)	Unfavourable - bad

Table 15 Short- and long-term trends in range and extent of Annex I subtidal habitats in Wales. UK conservation status included for reference. All information from 2019 Article 17 reporting (JNCC, 2019).

Habitats Directive Annex I habitat	Range of habitat in Wales -Short term trend	Range of habitat in Wales -Long term trend	Area of habitat in Wales - Short term trend	Area of habitat in Wales -Long term trend	Habitat condition (km2) - Good	Habitat condition (km2) - Bad	Habitat condition (km2) - Not known	Short term trend	UK condition assessment
Sandbanks slightly covered by sea water all the time	Stable	n/a	Uncertain	n/a	6.6	592.43	39.19	Uncertain	Unfavourable - bad
Large shallow inlets and bays	Stable	n/a	Stable	n/a	624.39	881.82	13.94	Uncertain	Unfavourable - inadequate
Reefs	Stable	Stable	Decreasing	Uncertain	537.7	932.33	1960.53	Unknown	Unfavourable - inadequate
Submarine structures made by leaking gases	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Unknown

Habitats Directive Annex I habitat	Range of habitat in Wales -Short term trend	Range of habitat in Wales -Long term trend	Area of habitat in Wales - Short term trend	Area of habitat in Wales -Long term trend	Habitat condition (km2) - Good	Habitat condition (km2) - Bad	Habitat condition (km2) - Not known	Short term trend	UK condition assessment
Submerged or partially submerged sea caves	Stable	n/a	Stable	Decreasing	0.05	0.036	n/a	Uncertain	Unfavourable - inadequate

Note: Marine Annex I features are not precisely aligned with notional intertidal and subtidal boundaries such as ‘estuaries’ features can contain subtidal components; ‘reefs’ and ‘large shallow inlets and bays’ features can contain intertidal components.

Marine and coastal water quality

Water quality is assessed within 32 estuarine and 23 coastal water bodies across Wales. 36 of these 55 water bodies failed to achieve good ecological status. The most widespread failures are for dissolved inorganic nitrogen; however, concentrations rarely give rise to biological impacts or lead to eutrophication (Water Watch Wales, 2018). Long term inputs of phosphorus from the Welsh land mass to the sea have significantly decreased over the last 30 years as a result of reductions at waste water treatment works in the catchment, however nitrogen inputs do not show a decreasing trend reflecting the difficulties in managing diffuse inputs. A lack of mitigation for water bodies that are physically altered as a result of human use is also a significant cause of failure for estuarine and coastal water bodies. Chemical status is assessed against organic and inorganic chemicals, such as metals, hydrocarbons, and contaminants produced by industrial processes. 20 water bodies failed to achieve good chemical status. The status of chemicals only tells part of the story: some chemicals are subject to long-standing bans and as a result their concentrations in the environment are decreasing, and while others are still permitted their use and regulation is tightly controlled. The most common failures for chemicals in the estuarine and coastal environment are for mercury and brominated diphenylethers. All data from Water Framework Directive Cycle 2 Interim Classification (Water Watch Wales, 2018) and summarised in Figure 2 to Figure 4.

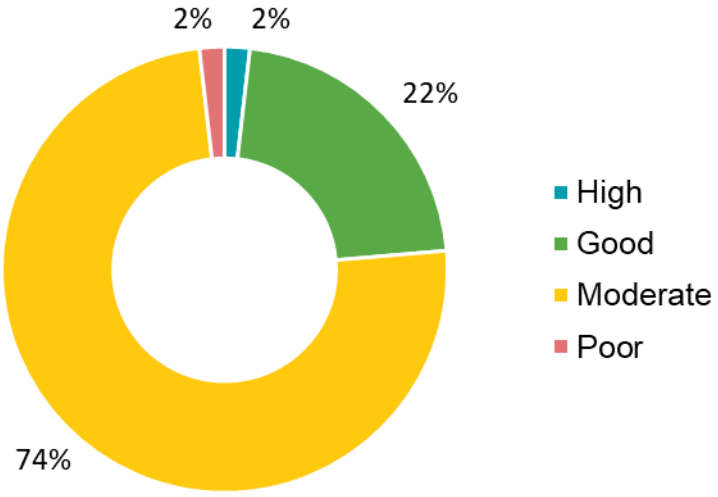

Figure 2 Overall status of estuarine and coastal water bodies (2018 interim assessment) (Water Watch Wales, 2018).

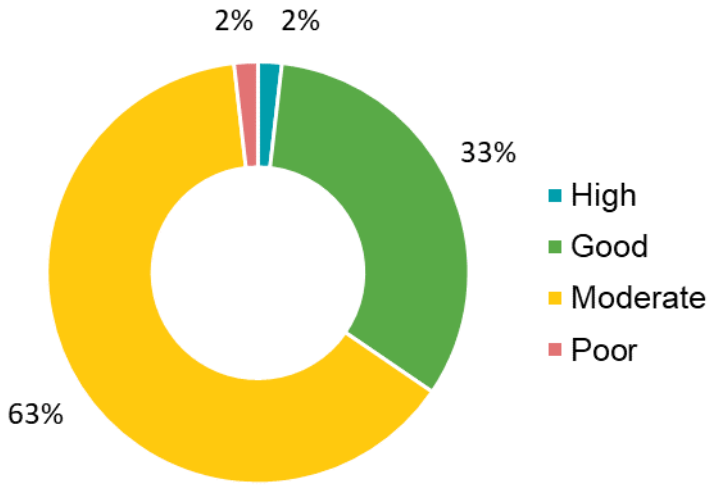

Figure 3 Ecological status of estuarine and coastal water bodies (2018 interim assessment) (Water Watch Wales, 2018).

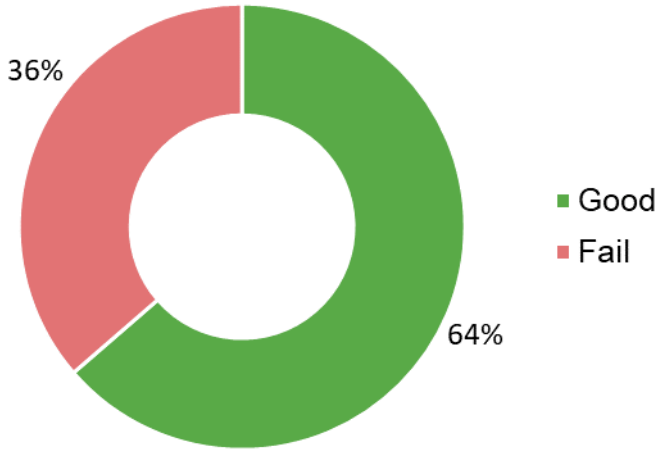

Figure 4 Chemical status of estuarine and coastal water bodies (2018 interim assessment) (Water Watch Wales, 2018).

Welsh beaches have 43 Blue Flags, 19 Green Coast Awards, and 83 Seaside Awards, all of which depend upon a high water quality standard. Bathing water quality in Wales has improved significantly over the past two decades and in 2020, 100% of designated bathing waters met the minimum standard, with 80% achieving the highest standard of 'excellent' (Natural Resources Wales, 2020a).

There is evidence to support that some Shellfish Water Protected Areas have improved over the last two decades, although compliance with the guideline microbial standard remains low. The microbial standard is a non-mandatory faecal organism indicator which is contained in the Shellfish Water Protected Areas (England and Wales) Directions 2016. The microbial standard is 300 or fewer colony forming units of Escherichia coli per 100 ml of shellfish flesh and intravalvular liquid.

In 2019 the majority of beds in the Menai Strait East, which supports a significant value of the industry, were upgraded to Class A (Food Standards Agency, 2020). Public perception of sea water quality in Wales is good with visitors rating 'Sea water quality' as 8 out of 10 (Welsh Government, 2017).

