Marine and Coastal Collaborative Research Ideas

The purpose of this document is to outline marine and coastal evidence needs where we have identified opportunities for collaborative research.

Natural Resources Wales's purpose is to pursue sustainable management of natural resources in all of its work. This means looking after air, land, water, wildlife, plants and soil to improve Wales's well-being, and provide a better future for everyone. Since its creation NRW has made a strong commitment to be an evidence based organisation. We seek to ensure that our strategy, decisions, operations and advice to Government and others are underpinned by sound quality-assured evidence. Whilst we have limited funds available for research, we recognise that there are many delivery mechanisms (e.g. academic partnerships, citizen science and collaborations) that will provide the evidence that is fundamental to our work.

NRW has a marine and coastal evidence programme that identifies our priority strategic and operational evidence needs; we update this on a yearly basis.

This document lists the projects that we think would be particularly suitable for research collaborations and is primarily aimed at increasing awareness and supporting further dialogue between NRW and the research community around opportunities to address these. Our highest priority evidence needs are described in a separate document, along with a brief description of work being done to address them. Where we have ideas for PhD projects etc. that stem from the highest priority evidence needs, these are marked as **HIGH PRIORITY**.

If you are interested in working with us on these, or any other research ideas, please contact Kirsten Ramsay: marinecoastalevidence@naturalresourceswales.gov.uk

1. List of Research Ideas

More information about each project is given in the following section (click on each project for the detail).

Activities & Impacts

What are the impacts of abandoned, lost and / or discarded fishing gear in Welsh waters?

How can we predict the underwater noise from wave and tidal energy devices?

How much noise is made by renewable energy devices (floating offshore wind & tidal energy)?

What are the impacts of acoustic surveys on marine fauna?

How can increased access to coastal & marine environments be achieved in a sustainable way?

How can we best influence people's behaviour to reduce impacts to the marine environment?

Benthos

HIGH PRIORITY What is the tipping point of community change in benthic sediment habitats when hard substrates are introduced?

HIGH PRIORITY What are the reasons for the decline of maerl in Milford Haven?

HIGH PRIORITY How might sediments have impacted the maerl in Milford Haven?

HIGH PRIORITY How might pathogens be impacting the horse mussel bed off the Llŷn Peninsula?

HIGH PRIORITY How might sea temperature be impacting the horse mussel bed off the Llŷn Peninsula?

HIGH PRIORITY Genetics and connectivity of horse mussel beds in Welsh waters and the surrounding seas

HIGH PRIORITY What are the reasons for the decline of sponges in the Menai Strait?

HIGH PRIORITY What is the sensitivity and longevity of the species that make up the Fragile sponge and anthozoan community Section 7 habitat?

How do human activities and changes in habitat condition affect carbon sequestration and storage in the marine environment?

Infrastructure enhancement: what is the optimal design, number and configuration of structures to best enhance biodiversity?

What are the impacts of dredge disposal on subtidal habitats?

How sensitive are horse mussel beds and other habitats of conservation concern to smothering by sediment?

Does the timing of low water spring tides impact lower shore habitats during extreme heat events?

What are the genetic links between different populations of Crawfish in Welsh and adjacent waters?

Movement of mooring lines/catenary chains from Floating Offshore Windfarms on soft sediment habitats - is the impact temporary or long-lasting?

What is the most cost-effective way of increasing the amount of seagrass in Welsh waters?

Birds

HIGH PRIORITY What are the productivity and survival rates of seabirds at various Welsh colonies?

HIGH PRIORITY How can we best restore Welsh islands to benefit seabirds?

What makes up the diet of seabird species in Welsh waters?

What areas of the sea are used by different seabirds and how?

Are urban gulls less aggressive when their eggs are replaced by dummy eggs?

How can conflicts between humans and urban gulls be reduced?

Saltmarsh restoration using polders: what are the costs, benefits and trade-offs to breeding and overwintering bird populations?

Coastal Habitats

How have the morphology and habitats of Welsh estuaries changed over the years?

Are our saltmarshes responding to climate change by rolling back inland?

What are the critical loads for nitrogen deposition & sea cliff habitats?

What are the impacts of coastal defences on coastal habitats?

To what extent do coastal habitats act as natural sea defences?

How do people perceive the value of coastal habitats in relation to coastal defence?

Can we use eDNA to assess species in lagoons?

At what locations could saltmarsh habitat be managed to provide coastal protection?

Is *Salicornia* gathering an issue to pioneer saltmarsh, what levels of gathering would be appropriate, and could this be licenced?

How well do brushwood polders work to protect and restore saltmarshes and what is the most appropriate design?

Ecosystems

Are there likely to be any ecosystem level effects of restricted water exchange between tidal lagoons and the area outside?

What was the historic distribution and abundance of marine species in Welsh waters?

What impact could climate change have on marine ecosystem services?

How do marine restoration activities support wider social and economic benefits?

Are artificial reefs a good thing for fish populations and benthic communities?

Fish

HIGH PRIORITY What are the reasons for the decline of herring in Milford Haven?

HIGH PRIORITY Identifying fish habitat hotspots in Wales

Fish utilisation and production in created or restored habitats

What is the distribution and abundance of sandeels in Welsh waters?

What are the effects on fish communities from the presence of offshore wind farms, or marine renewable energy device arrays?

What contribution do sandeels make to Welsh marine mammal, bird and piscivorous fish diets?

How does habitat loss affect fish populations?

What are the impacts on sandeels of passing through dredger screens?

Can we use eDNA to study presence of diadromous fish in Welsh waters?

What is the post release mortality of various fish species from recreational angling?

What are the impacts of removal of slow growing, long lived fish species by recreational angling?

How do changes in olfactory cues impact diadromous fish?

What are the wider benefits provided by sustainable fish populations?

Invasive Non-Native Species

What is the likely impact of *Agarophyton vermiculophyllum* (*Gracilaria*) on Welsh habitats and what is its likely spread in Wales?

What are the impacts of invasive non-native species on marine Special Areas of Conservation in Welsh waters?

Can we use eDNA analysis of dredge vessel hopper water to identify presence of Invasive Non-Native Species?

What is the origin of the of the slipper limpet (*Crepidula fornicata*) in North Wales?

What are the impacts of the slipper limpet (*Crepidula fornicata*) on horse mussel (*Modiolus modiolus*) beds?

What is the population status of the mitten crab in north Wales?

How suitable is the Conwy River for the establishment of Chinese mitten crab (*Eriocheir sinensis)*?

Are the Chinese mitten crabs (*Eriocheir sinensis)* in the Conwy genetically similar to those in the Dee?

What is the origin of the of the carpet sea squirt (*Didemnum vexillum*) in Milford Haven?

What are the likely impacts of carpet sea squirt (*Didemnum vexillum)* on benthic features in Milford Haven?

Are the pacific oyster (*Magallana gigas*) populations in Wales recruiting from existing populations or from elsewhere?

Marine mammals

HIGH PRIORITY What is the efficacy and potential longer-term impacts of acoustic deterrent devices?

