

Marine & coastal environments and well-being: a summary of the evidence base

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Executive summary

Coastal and marine environments impact directly on the well-being of communities in Wales through supporting local economies and tourism, the deployment of marine renewable energy, marine industries such as aggregates and fisheries and aquaculture, opportunities for physical activity and relaxation, and the physical and mental health benefits that flow from these. They also play important roles in helping to mitigate flood risks, supporting carbon sequestration and improving local water quality and waste remediation. They are environments with rich cultural heritages, and places that individuals can have strong emotional bonds and attachments to.

However, there are a range of pressures that are currently impacting on the delivery of these benefits. For example, there have been declines and significant losses in the extent, condition, and connectivity of coastal margin ecosystems in recent decades. And 45% of Marine Protected Area features were designated as unfavourable in the most recent assessments, with pollution being a key driver. Both marine and coastal environments are also under threat from the effects of climate change, including increased temperatures, sea-level rise and ocean acidification, and more widely, pollution and coastal development.

Several mechanisms already exist to address and tackle these issues. Recently introduced legislation including the Well-being and Future Generations Act and the Environment Act, and other relevant policy drivers such as the Welsh National Marine Plan provide frameworks to address cross-competing demands on marine and coastal environments, and to ensure that they are managed in a sustainable way in order that the benefits derived from healthy functioning ecosystems can continue to flow to communities across Wales.

The study of the interactions between coastal and marine environments and the well-being benefits derived from them is still, however, a relatively new field. Much of the research to date has related to the development of ecosystem services approaches which has helped to build our understanding of how marine and coastal environments provide a range of services that can benefit human well-being and the potential threats to these benefits. The emergence of Natural Capital accounting frameworks in recent years could also support an improved understanding of some of the benefits provided by marine and coastal habitats in Wales that could assist decision-making and conservation management.

However, there has been limited specific research to date that has directly explored the multi-faceted ways in which these environments impact on well-being outcomes. Many outputs have also tended to focus on a limited range of ecosystem services, such as provisioning services and those providing material benefits, such as fisheries or indicators that can be readily quantified such as around tourism sectors. Studies suggest management and conservation approaches have also tended to overlook the social elements of such systems.

In recent years there has been an emerging and developing research and activity base that has started to explore marine social science approaches. These studies have sought

to improve the understanding of these wider linkages, for instance the interlinkages between marine environments and socio-cultural attributes, values and perceptions and the health and well-being impacts of access to these environments.

This review sets out these evidence gaps and highlights where additional work could be progressed to improve our understanding of these areas. It also sets out several recommendations for actions that Natural Resources Wales should undertake in its current programmes to improve the cross-linkages between its marine programmes and supporting wider well-being benefits for communities in Wales.

Crynodeb gweithredol

Mae amgylcheddau arfordirol a morol yn effeithio'n uniongyrchol ar les cymunedau yng Nghymru drwy gefnogi economïau lleol a thwristiaeth, defnyddio ynni adnewyddadwy morol, diwydiannau morol fel agregau a physgodfeydd a dyframaeth, cyfleoedd ar gyfer gweithgarwch corfforol ac ymlacio, a'r manteision o ran iechyd corfforol a meddyliol sy'n deillio o'r rhain. Maent hefyd yn chwarae rhan bwysig wrth helpu i liniaru peryglon llifogydd, cefnogi'r gallu i ddal a storio carbon a gwella ansawdd dŵr lleol a'r gallu i adfer gwastraff. Maent yn amgylcheddau sydd â threftadaeth ddiwylliannol gyfoethog, ac yn llefydd y gall unigolion feithrin perthnasoedd emosiynol cryf â nhw.

Fodd bynnag, mae amrywiaeth o bwysau sy'n effeithio ar hyn o bryd ar y gallu i gyflawni'r manteision hyn. Er enghraifft, bu dirywiad a cholledion sylweddol o ran maint, cyflwr a chysylltedd ecosystemau ar ymylon arfordirol yn ystod y degawdau diwethaf. Dynodwyd 45% o nodweddion Ardaloedd Morol Gwarchoddedig yn anffafriol yn yr asesiadau diweddaraf, gyda llygredd yn un o'r ffactorau allweddol wrth wraidd eu dirywiad. Mae amgylcheddau morol ac arfordirol hefyd o dan fygythiad oherwydd effeithiau newid yn yr hinsawdd, gan gynnwys tymereddau uwch, cynnydd yn lefel y môr ac asideiddio yn y cefnforoedd ac, yn ehangach, llygredd a datblygu arfordirol.

Mae sawl mecanwaith eisoes yn bodoli i fynd i'r afael â'r materion hyn. Mae deddfwriaeth a gyflwynwyd yn ddiweddar, gan gynnwys Deddf Llesiant a Chenedlaethau'r Dyfodol a Deddf yr Amgylchedd, a ffactorau perthnasol eraill fel Cynllun Morol Cenedlaethol Cymru yn darparu fframweithiau i fynd i'r afael â galwadau amrywiol ar amgylcheddau morol ac arfordirol, ac i sicrhau eu bod yn cael eu rheoli mewn ffordd gynaliadwy er mwyn i'r manteision sy'n deillio o ecosystemau sy'n gweithio'n iach barhau i lifo i gymunedau ledled Cymru.

Fodd bynnag, mae astudio'r rhyngweithiad rhwng amgylcheddau arfordirol a morol a'r manteision sy'n deillio ohonynt o ran llesiant yn dal i fod yn faes cymharol newydd. Mae llawer o'r gwaith ymchwil hyd yma wedi ymwneud â datblygu dulliau sy'n ymwneud â gwasanaethau ecosystemau, sydd wedi helpu i feithrin ein dealltwriaeth o sut mae amgylcheddau morol ac arfordirol yn darparu ystod o wasanaethau a all fod o fudd i les pobl a lliniaru'r bygythiadau posibl i'r manteision hyn. Gallai datblygiad fframweithiau cyfrifyddu Cyfalaf Naturiol yn ystod y blynyddoedd diwethaf hefyd gefnogi gwell dealltwriaeth o rai o'r manteision a ddarperir gan gynefinoedd morol ac arfordirol yng Nghymru a allai helpu o ran gwneud penderfyniadau a rheoli cadwraeth.

Fodd bynnag, prin fu'r gwaith ymchwil penodol hyd yma sydd wedi archwilio'n uniongyrchol y ffyrdd amlweddol y mae'r amgylcheddau hyn yn effeithio ar ganlyniadau llesiant. Mae llawer o allbynnau hefyd wedi tueddu i ganolbwyntio ar ystod gyfyngedig o wasanaethau ecosystemau, fel y rhai sy'n darparu gwasanaethau a'r rhai sy'n cynnig manteision materol, fel pysgodfeydd neu ddangosyddion y gellir eu mesur yn hawdd megis o amgylch sectorau twristiaeth. Mae astudiaethau'n awgrymu bod dulliau rheoli a chadwraeth hefyd wedi tueddu i anwybyddu elfennau cymdeithasol systemau o'r fath.

Yn ystod y blynyddoedd diwethaf, daeth sylfaen ymchwil a gweithgarwch i'r amlwg sydd wedi dechrau archwilio dulliau gwyddoniaeth gymdeithasol forol. Mae'r astudiaethau hyn wedi ceisio gwella dealltwriaeth o'r cysylltiadau ehangach hyn a sut mae'r amgylcheddau hyn yn rhyngweithio ag ardaloedd sydd wedi tueddu i gael eu hanwybyddu hyd yma ym maes lles morol, gan gynnwys y cysylltiadau â phriodoleddau cymdeithasol-ddiwyllyannol ac effeithiau mynediad i'r amgylcheddau hyn ar iechyd a lles a sut y gellid ystyried y rhain wrth wneud penderfyniadau.

Mae'r adolygiad yn nodi'r bylchau tystiolaeth hyn ac yn amlygu lle y gellid gwneud gwaith ychwanegol i wella ein dealltwriaeth o'r meysydd hyn. Mae hefyd yn nodi nifer o argymhellion ar gyfer camau gweithredu y dylai Cyfoeth Naturiol Cymru eu cymryd yn ei raglenni presennol i wella'r cysylltiadau rhwng ei raglenni morol ac er mwyn cefnogi manteision llesiant ehangach i gymunedau yng Nghymru.

1. Introduction & Methodology

This summary review provides information on the evidence base relating to how marine and coastal environments impact on well-being.

Until recently, there had been limited focus on the specific interactions between coastal and marine environments and well-being outcomes. Much of the initial development of this work had been centred around the development of ecosystem services approaches, and broadly speaking, those that focussed on a specific set of service indicators that could most readily be quantified such as provisioning services associated with the fisheries industry.

More recently, however, there has also been an emergence of what has broadly been classified as, 'marine social science', which has begun to explore in more detail the wider ways in which coastal and marine ecosystems impact on physical and mental health, culture and heritage, and social values and issues. This is still an emerging area of research given the limited number of studies to date at the UK and Wales-wide level. For example, in a recent systematic review of well-being outcomes of Marine Protected Areas, only 4 of the 118 articles were directly UK-based (Ban *et al.* 2019). But in combination with the above, we now have an improved understanding of how specific or functional processes within these environments translate into the wide range of services and benefits that society derives from them.

Recent assessments demonstrate that there are various pressures that are currently impacting on the state, condition, and extent of coastal and marine habitats, including coastal development and water quality issues, which can have negative impacts both on ecosystem functioning and their capacity to provide the range of benefits we derive from them. The effects of climate change will exacerbate these pressures, and therefore it will be imperative to address how resilience of coastal and marine ecosystems can be maintained or enhanced in order that those systems have the capacity to absorb and withstand these pressures whilst continuing to provide benefits.

Over the past decade, there has been an increasing shift within Natural Resources Wales (NRW) to assess how conservation, management and environmental participation and access programmes link to broader socio-economic outcomes and sustainable development principles through Sustainable Management of Natural Resources (SMNR). But further work is needed to understand the full extent to which coastal and marine environments affect well-being and how this can translate into actions to support it.

This review contributes to such efforts through two key objectives. Firstly to summarise broadly detail the findings of research that has been undertaken to date to understand the impact of marine and coastal environments on well-being in the UK. Papers on a European scale have also been included where these highlight issues on a trans-boundary basis or provide novel insights into a particular approach to well-being research not found in UK studies.

Secondly, it draws together some of the key gaps and opportunities where further work could be progressed to improve the understanding and integration of well-being outcomes from these environments. In this review, the concept of well-being is used within its widest sense, in a similar way to that detailed in the Well-being and Future Generations Act (2015) and its associated goals, in encompassing the economic, social environmental and cultural well-being of Wales, and not solely physical and mental health outcomes.

The review is structured as follows. The first section focuses on the evidence related to the range of benefits provided by marine and coastal ecosystems. These are presented where possible by the type of ecosystem service provision, otherwise by specific sectors or industries.

The second part of the review details the various pressures and challenges on these ecosystems which impinge on the delivery of these benefits. The final section focusses on the tools that are available or currently in development that can support activities to address these challenges. These range from legislative frameworks such as the Well-being and Future Generations Act, through to emerging approaches related to Natural Capital accounting and the development of social indicators to support decision-making and management of conservation activities. Finally, some recommendations are made as to where NRW should prioritise its' own activities to enable health and well-being outcomes to be better reflected in the management of the marine and coastal environment.

Given the relative infancy of the area, further work is still needed to understand either the benefits and/or challenges in some areas, and how the latter impact on ecosystem functioning. In addition, several of the tools are still untested or limited in their application and may require further development to address some of these issues. The review aims to highlight these gaps and recommendations that have been highlighted by the literature for further research or application.

As several review papers had recently been published which assessed well-being linkages with various aspects of marine and coastal environments and management, it was decided that a systematic literature review of this broad areas should not be undertaken.

Thus, the following approach was taken:

- Those papers contained within the systematic reviews with an explicit focus on the United Kingdom were reviewed, and the findings are drawn out in each section, although where relevant, reference is made to the key findings of these systematic reviews which may span several countries.
- Additional papers were searched for against the key terms criteria contained within the reviews for those years subsequent to the publication of the review to the present, and also of relevant grey literature. The papers include Ban *et al.* (2019), Rasheed (2020), Blythe *et al.* (2020), and Short, R.E *et al.* (2021) detailed in the Bibliography, and articles were searched for in available databases comprising Web of Science and JSTOR. The search methodology is included in the Annex.
- Any relevant studies or papers not captured within the above, and that were highlighted by NRW colleagues were also included for review.