Hydrological processes

Hydrological processes are a key influence on marine ecosystems because they create conditions for life and supporting systems. This includes transport systems for food (both for human consumption and within the ecosystem), waste, nutrients, sediments and front creation. These processes include tidal range, tidal currents and sea levels; waves; temperature; and salinity. These hydrological processes also influence other ocean processes such as acidification and turbidity. In addition, coastal processes and their management and developments in the marine environment can have a direct influence on hydrological processes.

The waters of the Welsh inshore are strongly influenced by oceanographic processes, with influxes of water from the Celtic Sea and north from the continental shelf current. There are significant likely implications for coastal erosion, sea defence integrity, coastal flooding, storm events and sea level and temperature due to climate change signals and their interrelationships.

Known pressures and issues

In general, we have an incomplete understanding of some pressures due to the challenges in monitoring the marine environment and subsequently, establishing a causal link between pressures and observed impacts. We need to better understand the temporal and spatial distribution and impact of activities and related pressures. However, existing monitoring assessments and reporting provide some information on pressures that are impacting the marine ecosystem.

There remain a number of evidence needs relating to licensable activities which, if filled, will inform better management by improving the evidence upon which planning and decisions are based.

Climate change

The Marine Climate Change Impacts Report Card 2020 (MCCIP, 2020) presents the latest evidence from 26 topics regarding the physical, ecological, social, and economic impacts of climate change on UK coasts and seas. There is clear evidence that warming seas, reduced oxygen, ocean acidification, and sea-level rise are already affecting our marine and coastal areas. Increasingly, these changes are having an impact on food webs, with effects seen in seabed-dwelling species, as well as plankton, fish, birds, and mammals. The report card also includes projections of future climate impacts. Key changes and projections for the Irish Sea and Welsh Marine are identified in the Welsh summary report (Robinson et al, 2020), and include:

The upper range for the latest UK sea-level rise projections is higher than previous estimates, implying increased coastal-flood risk. Projected increases in sea-level rise

are larger for England and Wales than in Scotland and Ireland. The central estimate at 2100 for Cardiff is 0.43–0.76m.

Average projected sea temperature increases of 3°C by 2100 in the Irish and Celtic Seas will directly lead to a decrease in dissolved oxygen. Increases in stratification due to sea warming are also likely to drive declines in oxygen concentrations.

Many important habitats along the Welsh coastline, some of which are found within Marine Protected Areas (including salt marsh, maerl beds, horse mussel beds, and seagrass), are vulnerable to climate impacts. These include sea-level rise, sea warming, ocean acidification, and changes in storminess.

At the North Atlantic Ocean Basin scale, long-term datasets show that changes in plankton species and communities have been influenced by climate over multidecadal periods, and strongly correlate with temperature change.

Commercial fish populations in the North Sea and Celtic-Biscay shelf are reportedly among the most negatively impacted worldwide, due to intense and prolonged overfishing and rapid warming in recent decades (>0.2°C per decade).

Impacts of ocean acidification on shellfish fisheries may be more pronounced in Wales than other regions of the UK due to their relative importance to the industry.

Climate change could affect storms and waves in the North Atlantic, but natural variability will continue to dominate in the near future. Predicting future changes to the strength, frequency and track of storms is difficult, and there is still uncertainty as to what could happen within the Irish Sea region.

Welsh seas and coastlines will increasingly be impacted by climate change. Evidence bases focused on local and regional contexts will be increasingly important to aid decision-making regarding management and adaptation. In addition to the UK-wide impacts and projections, specific concerns for Wales include a risk of the invasive Pacific oyster becoming established; ocean acidification impacting important cockle and whelk fisheries; and around 70% of coastal defences becoming highly vulnerable to coastal flooding due to sea-level rise.

The evidence presented in the MCCIP Report Card reinforces the messages provided by UK Climate Projections 2018 (UKCP18) Marine Report (Palmer et al, 2018) in relation to sea level rise and coastal flooding. In addition, the Intergovernmental Panel on Climate Change Special Report on the Oceans and Cryosphere in a Changing Climate reports that warming seas, ice melt, reduced oxygen, ocean acidification, and sea-level rise are already affecting ecosystems and society across the globe (IPCC, 2019).

Water quality and pollution

Whilst there have been major improvements in water quality in recent years, the marine environment continues to receive inputs from various sources which can be detrimental to the functioning of the system as a whole, and to condition of specific habitats and species. Water quality is a priority issue in the marine ecosystem, as evidenced through recent monitoring and assessment products. Indicative feature

condition assessment reports for European marine sites demonstrate that 28% of SAC habitat features assessed failed to achieve good condition on the basis of one or more nutrient elements of water quality (dissolved inorganic nitrogen, dissolved inorganic phosphorous, phytoplankton and nuisance algae) (NRW, 2018a). 38% of habitat features assessed failed to achieve good condition on the basis of chemical elements of water quality, such as mercury, zinc, tributyl tin and brominated diphenyl ethers (NRW, 2018a).

Elevated nutrients levels and chemical contaminants were cited as main pressure or threat (ranked medium or high) for all seven Annex I marine habitats reported on at a Wales level for Article 17 reporting (JNCC, 2019b).

Marine litter

Marine litter has become a topic of significant public and political profile in recent years. Though used extensively nationally and internationally, there is a growing recognition that the term marine litter does not capture the full scale of the issue – including the sources, pathways, and impacts – of pollution from plastic and other materials in the marine environment. The distribution and abundance of micro-plastics and micro-litter in the marine environment are poorly understood but have been subject to increasing focus and research (Environmental Audit Committee, 2016; Lindeque et al, 2020).

In 2019, an average of 475 litter items per 100m stretch of beach were recorded (Marine Conservation Society, 2019). Figure 5 provides a breakdown of the type and source of litter recorded on Welsh beaches in 2019. Data from Welsh beaches indicates the following trends for the period 1993 to 2019 (Marine Conservation Society, 2019):

- 26% increase in total litter
- 13% increase in plastic litter
- 412% increase in glass bottles
- 52% increase in sewage related debris, of which:
    - 11% increase in cotton buds
    - 361% increase in wet wipes since 2005
- 17% increase in fishing related material, this includes all material that helps recreational anglers and commercial fishermen catch fish and shellfish
- 135% increase in smoking related litter

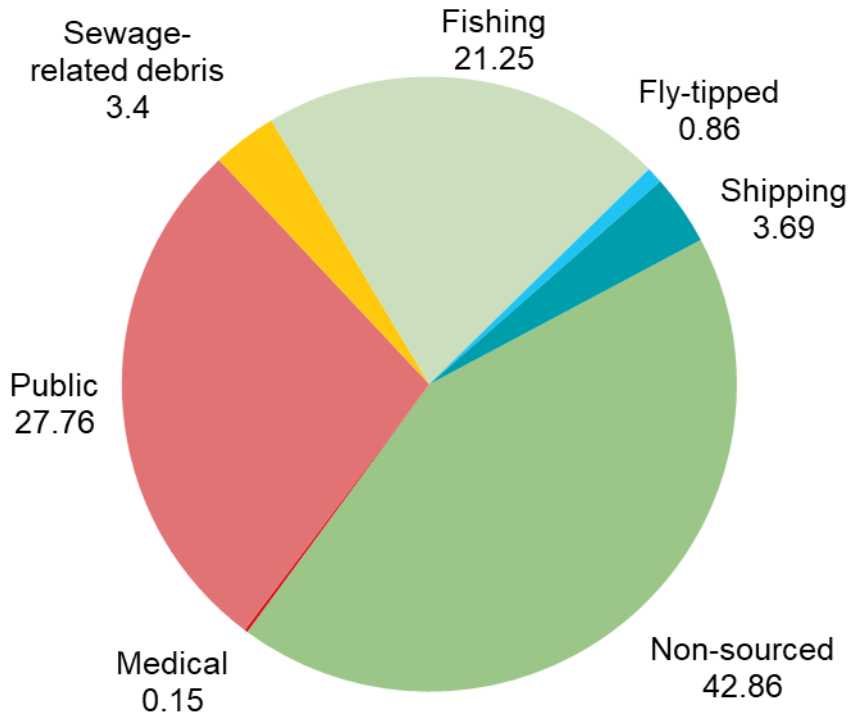

Figure 5 Percentage breakdown of the type and source of litter recorded on Welsh beaches in 2019 (Marine Conservation Society, 2019).