HIGH PRIORITY Developing Collision Risk Models for marine mammals

How effective are noise abatement methods in Welsh waters?

What makes up the diet of marine mammals in Wales and adjacent waters?

How much do the bottlenose dolphins in Welsh waters move between different areas?

What is the extent of netting activities and the impact on marine mammals in Welsh waters?

How does habitat loss impact marine mammals at the population level?

How are marine mammal populations structured in Welsh waters and further afield?

Understanding reasons for mortality in cetaceans inferred from strandings

How do marine mammal populations respond to removals of individuals?

To what extent do recreational activities disturb marine mammals?

What is the distribution, abundance and population demographics of Risso's dolphin in Welsh waters?

How are PCBs (and other contaminants) affecting marine mammals in Wales?

Is litter causing mortality / impacting on marine mammal populations around Wales?

Is prey availability limiting marine mammal populations in Welsh waters?

What is the origin of bycaught seals in southwest Britain?

What is the degree of connectivity and the extent of foraging ranges in grey seals associated with Special Areas of Conservation?

Physical processes

HIGH PRIORITY Measuring the impact of tidal stream energy devices on tidal currents.

HIGH PRIORITY Measuring wave attenuation by wave energy converters.

HIGH PRIORITY Understanding the connectivity of subtidal sandbanks in Pembrokeshire with the wider sedimentary system.

How can we improve our understanding regional and sub-regional sediment budgets?

How quickly do coastal systems recover from storm events?

What will be the likely impact of future extreme storms on Welsh coasts?

How is the wave climate in Welsh waters changing over time, and is the available data adequate?

Where does the sediment in the Milford Haven Waterway come from?

Where might beneficial use of dredge material be appropriate in Welsh waters?

What are the array scale effects of wave and tidal stream devices on physical processes over the medium to long-term?

How can we predict the rate of sediment erosion, transport and deposition within and in between tidal lagoon developments?

How can we improve models to predict medium to long term morphological changes from tidal range developments?

How can we use models to assess effects of decommissioning scenarios for renewable energy developments on physical processes?

What is the impact of large scale floating offshore wind farms in the Celtic Sea on hydrodynamics and wave climate?

What is causing persistent cliffing of frontal dunes?

Water Quality

Sensitivity and vulnerability of the Habitats Regulations features to elevated nutrient concentrations

Is phosphate in estuaries and coastal waters an important factor for eutrophication?

How important are river flushing events for estuarine habitats and dispersion of contaminants and nutrients in Welsh estuaries?

How do the dynamics of the Severn Estuary and Bristol channel control the exchange of freshwater and nutrients from river to sea?

2. Project Details

What are the impacts of abandoned, lost and / or discarded fishing gear in Welsh waters?

This evidence review will build on Defra Impacts Evidence Group funded review of abandoned, lost and / or discarded fishing gear. This review would provide an assessment of this issue in Welsh waters and would include sections such as number of pots / nets lost and collate evidence of currently known impacts in Welsh waters.

Suggested level of research: MSc

How can we predict the underwater noise from wave and tidal energy devices?

The development of noise propagation models for use in tidal waters is required to further reduce uncertainty regarding the potential impacts of commercial scale arrays of wave and tidal energy devices.

Suggested level of research: Postdoc or research programme

How much noise is made by renewable energy devices (floating offshore wind & tidal energy)?

There is little evidence of the operational noise from Floating Offshore Wind devices; particularly 'thrums' from anchor cabling. A field study is needed to monitor the noise from an operational device / array. Evidence of operational noise from tidal turbines is limited to a few device types from single devices. There is no information on how noise from single devices will extrapolate to an array scale project, and no information on operational noise for a wide range of device types currently proposed. Field observations are required to measure operational noise of different tidal turbine devices, and arrays. This would require collaboration with industry to record underwater noise around operational projects.

Suggested level of research: MSc and above

What are the impacts of acoustic surveys on marine fauna?

A practical study is required on the potential impacts from acoustic surveys (geophysical e.g. multibeam, boomer) on marine mammals, birds and invertebrates. A desk-based study has been completed, active field research is now needed. This is likely to include research on effects of sound on diving birds and impacts of particle motion components of sound.

Suggested level of research: PhD and above

How can increased access to coastal & marine environments be achieved in a sustainable way?

The Wales Marine Plan and other policy objectives such as Ocean Literacy have key aims to improve access to coastal and marine environments for well-being, recreational and educational benefits, but this could create further issues with regards to unsustainable access. This project will look at how access to these environments can be achieved in a sustainable way and the management activities that can help to support this.

Suggested level of research: PhD and above

How can we best influence people's behaviour to reduce impacts to the marine environment?

For some damaging activities in the marine environment we have limited ability to control behaviour by legal means. In this case the best course of action might be to encourage a change in behaviour. This study would look at the most effective ways to do this. Example activities could be bait digging at specific sites, cleaning boat hulls in a way that would minimise spread of INNS.

Suggested level of research: PhD and above

HIGH PRIORITY What is the tipping point of community change in benthic sediment habitats when hard substrates are introduced?

This project would examine sediment community change in areas where hard substrates are introduced as part of offshore infrastructure developments. There are various directions a project could head in, such as investigating the hard substrate-related tipping points that would lead to community change in different sediment types at local or regional scales, and at differing spatial densities or distributions. Work could include an evidence review and analysis of monitoring data from industry, as well as targeted field based studies to gather data from specific sites.

Suggested level of research: PhD

HIGH PRIORITY What are the reasons for the decline of maerl in Milford Haven?

The maerl bed in Milford Haven has been declining for several years now (decreasing percentage of live maerl etc) but the reasons for this decline are unclear. This project would be an investigation into the historic environment of Milford Haven and previous suitable conditions for estuarine habitats e.g. maerl, through use of deep cores, ancient DNA etc. What were the conditions in Milford Haven historically that promoted favourable conditions for maerl beds and other estuarine habitats and species? What has changed, what is now impacting the estuary and what can be improved?

Suggested level of research: PhD

HIGH PRIORITY How might sediments be impacting the maerl in Milford Haven?

The maerl bed in Milford Haven has been declining for several years now (decreasing percentage of live maerl etc) but the reasons for this decline are unclear. Maerl is very sensitive to sedimentation; we need to understand the sources and movements of sediments and how they interact with each other and deposition in marine habitats in the Haven This project would examine terrestrial vs marine sources of sediments in Milford Haven. It would investigate possible links between agricultural activity along the Cleddau rivers and possible run-off of sediments into the Haven, and how this potentially impacts estuarine habitats such as maerl. We also need to understand more about how activities in the Haven causing sediment movements (e.g. dredging) are affecting the estuary in terms of where the sediment is ending up.

Suggested level of research: PhD

HIGH PRIORITY How might pathogens be impacting the horse mussel bed off the Llŷn Peninsula?