2. Benefits

Marine and coastal environments provide us with a wide range of benefits. However these benefits are not always fully appreciated or understood in terms of their linkages with other sectors of the economy and/or society.

Before looking in detail at the benefits derived from specific areas, it is useful to provide some general context on the area of ecosystem services and how this translates to well-being. In recent decades, the framework of ecosystem services has been used to classify the broad range of benefits that people derive from the natural environment. Such frameworks tie core ecosystem processes to beneficial services which link to human and wider well-being and go beyond just a pure monetary valuation of direct benefits and can be applied to specific research and bespoke ecosystem service assessments. However, for the purposes of this review, an initial outline will help to contextualise and frame how core ecosystem processes tie to beneficial services which link to wider well-being outcomes.

The Millennium Ecosystem Assessment (2005) defined ecosystem services as, “the benefits that people obtain from coastal and marine ecosystems” and split them into four broad type of services:

- **Provisioning services** linked to the supply of material resources such as fish and aggregate materials for construction.
- **Regulating services** that control ecological and climatic processes, such as carbon sequestration or how organisms and habitats help to improve water quality.
- **Cultural services** which are the non-material, aesthetic, spiritual and recreational benefits we derive from ecosystems, and can include the ability of ecosystems to stimulate educational benefits, relieve stress and revitalize the brain’s ability to direct attention (Fairchild *et al.*, 2018). It must be noted here that not all the services and benefits provided by physical activity in the outdoors rather than just solely through recreation.
- **Supporting services** that provide the basic ecological functions that underpin all other services (e.g nutrient cycling and oxygen production) (Fletcher *et al.*, 2014).

Since the publication of the Assessment, there have been several initiatives which have updated the definitions of (marine) ecosystem services, including the Economics of ecosystem services and biodiversity (TEEB) and the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES). The current most widely used classification is the Common International Classification of Ecosystem Services (CICES) which define ecosystem services as the contributions they make to human well-being and grouped them into three main categories (provisioning, regulating and maintenance and cultural), with supporting services treated as part of the structures and processes of ecosystems (Buonocore, E *et al.*, 2021).

Figure 1 below provides a summary of the broad linkages between such services and well-being outcomes.

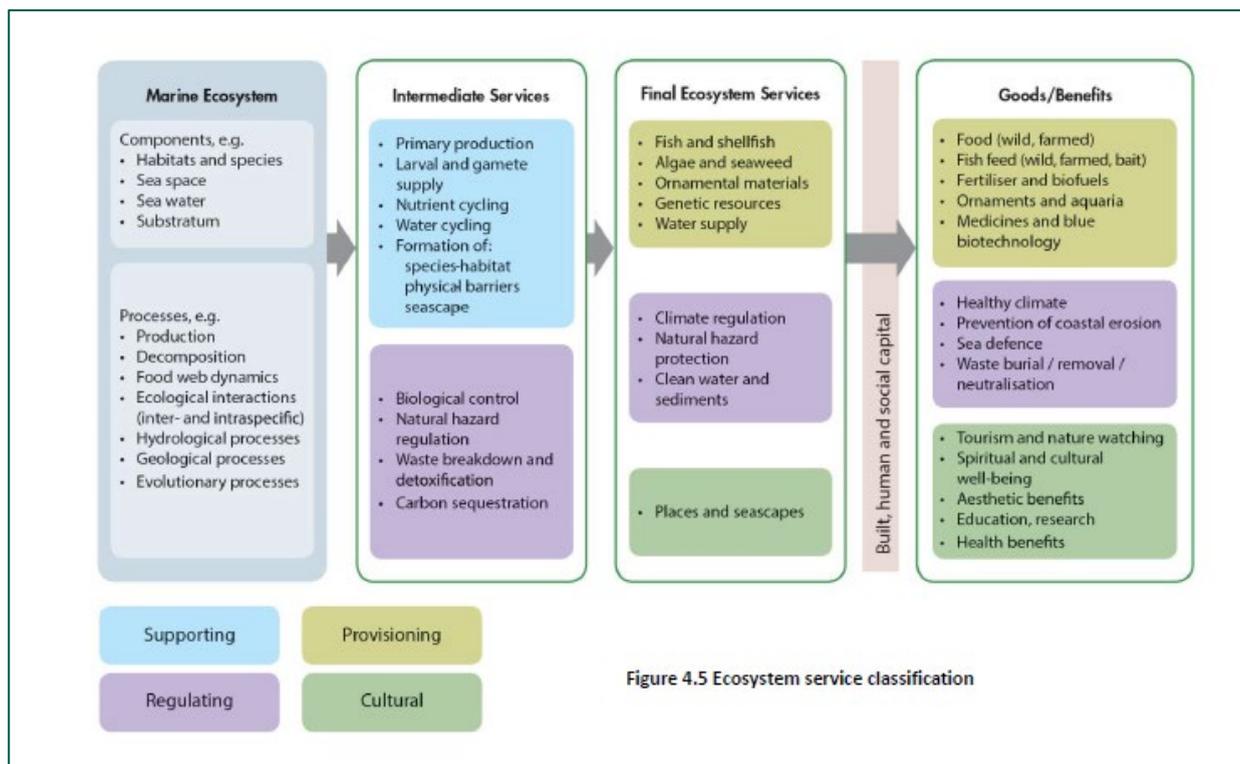


Figure 4.5 Ecosystem service classification

Figure 1: Diagram summarising the linkages between ecosystem services and well-being outcomes (taken from Turner, K et al (2014))

The first section of this review aims to summarise the findings of recent research that has helped to develop our understanding of the wider well-being benefits and impacts from marine and coastal environments.

2.1 Economy & provisioning services

Marine and coastal environments support a wide range of sectors of the Welsh economy and can continue to make a significant contribution to the transition towards more sustainable economies going forward, when undertaken sensitively and sustainably. In the UK, the combined marine and maritime sectors are estimated to be worth around £47 billion gross value added (GVA) (equating to 2.7 per cent of total UK GVA) and employ more than 500,000 people (Natural Capital Committee 2019). At the UK wide level, several estimates of the total GVA of marine ecosystem services in the UK have been made (Government Office for Science, 2018), including:

- Aquaculture, fisheries and processing (**£1.1 billion**).
- Marine recreation and tourism (**£4-5 billion**).
- Climate regulation/CO₂ sequestration (**£7 billion**).
- Coastal protection (intertidal habitats) (**£3.1-£33.2 billion**) (NEA, 2011).

In Wales, estimates have suggested that coastal and marine environments contribute up to £2.1 billion to the Welsh economy across a range of sectors (Atkins, 2020). For instance, they make an important contribution in tourism and recreational and physical activities. McDonough and Roche (2016) for example, estimated that there were 43.5 million visits to

the Welsh coast for walking in 2014, with direct expenditure by adult visitors on these trips at £547m.

The energy sector has a significant influence on the marine environment in Wales. Existing gas, oil and nuclear power infrastructure continue to play a role in the marine economy. Welsh Government has set an ambition for 70% of electricity to be derived from renewable sources by 2030 from current levels of roughly 25% of generation (Welsh Government, 2018).

Marine renewable energy is considered an important sector to contribute to the achievement of this target, and various assessments have been made of the potential opportunities that could result from the further deployment of marine renewable technologies in and around the Welsh coastline, including a potential export market of £76bn by 2050 (Marine Energy Wales, 2020).

As well as its direct role in helping to support emissions reductions, marine renewable energy can help to bring highly skilled employment to coastal regions, support the transition from fossil fuel based industries, and it is argued that it could help to support the regeneration and growth of rural economies and ports as well as an opportunity for economic diversification of such areas. However, the deployment of offshore renewable energy will have interactions with other sectors. Any resulting conflicts will need to be addressed through appropriate frameworks such as the Marine Plan. Qu *et al.* (2021) used economic modelling to assess the impact of increasing offshore wind developments in Scotland, and found for example that increasing the number of offshore windfarms would have a slight negative effect on seafood production sectors, although there would be improvements for energy security and wider economic benefits from lower energy costs in those cases where the prices are lower than the wholesale market.

To date, in Wales, £123.7 million has been spent to date on the development of the marine energy industry and the sector has generated over 737 person years of employment (Marine Energy Wales, 2020). There has been continued growth in the overall number of full-time employees (FTE) – with 176 people currently employed full time, an increase of 43 FTE from 2019.

2.2 Fisheries

The fishing industry has been an integral element of many coastal communities in Wales despite accounting for a small share of economic activity relative to other extractive and production industries. Estimates of the total GVA of registered vessels in Wales were just under £12m in 2018 (Atkins, 2021) compared to £32m and £615m for Forestry & logging and Agriculture & hunting sectors respectively (Welsh Government, 2021a).

In 2018, £3.24m (662 tonnes) of fish, £8.57m (4,539 tonnes) of shellfish (excluding cockles) and £0.76m (860 tonnes) of cockles were landed in either Welsh ports or NRW managed fisheries, whilst aquaculture operations produced £1.05m of finfish (234 tonnes) and £1.87m of shellfish (1,545 tonnes) in 2017 (Natural Resources Wales, 2020a). The

industry also directly and indirectly supports a wide range of businesses in the food, hospitality and tourism industries. Ultimately, the health of marine fisheries is linked to the health of marine ecosystems. Maintaining healthy and resilient ecosystems can support multiple productive fisheries and help adapt to some of the changes that will be experienced with climate change in the future (NOAA, 2020). However, there is also a wider recognition amongst policy and decision-makers of the need to monitor and evaluate the socio-economic outcomes of fisheries for example. Bennett *et al.* (2021a) have developed a guidance framework to support policy-makers and practitioners to develop individualised approaches to socio-economic monitoring and evaluation/assessment plans.

2.3 Tourism

Marine and coastal environments, habitats and species make a vital contribution to tourism and recreation, through activities such as wildlife watching, angling and adventure sports. Tourism is a significant contributor to the Welsh economy and was estimated to be worth £986 million from a total of 4.6 million visits in 2018 (Natural Resources Wales 2020a). Other estimates suggest that marine resources also provide tourism and recreation opportunities contributing £2.5 bn per year to the Welsh economy (Welsh Government, 2015). In addition, just under one half of full-time jobs in marine and coastal environments in Wales are in tourism related activities (Atkins, 2020). The sector also contributes to a range of wider indirect benefits including health and quality of life. For instance, a study calculated the economic value of the health benefits of walking on the Wales Coast Path in 2014 at £18.3m (Cavil, Rutter & Gower, 2016).

The ONS (2020) have also produced preliminary natural capital accounts which contain values for recreational aspects of cultural services at different environments. For example, they highlight that a significant proportion of hours spent outdoors are at coastal margins. In 2017, people in Wales also had the largest annual expenditure per person in visits to natural environments.

Similarly, a recent study by Börger *et al.* (2021) also estimated the value of recreational visits to blue-spaces across 14 European countries. They estimated the value of a visit at € 41.32 (€ 50.55 for the UK) which added to a total recreational value of €631bn per year across all states (€102.98bn for the UK). They also found that a one-level improvement in water quality can lead to a nearly 7 % increase in visits, whereas a one-level deterioration leads to fewer visits (-20.83%), which highlight that efforts to maintain and improve bathing water quality standards are not only crucial for human health but also for local economies.

A small number of research studies have attempted to assess the impacts of tourist and recreation activities on well-being. Rees *et al.* (2015) explored the impacts of Marine Protected Areas on leisure and recreation activities following the designation of an MPA in Lyme Bay, England. They found that it has had varying effects on the delivery of beneficial ecosystem services in the sector between different users such as dive businesses and sea anglers and parts of the MPA, but estimated a potential increase in the value of the MPA resource of £2.2 million. The authors noted that it is important to assess effects both inside and outside the MPA and from an ecological and a socio-economic perspective to help

refine management strategies and reflect the needs of various stakeholders to support effective conservation.

Chae *et al.* (2012) applied a model to estimate non-market recreational benefits from visits to Lundy Island marine nature reserve on tourist activities and found a mean consumer surplus in the range of £359-£574 per trip. The authors argue that it provides strong economic justification for designating MPAs for recreational as well as conservation purposes.

Beach-based activities can also help to support well-being and instil wider positive effects amongst individuals taking part in them. For example, in a study comparing beach cleans to other types of marine activities, Wyles *et al.* (2016) found that they can improve individuals' mood and well-being, support learning about the marine environment and support intentions to engage in more pro-environmental behaviours. The study also found that the type of activity has an influence on the outcomes, for example with beach cleaning scoring highly in comparison to other activities in terms of meaningfulness to participants, but less so on restorativeness effects.