Good Environmental Status under the UK Marine Strategy has not been achieved for marine litter in the Celtic Seas sub-region of which Welsh inshore waters form a part (UK MOAT, 2019). Marine litter (referred to as macro- and micro- particulate pollution) was cited as a main pressure or threat (ranked medium or high) for all seven Annex I marine habitats reported on at a Wales level for Article 17 reporting (JNCC, 2019b). However, only one of 47 habitat features assessed as part of the indicative condition assessment process failed to achieve favourable condition on the basis of marine litter (NRW, 2018a).

A collaborative project sought to assess evidence on the impacts of plastic pollution on the features of the English and Welsh MPA network, and then prioritise those features most at risk from plastic pollution based on the available evidence (MBIEWG, 2020). The study concluded that the highest potential for impact of any habitat feature, sub-feature, species, or bird feature is considered to be medium, and that marine plastic pollution is unlikely to pose a high risk to MPA features in England and Wales at concentrations of plastic that can be considered environmentally realistic. Larger marine species (such as birds and marine mammals) are more vulnerable to larger plastic debris that they may ingest or become entangled with. However, there is no evidence to suggest that this is having population level effects. Similarly, whilst studies suggest some potential effects on habitat functioning, the decline of habitats due to plastic pollution is not evidenced (MBIEWG, 2020). The issue of marine plastics is a relatively new topic in scientific research, and while there is no current evidence of major impacts, it must be noted that the evidence base for this study was limited. Further work is required to understand the sources, pathways and impacts of litter in the marine environment.

Marine fisheries

For the most part, we don't have a good enough understanding of stock status and the dynamics of fishing effort, its distribution and resulting catches to be able to determine the sustainability of fisheries resources in Welsh inshore waters. There is consensus across industry, Welsh Government, and NRW on the need to progress with initiatives already underway, and augment with further planned work (Table 2) to better understand both the status of fish and shellfish stocks and environmental impacts of fisheries activities.

Access and recreation

NRW's Wales Non-Licensable Activities project focuses on the non-licenced activities of greatest concern at the network scale in Wales. It seeks to develop the evidence base on the spatial and temporal distribution, intensity and impacts of these activities on features protected in the network and will involve working with appropriate stakeholders to identify and implement feasible and effective management interventions (such as regulation, financial incentives, behavioural change and so on), where required, to mitigate impacts. Initial priority topics were recreational sea angling, recreational boating (anchoring, mooring, and launching), bait digging and collection of living resources and foot access. Various reports related to this project are available. From the list of initial priorities selected, collection of bait in sensitive intertidal habitats emerged as the activity of principal concern, due to the damage that can be caused from digging and boulder turning. This was the reason for the failure of the intertidal mudflats and sandflats feature of the Pembrokeshire SAC (NRW, 2018a).

Invasive species

Invasive Non-Native Species (INNS) are present in Welsh waters and have varying levels of impact on both the ecosystem and economic interests such as fisheries and aquaculture. INNS can disrupt native marine life by preying on or outcompeting native species for food and shelter, spread disease or interfere with the genetic integrity of native species (Welsh Government, 2017). Welsh Government have published a marine INNS priority monitoring and surveillance list to inform future the development of future policy, action plans and contingency planning (Welsh Government, 2017).

Species on the INNS priority monitoring list are those that are present and breeding in Wales. Some species are well-established and outcompete or smother native species, for example the slipper limpet *Crepidula fornicata* in south and south west Wales, or wireweed *Sargassum muticum*, both of which have increased in Milford Haven (JNCC, 2019c). Intertidal monitoring for the MarClim project recorded the kelp INNS *Undaria pinnatifida* within Skomer MCZ for the first time (Mieszkowska, 2019). Recent surveys and monitoring have revealed five new records of INNS in north Wales, including *Crepidula fornicata* in the Menai Strait.

The highly invasive non-native sea squirt, *Didemnum vexillum*, has been recorded in Holyhead marina since 2008 and is known to significantly damage or modify marine habitats. In March 2018, a storm destroyed Holyhead marina, significantly reducing

the distribution of *D. vexillum* in the harbour. A survey of the harbour area in October 2018 indicated that *D. vexillum* is still restricted to the marina area and some nearby structures, though with a reduced distribution. This offers a rare opportunity to remove or treat any remaining contaminated structures to minimise the risk of the species either remaining or spreading or both. This would have significant biodiversity benefits in terms of reducing the risk of the species spreading to nearby SACs. Economic benefits would include the protection of the nearby mussel farm and other vulnerable aquaculture sites.

Species on the surveillance list are those that are not known to breeding in Wales, but in some cases are present or established in UK or neighbouring waters, such as the American lobster, *Homarus americanus.*

Management initiatives and successes

In the marine environment there are fewer opportunities to improve or enhance ecosystems directly. Instead, the focus is on management of the different pressures on the system to allow it to function and recover naturally. Several key regimes, both current and planned, that will support effective management are described below. These regimes can support the health and resilience of marine natural resources, such as water quality, intertidal and subtidal habitats, and hydrological conditions, which in turn will have a strong influence on the security of provisioning services and benefits to well-being.

Adoption of the Welsh National Marine Plan and Activity Regulation

Much of the management of the marine environment and MPAs is carried out through addressing the potential impacts of activities through both planning and regulatory processes. Strategic planning processes such as the Welsh National Marine Plan (WNMP) (Welsh Government, 2019b), River Basin Management Plans, and various sectoral planning processes (such as The Crown Estate's planning processes for aggregates and renewable energy) set the context for the type of activity that is suitable and sustainable in Welsh waters. In this regard, the adoption of the WNMP in 2019 can be considered a significant step in progress towards SMNR. The marine Area Statement also takes a whole-system approach to identify the evidence and key opportunities for improving the management of natural resources across all Welsh seas, including MPAs.

New Marine Protected Areas

In 2016, NRW and other country agencies consulted on four new MPAs and two extensions to existing sites that were either wholly or partly in Welsh waters. In 2017, three new SACs for the protection of harbour porpoise were submitted to the European Commission and three SPA proposals were also confirmed and classified. These extensive sites add further large-scale tools to manage biodiversity and ecosystem impacts in Welsh seas.

Marine Protected Areas Network and Management

The MPA Network Management Framework for Wales has been produced by the MPA Management Steering Group. It sets out the structure for improving the management of the network of MPAs in Wales for the period 2018 – 2023. The Framework is supported by an annual Action Plan, which sets out the priority network-level actions to improve MPA management and, therefore, improve or maintain the condition of the features of the MPA network in Wales. Together, the Framework and Action Plan provide a steer for Management Authorities to guide delivery of the long-term vision for the management of the network, which is:

The Welsh MPA network is under effective and consistent management which safeguards the marine wildlife and habitats of sites and leads to site features achieving or maintaining favourable condition. Network management supports resilient marine ecosystems which in turn help to achieve clean, safe, healthy, sustainable, productive, and biologically diverse Welsh seas. MPAs are valued for the long-term benefits they provide to the people of Wales through the protection of their rich natural and cultural heritage.

In 2017, Welsh Government committed to completing the Welsh contribution towards an ecologically coherent, well-managed network of Marine Protected Areas in the UK. This work is currently being taken forward through the Welsh MPA network completion project, with support from NRW and JNCC.