The condition of the horse mussel (*Modiolus modiolus*) bed off the Llŷn Peninsula has been declining for several years but the reasons for this are unclear. This project would examine the presence and impacts of pathogens in horse mussels and possible interactions with climate change (including higher water temperatures, pH etc). The project would include lab studies to determine the impact of known shellfish pathogens on horse mussels (currently limited research) and the influence of temperature on infection, and wider sampling at the Pen Llŷn a'r Sarnau Special Area of Conservation (SAC) reef to determine if there are differences between healthy and degraded reef as well as beyond the Pen Llŷn a'r Sarnau SAC bed to understand wider patterns in pathogen presence and / or impact . This project would also investigate whether damaged horse mussels (e.g. from potting/trawling impacts) are more susceptible to pathogen impacts and whether it affects survival. This would need to link with other proposed projects if successful.

Suggested level of research: PhD

HIGH PRIORITY How might sea temperature be impacting the horse mussel bed off the Llŷn Peninsula?

The condition of the horse mussel (*Modiolus modiolus*) bed off the Llŷn Peninsula has been declining for several years but the reasons for this are unclear. This project would investigate heat stress impacts on horse mussels, including modelling of water temperatures (past, present and future) at the Pen Llŷn a'r Sarnau Special Area of Conservation (SAC) reef area to understand what changes have and will occur here. Using modelled temperature scenarios, tank experiments could be used to assess the impacts on the horse mussels. Field sampling (diving required) could also be conducted to look at temperature conditions across a year with associated sampling of haemolymph to look for sub-lethal heat stress indicators.

Suggested level of research: PhD

HIGH PRIORITY Genetics and connectivity of horse mussel beds in Welsh waters and the surrounding seas

The condition of the horse mussel (*Modiolus modiolus*) bed off the Llŷn Peninsula has been declining for several years but the reasons for this are unclear. This project would examine genetics and connectivity of horse mussel beds, for Wales and beyond. This would include larval modelling and investigations of recruitment issues. Some work has been started already but wider research is needed. This could possibly be combined with the project on heat stress.

Suggested level of research: PhD

HIGH PRIORITY What are the reasons for the decline of sponges in the Menai Strait?

Monitoring has shown declines in the abundance and biomass of sponges in the Menai Strait but the reasons for the decline are unclear. This project would undertake sponge health investigations. For example: What are the impacts of water quality on sponges? Microbiome related lab trials may be possible. Pathogen impacts relating to water quality or other sources could be investigated. Seasonal changes could be studied, and comparisons made to other sponge samples. Following on from recent investigations it would be useful to study the growth and health changes of *Haliclona oculata*, *Halichondria panicea* and *Amphilectus fucorum* related to varying levels of sewage inputs. Ideally modelled data could be used to estimate past expected levels at the site followed by tank studies to look at growth compared to current levels. This would include various expected inputs related to sewage e.g. bacteria, suspended matter, ammonia / nitrogen etc. This could be accompanied by monitoring in the field at sites at different distances to sewage outfalls.

Suggested level of research: PhD

HIGH PRIORITY What is the sensitivity and longevity of the species that make up Fragile Sponge and Anthozoan habitat?

Limited data exists on the longevity and sensitivity of fragile sponge species and other species that form the Fragile Sponge and Anthozoan habitat listed under Section 7 of the Environment (Wales) Act. In order to understand how best to manage, determine condition and evaluate impacts, information is needed on how long the species live for, growth rates and how they respond to pressures (mainly physical, but other pressures such as sedimentation and water quality may also be relevant). The study could involve in situ recording, use of photo monitoring datasets and lab experiments. The research ask is quite broad and would benefit from collaboration with other Nature Conservation Bodies where this is also a feature of protected sites. It is hoped that outputs from this research would feed into evidence gaps within MarESA (Marine Evidence based Sensitivity Assessment) and update sensitivity information for these communities.

Suggested level of research: PhD

How do human activities and changes in habitat condition affect carbon sequestration and storage in the marine environment?

There is a growing focus on the ability of the marine environment to store and sequester carbon, and a requirement to both maintain and enhance blue carbon stores to help achieve net zero. Particular focus at present is on blue carbon habitats such as saltmarsh and seagrass, with a view to include them in the UK's Greenhouse Gas Inventory. Existing studies show that marine habitats play an important role in carbon storage and sequestration, but we have little current knowledge on how impacts on them, and / or changes to habitat condition, may affect their ability to provide this ecosystem service. There are various potential PhD projects that could be explored within this evidence need. Priority activities could include bottom trawling (though work is already being done on this), nutrient inputs (what impact to elevated nutrient levels (e.g. from waste water discharges, diffuse inputs from rivers etc.) have on sediment habitat condition and carbon storage), aggregate extraction, installation of offshore energy infrastructure etc.

Suggested level of research: Various

Infrastructure enhancement: what is the optimal design, number and configuration of structures to best enhance biodiversity?

The Ecostructure project has significantly increased our knowledge of the artificial enhancements that could be installed on existing and new structures to increase biodiversity. However, work to complete monitoring of installed structures is still ongoing. When completed, this will build on the current evidence available regarding aspects such as the optimal number of enhancement structures required, preferred citing and configuration for the most effective biodiversity enhancement. Monitoring of any additional newly installed enhancement structures is essential.

Suggested level of research: Various

What are the impacts of dredge disposal on subtidal habitats?

Further evidence is needed on the impacts of dredge disposal on subtidal habitats. This practical evidence collection project will include the monitoring of dredge disposal impacts and investigations into impacts of smothering, particularly on habitats of conservation importance using existing available evidence and new data collected in Wales.

Suggested level of research: PhD and above

How sensitive are horse mussel beds and other habitats of conservation concern to smothering by sediment?

There is a need to better understand the impacts of smothering on *Modiolus modiolus* (horse mussel) and other key habitats. This would be a practical (potentially lab based) study which would build on existing studies by investigating smothering at a variety of depths in order to assist NRW to develop thresholds to be able to provide robust advice.

Suggested level of research: PhD and above

Does the timing of low water spring tides impact lower shore habitats during extreme heat events?

Spring tide low waters in North Wales occur in the early morning or evening, whereas in South Wales they are around the middle of the day. This means that at times of extreme heat, the lower shore will be more exposed to this pressure in South Wales. A study could examine whether lower shore habitats in North Wales are less impacted by extreme heat events due to the timings of the spring tides.

Suggested level of research: MSc and above

What are the genetic links between different populations of Crawfish in Welsh and adjacent waters?

This work would use DNA sampling to provide a better understanding of the population dynamics of this species in Welsh waters and highlight potential relationships between sub populations. The project would incorporate Ireland and Southern England. Outputs would better inform management and restoration goals and could be undertaken in collaboration with a V-notching scheme.

Suggested level of research: PhD

Movement of mooring lines/catenary chains from Floating Offshore Windfarms on soft sediment habitats - is the impact temporary or long-lasting?

A number of different mooring systems are currently presented to anchor floating offshore wind (FLOW) devices. An example of this is the catenary mooring system where the catenary lines hang horizontally at the seabed. The lines from these mooring systems will move with the tide causing scour and abrasion of seabed habitats. It is unclear at present what the longevity of this impact is on soft sediment habitats.