2.4 Health, social & cultural benefits

Social & cultural benefits

Marine and coastal areas can provide a sense of place, identity and cultural heritage for individuals and communities. Not only do they influence artistic and creative works, but they can also evoke strong emotional connections and attachments for individuals.

The tangible cultural and subjective experiences, resonance and connections that the coast can provide for individuals was also highlighted in a study by Bell *et al.* (2015) who outlined how participants in the study expressed particularly strong and enduring connections to the local coastline which catered for varying therapeutic needs and interests, at multiple scales and intensities. They argue that the findings support calls to account for people's emotional and embodied connections to the coast within coastal management policy and practice and the multiple and nuanced ways in which people engage with coastal spaces for well-being, such as functional and pleasurable environments to pursue long-term goals or more immediate feelings of short-term cathartic release.

A small survey undertaken by WWF in 2012 (WWF, 2012b) explored the Welsh public's perceptions of the marine environment. It provides high-level figures of public attitudes to the Welsh coast which highlighted that 75% of people agreed that the Welsh coast is an important part of their life, and 67% of those surveyed were also concerned about the effects of climate change and sea level rise upon their lives. Similarly, in a recent survey of people living in England and Wales conducted by Defra (2021a), 85% of individuals stated that protecting the marine environment is very important or important to them. Nearly 60% of those surveyed also rated the health of the global marine environment as poor or very

poor and nearly 50% of those surveyed were concerned when asked to report their feelings when thinking about the marine environment.

Some recent studies have also looked to explore people's perceptions, values and attachments to the coast, including a study by Acott *et al.* (2022) where they highlight the strong relational values and personal connections held by people towards their local coastal environments and how these can also be captured within decision-making and policy development.

Thomas *et al.* (2022) also aimed to explore the perceptions of people to saltmarshes in two case studies in Wales. They found that saltmarshes are ambiguous places that do not have one obvious meaning and are open to more than one interpretation. They suggest that management should be attentive to the multiple and ambiguous meanings associated with them by exploring the values of those who stand to be affected by decisions and through adaptive management methods. They note how change is inherent not only in the physical nature of saltmarshes but also in peoples' relationship with them and the ways in which they are valued, as values may for instance gain or lose prominence as the saltmarshes themselves change under the pressures of climate change and sea-level rise and as how societies change around them.

Similarly, Roberts *et al.* (2021) argue that values cannot be isolated from place, time and culture and that management decisions should be tailored to attend to community concerns and understand cultural ecosystem services that are valued within a place.

Jefferson *et al.* (2021) highlight how although there has been a growing body of research exploring public perceptions of the oceans, there is a need to better integrate social science and ocean perceptions research into the broader marine landscape, and propose that a mechanism could be through undertaking a strategic, interdisciplinary assessment to identify marine conservation priorities to which ocean perceptions can leverage maximum impact. They also note that public perceptions research could benefit from wider social science methods and evidence to support more socially sensitive interventions.

However, much of the recent literature associated with marine well-being has highlighted the lack of attention to date paid to the social and cultural implications of marine restoration and management activities, and the resultant impacts on local communities, economies and individuals.

For example, Ban *et al.* (2019) undertook a systematic literature review of articles that analysed well-being outcomes related to Marine Protected Areas (MPAs). They found that half of documented outcomes were positive and roughly one-third were negative. The most positive outcomes were related to community involvement (76% positive) catch per unit effort (CPUE) (73%), and income (65%). The most negative aspects were related to the increasing cost of activities (100% in 13 instances) and conflict (79%). However, Rasheed (2020) argued that it is unclear whether the conclusion around the positive effects of outcomes in their paper would have been found if there were better data that accounted for a wider consideration of well-being domains, and at different temporal and social scales.

Rasheed (2020) also produced a systematic review that assessed the well-being outcomes of MPAs from an analysis of its impact on different aspects of human and social capital (human, social, built and natural capital). He highlights how relatively few studies have explicitly examined human well-being and, furthermore, empirical studies that quantify how much MPAs contribute to human well-being are particularly rare. Similar to the findings of Ban *et al* (ibid.), most papers only focussed on a narrow sub-set of attributes (indicators) representing a restricted number of capitals (e.g employment, income and food security), a small subset of stakeholders (frequently fishers) and are rarely used to directly measure human well-being, but instead are used as proxies to discuss perceived end goals of MPAs.

Similarly, Blythe *et al.* (2020) explored the interdisciplinary literature relating well-being in coastal areas to ecosystem services, and found that in many cases to date, well-being benefits from the marine environment have also tended to be framed through a focus on a small subset of ecosystem services or indicators. For example, provisioning services were considered most frequently (51%), followed by regulating and maintenance services (48%) and cultural services (37%). Food provisioning was the most common individual ecosystem service (measured by 33 of 50 articles), followed by recreation and tourism (20%). However, symbolic and aesthetic values (15%), coastal protection (10%) and life cycle maintenance (10%) were considered less frequently and they found that the relationship between ecosystems and well-being is still largely framed in terms of material benefits (e.g fish harvesting).

Scholte *et al.* (2015) and Solé and Ariza (2019) have also argued that a focus on ecosystem functionality and ecological processes for ecosystem provision has led to a narrow view of socio-cultural values in ecosystem service research to date. This, they argue, has led to the conflation of cultural ecosystem services with sociocultural valuations resulting in most assessments to socio-cultural aspects being limited to assessing recreational and tourism services and the neglect of social factors such as coproduction, institutions and governance, value pluralism and human well-being and its distribution

Some researchers have also attempted to understand the effects of dis-benefits in the marine environment to the provision of cultural ecosystem services. Willis *et al.* (2018) studied the effects of harmful algal blooms on human well-being (for example, through disruptions to therapeutic and inspirational opportunities or recreation). In interviews which they conducted with local residents they found that the understanding of the impacts of the blooms could be felt more deeply than would be revealed through an economic or health analysis, and argue that there is need for further research to incorporate local experiences and cultural insights with ecological and economic changes into decisions around responding to environmental shocks in order to arrive at more locally appropriate solutions.

Another key challenge to the realisation of benefits from coastal and marine environments is the low awareness of the ecosystem services and benefits provided by marine and coastal environments in Wales. The recent Defra survey (2021a) for example highlighted a limited knowledge of the benefits provided by marine environments other than those associated with provision services (e.g food). For example, roughly 20% of respondents

were aware of their carbon sequestration or coastal protection potential and only 12% as places to support mental health and well-being.

The risks associated with this are that lack of awareness could translate into a limited reflection of these benefits in public policy and strategy objectives. Ibrahim (2020), for example, highlights how many Public Service Boards in Wales had failed to recognise or integrate the benefits that marine and coastal environments can provide into the development of their first set of Well-being Assessments in Wales in 2016. McKinley *et al.* (2020b), focussing on coastal environments in Wales, found limited public awareness of saltmarshes and a high degree of uncertainty regarding the benefits provided by these ecosystems.

Health

Marine and coastal environments can have a range of both positive and negative impacts on people's health and mental well-being. For instance, they provide a range of benefits such as acting as therapeutic and restorative landscapes for promoting well-being and mental health, they provide opportunities for physical activity and exercise helping to reduce the risks of obesity, developing diabetes, cardiovascular and respiratory diseases and various cancers (SOPHIE, 2020), through to the provision of seafood. For example, in a recent survey, good mental and physical health were the most frequently reported outcomes from spending time in the marine environment (Defra, 2021a).

Some of the negative health outcomes of these environments however include exposure to coastal flooding events, hazards and accidents through recreational or work-based activities, and contamination of water and seafood by sewage and/or other pollutants (Depledge, 2019).

To date, the majority of research looking at the interactions between the natural environment and human health and well-being has tended to focus on, 'green' rather than 'blue' spaces (SOPHIE 2020). Hence the potential benefits of interacting with ocean, coastal and inland waterway areas are less well understood. However, it is becoming increasingly recognised that access to opportunities for physical and therapeutic activity at coastal locations can provide opportunities for supporting improvements in people's physical and mental health, helping the shift towards preventative health care and a One Health (CDC, 2018) approach in Wales.

Several reviews have been undertaken to assess the linkages between blue spaces and health (well-being). Gascon *et al.* (2017) undertook a systematic review of quantitative studies focussed on outdoor blue spaces and human health and well-being and found that there was consistent evidence that suggest a positive association between greater exposure to outdoor blue spaces and benefits to mental health and well-being and levels of physical activity. The evidence of any direct causation was however limited and there was less consistent evidence of an association between outdoor blue space exposure and general health, obesity and cardiovascular and associated outcomes.

Results from some studies have suggested a positive association between positive health and well-being outcomes amongst populations/communities living closer to the coast (Wheeler *et al.*, 2012) and those visiting green and blue spaces more frequently (White, M.P *et al.* 2021). In addition Garrett *et al.* (2019) found that the association is stronger for more deprived socio-economic groups, although they noted that this should not be interpreted as demonstrating a general, causal relationship between coastal proximity and mental health disorders. Similarly, White *et al.* (2013b) found that the effects of coastal proximity on individuals' health was also significantly higher for those living closer to the coast after controlling for additional factors that could influence outcomes, although no effect was found on life satisfaction.

In an analysis examining the frequency of and predictors of recreational visits to coastal environments in England, Elliot *et al.* (2018) found that visits to the coast involving walking compared to woodland walks were more likely to be made by individuals from lower socio-economic classification groups, and suggest that accessibility to coastal areas may support a role in reducing activity inequalities in these groups.

In recent years there has also been an increase in the use of blue space therapeutic interventions/activities to promote improved health and personal well-being at coastal settings.

Britton *et al* (2020) undertook a systematic review to investigate the impact of these interventions on health and well-being. The evidence from from the available studies suggests that blue care can have direct benefits for health, particularly mental health and psycho-social well-being. Some studies found evidence for greater social connectedness during and after interventions, although results were inconsistent and mixed across the studies. Godfrey *et al* (2015) similarly evaluated the impacts of a surfing programme with aims to boost well-being and confidence of a participatory group of young people with mental health issues or social exclusion in the UK which resulted in significant and sustained increases in well-being amongst participants. Similarly, White *et al.* (2016) describe how sail-training voyages have benefited clients in recovery from addiction in drug rehabilitation centres across the UK.

However, the evidence on the effects of therapeutic interventions have to date been limited by small sample sizes, lack of control and follow up groups, and diversity in participant selection (Britton *et al.*, *ibid.*). In addition, not all interventions were necessarily undertaken with the intention of conducting research.

Pellens *et al.* (2022) reviewed a series of 150 innovative actions to promote both ocean and human health (including citizen science, ecotourism, environmental education and mental health) across countries in Europe, including the UK. The authors argue that overall, they provided a positive impact on the health of both the oceans and humans through for example outcomes such as improved water quality, participation in addressing environmental issues and supporting sustainable tourism and the example models could potentially be scaled-up to further integrated actions at local, regional and national levels. The studies were however limited to content analysis and interviews with programme

leads. Further scientific research would be needed to evaluate the effectiveness of the programmes and impacts on both the environment and human health.