Marine Protected Areas Network Condition Improvement Project

In 2016 NRW started work with partners on the MPA Network Condition Improvement Project (CIP), building on the marine outputs of the LIFE N2K Programme for Wales (2012 to 2015), and this work is now taken forward as part of the MPA Network Management Framework. This project is intended to address the recognised threats and pressures that can impact MPA features, grouped under six priority work areas:

- access and recreation – such as damage to habitats or disturbance of species
- water management and issues – such as coastal squeeze, flood, and coastal erosion risk management
- pollution and waste – such as marine litter and diffuse water pollution
- agriculture and land management
- marine fisheries

The overarching purpose of the programme of work is to focus effort on priority management challenges, based on identified pressures and threats, and develop and deliver actions that have the greatest potential to improve (or maintain) the condition of features across the network, or improve understanding of links between activities and feature condition.

Fisheries Management

The Assessing Welsh Fishing Activities (AWFA) project is a collaboration between Welsh Government and NRW to undertake a structured evaluation of fishing activity interactions with features of Welsh European Marine Sites (EMS). The project is developing an evidence base to ensure appropriate steps are taken to avoid the deterioration of natural habitats and the habitats of species as well as disturbances to the species for which the EMS have been designated.

Water quality

There have been a number of successes relating to marine and coastal water quality. These include 100% compliance with the required standards of the Bathing Water Directive and achieving Class A status for Menai Strait shellfish beds (Food Standards Agency, 2020). This reflects the successive investment in improving discharges from the wastewater sector and agriculture measures in specific catchments.

The joint UK administration's strategic approach for managing chemical risks in water provides the context for how we manage chemicals. Source control measures are taken at a national or European level resulting in chemicals being restricted in their production and use. Other more local measures are advisable if the issues are related to a particular activity in a particular catchment. We currently monitor and assess emerging chemicals as part of a wider UK and European network.

Welsh Government are currently considering a whole territory approach to designation of a Nitrate Vulnerable Zone which would reduce diffuse inputs into the marine waters.

Habitat restoration initiatives

The 'Wales Native Oyster Restoration Project' led by NRW is a three-year Welsh Government funded project (European Maritime Fisheries Fund), the main aim of which is to investigate the approach and feasibility of restoring the native oyster (*Ostrea edulis*) in the Milford Haven waterway. The project is due to launch in 2020 and will run to 2023.

The 'Seagrass Ocean Rescue' case study is a collaboration between Project Seagrass, Swansea University, Sky, and WWF.

It is a great example of both a nature-based solution and where it is possible to optimise links between biodiversity and climate change.

In many parts of the world marine restoration is an active part of the tool kit available to marine and coastal conservation managers. In the Chesapeake Bay in the US, after decades of fish declines, pollution impacts and large-scale habitat loss, a basin wide programme to reverse those declines was put in place, resulting in the restoration of over 1000 hectares of seagrass. Conversely in the UK, habitat restoration was not considered to be a viable means of creating marine ecosystem recovery until recent years. Following four years of research and development work by Swansea University and Project Seagrass, the UK's biggest ever marine

restoration project was launched in Dale, Pembrokeshire with the aim of restoring two hectares of seagrass.

Figure 6 Divers and volunteers gather seeds quickly and efficiently. Photograph: Lewis Jefferies/WWF-UK.

Figure 7 The seagrass seeds are bagged to prevent them from being dispersed outside of the licensed restoration area and to protect them from being eaten. Photograph: Joseph Gray/WWF-UK.

The techniques used (Figure 6 and Figure 7) build on those successfully employed in the Chesapeake Bay. Over one million seeds will be planted using lines of small hessian bags to overcome the high tidal currents, abundance of seed predators, and sediment instability. Due to the large-scale historic loss of seagrass in the UK and North Atlantic area, there remain opportunities to restore these once abundant meadows.

The marine environment plays a crucial role in climate regulation by acting as a sink for carbon in living tissue and oceans, and the longer-term sequestration of carbon in sediments. Seagrass beds and saltmarsh are good examples of ‘blue carbon’ sinks (Armstrong et al, 2020).

4. Assessment of Resilience (Aim 2)

This assessment of marine resilience is a qualitative exercise based on expert judgement. Information from the 2018 indicative site-level feature condition assessments, 2018 interim WFD water body classification, and 2019 Article 17 reporting form a major part of the resilience assessment for intertidal and subtidal habitats. However, it should be noted that the indicative assessments were based on readily available evidence and expert judgement to provide an indication of feature condition at the site level, and each has an associated confidence rating in the assessment. The confidence rating associated with the assessments is an integral

part of the indicative assessment. NRW will develop a new site condition reporting process based on the findings of the EMFF project, 'Improving marine site level feature condition assessment reporting in Wales', which aims to develop indicators and a process for reporting on condition of features protected in Wales's network of MPAs. This should ensure that we have higher confidence in assessments in the future.

The indicative condition assessments were also a major component of the outcome of marine reporting for Welsh features in Article 17. Both the indicative assessments and Article 17 reporting use WFD water body status to inform their outcomes, but the boundaries of water bodies and MPA features do not always closely align. As such, the marine resilience assessment remains a qualitative process reliant on best-available evidence, rather than a definitive and quantitative assessment.

The assessment of marine resilience shows that the extent and connectivity of intertidal and subtidal habitats is stable or good overall. There are issues with diversity and condition of some habitats, due in some cases to a decline in the typical species found within the feature, and in others due to pressures such as elevated nutrients, chemical contaminants, established populations, and new records of INNS, coastal squeeze, and developments.

It can be challenging to consider the resilience of marine species in the same way as marine habitats as the attributes of resilience are better intended for the latter. The state and trends reported in section 3 provide relevant information for the condition of marine species. All species assessed in the indicative condition assessments were found to be in favourable condition, but there remain some gaps in our understanding of the harbour porpoise population. Some bird features are in favourable condition and demonstrating positive trends in terms of population size and recovery, but some important species are restricted to a single colony or a small number of island colonies, suggesting that they are not resilient to potential threats.

There are unlikely to have been significant changes in the attributes of resilience or in resilience overall since SoNaRR 2016, but the indicative condition assessments and Article 17 reporting represent an improved evidence base to draw from for SoNaRR 2020. There is a significant programme of work in place to address the issues identified within this resilience assessment, but it takes time in the marine environment for management activity to lead to discernible improvement to feature condition.

Table 16 SoNaRR2020 Ecosystem Resilience Assessment by attribute of resilience for each marine habitat unit.

Practical habitat unit	Diversity	Extent	Condition	Connectivity
Intertidal habitats	Medium Many habitats retain their high diversity. WFD and UK Marine Strategy assessments suggest a positive picture for some intertidal habitats. However, there are some issues due to declines in typical species, and historical losses of some very diverse biogenic habitats.	Medium Article 17 reporting shows no change in range and area covered by intertidal Annex I habitats between 2013 and 2019. However, there have been losses in extent over the longer term due to coastal squeeze and historical development.	Medium A number of intertidal Annex I habitats were given an indicative unfavourable condition due to various issues relating to water quality (nutrients and chemical), hand gathering, INNS, coastal squeeze, and development. However, data from WFD reporting for seagrass, saltmarsh, and benthic invertebrates suggests a more positive view across the range of intertidal habitats.	High MPAs protecting intertidal habitats are well connected overall, with a small gap in the connectivity of circalittoral rock, and some localised disruption through alterations to hydrological processes.

Practical habitat unit	Diversity	Extent	Condition	Connectivity
Subtidal habitats	Medium Many habitats retain their high diversity. WFD assessments suggest a positive picture for some subtidal habitats, but there are some issues due to declines in typical species, particularly in sandbanks and reefs, and localised losses of some very diverse biogenic habitats.	High Small historical losses due to coastal development, energy development, and cabling, but a positive picture overall based on recent assessments of extent.	Medium Various historical impacts from unassessed fishing, pollution, aggregate extraction, coastal, and energy development, INNS. Recent issues demonstrate the impact of water quality (elevated nutrient levels and chemicals).	High MPAs protecting subtidal habitats are well connected, with some localised alterations to hydrological processes in nearshore areas.