Suggested level of research: PhD

What is the most cost effective way of increasing the amount of seagrass in Welsh waters?

There are two main ways of increasing the amount of seagrass in Welsh waters. One is creation of new beds by planting. The other is by reducing pressures on and around existing beds to create conditions whereby the bed expands. This multidisciplinary study would look at the likely effectiveness of both approaches in Welsh waters. The pressures that could be limiting expansion of beds would be examined and the likely degree of change if these pressures were removed would be modelled (noting that for some sites there will be physiographic factors limiting expansion). The economic costs of doing this would also be calculated. This would then be compared to the economic costs of planting new seagrass beds. This would allow us to calculate the cost effectiveness of both approaches. Additionally, the social benefits of either approach could be investigated.

Suggested level of research: PhD

What are the productivity and survival rates of seabirds at various Welsh colonies?

A project to set up ringing and resighting for seabird species as well as camera traps for productivity and diet at seabird colonies. This could include the following species: Atlantic puffin, black-legged kittiwake, common guillemot, lesser black-backed gull, razorbill, shag cormorant, tern species, gulls.

Suggested level of research: Various

What makes up the diet of seabird species in Welsh waters?

Monitoring of seabird diet is already in place at some colonies around the Welsh coast but could be expanded to other areas, especially where the colonies are easily accessed. This project will involve practical research work to investigate the prey species being returned to colonies. Species of particular interest would include shags, cormorants and puffins.

Suggested level of research: MSc and above

What areas of the sea are used by different seabirds and how?

This practical study will develop our understanding of Welsh seabirds, especially in relation to the main areas of Welsh seas that they use to help inform potential impacts. The project will involve using GPS and data loggers fitted to birds and will particularly focus on diving birds such as auks, cormorants and shags.

Suggested level of research: MSc and above

How can we best restore Welsh islands to benefit seabirds?

Rat free islands are a great resource for seabirds due to the lack of predation by these invasive mammals. However often after eradication, populations of ground or burrow nesting birds do not increase due to lack of management e.g. grazing. To increase resilience to climate change impacts, ensuring connectivity and ensuring adequate locations for these birds to breed is important. Different management techniques could be considered as an experiment to see what works best on different islands.

Suggested level of research: PhD

Are urban gulls less aggressive when their eggs are replaced by dummy eggs?

Experiment to see whether urban gull populations are less aggressive when their eggs are replaced by dummy eggs. This could be done in urban sites e.g. Cardiff. If shown to be effective, this could be an alternative to destruction of gull eggs and nests.

Suggested level of research: MSc and above

How can conflicts between humans and urban gulls be reduced?

Study of urban gulls looking at ways of decreasing conflict between urban gulls and people. Ways to reduce aggression. Humane ways of stopping nesting, communications about urban gulls to inform the public etc.

Suggested level of research: MSc and above

Saltmarsh restoration using polders: what are the costs, benefits and trade-offs to breeding and overwintering bird populations?

Polders (a nature based solution to coastal defence) are a commonly used technique in Belgium, Germany and the Netherlands, but are much less commonly used in the UK, where experience has been mixed. The Rumney Great Wharf polder re-initiation project provides an excellent opportunity to learn about the use of these structures. This proposal focusses on the ecosystem effects on birds that are designated under the Severn Estuary Special Protection Area.

Suggested level of research: MSc and above

How have the morphology and habitats of Welsh estuaries changed over the years?

This evidence review will develop an understanding of the historic evolution of Welsh estuaries in terms of morphological and habitat distribution changes. A wide range of information could be used to inform the study including bathymetric charts, aerial photographs, LiDAR, Topographic information, wave and tidal data and sediment budget information. It will be important to consider the influence of natural and anthropogenic changes and their impacts. It would also be beneficial to develop an updated baseline understanding of present day physical processes. It will first be necessary to determine priority areas for review which could be based on availability of existing and new data/information and casework demand. When a priority area is determined, a review should be undertaken of the adequacy of existing information. Recommendations could also be made in relation to any data/evidence gaps.

Suggested level of research: PhD and above

Are our saltmarshes responding to climate change by rolling back inland?

There is currently conflicting evidence regarding the resilience of coastal ecosystems. There is an assumption that saltmarsh will naturally move inland as sea level rises. However, there is little evidence to back this up. A research project to test this assumption in Wales would help with understanding of resilience and coastal management. Long term surveillance would be required at locations where there are no constraints (e.g. sea defences) to the landward movement of saltmarsh.

Suggested level of research: Long term research programme

What are the critical loads for nitrogen deposition & sea cliff habitats?

A study is required to determine the critical thresholds for nitrogen deposition on maritime cliff and slope. There are no critical thresholds for nitrogen deposition on maritime cliff and slope, this component feature is made up of different vegetation types (maritime heath, maritime grassland, crevice and ledge communities, supra littoral lichen communities etc) not covered by the Air Pollution Information System (APIS) data. The study will investigate the effects of nitrogen deposition on the sea cliff habitats to 2030.

Suggested level of research: PhD

What are the impacts of coastal defences on coastal habitats?

NRW wish to better understand of the impact of coastal defences on adjacent coastal margin habitats, which will include consideration of coastal geomorphology impacts. This review will include a consideration of what the positive and negative impacts of coastal

defences are and where they are located along the coastline of Wales. Suitable case studies could include Borth and Morfa Dinlle.

Suggested level of research: MSc and above

To what extent do coastal habitats act as natural sea defences?

This would evaluate the value of coastal margin habitat in providing / contributing to soft sea defences, including system thresholds which govern that role.

Suggested level of research: PhD

How do people perceive the value of coastal habitats in relation to coastal defence?

A study investigating the social perception of coastal margin habitats (particularly dunes and shingle) in relation to coastal defence is required to improve our social evidence base for the value and potential inclusion of coastal margin habitats. This study will assist with future reporting within NRW.

Suggested level of research: MSc and above

Can we use eDNA to assess species in lagoons?

There is a lack of contemporary information relating to species communities and diversity of Welsh saline lagoons. eDNA analysis of water samples from saline lagoons could provide valuable information on species diversity and presence / absence of notable species (e.g. lagoon specialist species).

Suggested level of research: PhD and above

At what locations could saltmarsh habitat be managed to provide coastal protection?

This project would identify specific locations and actions where managing saltmarsh to protect and enhance coastal flood defences is appropriate.

Suggested level of research: PhD

Is *Salicornia* gathering an issue to pioneer saltmarsh, what levels of gathering would be appropriate and could this be licenced?

We have little information on gathering of *Salicornia* and we do not know if this is having an impact. This field based study would compare sites with different levels of gathering activity.

Suggested level of research: PhD

How well do brushwood polders work to protect and restore saltmarshes and what is the most appropriate design?