In addition, several studies have identified some of the areas where there are gaps in our knowledge of the impacts of marine and coastal environments on health outcomes, and which could provide opportunities for further research, including:

- Some studies have highlighted how current public concerns with the health impacts related to the marine environment have been predominated by the impacts of marine plastic pollution despite the lack of substantive evidence yet to suggest a strong link with human health. As well as highlighting the need for further research to better understand the health/well-being implications, Davison, *et al.* (2021) argue that the findings, which revealed how perceptions vary between different socio-demographic groups could provide insights into novel pathways to action on climate action as health concerns have been shown to motivate action for climate change. Similarly, Britton *et al.* (2021) argue that linkages between Oceans and Human Health provides an opportunity for a new way of understanding interrelationships with the ocean and to humanise environmental crises.
- Opportunities to further explore how variations in accessibility to the coast affect the quality and frequency of visits and related mental health benefits (Garrett *et al.*, *ibid.*). As noted by Wheeler *et al.* (*ibid.*), blue spaces could help to support reductions in health inequalities and stress reduction and increased physical activity for more socio-economically deprived communities and behavioural change. Similarly, Godfrey *et al.* (*ibid.*) note that blue space/therapeutic schemes could act as cost-effective ways to support delivery of mental health and substance abuse care, mentoring and social integration of young people but this research area is still in its infancy. Many of the health benefits of such therapies have not yet been thoroughly researched and some impacts remain poorly quantified or the specific mechanisms are yet to be understood (Short *et al.*, *ibid.*). More work is needed to understand these to optimise their use in integrated coastal management and planning activities (SOPHIE 2020) and for designed interventions that are undertaken collaboratively with wider population groups, researchers and policymakers and which have more detailed evaluation of outcomes (Britton *et al.*, 2020).
- There have been few studies that have evaluated the effectiveness of interventions on physical and mental health and well-being and to determine the factors or interventions that are most effective in promoting different health and well-being outcomes such as the mechanisms, pathways, and interactions with which different types of coastal environments and blue spaces improve human health and well-being or increase the risk of disease and/or physical issues (SOPHIE, 2020).
- There has been limited use of quantitative experimental studies such as randomised control trials and longitudinal research which could allow the ability to draw causal inferences between blue spaces, coastal proximity, health and well-being (Gascon *et al.*, *ibid.*) (Garrett *et al.*, *ibid.*) or studies using cohort data (Defra, 2019).
- There is limited evidence on the monetary value of benefits derived from health interventions. Some studies have attempted to quantify the contribution of health

benefits from physical activities in the marine environment. Research by Papathansopoulou, E *et al.* (2016) for example estimated that the UK economy could benefit from approximately £176m in health care savings in one year through savings to non-occurring health care expenditure.

- Other areas that have been noted as priorities for future research in assessing marine impacts on human health include:
 - proactive assessments of chemical pollutants,
 - measuring the health impacts of emerging marine industries, and regional and global assessments of ocean and human health outcomes (Short *et al.*, 2021). For example, Depledge *et al.* (2017) argue that the risks posed by pollution, contamination of seafood, and the emergence of new chemicals in coastal ecosystems require thorough evaluation.

2.5 Regulating and supporting services

Marine and coastal environments provide a range of important regulating and supporting services. They can help to mitigate flood risk, improve water quality, and regulate climatic processes through their role in carbon sequestration.

A recent report published by NRW on Blue Carbon (Armstrong *et al.*, 2020) for example, outlined the significant role that coastal habitats can play in climate regulation in Wales through carbon storage. It is estimated that Welsh marine habitats sequester at least 26,000 tonnes (0.03 Mt C) of carbon every year (roughly equivalent to the emissions of 65,000 vehicles), making them as significant a carbon store as Welsh woodlands and forests. Saltmarshes and intertidal flats accounted for a large percentage of this value. However, Williamson and Gattuso (2022) have challenged the assumption that restoring areas such as mangroves, saltmarsh and seagrass can remove large amounts of CO₂ from the atmosphere. They state that carbon accounting for coastal ecosystems is both challenging and risky due to high variabilities in carbon burial rates, vulnerability of habitats to future climate change and fluxes of methane and nitrous oxide. They do note however that the restoration of blue carbon habitats is still highly advantageous for climate adaptation, coastal protection, food provision and biodiversity conservation.

Coastal habitats can also play an important role in providing other services, such as mitigating flood risk. For example, shingle ridges, and sand dune systems play critical roles in protecting the coast through dissipating and absorbing wave energy or regulating sediment movement (Defra, 2021b) (Pye, K and Blott, S, 2018).

Saltmarsh ecosystems can play an effective role in storm wave dissipation even during the most extreme storm events (Möller *et al.*, 2014). Recent research by Fairchild *et al.* (2021) focussing on eight estuary types in Wales found that they can play significant roles in reducing flood risk in estuarine settings, delivering mean annual damage savings of \$2.7M per estuary through the effects of localised wave attenuation and estuary-scale surge attenuation and reducing flooding risk by up to 35% for the largest 100yr storms. The authors argue that current valuation tools based on local-scale interactions tend to

oversimplify and underestimate contributions by coastal marshes to flood mitigation in estuaries.

3. Risks & challenges

3.1 Ecosystem condition

Healthy and resilient ecosystems are more likely to respond to pressures by resisting, recovering or adapting to change, whilst continuing to provide benefits and resources to people. Therefore, whilst our understanding of coastal margin environments in Wales has improved, coastal margin environments in Wales have experienced declines and significant losses in their extent, condition and connectivity of habitats. Major changes in saltmarsh extent have occurred due to historical land claim and roughly 30% of the original sand dune area in Wales has been lost to development and erosion since 1900 (Natural Resources Wales, 2020a). Pollution is also a key pressure. Coastal saltmarshes and lagoons have been detrimentally affected by elevated nutrient levels and chemical contaminants (ibid.) such as in Milford Haven Inner and Outer waterways (Natural Resources Wales, 2018). In recent years there has also been an increasing pressure from a rise in the amount of marine litter.

Assessments of marine resilience show that the extent, diversity and connectivity of habitats is stable or good overall, but some are impacted by elevated nutrient and chemical contaminants, invasive species, and coastal squeeze and development. Climate change and sea level rise will pose additional threats through increases in storms and coastal flooding events. This will be further compounded by constraints to physical processes and sediment supplies and lack of space for saltmarsh, sand dune and shingle habitats to adapt to these changes where they are restricted by coastal development and defence, leading to 'coastal squeeze'.

Culhane *et al.* (2019) explored the risk to ecosystem service supply (RESS) across a range of aquatic ecosystems in Europe from the purely oceanic, to those with an interface between freshwater to marine. Coastal realms, alongside lakes, rivers, and inlets had some of the highest RESS and they found a positive relationship between impact risk and service supply potential, indicating the ecosystem components we rely on most for services are also those most at risk. They argue that protecting the supply of ecosystem services alone will not protect ecosystems fully. However, the sites with the greatest levels of management were of lowest risk to being able to sustain service supply.

Similarly, the predicted levels of ecosystem services derived from particular habitats could be affected by climate change and other drivers. For instance, the Government Office for Science (2018) note that the estimated carbon sequestration value of sand dunes and saltmarshes could decrease by £0.25 billion by 2060 with further habitat loss.

The Marine Area Statement, published by Natural Resources Wales (2021a), recognises that if we want to continue to benefit from our marine and coastal environments, it is crucial that we take steps to address these pressures. Enhancing the condition and restoring the extent of these ecosystems can help to support enhancements in resilience together with their protection through effective management of the MPA network. This has the potential to increase the delivery of a range of wider benefits, including increased

storage/sequestration of blue carbon, increased fish production, improved water quality and nutrient removal, and reduced flood risks through wave dampening.

3.2 Climate Change

As previously noted, access to coastal and marine environments can provide opportunities for supporting beneficial outcomes and improvements in people's mental and physical health and well-being. However, the range of health and well-being benefits provided by these environments could be adversely affected in the future.

Coastal margin habitats for example, are doubly sensitive to climate change and will experience major changes on the Welsh coast in the next 10 to 20 years. Sea-level rise will result in deeper waters and bigger waves reaching saltmarsh, dunes, shingle and maritime cliffs which will cause erosion at the seaward edge (Natural Resources Wales, 2020a). Changes to rainfall, temperature and storminess will also impact on the extent of habitats and biodiversity (Jones, L *et al.*, 2013).

Estimates suggest that over 3,400ha of intertidal habitat in Wales could potentially be lost to coastal squeeze by the next century where habitats cannot migrate inland due to the presence of sea-defences (Oaten, J, Brooks, A and Frost, N, 2018). For example, saltmarsh extent could be threatened by sea level rise. Current assessments also point to the challenge of creating enough saltmarsh habitats to offset that which is predicted to be lost by coastal squeeze (Natural Resources Wales 2020a).

In addition, estimates suggest an average loss of 8% of the sand dune area in the UK due to sea-level rise by 2080 but the likely results of projected changes in temperature and rainfall are uncertain (Jones, L *et al.*, 2013). Sites in Wales that would be significantly affected include Morfa Dyffryn, Newborough Warren, Whiteford Burrows and Kenfig. And the physical, chemical and ecological characteristics of saline lagoons are also likely to be affected by rising sea levels, storminess and changes in seasonal temperature and rainfall patterns, although the impacts of climate change are likely to be variable between sites (MCCIP, 2018).

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 and increased stratification. This will lead to impacts on species and food webs such as plankton communities and commercial fish populations in the Celtic-Biscay seas and increase the risks of the establishment of invasive non native species (Natural Resources Wales, 2020a).

The effects of ocean acidification will also lead to impacts on marine and coastal species. The North Atlantic contains more anthropogenic CO₂ than any other ocean basin and ocean surface measurements between 1995 and 2013 revealed a pH decline of 0.0013 units (MCCIP, 2020). This could cause functional changes and impacts on food webs, fish productivity and shellfish yields, and the ability of marine organisms to provide climate regulation (Welsh Government, 2019).

As well as gradual sea-warming events, the frequency and severity of short-term oceanic warming events has increased substantially. Marine heatwaves are also becoming more widespread and frequent and are having the effect of severely altering ecosystem service provision by impacting on species range shifts, mass mortality of marine species and harmful algal blooms (Smith, K.E *et al.* 2021). These can have knock-on socio-economic impacts such as loss of fisheries income, erosion of essential ecosystem services and conflict with estimates of economic losses of single marine heatwave events to date of at least US \$800 million globally in direct losses and at least US \$3.1 billion per annum in indirect losses (*ibid.*).

The impacts of climate change can have markedly different effects between individuals and groups in society which has implications for the approach to engaging different audiences on such issues.

Spence *et al.* (2018) explored the perceptions of risks related to ocean acidification in the UK. They found generally low levels of awareness and knowledge of the issue amongst individuals, but high levels of concern amongst those surveyed. Those most concerned were participants that had stronger environmental identities and higher levels of knowledge about ocean acidification. Place attachment and environmental identity were important factors which the authors argued should be considered when communicating risks.

Maltby, Simpson and Turner (2021), in a study focussing on demersal fishers in the south west of the UK, also found that most fishers perceived climate change as a low risk to future fish stocks, their business and the wider industry compared to other environmental and socio-economic and governance risks, and low-risk perceptions were also associated with a perceived self-efficacy regarding their ability to cope and adapt to the impacts. Recent research has suggested that people with lower risk perceptions may be less willing to engage and support climate change policies and initiatives. They argue that this will require adapting climate change risk messaging and communication to ensure effective engagement with these groups and including them throughout decision-making processes or adopting effective co-management approaches could improve transparency and trust in how decisions are made and the types of information used to inform decisions.

Spence *et al.* (2018) argue that measures are needed to raise awareness of particular effects of climate change beyond their current low levels. In their study they recommend that strategies to address ocean acidification should not only focus on adaptation measures but should involve inclusive and co-operative public engagement to encourage motivation to act and political will to introduce effective policies, and the tailoring of information that is appropriate to target groups. They suggest that localising the issue will be key in engaging the public and addressing risks around future threats such as ocean acidification, such as through the use of narratives and stories of its impacts in local communities but further research is needed to explore the validity of the assertion.

Recent examples of localised community engagement in Wales include work being undertaken by Pembrokeshire Coastal Forum and CCAT and partners in Ireland in developing tools such as interactive games and online learning resources to help young

people understand how climate change is affecting their local area and supporting local communities to understand how they can adapt to climate change through user experience and augmented reality apps.

Climate change at the coast will also have negative impacts on human physical and mental health and well-being as it will likely lead to an increase in events such as storms, flooding and ocean acidification. There has been limited research in this area to date that has explored these linkages, but several studies have begun to explore these linkages in recent years.

Flooding and coastal erosion events are considered as serious problems by many people in society. For example, in a recent survey that explored the perceptions of the public to climate risk, adaptation options and resilience, flooding (90%) and coastal erosion (88%) were considered as the two most serious current problems associated with climate change (Steentjes, K *et al.*, 2020).

Demski *et al.* (2017) for example, focussing on the flooding events of the Winter 2013/14 in Wales, highlighted that direct experience of extreme weather events can lead to people viewing climate change with increased importance, and produce greater perceived vulnerability and risk perceptions amongst individuals which can give rise to behavioural intentions that go beyond sustainability actions. More widely, Köpsel and Walsh (2018) argue that the effects of coastal flooding can lead to divergent and conflicting responses from various individuals and stakeholders as to suitable adaptive measures, and between conflicting objectives of nature conservation and providing access to the coast.