5. Healthy Places for People (Aim 3)

Regulating services provided by the marine ecosystem provide several benefits, including climate regulation through several biogeochemical processes involving marine organisms (Table 17). Marine ecosystems also dissipate energy to provide protection at the coast from environmental hazards such as storms, floods, waves, and tidal surges. Less apparent benefits also include opportunities for wastewater management and disposal of waste materials through the water system and ultimately into the marine environment. Maintaining water quality despite these inputs is finely balanced and is a key factor in ensuring well-functioning marine ecosystems.

The marine environment plays a crucial role in climate regulation by acting as a sink for carbon in living tissue and oceans, and the longer-term sequestration of carbon in sediments. Through these processes, marine ecosystems store up to 55% of the world's carbon (Nellemann et al, 2009), and approximately a quarter of annual anthropogenic CO_2 emissions dissolves into the Earth's oceans each year (Le Quéré et al, 2018). Seagrass beds (Fourqurean et al, 2012) and saltmarsh (Beaumont et al, 2014) are well established components of 'blue carbon' sinks, and there is an increasing appreciation of the contribution of macroalgae (Krause-Jensen and Duarte, 2016). An NRW-funded project (Armstrong et al, 2020) estimated the blue carbon sink potential of marine habitats in Wales and their contribution to offsetting carbon released by human activities, reporting the following key findings (summarised in Figure 8):

- A substantial amount of carbon is already stored in Welsh marine sediments; at least 113 Million tonnes (Mt) in the top 10 cm of sediment. This represents almost 170 % of the carbon held in Welsh forests.
- In any given year, the water column holds at least another 48.7 Mt of carbon in Welsh seas, mostly in the form of dissolved inorganic carbon.
- It has been estimated that Welsh marine habitats sequester at least 26,100 tonnes of carbon (or 0.03 Mt C) every year, with saltmarshes and intertidal flats accounting for a large percentage of this value.
- The protection and restoration of habitats, such as saltmarsh and seagrass that store and sequester carbon, could contribute further to the offsetting of carbon released by human activities in the future.

Climate regulation through the carbon cycle is dependent on stable systems, but climate change impacts like increasing anthropogenic CO_2 emissions are leading to acidification of marine waters, with projections suggesting that deeper continental shelf waters will become corrosive to some forms of calcareous invertebrates (MCCIP, 2020). There are varied pressures impacting on seagrass (Jones and Unsworth, 2016) which may compromise their role in carbon sequestration.

The coastal environment is dynamic, and the coastline of Wales is vulnerable to coastal erosion and flooding as a result of storms, floods, waves, and tidal surges. Natural habitats protect the coast by directly dissipating or absorbing wave energy, or indirectly through regulating sediment movement (NRW, 2014a). For more information about the Welsh coast see the SoNaRR2020 Coastal margins chapter.

The supply of clean water underpins a healthy marine ecosystem and the provision of other ecosystem services and benefits. This is reflected in the importance of clean water for cultural services like recreational activities and tourism (Welsh Government, 2017).

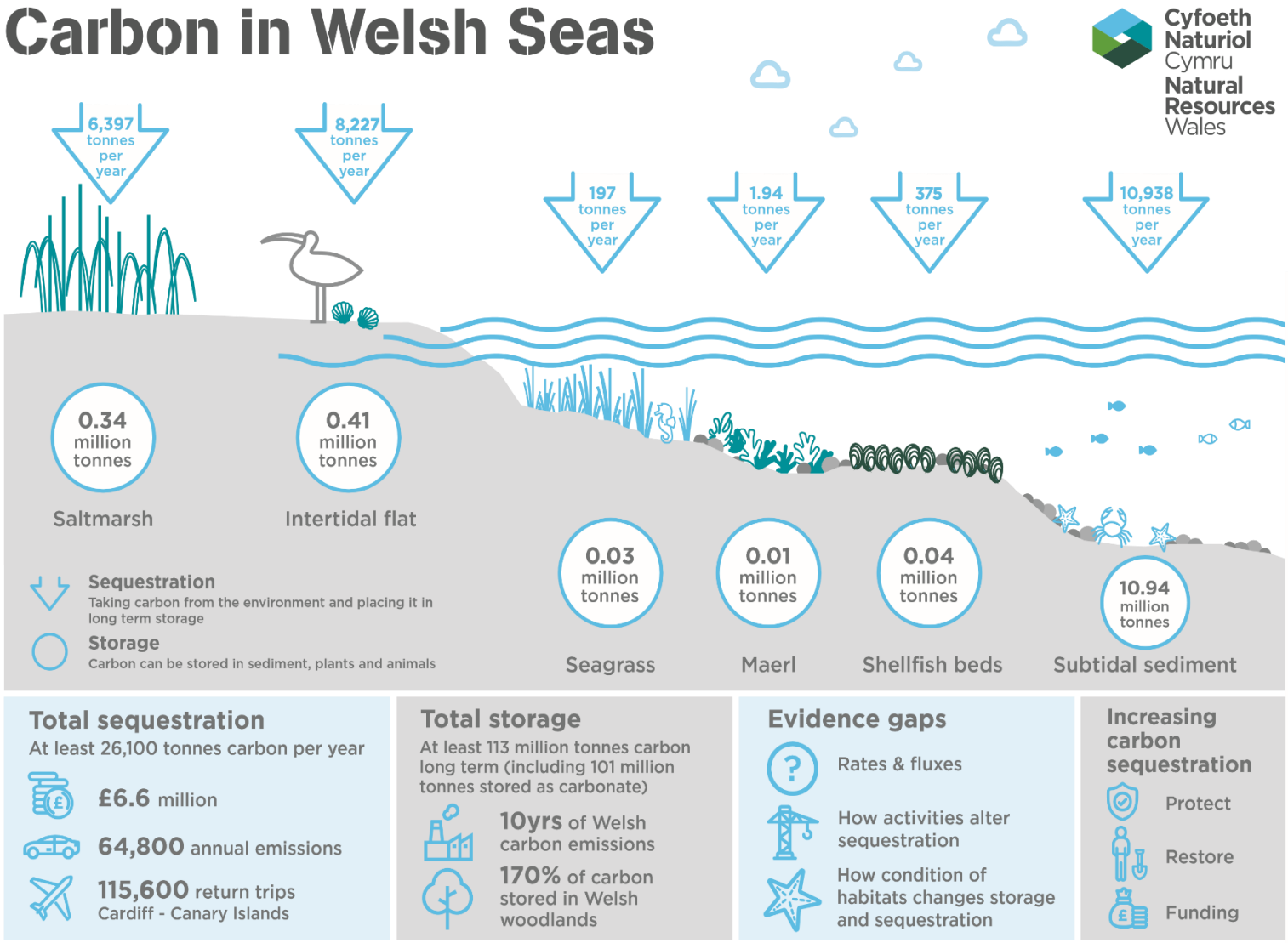

Figure 8 Summary of carbon sequestration and storage potential in Welsh seas.

Cultural ecosystem services are focused on the environmental settings for a number of activities (Table 18). It can be difficult to disentangle the cultural benefits derived from the marine environment from those derived from coastal land, as most people experience the sea from the coast. For more information about the Welsh coast see the SoNaRR2020 Coastal margins chapter. The seas around Wales and activities associated with the sea play a significant role in peoples' well-being by providing jobs, opportunities for recreational activities, and by supporting cultural diversity and a sense of heritage (Welsh Government, 2015). Those living near the coast are more likely to be skilled and employed part time, compared to those living more inland. There is, in general, less poverty, along with lower disability levels and better health, compared to non-coastal areas (Welsh Government, 2014). A review of the well-being plans of Wales's 19 public service boards (PSBs) found that the majority recognised the importance of the marine environment for physical and mental well-being and outdoor activity. However, there was significant potential for greater recognition of the contribution that the coast and marine environment can make to generating jobs through recreation and tourism (NRW, 2020b). The cultural services and benefits to well-being contribute to the overall picture in the UK, where the marine sector is estimated to contribute 8.1% of Gross Value Added (Stebbings et al, 2020).