Polders are a commonly used technique in Belgium, Germany and the Netherlands, but are much less commonly used in the UK, where experience has been mixed. The Rumney Great Wharf polder re-initiation project provides an excellent opportunity to learn about the use of these structures. For physical processes: how well do polders slow currents and promote sediment accretion (that can be subsequently colonised by saltmarsh plants). Detailed monitoring is underway, but further short-term process experiments would provide beneficial insight. Investigation into the ability of numerical models to accurately represent the structures and their effect would also be useful. Ecological and blue carbon aspects of the project also provide opportunities for research.

Suggested level of research: PhD

Are there likely to be any ecosystem level effects of restricted water exchange between tidal lagoons and the area outside?

Tidal lagoons may create areas with less exchange of water with surrounding areas than was the case before construction. This desk-based study would investigate these possible changes and specifically whether there may be changes to pelagic communities (including plankton) as a result.

Suggested level of research: PhD

What was the historic distribution and abundance of marine species in Welsh waters?

This desk based exercise would build on work already carried out and investigate historical distributions of marine flora and fauna to understand changes in the Welsh marine environment over time. This will highlight changes such as historical losses of habitat and which species and habitats have experienced the most changes.

Suggested level of research: MSc and above

What impact could climate change have on marine ecosystem services?

A review is required to investigate potential changes in marine ecosystem services in Welsh waters resulting from climate change. This will include the known impacts that climate change could cause (e.g. water temperature and chemistry, sea level rise, non-native species). It will assess how these changes could affect those provisioning, regulating and cultural services that marine ecosystems provide.

Suggested level of research: PhD

How do marine restoration activities support wider social and economic benefits?

The project would develop an understanding of how marine restoration activities can support job creation & local economies in Wales.

Suggested level of research: MSc and above

Are artificial reefs a good thing for fish populations and benthic communities?

Artificial reefs have been proposed as a mechanism to increase fish numbers and also to increase biodiversity. A study is needed to investigate whether artificial reefs result in absolute or only perceived improvements in biodiversity and resilience. For example, increases in fish numbers may not be at the population level but simply spatial aggregations. For benthic flora and fauna, the increases of epifauna on the structure may have concurrent decreases in infauna of the sediments under the reef. Additionally, the study could investigate whether the species attracted to artificial reefs are likely to be of particular ecosystem or conservation importance.

Suggested level of research: PhD

HIGH PRIORITY What are the reasons for the decline of herring in Milford Haven?

There has been a recent decline in herring abundance observed in the Milford Haven Waterway. Various projects could look at the possible reasons for this decline, including: suitable conditions for spawning of herring in Milford Haven; analysis of multi-year environmental data, changes in sediments; egg numbers (possibly eDNA work to detect peak spawning times) etc. This could potentially also include further genetic and otolith work. Further analyses of historic data regarding sub race of herring in Milford Haven and links to wider population of herring spawning grounds in Wales could be investigated.

Suggested level of research: PhD

HIGH PRIORITY Identify fish habitat hotspots in Wales

This project would apply and further develop methods used in Campanella & van der Kooij (2021) to collate a wide range of fisheries data and surveys and produce maps of fish habitat hotspots, with a focus on a subset of species (e.g. gadoids) and inshore waters.

Suggested level of research: PhD

Fish utilisation and production in created or restored habitats

This PhD would examine the habitat function of sea grass beds / kelp forest / blue mussel beds for a range of fish species of commercial and conservation importance. The aim would be to provide evidence of habitat functions, such as foraging, spawning / nursery and refuge functions of fish in selected natural and, if possible, restored habitats through comparing life history traits e.g. growth rates, species richness, life stages, mortality etc. The overall objective of the work would be to inform NRW casework and policies on the benefits of restoring existing or establishing new habitat, as well as providing additional protection of existing habitat. This would need to be coordinated with work already in progress on this topic.

Suggested level of research: PhD

What is the distribution and abundance of sandeels in Welsh waters?

Sandeels are a key prey species for marine mammal and seabird species and are an important component of marine ecosystems and trophic structures in Welsh waters. Identification of the areas of potential sandeel residency and spawning habitat in Welsh waters using existing mapping is needed, along with ground truthing studies using sandeel dredges or grab sampling to identify the use of this habitat by sandeels. Methods for ground truthing could include eDNA and trawling to identify whether sandeels are using these areas in their pelagic phases. This will build upon the work presented in Ellis et al. (2012) and allow assessments to robustly consider the effect upon this species, which is often overlooked by standard survey techniques. Similar studies for other species which show habitat preferences e.g. Atlantic herring, black bream, sand goby and European plaice would also be of value.

Suggested level of research: PhD

What are the effects on fish communities from the presence of offshore wind farms, or marine renewable energy device arrays?

An evidence review is required on the response of fish communities to the presence of offshore wind farms or marine renewable energy device arrays. This would weigh the potential for habitat loss and displacement from spawning / nursery / feeding grounds and migratory routes and disturbance / electromagnetic fields, with the potential for reduced fishing pressure and increased habitat complexity / hard substrates within the array area. Key questions to consider in this review would be; Is the effect beneficial overall? Is there a changed community structure, diversity or abundance as a result? Which key species are positively and negatively affected?

Suggested level of research: BSc and above

What contribution do sandeels make to Welsh marine mammal, bird and piscivorous fish diets?

The importance of sandeels to Welsh birds, marine mammals and piscivorous fish requires a review to inform our advice on this species from e.g. renewables, fisheries, aggregates, dredging and disposal. Some historic information is available for marine mammals in e.g. Strong (1996) and from the Cetacean Strandings Investigation Programme reports more recently. Gut content metabarcoding could also be used. Spatial mapping of the importance to relevant populations would also be valuable as in some ecosystems and to some species, sandeels may be a more important prey item.

Suggested level of research: PhD

How does habitat loss affect fish populations?

Losses of habitat due to development or human activity (such as dredging, commercial fishing etc.) may result in exclusion of certain fish species from habitats they rely upon, but the effect of this upon the wider populations of the species is unclear and generally lacks evidence within assessments. The potential for fish to move to other feeding / spawning / nursery areas, and the likelihood of them doing so following disturbance, requires further review, research and assessment. This should consider how to identify and assess the availability of other areas nearby that may be utilised by the respective species.

Suggested level of research: PhD and above

What are the impacts on sandeels of passing through dredger screens?

Evidence is required on the size of sandeels which can pass through the screen of a dredger, and the mortality of individuals which do and do not pass through the screen. It is unclear whether there are any studies available; if not, some trials or in-situ monitoring are likely to be needed to gather evidence.

Suggested level of research: MSc and above

Can we use eDNA to study presence of diadromous fish in Welsh waters?

This project is based on a recommendation in the Evidence report: 'Feasibility Study of Methods to Collect Data on the Spatial and Temporal Distribution of Diadromous Fish in Welsh Waters'. This project would review existing evidence of using eDNA on a large scale to establish presence or effective absence of key fish (and other) species. Following on from this, a two-year, comprehensive survey using automated samplers would collect eDNA across full tidal cycles, with replicate samples spread across key areas for marine developments. As eDNA screening is an emerging technology, such a study could include an initial, short pilot phase to test and refine these field techniques across a number of areas.