Borja *et al.* (2020a) have argued that further research and evidence is needed to understand the risks and impacts of climate change on human health, such as the threats to human life and/or mental health after coastal events/destruction such as coastal flooding. Depledge *et al.* (2017) have also argued that there is a need for rigorous analyses of demographic and socio-economic trends in different types of coastal communities that would allow appropriate actions to be taken to meet specific health and well-being objectives and provide insights into changes required by coastal communities in the coming years.

3.3 Unsustainable use

The coastal environment can provide opportunities for new economic activities and the promotion of additional activities in established sectors such as tourism. However, there are risks and challenges that could impact on the realisation of these benefits. The common thread running through these challenges is ultimately the need for the management of activities to ensure that they are undertaken sustainably, both from an ecological, economic and socio-cultural perspective.

As noted, marine renewable energy could make an important contribution to climate mitigation efforts and to the economies of coastal communities in Wales. However, evidence suggests that there are risks that the benefits from the development of new

coastal industries do not necessarily flow down to coastal communities (Depledge, M.H *et al.*, 2017). Maximising these benefits will require actions to provide opportunities for local employment and reskilling and training programmes, taking account of both short-term and longer supply and demand dynamics in the market, and actions to reduce leakage effects in Welsh coastal communities affected by developments.

Risks to the flows of benefits can also come from unsustainable levels of resource extraction, management practises or detrimental impacts on local marine and coastal habitats, which could have potential impacts on the fishing industry in Wales. The State of Natural Resources Report (SoNaRR) (Natural Resources Wales, 2020a) for example highlights how historical unsustainable fishing practises and the absence of effective management, together with other drivers such as pollution are likely to have impacted on fish and shellfish populations. However, data limitations have made it difficult to assess the current conditions and trends of commercially targeted marine and shellfish species. There have also been recent concerns from within the industry itself of the lack of development of an overarching adaptive management regime and strategy for the fisheries industry in Wales (WFA, 2020).

Similarly, in some localities such as Pembrokeshire and Gwynedd there are challenges in reconciling the demand for tourism, recreational and educational activities for positive health and mental well-being outcomes with preventing the excessive use of, or damage to coastal and marine habitats and species. Across Wales more widely, pressures from unmanaged access and recreation can lead to erosion of coastal habitats and declines in habitat extent and condition (Natural Resources Wales 2020a). As such, it will be important to understand some of the factors that can enable access to the coast be optimized for physical and mental health and well-being benefits in a sustainable manner that do not detrimentally impact on coastal and marine ecosystem functioning and biodiversity (SOPHIE, *ibid.*) (Borja *et al.*, 2020).

The demand for access to picturesque marine and coastal areas in Wales has also had notable effects in the housing market, witnessed through the impacts that second-home ownership has had on the opportunities for housing for local residents and on culture and the language (Williams, B, 2021).

4. Tools and Opportunities

The new legislative framework in Wales related to well-being is still very much in its infancy, and no more so than in its translation to conservation and environmental management programmes and strategies. In recent years, several tools and frameworks have emerged to support the conservation and management of marine and coastal environments in Wales to support wider well-being for communities and address the challenges listed above.

These range from legislative and policy frameworks that place a duty on public bodies in Wales for the sustainable management of natural resources and the consideration of the long-term well-being of communities in Wales, through to specific tools that are designed to support decision-making in specific areas such as the use of emerging Natural Capital accounting approaches that aim to quantify and map natural assets and link them to a valuation of the benefits derived from them. This section aims to discuss each of these mechanisms in turn, outlining their applicability to supporting well-being agendas, and highlighting the gaps in understanding and application and where there might be opportunities for further development in approaches.

4.1 Marine Protected Areas, restoration & coastal adaptation

Marine Protected Areas

There are 139 Marine Protected Areas (MPAs) in Wales, forming part of a network of sites across the UK. The management of MPAs is an important mechanism to improve marine biodiversity and mitigate the risks associated with some of the pressures and challenges to marine environments. The latest SoNaRR report (NRW 2020), for example, outlined several actions that can be taken to help build the resilience of marine ecosystems in Wales and support the delivery of the range of benefits derived from these ecosystems. These included improving the overall management and condition and ensuring an ecologically coherent network of well-managed MPAs. However, the report also noted that we also need to improve our ability to assess MPA feature condition to help support restoration and improvement in the condition of marine ecosystems in Wales over the long term.

Restoration of habitats is also a key mechanism for maintaining and enhancing the resilience of marine and coastal ecosystems. Restoration of these habitats has the potential to produce a range of benefits, including increasing fish production, improved water quality and nutrient removal, and reduced flood risks through wave dampening.

Several researchers have used natural capital or cost-benefit approaches to help quantify the value of ecosystem services to support the case for restoration of coastal and marine habitats. For example, Watson *et al.* (2020) assessed the natural capital value of seven

key temperate coastal biotopes in the Solent Marine site area in southern England and estimated that at minimum, they provide nutrient reductions and avoided climate damages equivalent to £1.1 billion each year. They argue that the evidence helps to support the rationale for the restoration of temperate coastal biotopes.

Stewart-Sinclair *et al.* (2021) also looked at the cost-benefits of blue restoration actions globally related to activities to assist the recovery of ecosystems that have been damaged, degraded or destroyed. The authors highlight that the benefits outweighed costs for all of the habitat types studied (seagrass, saltmarsh, mangroves and coral reefs), with saltmarsh demonstrating the highest net benefits. However, the authors note that there is a limited data availability and high levels of uncertainty for both benefits and costs and recent studies from the UK were limited (solely saltmarsh). They argue that longer term monitoring and more comprehensive reporting of data on the costs and benefits of blue restoration would improve the evidence on the overall economic value of restoration.

Similarly, Guarnieri and De Leo (2022) note that the current lack of long-term maintenance and monitoring costs of restorations for the majority of habitats – excluding mangroves and saltmarshes currently inhibits the provision cost-benefit analyses that can support the investments necessary for effective scaling-up of blue restoration activities.

Social assessments of MPAs & restoration activities

There have been several studies that have looked to assess stakeholder perspectives regarding the acceptability of MPAs in the UK, including a study by Gall and Rodwell (2016) of MPAs in Devon and the Severn. They revealed that although there was a broad social acceptability of MPAs across thematic areas, there were some differences in opinion between stakeholders, as the establishment of MPAs can have notable social impacts between different actors. The study highlighted that a well-developed process of stakeholder engagement during planning phases led to broad social acceptability, but this became more limited following the cessation of engagement in the implementation period and during the development of management measures. This resulted in disenfranchisement of certain segments of the population.

The authors argue that social acceptability requires effective and ongoing stakeholder engagement throughout the duration of the MPA process, incorporating both bottom up and top-down approaches to design, implementation and development. They also argue of the need for setting clear and transparent parameters and communication progress throughout the process.

Similar issues were found by Hattam *et al.* (2014) in their study of the impacts arising from the establishment of an MPA in Lyme Bay, England. They found that costs were principally borne by those who lost rights (e.g mobile gear fishermen) and there were instances of increased tension between supporters and opponents of the closure. Impacts also varied depending on the type of activity conducted, with positive themes being improved experiences for commercial fishermen and recreational users, but negative ones including lengthening fishing trips, tension and conflict. The papers outline the need for continued

stakeholder engagement to understand the views of all affected groups to understand how management can secure wider social acceptability.

Schere *et al.* (2021) for example explored whether 3 Marine Protected Area sites in the Irish sea were equitably governed. Their study assessed the extent to which different stakeholder groups perceived the management of the protected area and how included they felt in decision-making. They found a lack of communication between MPA authorities and local stakeholders and argue that there is need for inclusive partnerships in the management of MPAs

A recent study by Rees *et al.* (2021) which assessed the spatial use, economic performance and well-being of fishers following the designation of an MPA in Lyme Bay, England, highlights the effects that can be produced by not taking an integrated approach to conservation goals and fisheries management. Mobile, demersal gear fishers experienced subjective and material losses in comparison to gains for fishers predominantly operating static gear for whom there was an increase in activity within the MPA. Mobile demersal gear users also reported lower subjective wellbeing compared to their static gear counterparts. As well as social impacts, the authors argue that the lack of early integration in management approaches has the potential to mask MPA performance in ecological goals through the removal of one pressure by the unintended introduction of others.

Jones *et al.* (2022) have proposed a four-staged approach/framework to support decision-makers to assess and understand the levels of public support for an existing or proposed protected area and why these levels of support are observed, which they argue can support decision-making by identifying any weaknesses in the policy and governance systems and improve outcomes and benefits for people affected by the designations. More broadly, Bennett, *et al.* (2021b) argue that several areas will require further attention in conservation management to support socially equitable conservation, including improved recognition of diverse peoples and perspectives in management, championing local involvement and leadership in management and fostering participation in decision-making and governance activities.

Rees *et al.* (2014) and several other studies have argued that decision-makers should not only consider those ecosystem services that are easy to quantify in the design of MPAs, but also the wider range of beneficial ecosystem services and well-being outcomes that can be delivered across MPA networks (Leenhardt *et al.*, 2015) (Rasheed, *ibid.*) (De La Cruz, 2021) (McAfee, Costanza and Connell, 2021). Belgrano *et al.* (2021) for example, argue that the assessment of MPAs often lacks simultaneous consideration of ecological and socio-economic outcomes which may lead to misconceptions on the effectiveness of MPAs

Although there currently is no statutory basis for considering ecosystem services in the designation of MPAs in Wales, the principles of sustainable management of natural resources set out in the Environment (Wales) Act 2016 should help to address issues

around engagement by requiring bodies to make appropriate arrangements for public participation in decision-making.

A recent study by Erskine *et al.* (2021) however, which focussed on the intensity of photographic activity by individuals and perceptions, found that the establishment of MPAs can lead to an increase in cultural ecosystem service values vis-à-vis adjacent coastal areas.

Leenhardt (*ibid.*) has argued that there is a need for closer collaboration between natural and social scientists to develop the frameworks and datasets to address the links between MPAs, ecosystem functioning and ecosystem services. Rasheed (*ibid.*) and Blythe *et al.* (2020) also argue that time-sensitive data to capture short and long-term impacts on well-being are also important, given the dynamic nature of marine ecosystems, with feedbacks, time lags, and complex interactions that change over time. Belgrano *et al.* (*ibid.*) have proposed a transdisciplinary approach/framework to help map and evaluate MPAs for their ability to protect biodiversity whilst providing ecosystem services and related human well-being benefits.

As noted previously, there is evidence to suggest low levels of public awareness in Wales of the benefits provided by coastal and marine habitats in Wales. McKinley (2020b) for example argues that there is a need to foster and enhance public knowledge and understanding of the role of coastal fringe environments through the development of effective and appropriate awareness raising schemes, particularly given the myriad of socio-ecological interactions associated with these environments, together with effective marine and land-based planning and management.

On a broader scale, ocean literacy and citizen science schemes are mechanisms which can help to improve people's understanding and awareness of the risks and benefits to their health of interacting with the ocean, the actions that they can undertake to mitigate the pressures on marine and coastal ecosystems, and provide further impetus for opportunities for environmental protection from a wider audience.

For example, the SWEPT programme in the Milford Haven Estuary, led by the Pembrokeshire Marine Special Area of Conservation and funded by NRW, has engaged with community volunteers to produce an indicative assessment of areas of nitrate and phosphate pollution in the estuary, the results of which will provide valuable information for NRW to target additional more accurate monitoring and subsequent actions to reduce nitrate and phosphate levels in the estuary (Natural Resources Wales, 2020b). Nash *et al.* (2022) argue that we are likely to achieve fewer of the UN sustainable development goals unless there is improved engagement and awareness amongst the wider population of interactions and impacts on the ocean through ocean literacy and greater participation in activities such as citizen science through ocean literacy.

Coastal adaptation

As previously noted, our coastlines will experience marked changes from the predicted impacts of climate change due to sea-level rise, coastal erosion and storm events. This will

have significant implications for decisions that will need to be made with regards to coastal adaptation and defence.

Shoreline management plans (SMPs) identify risks from flooding and coastal erosion, opportunities to maintain and improve the environment by managing these risks. Relevant policy changes specify those areas that would maintain or lose their current status of protection and relevant interventions that can be considered to manage these changes. For example, in those areas which will move from hold-the-line to managed realignment policies, restoration of habitats such as saltmarsh could be considered. However, the cost-benefits of the use of nature-based solutions relative to traditional solutions are still under-researched in Wales (Atkins, 2020) and further work is potentially needed to understand how their use could support decisions around conservation and management objectives.