Education and eco-knowledge opportunities include school trips to beaches, museums and aquaria, and educational programmes such as those operated by NGOs (such as the Marine Conservation Society's Cool Seas campaign), and through the eco-schools programme. There are benefits from learning and fun based educational programmes for both well-being and positive environmental behaviour, and exposure to coastal environments through learning can aid stress reduction, promote physical activity, and encourage positive social interactions (Kelly, 2018).

There is a growing body of evidence to demonstrate the health and well-being benefits of coastal and marine areas or 'blue spaces'. General perceptions of happiness in natural environments are more pronounced in marine and coastal areas (MacKerron and Mourato, 2013). Research finds that living by or visiting the coast is associated with lower rates of health inequalities (Wheeler et al, 2012) and depression or anxiety (White et al, 2013a) and higher rates of physical activity (White et al, 2014) and stress reduction (White et al, 2013b). In addition, coastal areas are more frequently accessed by individuals from lower socio-economic groups, suggesting the coast may support reducing activity inequalities (Elliott et al, 2018). These individual studies have been supported by systematic review of evidence on blue spaces (Gascón et al, 2017).

Coastal and marine tourism in Wales is important to local economies, and includes accommodation, restaurants, cultural activities, sports activities, and recreation (Welsh Government 2015). The Wales Coast Path showcases the diversity of the Welsh coast and marine environment. In 2018, coastal and seaside tourism was estimated to be worth £968 million and totalled 4.6 million trips (Great Britain Tourism Survey, 2018). Tourism and recreation are often a catalyst for wider economic and local regeneration activity. Spending by tourists helps to support local services, shops, and community amenities that would not otherwise be viable, enhancing quality of life and creating a greater range of opportunities for all sectors of the community (Welsh Government, 2020).

Recreational activities are of huge importance in Wales, including wildlife watching; sailing and leisure boating and associated marinas; clubs and infrastructure; surfing; angling; swimming; kayaking and many more (Welsh Government, 2015). The marine and coastal leisure and recreation sectors are the second largest sector in the UK marine economy and account for the largest number of jobs (Stebbings et al, 2020). The popularity of activities such as wildlife watching and visiting beaches has increased significantly in recent years (Natural Resources Wales, 2017). The Wales Visitor Survey found that the quality of the marine environment was important, with environmental recognition such as Blue Flag or Green Coast awards recorded as a key factor for visitors motivated by a visit to Welsh beaches (Welsh Government, 2017). Some recreational activities have additional value, such the citizen science contribution of volunteers as part of the Wetland Birds Survey (WeBS). Across the UK, WeBS has 3,290 registered volunteers monitoring 2,846 sites at an estimated value of £2.5m (JNCC, 2020b).

The temporal and spatial distribution of recreational activities, and their value to the economy, is poorly understood on the whole, but a project in south west Wales has gathered information on the type, amount and distribution of activities carried along the south and west coasts (Wales Activity Mapping, 2020). The Wales Activity Mapping project has potential to be replicated in other areas to assist with the sustainable development of recreation and tourism.

The GVA of subsea cabling for telecommunications has been estimated at £260 million, and Welsh ports handle approximately 12% of UK traffic (Welsh Government, 2015).

Further information on the key natural, cultural and perceptual influences that underpin the prosperity of coastal communities and their appeal to visitors can be found in a series of 29 Marine Character Areas (NRW, 2015).

Table 17 and Table 18 are based on Fletcher and Ingwall-King (2017), an assessment of the potential of marine ecosystem services to contribute to the well-being goals. This NRW-commissioned study used the UK NEA marine ecosystem service classification system (Austen et al, 2011) as its basis. It also included several additional services and benefits to the classification (specifically, low carbon energy production, energy from oil and gas, and aggregate extraction) in order to reflect the full range of marine activities in Welsh seas, particularly those identified in the draft Welsh National Marine Plan.

Table 17 Relative importance of regulating ecosystem services delivered by Marine ecosystem.

Regulating services	Level of importance
Climate regulation	High
Disposal	Medium to high
Hazard regulation	Medium to high
Wastewater management	Medium
Water quality	High

Table 18 Relative importance of cultural ecosystem services delivered by Marine ecosystem.

Cultural services	Level of importance
Environmental setting for health goods	High
Environmental setting for heritage goods	Medium to high
Environmental setting for marine transport	Medium
Environmental setting for setting for recreation, tourism and leisure	High
Environmental setting for religious and spiritual goods	Medium to low
Environmental setting for subsea cabling	Medium

6. Regenerative Economy (Aim 4)

Table 19 Provisioning Ecosystem services provided by Marine Ecosystem.

Provisioning services	Level of importance
Aggregates	High
Algae	Low
Biofuels	Low
Energy (low-carbon)	High
Fertilisers	Medium
Fish and shellfish	High
Fish feed	High
Food	High
Genetic resources	Low
Oil and gas	Low
Ornamental resources	Low
Seaweed	Medium
Water supply	Medium

Note: Information provided in Table 19 is based on Fletcher and Ingwall-King (2017), an assessment of the potential of marine ecosystem services to contribute to the well-being goals. This NRW-commissioned study used the UK NEA marine ecosystem service classification system (Austen et al, 2011) as its basis. It also included several additional services and benefits to the classification (specifically, low carbon energy production, energy from oil and gas, and aggregate extraction) in order to reflect the full range of marine activities in Welsh seas, particularly those identified in the draft Welsh National Marine Plan.

Welsh seas provide a range of social, environmental, and economic benefits derived from provisioning services, as detailed in Table 19. Key benefits include low-carbon marine renewable energy from abundant wave, tidal (stream and range), and wind resources; food such as fish and shellfish, both from wild capture and aquaculture; and aggregates (sands and gravels) extracted from the sea bed. Other benefits

include water abstraction; genetic resources for aquaculture; various applications of micro- and macroalgae, including as inputs for pharmaceuticals and biofuels, as fertilisers, food additives, and direct consumption as food. Some of these benefits are reliant on biological resources and as such the optimisation of their delivery is dependent on the resilience of the marine ecosystem. Other key services, such as renewable energy and aggregates, do not depend on the resilience of the ecosystem, so the focus of optimisation here lies in reducing the environmental impact of their production. These provisioning services contribute to the overall picture in the UK, where the marine sector is estimated to contribute 8.1% of GVA (Stebbings et al, 2020).

A secure, sustainable, and affordable supply of energy is of central importance to the economic and social well-being of Wales, and the marine environment will make an increasingly major contribution to the provision of the UK's energy supply. There are further economic and social well-being benefits from associated activities such as the construction (and maintenance) of marine energy installations, decommissioning of structures, and transmission of electricity to the distribution system distribution (Welsh Government, 2020). A Welsh Government commissioned study proposed that the development and installation of 1GW tidal stream installation and a 1GW wave installation would generate £840m in GVA and 24,000 person years of employment, and a further 440 FTE per annum during generation (Welsh Government, 2013). A review of the well-being plans of Wales's 19 PSBs found that there was potential for increased recognition of the value of marine renewable energy in creating new jobs (NRW, 2020b).

The existing operational offshore wind farms in Welsh waters have a generating capacity of 726MW (Carbon Trust, 2018). Various studies have highlighted the potential for further renewable energy development in Welsh waters due to the abundant wind, wave, tidal stream, and tidal range resource (The Crown Estate, 2011, Welsh Government, 2011). Wave, tidal range, and tidal stream technologies have the potential to deliver a further 6.4GW of installed capacity, and up to 10GW including the Severn (Marine Energy Wales, 2019). Opportunities to harness this wave and tidal potential are being explored through several demonstration zones and projects planned or underway around the Welsh coast (Marine Energy Wales, 2020), with leases for sites totalling 362MW agreed to date. North Wales has been identified as a priority region for Round 4 offshore wind leasing, with aspirations to add 1.5 to 3.5GW of capacity by 2030, based on potential extensions and a new leasing area (Carbon Trust, 2018).