Suggested level of research: PhD

What is the post release mortality of various fish species from recreational angling?

In Wales, more information regarding fish populations and post-release mortality is required to better understand the overall effect of biological removals. This is especially relevant for species which are valued by both the recreational and commercial fisheries sector.

Suggested level of research: PhD

What are the impacts of removal of slow growing, long lived fish species by recreational angling?

It has been identified that the pressures of recreational sea angling may have the greatest effect on species which are slow growing, long lived and late maturing (e.g. wrasse). Work is required to investigate the impacts of removal of these types of species in angling hotspots in Wales and link this to important species for protected features of Welsh MPAs such as reef.

Suggested level of research: PhD

How do changes in olfactory cues impact diadromous fish?

Anthropogenic changes to the olfactory cues may alter the homing success of diadromous fish with impacts to the sustainability of their populations. There are a number of evidence gaps identified on the impact of changes in olfactory cues for diadromous fish, from the scale of changes in hydrodynamics required to impact homing, to the implication of individual-level impacts to the populations. A review of the evidence / evidence gaps on this subject would be valuable.

Suggested level of research: MSc

What are the wider benefits provided by healthy fisheries?

The project would entail an analysis of the wide range of ecosystem services and benefits provided by healthy fisheries (fish and shellfish) and associated ecosystems including, but not limited to food provision, nutrient cycling, water quality, and supporting wider food chains and ecosystem functionality. It would also where possible provide an economic valuation derived from fisheries and summarise their role in supporting local economies and employment opportunities.

Suggested level of research: PhD

What are the impacts of invasive non-native species on marine Special Areas of Conservation in Welsh waters?

NRW wish to gain a better understanding of the impacts of non-native species on Welsh Special Area of Conservation features. This will build on a recent report which assesses the impacts of key marine invasive non-native species on Welsh MPA habitats and features, fisheries and aquaculture (Tillin et al., 2020). This work would need to use the evidence review as a base and go on to undertake desk and site based investigations to document evidence of impacts in Welsh waters.

Suggested level of research: PhD

Can we use eDNA analysis of dredge vessel hopper water to identify presence of Invasive Non Native Species?

This practical study would provide a better understanding of the risks of introduction and spread of INNS due to marine dredging activities in Wales. An important part of this work would be to develop working relationships with dredge operators.

Suggested level of research: PhD

What is the origin of the of the slipper limpet (*Crepidula fornicata*) in North Wales?

We are aware that an established population of the slipper limpet (*Crepidula fornicata*) is in the Menai Strait and southeast Anglesey due to a number of records from 2020 onwards. NRW wish to understand more about the method of introduction of this species to North Wales. An established population exists in Milford Haven and Northern Ireland, but it is unclear whether this species has arrived through natural spread or whether it was introduced through a specific introduction event, either a new event or whether the species has been present since the previous introduction event of 2006. This project could involve genetic analysis and an examination of pathways. Evidence on the method of introduction is important to ensure existing biosecurity protocols are adequate and will help target pathways for potential future introductions to an area. This would be one of the higher priority projects related to non-native species.

Suggested level of research: MSc and above

What is the origin of the of the carpet sea squirt (*Didemnum vexillum*) in Milford Haven?

The invasive carpet sea squirt was discovered in Milford Haven in 2023. NRW wish to understand more about the method of introduction of this species to this area. This project could involve genetic analysis and an examination of pathways. Evidence on the method of introduction is important to ensure existing biosecurity protocols are adequate and will

help target pathways for potential future introductions to an area. This would be one of the higher priority projects related to non-native species.

Suggested level of research: MSc and above

What are the likely impacts of *Didemnum vexillum* on benthic features in Milford Haven?

The invasive carpet sea squirt was discovered in Milford Haven in 2023. This project would examine the potential ecological impacts of this species, especially on the designated habitats of the Special Area for Conservation (e.g. Reef habitat).

Suggested level of research: MSc and above

What is the likely impact of *Agarophyton vermiculophyllum* (*Gracilaria*) on Welsh habitats and what is its likely spread in Wales?

This species was recently found in Porthmadog and quickly further discovered in the Mawddach, and Malltraeth and was also present in 2020 in the Burry Inlet. The extent suggests a mass influx of propagules, and maybe not a localised source around Porthmadog. It is likely that this species has not yet reached its limit of extent and density in Wales. The project should primarily include an investigation into the likely impacts of this species on Welsh habitats.

This project could also review likely propagule spread (e.g. through modelling). It could also model the habitats where we could expect this species to be found and where it could prove problematic through the recycling of propagules locally, which would increase the density to problem levels. Ground truthing of the model would be an important element to the project. This would be one of the higher priority projects related to non native species.

Suggested level of research: MSc and above

What are the impacts of the slipper limpet (*Crepidula fornicata)* on horse mussel (*Modiolus modiolus)* beds?

Crepidula fornicata are now being found off of the north Llŷn Peninsula in north Wales and have been recorded within Wales's main horse mussel (*Modiolus modiolus*) reef, which is a protected under Annex 1 of the Habitats Directive. Understanding the potential negative impacts on this habitat from a newly arrived INNS species would be valuable in terms of MPA management and condition assessment and potentially practical management. This could involve fieldwork.

Suggested level of research: MSc and above

What is the population status of the mitten crab (*Eriocheir sinensis*) in north Wales?

Currently there is no formal monitoring programme of Mitten Crab, however, some data on population trends is collected from the fish trap in Chester. This shows that numbers have been increasing steeply in recent years. Additional monitoring and research such as planktonic megalopa studies, mark release recapture and genetic investigations are needed to better understand the Dee population and potential impacts. We have no evidence about natural predator response, but this could be incorporated into a monitoring programme. This evidence will help us better understand the population of mitten crab in the Dee, including the size of the population and the movements of this species within the estuary and river catchment system. This could be extended to the Conwy Catchment, where new sightings have been recorded in 2024.

Suggested level of research: MSc and above

How suitable is the Conwy River for the establishment of Chinese mitten crab *(Eriocheir sinensis)*?

The Chinese mitten crab has been confirmed in the Conwy estuary in 2024. It is unclear how suitable this catchment would be for mitten crabs, in terms of its flushing time, bank composition, barriers etc. A desk based or site based project could be conducted to provide NRW a more reliable picture of the potential distribution and impacts of mitten crab in this new catchment.

Suggested level of research: MSc

Are the Chinese mitten crabs (*Eriocheir sinensis)* in the Conwy genetically similar to those in the Dee?

It is possible to distinguish different haplotypes of Chinese mitten crab using genetic analysis (using mitochondrial DNA, but also nuclear DNA for a more robust conclusion). Genetic testing of the Chinese mitten crab in the Conwy would allow conclusions to be drawn on the source of the Conwy population, to ascertain whether movement of larvae from the Dee was the likely source of introduction. This could be coupled with larvae dispersal modelling from the Dee estuary.