It will be important for local authorities and wider stakeholders to address the issues of coastal inundation and policies associated with Shoreline Management Plans far in advance of their commencement. It has been proposed that anticipatory and dynamic pathways to retreat can be a positive approach to reduce coastal risks and minimise impacts on investments and social inequities, including the need for early engagement with affected communities to understand risk tolerances, vulnerabilities and values (Haasnoot, M, 2021).

Marine and coastal habitats such as saltmarshes, shingle and sand dunes play an important role in helping to mitigate coastal flood risk and support climate change adaptation. Natural flood management schemes could potentially provide cost-effective solutions to reduce flood risk and support coastal zone management and adaptation.

However, Anderson *et al.* (2021) argue that understanding what drives public acceptance of nature-based solutions for risk reduction is essential for the success of projects and their continued uptake. From a study of three communities impacted by local nature-based solution schemes, they propose several recommendations to improve public perceptions, including demonstrating their effectiveness to overcome skepticism regarding their effectiveness and the public's sense of place/connectedness to place should be considered within projects. They also note that trust in implementers was also revealed as a key factor for individuals, particularly until the evidence of their effectiveness becomes more widespread.

McKinley (2020b) argues that because local and national perceptions and values of coastal environments may vary, it could be prudent to develop a programme of research to discover local values to ensure local specificity to management plans and decision-making. It will also become more important to build an increased awareness of the threats to communities from future climate change events and with regards to planning for future actions associated with Shoreline Management Plans and adaptation activities.

Tubridy *et al.* (2022) have similarly argued that co-production approaches, including integrating local knowledge and risks posed by climate hazards and/or retreat and facilitating community-led processes of retreat and redevelopment, will be key to address

planning challenges associated with managed retreat going forward. They argue that there is evidence that in many cases, managed retreat has had problematic social impacts and has frequently been implemented through top-down models of planning.

Access to high-quality data will also be an important tool to support analyses of coastal risk and resilience. However, Lazarus *et al.* (2021) argue that there is a need for a transformation of the currently scattered and fragmented coastal data resources and sets in the UK and bring them into a systematic and integrated publicly accessible open data portal which should also integrate associated population, socio-economic indicators and infrastructure as well as layers relating to flooding and erosion.

In some areas of coastline, such as in densely populated urban areas and where property has to be protected, there will inevitably be a need to maintain investment in traditional hard coastal defence structures. The Wales Coastal Review (2014) for example highlighted that coastal flood defences provided £3bn of damages to properties and land during the flood events of 2013 and 2014 (Atkins (2020)).

However, these structures tend to be poor for ecological biodiversity compared to natural shorelines and rarely support similar species assemblages to those of natural coastal and marine habitats and are often associated with nuisance and invasive species (Firth *et al.*, 2014b).

Much research has been undertaken in recent years to demonstrate the potential use of ecological enhancement features which can be applied to coastal defence structures. The evidence has demonstrated that the use of such structures can provide a variety of ecological benefits to structures, including increased biodiversity and/or abundance of target species on structures by helping to mimic the natural complexity found on natural shorelines (Naylor, L.A *et al.*, 2017), (Lawrence, P.J *et al.*, 2021) (Evans, A.J *et al.*, 2021a).

For example, artificial rock pools can be used to help provide valuable nursery and refuge areas for marine species and enable the flood/coastal structures to function more like natural habitats (Evans, A.J *et al.*, 2015). A summary of the evidence relating to the use of ecological enhancement features and their benefits has recently been published by Evans *et al.* (2021b).

Recent evidence has also highlighted the potential resilience benefits of the features through reducing flood risk and wave topping, with benefits from reductions in wave energy, and mitigating wave overtopping, particularly for violent, impulsive wave conditions (O'Sullivan, *et al.* 2020). In addition, it is argued that the use of structures can provide the potential value for money from increased enhanced ecosystem services, and by providing social benefits and additional returns compared to traditional grey engineering whilst not adding substantially to construction costs (Naylor, L.A *et al.*, 2017).

It is important to note that the ecological benefits derived from the use of such structures are specific to the structures when evaluated against those same structures without

enhancement features at the location, and not necessarily a net enhancement in terms of the wider environment (Evans, A.J *et al.*, 2019). It is also difficult to predict the level of biodiversity that will be created by different types of features. However, there are some studies currently in development that are looking to predict the flows of ecosystem functions (such as nutrient cycling, oxygenation) derived from the use of enhancement features which will help to improve our understanding of some of these issues.

4.2 Welsh National Marine Plan

The first Welsh National Marine Plan (WNMP), published in 2019, provides a framework to support the economic, social and environmental objectives and guide the sustainable development of Welsh coasts and seas. The Welsh marine plan area covers 32,000km² of sea, and 2,210km of coastline and incorporates many of the activities being undertaken at the Welsh coast and seas. The WNMP sets out Welsh Government's vision of clean, healthy, safe, productive and biologically diverse seas. It recognises the diverse and valuable marine natural resources that underpin our well-being and Welsh Government's commitments to supporting the Well-being of current and future generations.

The WNMP has a number of objectives which nest under three key themes:

- Achieving a sustainable marine economy
- Ensuring a strong, healthy and just society
- Living within environmental limits

and includes general, cross-cutting policies and sector- specific objectives and policies to support delivery of its objectives. Well-being cuts across several of the objectives and policies, and policy SOC-02 makes specific reference to it by encouraging proposals that contribute to the well-being of coastal communities, recognising that development and use of the marine environment has the potential to both positively and negatively affect the socio-economic character and future prospects of coastal communities.

Other policies directly linked to well-being encourage developers and decision-makers to consider a range of social issues that affect coastal communities (e.g. access to the marine environment; marine pollution incidents; coastal change and flooding; and climate change), and characteristics that contribute to a sense of place (e.g. Welsh language and culture; and heritage including historic assets, designated landscapes, and seascapes). National Marine Character Areas (Natural Resources Wales 2021b) have been designed to aid public bodies with details of these characteristics to support decision-making and engagement with local communities and help to identify, protect and enhance local identity characteristics.

Evidence is needed to support implementation of these policies and spatial evidence is particularly valuable to bring these policies to life for coastal communities. Welsh Government are currently developing a spatial approach to marine planning in Wales which includes improving the spatial evidence base on current use, opportunities and constraints, and this will support consideration of well-being in the marine context. This will

identify Strategic Resource Areas which will describe and safeguard key areas of natural resource with the potential to support future sustainable use (Welsh Government, 2021b).

Effective strategic marine planning is a key mechanism to support the maximisation of benefits to communities and to ensure that conflicts between different uses of the marine environment are minimised. Komyakova, V *et al.* (2022) for example argue that marine spatial planning alongside a range of mitigation measures that are currently available (including nature-based solutions, innovations in technologies and material design including the use of eco-engineering and data modelling processes) is necessary to achieve the best outcomes and avoid synergistic negative impacts associated with marine infrastructure and developments in the marine environment.

Marine spatial planning could provide the frameworks to balance trade-offs and potential conflicts between different users of the marine environment. Niner, *et al.* (2022) argue for example, that methods of co-production could help to support a sustainable transition to blue economies through respecting human rights and addressing issues for those groups closely dependent on marine resources and space, although capacity development at all levels of society will be required to enable the transformation of governance systems.

In addition, marine spatial planning will play a role going forward in increasing demands for multiple uses of the sea for different activities. Felix Schupp *et al.* (2021) assessed local stakeholder perspectives from two case studies (East coast of Scotland and Germany's North Sea EEZ) to scope the feasibility of combining multiple uses of the sea such as offshore wind farms and commercial fisheries.

Although both users had specific key drivers that would influence their engagement, they found that the offshore wind industry showed little interest in multi-use solutions unless clear added value is demonstrated and no risks to their operations are involved, whilst the commercial fishing sector was more proactive towards multi-use projects. They argue that if multi-use of ocean space is to become a potential solution for reducing conflict in marine spatial planning, a clear commitment will be needed from policy makers which will require a regulatory framework that guides the process of weighing multi-use options by considering both environmental and socio-economic impacts.

Ecosystem service based approaches can help to support the development of marine planning. However, Galparsoro *et al.* (2021) highlight that although there has been a significant increase in the number of publications in recent years to help to inform marine planning, these have predominantly focussed on providing theoretical frameworks or methodologies, with few studies looking at practical examples of their integration.

The authors highlight nine main needs/gaps which they argue can help to improve the adaptation of existing ecosystem service assessments into marine planning, including, the further development and adaptation of common ecosystem service classification systems to achieve a common understanding of the links and flows between ecosystems, maritime uses and beneficiaries, and the integration socio-economic indicators that can better explain wider benefits to society. In addition they highlight the need to take advantage of

improvements in data collection and processing (e.g artificial intelligence), and tools for communicating evidence to stakeholders through better use of geospatial information (data and presentation).

More widely with regards to the development of marine planning, Roche *et al.* (2016) for example highlight that there has been a knowledge gap in the evidence base to date regarding the perceptions, attitudes and opinions of individuals and local communities to different types of marine renewable energy developments. Similarly Lange and Cummins (2021) argue that it is important to understand the cultural fabric of communities and their perceptions, expectations and concerns alongside the needs of policy and regulation and industry development and governance structures that can ensure fair balances of power and interests, integrative processes of negotiation and that can incorporate meaningful stakeholder participation as an integral part of the decision-making process to help support energy transitions and reduce conflicts and delays to projects.

There have also been arguments made that marine planning could provide unique opportunities to engage with and incorporate the views of often difficult to reach groups into decision-making. Devenport *et al.* (2021) explored young people's views, awareness and participation (current and potential) in decisions and strategies for the marine environment in Scotland. They argue that although traditional ocean literacy and education schemes will play an important role in engaging young people on the issues, marine planning (specifically through regional development plans in Scotland) could provide a useful mechanism to integrate young people's views and needs into marine decision-making through for example the development of youth-specific sessions within the plan frameworks focused on understanding young people's perspectives and priorities with clear links and feedback to the formal process.

4.3 Blue Economy & Finance

The concept of the Blue Economy has gained greater prominence in recent years and has been promoted by a wide range of governments, conservation organisations, NGOs and businesses and private companies. For example, the European Union recently set out plans to support the development of a, 'Sustainable Blue Economy' that could support its ambitions around a Green New Deal and a recovery from the pandemic (European Commission, 2021).

Marine sectors and activities such as offshore and tidal renewable energy, sustainable food production through the use of aquaculture, seagrass and seaweed, coastal tourism, port activities and decarbonisation of maritime transport provide opportunities for the expansion of maritime economies and growth. It is argued that the expansion of a sustainable blue economy will provide employment opportunities and economic revenues for coastal populations and communities, as well as raw materials and food security and infrastructural development, whilst simultaneously mitigating their impact on natural habitats and ecosystems, and supporting climate mitigation and nature resoration strategies.

However, Bennett *et al.* (2021c) highlight how rapid and unchecked development could produce negative outcomes and risks for people and the environment. From a review of the literature, they highlight ten social injustices that can be produced by blue growth, including, an inequitable distribution of economic benefits, exclusion from decision-making and governance and environmental degradation, and reduction of the availability of ecosystem services. They argue that in order to minimise social harms and maximise benefits from blue growth, human well-being and environmental sustainability must be prioritised alongside economic profits. They propose ten key considerations that will require attention to advance blue justice during blue growth, including, developing inclusive and participatory planning and governance processes for ocean development, and maintaining and promoting access to marine resources needed for food security and well-being.

Similarly, Germond-Duret and Germond (2022) highlight how the framing of the Blue Economy in the British media has largely tended to focus on economic opportunities, and has been limited in its focus on the wider sustainability implications nor the impacts on wider social outcomes. Germond-Duret (2022) argues that to address current challenges with the oceans and avoid creating further negative externalities that we have seen with practises on land, we need to critically reflect on the norms, discourses and ideas associated with the Blue Economy which tend to view the oceans as a resource to exploit.

McKinley (2020) similarly noted the need to better understand the trade-offs, and equity and equality issues associated with blue growth initiatives, and the balance between the economic value of the coast against social well-being and cultural values.

In recent years, there has been a greater focus on how to support the financing of projects to support marine conservation efforts and activities associated with the blue economy, including food production and marine renewable energy. A range of local, national and international level financial instruments can be used to support marine projects, including traditional loans and grants, funds, carbon markets and insurance and more recently the development of blue bonds, where the deployment of different types will depend on the expected return from the investment and the risk-return faced by investors. The UN Environment Programme (UNEP, 2022) in conjunction with the European Investment Bank and Commission has also developed a set of sustainable Blue Economy finance principles to guide banks, financial institutions to finance and invest in a sustainable blue economy.