Inshore fisheries involve the harvesting of fin fish, elasmobranchs, wild molluscs and crustaceans, as well as other marine organisms such as seaweed. Key capture fisheries for the Welsh industry are scallop, whelk, bass, lobster and crab. Sole, anglerfish, megrim, skates and rays are the most important demersal species in terms of their contribution to landed value (MMO, 2019). Other activities associated with the sector include fisheries enforcement, boat and gear building and maintenance, in addition to processing, distribution, sale and export of fish and shellfish (Welsh Government, 2020).

In 2018, £3.24m (662 tonnes) of fish and £8.57m (4,539 tonnes) of shellfish (excluding cockles) were landed in Welsh ports by vessels registered in Wales (Seafish, 2020). £0.76m (860 tonnes) of cockles were landed in the NRW managed

fisheries in the Dee Estuary and Burry Inlet (Seafish, 2020). There are 440 registered fishing vessels in Wales in 2018, of which 410 are less than 10m in length and 30 are greater than 10m in length. There are an estimated 1,193 fishermen in the Welsh fleet (MMO, 2019).

In 2017, aquaculture operations produced £1.05m of finfish (234 tonnes) and £1.87m of shellfish (1,545 tonnes) (Seafish, 2020). In 2015, aquaculture supported approximately 23 full time equivalent staff across Wales and provided over £3.5 million GVA. The principle species cultivated at sea was blue mussel (*Mytilus edulis*) with smaller numbers of native (*Ostrea edulis*) and Pacific (*Magallana gigas*) (Welsh Government, 2020).

The marine aggregates sector involves the extraction of sands and gravels from the seabed for use in construction, with the sector being a major contributor to the Welsh economy both directly and through ancillary services (Welsh Government, 2016; 2020). Broader economic benefits of the aggregates industry include skilled, stable employment and the generation of income through the construction industry supply chain. 47% of sand and gravel sold in Wales is from the marine environment, with 80% of outh Wales fine aggregate demand being met from marine sources (Welsh Government, 2020).

Further quantitative information relating to provisioning marine ecosystem services and benefits can be found in Wales' marine evidence report (Welsh Government, 2015) and update to Wales marine evidence report (Welsh Government, 2020); the UK NEA marine assessment (Austen et al, 2011); UK sea fisheries annual statistics (MMO, 2019); and Aquaculture in England, Wales and Northern Ireland (Seafish, 2016).

7. Synergies and Trade-offs

Based on the assessments of natural resources, resilience, and ecosystem services for well-being, there are synergies and trade-offs to highlight across a number of key areas. Many are consistent with priorities and commitments under other policies and mechanisms, such as the Welsh National Marine Plan and the Marine Area Statement. In some cases, appropriate consenting and management structures are planned or in place to guide the sustainable management of the activities concerned, although there may be evidence shortfalls. In other cases, trade-offs may relate to impacts from non-licensable pressures or issues and there may be significant opportunities for progress towards SMNR. Key areas include:

- building the resilience of marine ecosystems
- marine renewable energy
- water quality
- tourism and recreation
- marine and coastal habitat restoration

Synergies

- The Welsh National Marine Plan offers a unique opportunity to establish a synergistic relationship between building ecosystem resilience and sustainable strategic and project level development planning.
- Improving the overall management and condition of MPAs will help to meet national and international network obligations and increase the appeal of the marine environment, leading to increased cultural services and benefits for well-being such as health, tourism, recreation and associated economic benefits.
- Improved water quality, reduction of litter, and additional designations of beaches as Blue Flag, leading to increased cultural services and benefits for well-being such as health, tourism, recreation and associated economic benefits.
- Improved land management could reduce diffuse pollution into rivers and marine environment, reducing DIN levels and impacts on marine ecosystems.
- Restoring and enhancing coastal and marine habitats could secure regulating services and benefits of hazard protection such as flooding and erosion.
- There are significant opportunities through low-carbon marine renewable energy development to contribute to well-being, meet emissions reduction targets, address the global climate emergency, and help to ensure ongoing marine climate regulation benefits.
- Increasing sustainable aquaculture production could lead to multiple well-being benefits through increased provision of sustainably produced fish, shellfish, and algae.
- Restoring and enhancing seagrass, saltmarsh, and macroalgae habitats would increase ability of Welsh marine ecosystem to sequester carbon and provide natural defence against hazards such as coastal flooding.
- Improving our knowledge of the marine environment should drive more effective and efficient planning and decision-making and more refined understanding of conflicts between activities to support better use of marine space.

Trade-offs

- Agricultural practices are likely to need to change in order to reduce marine DIN levels, either through the use of Nitrate Vulnerable Zones or other management. These changes could impact the agriculture sector.
- Increasing tourism and recreational activities could result in increased impacts (such as marine litter, marine traffic, disturbance to marine species, damage to sensitive habitats) on the marine environment unless managed sustainably, particularly as many activities are non-licensable and there are therefore limited tools to guide their management.
- Promoting sustainable tourism while supporting the natural environment is a major challenge for the tourism and recreation sector, particularly as tourism and recreation are often centred around areas of high biodiversity such as MPAs.
- Development of the marine renewables sector could potentially impact the extent and condition of subtidal and intertidal habitats and could potentially have impacts including collision risk and displacement effects on mobile species.
- Developing WNMP resource areas and potential growth sectors (such as aggregates, ports and shipping, renewables, aquaculture) at a rate that prioritises

maintaining and enhancing the resilience of marine ecosystems may be at the cost of economic benefits through creation of jobs and supply chain benefits.

- Addressing pathways of marine litter will potentially have financial implications for the water and waste industries, local authorities, and businesses.
- Fishing material, this includes all material that helps recreational anglers and commercial fishermen catch fish and shellfish, represents a significant component of marine litter, but addressing issues may have financial and logistical implications for industry. However, the material does not necessarily originate from Wales and it is therefore not always appropriate for the fishing industry to foot the bill. Trade off might need to extend beyond industry such as to port authorities and local authorities responsible for collection and segregation of waste, provision of appropriate infrastructure and disposal costs.
- Addressing the potential impacts of fishing on MPA features that have been identified through the AWFA project high risk mobile gear assessments may have implications for fisheries that use 'high risk' gears in question.

8. Opportunities for Action

The UK NEA (Austen et al, 2011) recommendations for sustainable management of the marine ecosystem focused on:

- policy and legislation
- conservation, protected areas, and fisheries management
- management of human activities and future environmental change

Similarly, there are a number of processes underway that represent opportunities to address the pressures and issues identified here, make progress towards the sustainable management of marine natural resources and enhance the provision of benefits for well-being. Some existing opportunities stem from existing statutory processes in relation to licensable activities, or activities for which there is already considerable management. However, other opportunities relate to investing in addressing evidence gaps to improve Wales's ability to sustainably manage marine natural resources, or activities that are not currently subject to regulatory measures or management.

The scale of the MPA network means that effective management of Welsh MPAs is a fundamental part of delivering SMNR for the Welsh coast and sea. Strategic and prioritised whole-seas processes such as the marine area statement and WNMP are the most effective way to secure sustained improvement in the management and condition of MPAs, and hence in the health and resilience of the wider marine environment. However, these strategic processes are not intended to address challenges for well-being benefits in isolation and need to be supported and augmented by other approaches. Such approaches could involve collaborations across policy areas and external organisations to address pressures that span multiple ecosystems.

Welsh National Marine Plan and regulatory processes

The Welsh Government is undertaking marine planning for the sustainable development of Welsh seas to support jobs and social equity while ensuring natural assets can continue to provide the resources and environmental benefits upon which Welsh society's well-being relies. The Welsh National Marine Plan represents the start of a process of shaping Welsh seas to support economic, social, cultural, and environmental objectives.