Suggested level of research: MSc and above

Are the pacific oyster (*Magallana gigas*) populations in Wales recruiting from existing populations or from elsewhere?

Pacific oyster *Magallana gigas* are grown in intertidal fisheries, for example in Milford Haven and the Menai Strait. We currently have few records of juvenile oysters and spat. We would like to understand further, possibly using previous genetic work on this species and modelling, whether the current individuals are being generated from existing

populations, or whether larvae are travelling to Wales from nearby populations in England and France.

Suggested level of research: MSc and above

How effective are noise abatement methods in Welsh waters?

It is likely that noisy activities such as piling for offshore wind, and detonation of unexploded ordnance, may cause adverse effects, especially for marine mammals and fish. Noise abatement methods, such as bubble curtains, to reduce noise at source or reduce how far the noise is able to propagate, have been demonstrated to reduce the noise impact. However, there is no information on how these techniques might perform under the hydrographical conditions in Welsh waters, such as deep water or strong tidal areas. This project ideally should include lab studies (testing resonant bubbles), field studies (bubble curtains for UXOs) and a desk review.

Suggested level of research: Varied

HIGH PRIORITY What is the efficacy and potential longer-term impacts of acoustic deterrent devices for marine mammals, birds, and fish?

There remains a gap in knowledge of how some marine mammal, fish and bird species respond to acoustic deterrent devices (ADDs). They are routinely advised as potential mitigation techniques for tidal energy and other industries/activities but while there is some information for seals around aquaculture sites, and for fish at power stations, our understanding of how effective these are for some species remains limited or unknown, for example for delphinids like bottlenose and Risso's dolphins. There are multiple avenues of research, but this can mainly focus on three or four different areas:

- basic research on the behavioural response of a species (birds, mammals, fish) to a specific type, or types, of ADD in the shorter term
- similar to the above, but focusing more on longer term deployment (e.g. Findlay et al 2024 is a good example based on evidence from Scottish aquaculture on the West coast)
- physiological (particularly stress) responses, with a specific focus on impacts on energy budgets and fertility and / or linking these to population models such as IPCoD or DEPONS.

Suggested level of research: PhD

HIGH PRIORITY Developing Collision Risk Models for marine mammals

Collision risk and encounter rate models (CRM and ERM) and their input parameters are widely used to inform the risk of collision with protected species in renewable energy developments. Underwater versions of these models are used for consenting tidal energy projects, where the risk and potential effects of collision on marine species is evaluated

and the approval of the development can be dependent on the outputs of these predictive models. Collision Risk / Encounter Risk models designed by SNH (NatureScot 2016 Assessing Collision Risk between Underwater Turbines and Marine Wildlife) are commonly used in consenting in the UK but other models have been / are being developed, especially to accommodate different / unusual tidal turbine designs.
A review (with recommendations) of available models / techniques is needed to understand the status of known models applicable for marine wildlife, especially marine mammals. Further, development of novel modelling routines should be examined to explore their utility for new tidal device designs. Moreover, the input parameters for such models rely on up to date, regionally relevant information. A collation of plausible input parameters for protected marine mammal species found in Wales, UK, is needed to update models. A key aspect of this PhD is to examine the likely impacts of potential collision via population modelling of removals / mortality from collision on marine mammal species in Wales. Critically needed is a review of available information on, and establishment of a framework of, avoidance rates that are likely and pragmatic for consenting in the face of uncertainty.

Suggested level of research: PhD

What makes up the diet of marine mammals in Wales and adjacent waters?

Knowledge of diet in marine mammals in Wales is minimal and / or dated. There are no analysed stomach content samples from bottlenose dolphins in Wales. There is stomach content information from stranded harbour porpoise in Wales but data is not fully analysed. Grey seal diet work in Wales is from a single report from 1996 in Pembrokeshire (Strong 1996) and requires updating. Diet is an important descriptor of prey changes in the ecosystem. As diet is intricately linked to habitat, knowledge of diet will inform our assessments of the condition of marine mammal habitats. This project will primarily involve a desk-based collation of existing data.

Suggested level of research: MSc and above

How much do the bottlenose dolphins in Welsh waters move between different areas?

This desk-based project involves the collation of data on movements of bottlenose in Welsh waters and adjacent seas (i.e. the relevant management unit) and quantification of the degree of connectivity among areas. This work will help NRW to develop advice on management of bottlenose dolphins, especially relating to Habitats Regulations Assessment.

Suggested level of research: MSc and above

What is the extent of netting activities and the impact on marine mammals in Welsh waters?

Mapping the extent of netting activities in Welsh waters and examining the overlaps with areas that are used by marine mammals is a key step in identifying potential risk areas.

This evidence need is dependent on sourcing reliable fisheries effort data. NRW's recent report provides the baseline for cetacean distribution.

Suggested level of research: MSc and above

How does habitat loss impact marine mammals at the population level?

The population consequences of habitat loss are poorly understood. Current population prediction models concern disturbance only, rather than actual habitat loss caused by, for example, permanent displacement or habitat removal from sea wall construction (e.g. tidal lagoons). A modelling framework is required to predict effects on populations.

Suggested level of research: MRes and above

How are marine mammal populations structured in Welsh waters and further afield?

Beyond abundance and distribution, we have a limited understanding of how our marine mammal populations are structured around the UK and Europe. Further information is needed to investigate potential population structuring (including genetic structuring) and regional population demographics (including age and sex ratios).

Suggested level of research: Postdoc or research programme

Understanding reasons for mortality in cetaceans inferred from strandings

NRW's recent publication on Harbour Porpoise Strandings recommended further work on establishing causes of death in stranded specimens. Analysis of data on multiple species of cetaceans collected by the UK Cetacean Strandings Investigation Programme (CSIP) around Wales and adjacent seas would enable impacts from a variety of pressures to be better elucidated.

Suggested level of research: Postdoc or research programme

How do marine mammal populations respond to removals of individuals?

Update and improve understanding of marine mammal population responses to anthropogenic pressures, particularly removals as a result of marine industrial developments. Following an NRW report on marine mammal population demographics and modelling (Evans and Cordes 2021 in prep) there will be a need to regularly update and review information on existing models, population parameters, spatial scales, and pressures.

Suggested level of research: Postdoc or research programme

To what extent do recreational activities disturb marine mammals?

The aim of this work is to gather evidence to assess whether disturbance from recreational vessels or other recreational activities is having an impact on marine mammals, especially bottlenose dolphins, in Welsh waters. This follows on from PhD work carried out at Bangor University. While there are detectable impacts e.g. changes of behaviour in cetaceans, we need to investigate whether these changes are having any detrimental effect on the population or is it mainly a perception that this kind of disturbance is adverse. More work is needed to understand the impacts and to assess potential management options if there is an adverse impact, given the unregulated nature of this activity.

Suggested level of research: PhD

What is the distribution, abundance and population demographics of Risso's dolphin in Welsh waters?