Sumaila *et al.* (2021) argue that finance will be an important enabler of a sustainable ocean economy by directing investments to activities, policies and actions that minimise ocean risks and maximise social equity and environmental sustainability. For example, the insurance industry could choose to exclude or restrict access to insurance to clients or projects that engage in unsustainable or illegal practices and through their roles as institutional investors.

However, they highlight how the current finance gap is large and the main barriers that are preventing an adequate financing of a sustainable ocean economy include a weak enabling environment for attracting sustainable ocean finance, insufficient public and

private investment in the ocean economy, and the relatively high-risk profile of ocean economic sectors. They argue that the public and private sectors need to create and better mobilise a full suite of financial tools and approaches, insurance, fiscal and market incentives, and strengthen key aspects of the enabling environment to support the transition to an ocean economy that is sustainable and inclusive by making the benefits it generates available to all, especially, women, youth, and marginalized communities.

In those cases where investments in ocean projects can generate positive, but below market returns, public or philanthropic co-financing (blended finance) will also be needed to make them attractive to private investors. As highlighted by Christiansen (2021), blended-finance schemes (such as public-private partnerships) have been cited as a method and solution that can help to address the failure of biodiversity finance to materialise at scale, and meet private investors' requirements and expectations. However, in a more cautionary assessment of their potential, he highlights how these solutions have yet to prove their large-scale effectiveness and there are risks in them creating development rents that can be captured by the financial sector/investors and thus poses the question as to whether tackling the root causes of environmental degradation should still take preponderance rather than resting faith in market-based solutions as being a solutions to such issues.

4.4 Natural Capital

The development of ecosystem services frameworks over the past few decades have provided a basis for appreciating the role that healthy ecosystems and biodiversity play in supporting human well-being through connecting ecosystem functions and the services derived from them to the benefits provided by them. A study by Fletcher *et al.* (2014) for example, noted how the socio-economic benefits provided by the marine environment, MPA networks and individual MPAs in Wales are potentially significant.

In recent years, and largely building on the initial conceptual frameworks outlined by the work of the Natural Capital Committee (2014), Natural Capital approaches have attempted to build on these frameworks and operationalise them to support decision-making through linking the measurement and mapping of the extent, condition and state of natural assets to an accounting framework of the valuation of the flow of services derived from those assets. This is generally done in order to support an evaluation of the impacts of management options in the context of objectives around environmental exploitation, protection and restoration (Defra 2020).

The development of Natural Capital frameworks for the marine environment have lagged behind those of terrestrial systems. They are still very much in the early stages of their development and have not been fully tested in terms of their application in policy and decision-making contexts (Hooper *et al.*, 2019). In addition there are significant data gaps around habitat condition, such as for intertidal environments and saltmarshes (Dowdall, Bowe and Kirby, 2022). But there have been several recent examples of attempts to develop them.

The Scottish Government produced its first Natural Capital Index in 2011 and, 'increasing natural capital' at the national level is one of the 55 indicators included in the Government's national progress and priority outcomes. Marine areas were not included in the original index due to the lack of marine data to assess ecosystem condition and develop stock assessments, but the Scottish Government recently published a feasibility study for a Marine natural capital asset index for Scotland (Tillin, H.M *et al.*, 2019) which indicated that it could be technically feasible to produce one for Scottish seas with caveats around data limitations.

The South West Partnership for Environmental and Economic Prosperity (SWEEP) programme has also developed pilot asset and risk registers for marine habitats in the region which link assessments of their extent and condition to specific ecosystem services. From this, they have identified some of the dominant pressures/risks to these in the region, which were found to be fishing, farming and the water industry. The findings of the North Devon Pioneer programme (Rees *et al.* 2022) suggest that the majority of asset features from which benefits are derived are at a medium to high risk of loss under current use and management through the impacts of fishing, farming and the water industry. They argue that current marine governance strategies to protect biodiversity are not sufficient to reduce the risk of loss of ecosystem services and that Marine Protected Areas as a single tool are insufficient to prevent further loss of biodiversity that underpins all asset–benefit relationships. They suggest that there will be a need to scale up and work across agencies with different policy remits to collaboratively deliver an overarching transformative strategy to improve the status of natural capital in the area.

Stebbing *et al.* (2021) have built on such studies by developing a framework to investigate how the combination of different forms of capital (natural, financial, social and human) provide a potential supply of benefits to four areas from the marine environment (seafood, offshore wind energy, wildlife watching and water sports), and how changes in quality or extent of natural capital affects supply. They found that the supply of all four of the benefits increased between 2013 and 2018, with Capacity to supply seafood for example increased, but the resource rent for seafood declined in real terms, despite an increase in the volume of seafood being caught.

It has been argued that the Natural Capital approach can offer a structured way to consider the status of, and beneficiaries of particular ecosystem services, the trade-offs that occur in the distribution of those benefits, and the effects that human pressures can have on the specific ecosystem services and could help to inform policy and management decisions for marine and coastal environments, in areas including (Defra, 2020):

- green versus grey solutions to address coastal flooding and erosion.
- understanding and managing trade-offs associated with different uses of the sea e.g with Marine Protected Areas and the expansion of offshore wind, and
- developing a holistic view of fisheries management balancing food provision and its economic returns against the costs to other natural capital assets and ecosystem services.

There are still ongoing debates as to whether natural capital based accounting approaches are the most appropriate way to reflect nature in decision-making, with some commentators arguing it amounts to the commodification of nature through the back door, and neglects fundamental behavioural change at a societal and political level that is needed to address climate and ecological crises, see for example Hepburn *et al.*'s (2018) response to such claims (2018) and Williams, C (2020).

Diaz *et al.* (2018) for example have argued that the development of the Ecosystems Services framework has ended up becoming a stock-and-flow framing of people-nature relationships, principally in assessing monetary flows from natural stocks, and has failed to engage a range of perspectives from the social sciences or local practitioners. McKinley *et al.* (2019), also argue that although the use of wider ecosystem services approaches (including natural capital) has been beneficial in terms of communicating benefits, supporting management and linking the environment to human actions, there is a need for an interdisciplinary suite of approaches and methodologies which account for a wider range of values and uses, including recognition of culture and heritage. The assignment of monetary values to cultural ecosystem services can also limit physical activities to recreational ones which can undervalue wider physical value opportunities and benefits gained at marine and coastal environments.

The approach is however gaining increasing traction in UK Government and policy environments. The Natural Capital Committee (2019) for example, argued that natural capital thinking should be applied when implementing marine regulation and decision-making in England under the Marine and Coastal Act when making licence decisions or developing planning policies. Some commentators see the development of natural capital approaches as an opportunity to increase the use of new financial models and private investment into conservation projects or marine protected areas (Rees, S.E *et al.*, 2018) (Vivid Economics, 2018b). The recent Dasgupta review published by HM Treasury went further, by seeing the integration of the approach into national accounting frameworks as being a critical step towards developing metrics other than GDP (inclusive wealth) for assessing societal progress (Dasgupta, 2021).

In Wales, the Environment (Wales) Act requires Natural Resources Wales to publish regular assessments every five years on the state of natural resources in Wales and of the dominant factors or risks affecting them. SoNaRR reports in 2016 and 2020 have included information on the condition and status of marine habitats and features associated with the Marine Protected Area (MPA) network. In recent years, there has been an improved understanding of the benefits derived from particular ecosystem services where information was previously lacking, such as the carbon sequestration potential of marine ecosystems (Armstrong *et al.*, *ibid.*) and its broad economic benefits.

However, to date, natural capital accounts for marine and coastal environments have not been developed in Wales although it had previously been argued that there is need for improved quantification of the socio-economic benefits derived from these ecosystems to help support decision-making (Fletcher *et al.*, 2014). The Environmental and Rural Affairs Monitoring & Modelling Programme (ERAMMP) project (2020) is developing models to

simulate the effects of policies on agriculture and the natural environment in Wales and simultaneously value ecosystem services/public goods, including water quality, but they do not focus on marine and coastal systems and impacts.

It could be argued that the principles underpinning the sustainable management of natural resources approach (SMNR) through the Environment Act and those set out by the Well-being and Future Generations Act in Wales (and complemented by SoNaRR assessments as detailed above) requires a broader assessment to support the management of natural resources in Wales, rather than primarily focussing on the development of natural capital accounts for the Welsh marine environment. This is demonstrated for example through the development of Area Statements, which set out priorities and plans for the management of natural resources across place-based areas in Wales through extensive consultation and collaboration with stakeholders and communities in Wales.

However, some researchers have argued that there are potential risks of gaps in the application of the ecosystem services concept in Wales at a high policy level. McKinley et al. (2018) for example, in a study of saltmarsh habitats found limited mention of ecosystem services, benefits and processes in five key policy drivers in Wales and that the complex web of governance makes it difficult for coastal managers to accurately assess the effectiveness of the instruments of the Acts and their implementation. They argue that greater consideration of (and inclusion) of the ecosystem services framework in governance frameworks, encompassing improved understanding of the values and benefits associated with coastal systems would lend itself to more effective coastal management.

NRW commissioned Vivid Economics (2018) to review and put forward recommendations for developing natural capital approaches at the regional level to support national well-being goals for SMNR and Area Statements. They set out an indicative list of tools and approaches that could be developed at each stage of the SMNR process, with a list of corresponding actions over the short (next 1-2 years) and long-term (3-5 years), which included:

- the development of a small pilot programme over the short-term for the application of natural capital accounts as part of the analysis phase and/or focussing on one or two priority services for mapping and valuing (e.g recreation or flood risk).
- scoping the development of a risk register in the short-term to apply to the Area Statements.

The largest number of examples of natural capital frameworks developed to date have been monetary natural capital accounts for specific marine and coastal habitats and services, namely fisheries and recreation for where there are readily available market prices. These have featured most frequently in pilot studies and in work undertaken by the Office for National Statistics (ONS) to develop natural capital accounts which contain values for provisioning, regulating and cultural services at different environments (ONS 2019) (ONS, 2020), which include:

- green versus grey solutions to address coastal flooding and erosion.

- **Provisioning services (£21.2 bn in 2018)** including *renewable energy, mineral extraction, timber, fossil fuels, fish capture, agriculture and water extraction.*
- **Regulating services (£3.9bn in 2018)** include *pollution removal, urban cooling, noise mitigation and carbon sequestration.* These do not however contain any values for marine environments nor for carbon sequestration due to a lack of data, and
- **Cultural services (£11.2bn in 2018)** split into *recreational (£8.5bn) and aesthetic values (£2.7bn)*, the former including the value of visits to green and blue spaces, and the latter measured through an estimation of the value added to house prices by nature.

There have been greater challenges in valuing services associated with other regulatory and habitat functions of marine ecosystems, including, sea defence, coastal erosion and storm damage, pollution control and at the UK level, carbon sequestration, where the services are not necessarily directly marketed and have needed to be determined indirectly through their support for valuable production activities (e.g the protection of property) (Barbier, 2017).

In addition, progress has been limited by the lack of valuation data for the marine environment that can link changes in ecosystem structure and function to the valuation of goods and services. This has limited the potential for value for money assessments associated with policy changes and led to uncertainties over the location and extent to which habitats and species support the delivery of ecosystem services. (Barbier, 2017) (Tillin, H.M *et al.*, *ibid.*). More widely, Watson *et al.* (2022) have argued that there is a need to improve the understanding of the link between habitat condition and ecosystem service provision in natural capital assessments. In a study of the Solent Marine sites, they found that incorporating condition classification indices, such as water framework directive data, improved ecosystem service benefits by between 11-67%.

Hooper *et al.* (*ibid.*) have argued that the lack of data does not mean that these approaches are not fit for purpose, but simply that it is not currently possible to evaluate them comprehensively in the marine context without further research. The Dasgupta Review (*ibid.*) has also argued that limitations in the development of some frameworks should not deter governments from supporting and embracing them and argues that increased investment in physical accounts and valuation to improve the quality of accounts and that standardisation of data and modelling approaches could make it easier to embed natural capital accounting into national economic accounts.

There are also opportunities at the local scale to involve local stakeholders in a collaborative process to understand the benefits derived from natural capital and how different actors could be affected by different interventions. Burdon *et al.* (2022) for example used participatory mapping approaches with relevant stakeholders in the Deben estuary, Suffolk which allowed for the exploration of the relationships between natural capital and the reliance of varying stakeholders on the benefits derived through multiple lenses which can help to support management decisions.