Activities that require permission to take place in the marine environment are regulated and assessed through various processes, including: Habitats Regulation Assessment (HRA), Environmental Impact Assessment (EIA), marine licensing, and a number of other consenting and decision-making processes. Strategic planning processes such as these will be vital for coordinating action to sustainably manage social, economic, and environmental interests.

Initiatives such as the Sustainable Management of Marine Natural Resources project will improve access to data to support decision-making under marine planning by developing the environmental evidence base in relation to tidal stream energy, wave energy, and aquaculture resources in the Welsh marine area. Sector based programmes such as the Offshore Renewables Joint Industry programme are also developing evidence, particularly about potential impacts on the environment. In particular, the project is examining how use of these resources may affect marine protected areas and other sensitive species and habitats.

There are further opportunities to explore what marine planning could deliver, in terms of identifying areas of habitat for restoration or encouraging the embedding of ecosystem recovery measures into projects. These are areas of significant overlap with the Marine Area Statement and represent opportunities for collaboration with Welsh Government.

Marine Protected Areas Network condition and management

The MPA Network Management Framework sets out the structure for improving the management of the network of MPAs in Wales for the period 2018 – 2023, supported by an annual Action Plan. We need to improve our understanding of MPA condition over time, through monitoring and assessment, and this will be delivered in part through a revised integrated UK marine biodiversity monitoring programme. Within Wales, the programme will also inform wider marine evidence needs, supporting marine planning, management, and regulatory functions for NRW, WG and their partners. NRW will develop a new site condition reporting process based on the findings of the European Maritime and Fisheries Fund project 'Improving marine site level feature condition assessment reporting in Wales', which aims to develop indicators and a process for reporting on condition of features protected in Wales's network of MPAs.

Wales Marine Evidence Strategy

Programmes of evidence gathering will stem from the Wales Marine Evidence Strategy (Welsh Government, 2019), a joint initiative between WG and NRW. Through a series of strategic policy goals, it will help to address the most significant issue in assessing marine ecosystem resilience: the numerous evidence gaps across social, economic, and environmental uses of the marine environment. There will be opportunities for gathering, reporting, and using marine evidence and data in Wales through successful investment in and implementation of the strategy.

The strategy is aligned with the UK high level marine objectives, as shown below, and a result there will be opportunities for improving the evidence base across the full spectrum of uses and interests in the marine environment:

- achieving a sustainable marine economy
- ensuring a strong, healthy, and just society
- living within environmental limits
- promoting good governance
- using sound science responsibly

The NRW Marine Evidence Priorities work programme seeks to address some of the high-level priorities within the Wales Marine Evidence Strategy.

Good Environmental Status

The UK Marine Strategy identifies programmes of monitoring and measures to assess and deliver progress towards the Good Environmental Status of UK seas. There are many synergies between Good Environmental Status, SMNR, and the requirement to maintain and enhance biodiversity, and contribute to wider ecosystem resilience.

Fisheries

The existing and planned initiatives aimed at improving our understanding of the condition of stocks of commercially targeted fish and shellfish will contribute valuable information on the sustainability of marine fisheries activities and their locations in Welsh waters. These include:

- assessment and management outputs of the Assessing Welsh Fishing Activities project and the potential Assessing Welsh Aquaculture Activities project
- WG/NRW Marine Evidence Strategy
- Welsh Government commissioned fish and shellfish stock assessments
- Welsh Fishermen’s Association project to undertake pre-assessments in accordance with the core principles of the Marine Stewardship Council process and develop Fisheries Improvement Plans
- mandatory catch recording for all English and Welsh licensed fishing boats under 10 metres in length

- inshore vessel monitoring system (iVMS) for licensed fishing boats under 12 metres in length
- UK Fisheries Act and possible subsequent Wales Fisheries Bill

The opportunities presented by these initiatives, and the potential benefits for well-being, may depend on securing long-term funding.

Marine renewable energy

The development of the marine renewable energy sector represents a significant opportunity to contribute to a circular economy by making more efficient use of natural resources while optimising benefits of provisioning ecosystem services. However, increasing the deployment of renewable devices and sites will need to continue to take place sustainably to avoid potential consequences for the extent, condition, and connectivity of marine habitats, species, and natural resources.

Low-carbon energy was the service found to have the greatest potential capacity to increase its contribution to well-being goals (Fletcher and Ingwall-King, 2017). This was assessed to have a substantial potential contribution to both a ‘cohesive Wales’ (through the economic benefits from a thriving industry contributing to more cohesive local communities) and to a ‘globally responsible Wales’ (through provision of energy that does not contribute to greenhouse gas emissions).

River Basin Management Plans (RBMPs) and Good Ecological Status

RBMPs will integrate the measures and objectives of a variety of legislation including European Marine Sites, Bathing, and Shellfish Waters to protect, enhance, and restore all water bodies through the application of an ecosystem-based approach. These plans will manage pressures, put in place improvements, and align objectives with SMNR. There are further opportunities to address issues of water quality and impacts on marine features and associated well-being benefits, though these will require careful consideration due to the potential trade-offs.

Marine litter

There is evidence relating to the occurrence of marine litter on Welsh beaches, but we know less about the impacts in Wales. Welsh inshore waters are only partially covered by the established monitoring programmes for seabed litter and there is a poor understanding of the distribution of microplastics. Several policies and initiatives that are planned or in place seek to reduce the inputs of litter into the marine environment. These include:

- proposals and consultation to restrict single-use, hard to recycle and commonly littered plastics in Wales
- proposals for a Deposit Return Scheme
- proposals for Extended Producer Responsibility
- the Wales Clean Sea Partnership

- the Circular Economy Strategy
- the National Litter Prevention Strategy

A joint Natural England and Natural Resources Wales project funded through the Defra Impacts Evidence Group has investigated the impacts of marine plastics on MPA habitats and features (MBIEWG, 2020). This work could be further developed to identify new opportunities for SMNR in relation to biodiversity and impacts from marine litter. NRW is working to identify the links between waste, freshwater, and marine functions in order to ensure better coordination and develop activities that can address the sources, pathways, and impacts of marine litter.

Area Statement

The Marine Area Statement is a key vehicle for addressing the issues and opportunities that either fall outside of existing regulatory and management processes, or are related to opportunities for better integration and collaboration between policy areas. The actions we have identified with our partners are centred around three themes, all of which relate directly to ecosystem resilience and SMNR:

- building resilience of marine ecosystems
- nature-based solutions and adaptation at the coast
- making the most of marine planning

9. Evidence needs summary

The Welsh Government and Natural Resources Wales have jointly developed the Welsh Marine Evidence Strategy (Welsh Government, 2019) to identify the high level, strategic marine evidence priorities needed to support our respective marine policies and plans. The strategy is aligned with the UK shared vision for the marine environment of delivering ‘clean, healthy, safe, productive, and biologically diverse oceans and seas’. The UK high level marine objectives attached to this shared vision, as captured in the UK Marine Policy Statement, form the basis of the priorities in this Strategy. These are:

- achieving a sustainable marine economy
- ensuring a strong, healthy, and just society
- living within environmental limits
- promoting good governance
- using sound science responsibly

Building on the 2017 Marine Biodiversity Collaborative Research Priorities, NRW have developed a revised list of Marine Evidence Priorities to guide our internal evidence development programmes against several key drivers. There are some overlaps between the NRW Marine Evidence Priorities and the priorities of the Marine Evidence Strategy, but the intention of both frameworks is to work collaboratively with other organisations where possible.

The evidence priorities identified in these strategies and programmes best reflect the consensus of the key public bodies in Wales undertaking evidence work in the marine environment, and so are reflected here as the evidence needs for future iterations of the marine ecosystem assessment for SoNaRR.

Delivering against the evidence priorities identified will yield new understanding to support our assessment of progress towards SMNR in the marine environment. It is anticipated that these priorities will evolve, and more detailed evidence programmes will be developed to deliver these high-level priorities.

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