Hooper *et al.* (ibid.) also note that in the current absence of a full suite of monetary values, there are mechanisms within natural capital frameworks and guidance, such as HM Treasury's Green Book, and regulatory impact assessments which can incorporate economic and social information. They highlight that there are several areas for development of current frameworks, including:

- alternative methods (including proxies for information and remote sensing) should be explored further and greater efforts are needed to develop methodologies specifically for the marine environment which are interdisciplinary, cross-sectoral, coherent across policy areas and applicable across a range of contexts. McKinley *et al.* (2019) similarly argue for the use of an interdisciplinary suite of approaches and methodologies which take account of a pluralistic (including cultural and heritage) set of values and uses.
- an approach which undertakes a direct assessment of the extent and condition of marine benthic habitats has greater potential at smaller scales.
- ecosystem services that have been less explored to date, e.g regulating services such as bioremediation of waste, and less tangible elements of cultural services including heritage.

4.5 Health, social & cultural

Several approaches have been used to try to measure how coastal environments contribute to socio-cultural and attachment values and wider cultural ecosystem services.

Bryce *et al.* (2016) used subjective well-being indicators to evaluate cultural ecosystem services provided by 151 UK marine sites proposed for inclusion in a network of marine protected areas. The analysis revealed multiple cultural ecosystem service benefits that contribute to (subjective) human well-being (e.g engagement with nature, place identity and therapeutic value) and the biophysical attributes of sites (e.g the presence of charismatic species and species diversity) which were positively associated with the provision of cultural ecosystem service (CES) benefits.

Pike *et al.* (2015) also used a framework to quantify unmeasurable and subjective cultural values of two marine protected areas, one being an AONB in Chichester Harbour. The particular areas held three predominant, 'factors' of value for individuals, which included, as a place of care for each other and oneself through interactions with the natural world, and a place of spirituality and freedom and refuge. They argue that the use of such frameworks can highlight a depth of information that traditional methods may not highlight about people's interactions with coastal environments. Willis (2015) has also proposed a method for assessing and measuring in-situ how interactions at the coast contribute to a range of dimensions associated with psychological well-being and needs.

More widely, some studies point to the potential for increased human interest in those ecosystems that have greater taxonomic and functional diversity, and which can simultaneously lead to pathways for cultural services through educational and experience opportunities. Fairchild *et al.* (2018) for example explored the effects of different

dimensions of animal biodiversity (species and phyletic richness and functional diversity) on an individual's interest in tide pool systems and how this translates into facilitating cultural ecosystem services. The results of the experiments suggested that multiple dimensions of biodiversity can enhance human interest and they argue that the findings suggest that conservation initiatives that maintain and/or restore biodiversity could also help stimulate interest in ecosystems with wider educational and recreational benefits.

Wyles *et al.* (*ibid.*) have noted that the findings of their research into the effects produced by specific coastal-based activities such as beach cleans could be used by organisations to help promote events to new volunteers through an emphasis on the personal benefits obtained through these activities. However, the authors also noted that the effects of different activities in the natural environment and their links to well-being and awareness merit further research, together with assessing the mechanisms for and levels of actual behaviour change resulting from undertaking these activities.

Tourism and citizen science provide potential mechanisms to support ocean literacy (SOPHIE, *ibid.*), but further research is needed to better understand how individual and group interests in particular issues can be turned into further action(s). McKinley (2020a) has also argued that more can be done to increase levels of ocean literacy and change behaviours through gaining a more comprehensive understanding of the various levels of knowledge, attitudes, perceptions, and concern towards marine habitats and species and ecosystem services and their benefits.

However, efforts to improve ocean literacy should be made across all of society, through for instance including ocean literacy or educational programmes into school curricula and activities to engender an awareness of and stronger interactions with the ocean amongst younger people (Evans K, *et al.* 2021)

Several approaches have also explored the changes to cultural ecosystem services following restoration or designation of conservation area status, and the trade-offs that this can have with the provision of other ecosystem services.

Pouso *et al.* (2020) for example investigated the changes in cultural ecosystem services following on the restoration of ecological systems in the Nerbioi estuary in Spain. Focussing on two recreational activities, namely bathing waters in beaches and recreational fishing, they found that the restoration investment and management measures resulted in a recovery of the ecosystem components which provided benefits for human well-being in terms of enhancing the provision of cultural ecosystem services, which covered the costs of most of the investments and maintenance of the services required for management of the estuary.

Spanou *et al.* (2020) by contrast developed an integrated cultural ecosystem services valuation approach – including non-monetary well-being assessments with valuation (pricing) effects)- to assess the impact of a marine protected area designation on the west coast of Scotland on CES values and potential trade-offs with aquaculture developments nearby. They found that the visibility of (but not proximity) to aquaculture negatively

influenced housing prices whilst proximity to the MPA and visibility of scenic areas increased both house prices and were positively and significantly associated with all well-being value factors (including engagement and interaction with nature, place identity, and social bonds). They argue that the use of such integrated approaches can help decision-makers with a more comprehensive picture of CES values, relations to conservation policies and trade-offs with other activities and services.

It is argued that the methods outlined above could provide opportunities for integrating socio-cultural valuation into environmental assessments. Pouso *et al.* (ibid.) for example, highlight that their approach could provide a systematic framework to analyse the change in cultural ecosystem service provision and the environmental, economic, and social consequences of restoration activities, whilst Solé and Ariza developed a conceptual framework which includes consideration of the need for co-production in assessments, and analysis of power relations and impacts on the distribution of ecosystem service benefits. A broad overview and guidance on various methods that can be applied is provided by Scholte *et al.* (2015).

Several indicators have also been developed to integrate environmental attitudes and contextual values into management options. Bryce *et al.* (ibid.) and Tratalos *et al.* (2016) developed an initial set of terrestrial cultural ecosystem service indicators for decision-makers which could be developed further for coastal environments. Participatory GIS mapping approaches have also been used to engage with stakeholders and local communities and allow a mapping of ecosystem uses and data relating to local values (Burdon *et al.*, 2019).

There are several areas which have been flagged as gaps in terms of the inclusion of socio-cultural valuation in ecosystem management. These include:

- develop a co-designed, transdisciplinary marine social science research agenda to respond to global priorities and address key challenges affecting coasts and seas (McKinley *et al.*, 2022)
- the need to broaden ecosystem assessments to take account of the full value of ecosystem benefits derived from them, including social, cultural and intangible values and impacts on relational and subjective dimensions of well-being (Blythe *et al.*, 2020) (McKinley *et al.*, 2022). McKinley (2020a) similarly recommended assessing how non-monetary values can be meaningfully included in the application of ecosystem services approaches, and to develop, test and implement effective pathways to impact for the use and inclusion of this research into marine governance and management.
- the need to better understand the impact of management interventions or changes in the marine and coastal environment on cultural ecosystem services (McKinley *et al.*, ibid.). For example, questions on how the construction of flood defences or an offshore wind farm impact on individuals' sense of place, well-being, identity or the value they place on an area. It is suggested that this could be through the development of indicators that account for different types of value drawing on qualitative approaches from the social sciences.

- a need to understand how benefits derived from coastal ecosystems flow to different individuals and socio-economic groups (Blythe *et al.*, *ibid.*).
- improve the integration of social-science within the industry and across the science-policy-practice interface through regionally specific training and capacity building for marine social science (McKinley *et al.* 2022).

5. Tools and Opportunities

From this summary, several areas have emerge where NRW can take immediate actions to support the delivery of wider well-being benefits from its coastal and marine programmes. It is recommended that NRW should:

- Seek to develop the evidence base around key benefits derived from marine and coastal ecosystems including from access & recreational activities and impacts on physical and mental health and well-being; carbon storage and sequestration ('blue carbon'); food and fisheries; and coastal erosion and flood defence. This information should then be used to inform planning and management decisions.
- Continue to work with Public Service Boards and other stakeholders to ensure that opportunities to support well-being from marine and coastal environments are reflected in Wellbeing Assessments and Plans.
- Ensure that the development of frameworks for marine planning support the opportunities to sustainably manage conflicting uses of the marine environment and support implementation of Welsh National Marine Plan policies in decision making
- Continue to support the delivery of actions to improve the management and condition of Marine Protected Areas and the Marine Area Statement.
- Raise awareness of and enhance the understanding of the role and wider benefits of coastal fringe and marine environments to support further activities such as the restoration of habitats and deployment of nature-based solutions and through opportunities to engage the wider public and coastal communities around such issues
- Work with partners to identify further opportunities for the deployment of marine habitat restoration projects and blue carbon opportunities.

Furthermore, this review has highlighted several areas within the wider evidence base where there are gaps in our understanding of how management of coastal and marine ecosystems can impact on wider wellbeing. As such, there could be opportunities to explore the following areas, and linked to the above activities:

- Evaluate the effectiveness of recreational and therapeutic interventions in the marine environment and wider factors that can support improvements in physical and mental health and well-being outcomes in a sustainable manner, and to understand the risk and impacts of climate change on human health.
- Explore gaps in our understanding of the condition of coastal and marine features in Wales and the links to the ecosystem services provided by them. For example, NRW should look to assess if natural capital accounts could potentially be developed for marine and coastal environments in Wales where they would provide added value to support decision-making and where there are recognised gaps in relation to our understanding of the benefits provided by particular ecosystem services in relation to the management of specific habitats or the MPA network.
- Assess the relationships between how the well-being effects and outcomes from marine and coastal environments are distributed between different socio-economic

groups and individuals and how they can be addressed, for example in relation to coastal flooding or access.

- Determine how socio-cultural values, attributes and indicators can be further applied/integrated into ecosystem assessments and decisions made in marine governance and management.

6. Conclusion

Our knowledge of the benefits that coastal and marine ecosystems provide to support wider well-being has developed substantially over the past couple of decades, through fields such as the study of ecosystem services and emerging disciplines such as marine social science. Likewise, our knowledge of the risks and pressures to the delivery of these benefits have continued to develop, for example through the most recent assessment of marine and coastal environments and species in the State of Natural Resources in Wales report.

However, several gaps remain in our understanding of these areas and in their linkages to well-being outcomes, including, for example, our ability to assess MPA feature condition, targeted actions around the creation or restoration of marine and coastal and blue carbon habitats to provide wide-ranging ecosystem service flows, or opportunities to further incorporate socio-cultural values into environmental management activities and decision-making.

The new legislative framework around well-being and associated policies such as the Welsh National Marine Plan provide a framework for greater reflection of the linkages between traditional conservation practises and the wider impacts on communities in management activities. In addition, there are a range of tools which could help to support further assessment of well-being outcomes and their delivery, such as Natural Capital approaches and methods to integrate social indicators into coastal and marine management. This will require actions across the public, private and academic spheres at all levels to ensure that our seas are managed effectively and to continue to support the benefits they provide to communities across Wales.

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7. Appendix

The following method was used to search for additional papers not contained within the systematic reviews detailed above (Ban *et al.* (2019), Rasheed (2020), Blythe *et al.* (2020), and Short, R.E *et al.* (2021)).

The key search terms were derived from these reviews and are listed in the table below. A search was made against these for those years subsequent to the publication of the review to the present (i.e from 2020) in Web of Science and JSTOR.

Search terms used for databases (last search date: Nov 2022)

	"marine protected area" OR "marine reserve" OR "marine conservation area" OR "marine conserved area" OR "marine" OR "coastal" OR "marine ecosystem services" OR "coastal ecosystem services" OR "marine ecosystem service" OR "coastal ecosystem service"
AND	"well-being" OR "wellbeing" OR "human well-being" OR "human wellbeing" OR "social impact" OR "social impacts" OR "social effect" OR "human health" OR "socio-economic wellbeing" OR "socio-economic well-being" OR "economic wellbeing" OR "economic well-being" OR "cultural wellbeing" OR "cultural well-being" OR "natural capital" OR "economy", OR "socio-economic" OR "social outcome" OR "socio-eco"

To be included in the Review, papers had to focus on the impact of marine environment/habitats/ecosystems on socio-economic or human health and well-being. Well-being is thus understood in its broad sense, as per the Wellbeing of Future Generations Act. Some of the articles within the systematic reviews and searches focussed on specific impacts/outcomes, such as particular health conditions associated with marine activities (e.g the prevalence of, 'surfer's ear' in Cornish surfers) and these studies were excluded from the review. The aim of this review was not to undertake a critical appraisal of the methods contained within the studies but solely to detail the findings of peer-reviewed articles.