There are frequent sightings of Risso's dolphins, including calves, in several areas around Wales. However, we have a limited detailed understanding of their occurrence in Wales. This poses a potential consenting risk for marine activities/industrial developments and is a potential conservation issue if important areas for this species are not recognised. NRW require better information on abundance, range, breeding, site fidelity, distribution etc. of this species. Photo ID and acoustic detection may be useful methods to obtain much of this information, in addition to collation of existing sighting data.

Suggested level of research: MSc and above

How are PCBs (and other contaminants) affecting marine mammals in Wales?

Some recent literature, including analyses of samples from Welsh strandings indicates that PCB levels are higher than toxic / reproductive impairment thresholds in bottlenose dolphins and around the thresholds in harbour porpoise. However, there is a lack of interpretation from this and limited information on impact / consequences at a population level.

Suggested level of research: PhD

Is litter causing mortality/impacting on marine mammal populations around Wales?

This project would investigate whether there is any evidence that litter is causing mortality or otherwise impacting on marine mammal populations around Wales.

Suggested level of research: MSc and above

Is prey availability limiting marine mammal populations in Welsh waters?

Prey availability is a key aspect of marine mammal ecology and conservation and management (e.g. supporting habitat conservation objectives). What is prey availability in Welsh waters and is prey availability limiting the populations?

Suggested level of research: PhD and above

What is the origin of bycaught seals in Southwest Britain?

Estimates of bycatch of grey seals in the Southwest are consistently high and based on recent Potential Biological Removal calculations appears to outstrip the theoretical maximum sustainable take for the relevant management unit (see SCOS 2018). Despite this, grey seal populations in West Wales continue to increase (Bull et al 2016, 2017; Morgan et al 2018). Identifying the source of bycaught seals in the southwest is a priority. This could be achieved through DNA samples, stable isotope and fatty acid samples and photoID records collected from bycaught seals and from regional grey seal pupping sites (Wales, Ireland and Western Scotland). Such sampling alongside ongoing work to describe the grey seal genome for example should help us to characterise the natal origin of the seals caught in fishing nets in the South-Western approaches.

Suggested level of research: PhD and above

What is the degree of connectivity and the extent of foraging ranges in grey seals associated with Special Areas of Conservation?

Tagging and PhotoID evidence suggests that grey seals from Special Areas of Conservation (SACs) are connected, and seals move among several protected and non-protected areas within a wide area/region (e.g. the OSPAR Region III management unit). However, the amount of connectivity is not well estimated - is it a large proportion of animals that share these sites, is there a high level of site fidelity at different times of the year which would influence management/impacts, or does connectivity follow a random/expected distribution suggesting that connectivity is somewhat trivial? Recent analyses of seals at sea (Carter et al 2022) provides a probable foraging range of 448km from Welsh SACs and maps the expected presence/density of seals at sea from these SACs. Further work is needed to develop a tool to estimate potential impacts / interactions at distance from SACs.

Suggested level of research: PhD and above

HIGH PRIORITY Measuring the impact of tidal stream energy devices on tidal currents.

This PhD would focus on obtaining measurements of tidal velocity deficit behind devices deployed at the Morlais tidal stream energy project, therefore it would require agreement with both Morlais and developers. It is suggested that ADCP transects and drone-based surface current measurements be used. The aim of the project would be to understand the real world impact of energy extraction on tidal flows and to assess how well model predictions of wakes behind tidal turbines match reality. Therefore, either existing model predictions would be required, or model wake predictions would need to be generated.

Suggested level of research: PhD

HIGH PRIORITY Measuring wave attenuation by wave energy converters.

This PhD would aim to measure attenuation of waves by wave energy converters (WECs), if devices are deployed in the META test sites. It is proposed that an array of calibrated pressure transducers could be used to measure wave energy around the WEC and try to measure the impact of the WEC on the incident wave field. Other tools could also be considered, such as (stereo) optical remote sensing to better understand spatial variation. It is suggested that developing and testing approaches to measure the real world impact of energy extraction by WECs on the wave field would be non-trivial and could be an important part of the PhD. This PhD depends upon devices being deployed, the likelihood of this is unknown and so would need discussion with interested developers.

Suggested level of research: PhD

HIGH PRIORITY Understanding the connectivity of subtidal sandbanks in Pembrokeshire with the wider sedimentary system.

One of the major concerns with sand wave levelling is the impact on residual sediment transport. If this is conducted across a sand bank, this could alter the form and stability of the bank. Certainty about this is limited by the lack of understanding of regional scale sediment transport around SW Pembrokeshire and the role that the offshore sandbanks have in the wider sediment budget; both directly, as a store and source of sediment, and indirectly, due to wave dissipation and modulation. It is envisaged that this PhD would primarily be a numerical modelling study.

Suggested level of research: PhD

How can we improve our understanding regional and sub-regional sediment budgets?

NRW wants to improve the evidence base on sediment budgets in Welsh waters, by conducting a review of the adequacy of existing information, the methodology applied, identification of any data / evidence gaps and areas that need to be updated. The review, intended to be a desk-based study, should provide recommendations as to the merit in

updating the sediment budget. This will inform further work on sediment budgets in NRW. Whilst this evidence request applies to the whole Welsh coast it can be delivered through smaller scale projects applied regionally. The methodology should be informed by this handbook: https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/sediment-budget-analysis-practitioner-guide

Suggested level of research: MSc and above

How quickly do coastal systems recover from storm events?

The nature and shape of the Welsh coastline has significantly altered following storm events (e.g. the 2013/14 storms), to the extent that ecosystem structure and functioning will have changed. NRW is seeking to understand to what extent dynamic coastal systems have the capacity to recover following storm events and gain an understanding of habitat resilience and vulnerability to climate change. Analysis could include one or several coastal types (open coast / estuaries, beaches and dunes, shingle, mudflats and saltmarsh) and could reflect on the storm effects noted following the 2013/14 storms. Physical and ecological data could be used to inform understanding of recovery and resilience.

Suggested level of research: PhD and above

What will be the likely impact of future extreme storms on Welsh coasts?

It is important to understand the expected impact of extreme storm events on the Welsh coast, both in terms of habitats and defences. This is important to feed into coastal adaption and coastal planning. The combination of sea level rise, increased surges and increased wave heights under climate change need to be modelled in combination both on a Welsh wide scale and at key sites around the Welsh coast.

Suggested level of research: PhD and above

How is the wave climate in Welsh waters changing over time, and is the available data adequate?

There is a need to improve the understanding of wave data availability in Wales including existence of historic, present, short-term and long-term deployments. NRW supported a KESS II project which provides an insight into wave data available in Wales but there is a need to understand the availability of project level data / any new datasets that have become available. It would be beneficial to:

- create a look up guide for wave data (including metadata) as a source of reference.
- develop an understanding of data gaps
- analyse data to improve our understanding of the Welsh wave climate and analyse wave data with other physical processes datasets such as topography and bathymetry to understand past and coastal change.

Suggested level of research: PhD and above

Where does the sediment in the Milford Haven Waterway come from?

The Estuary feature of the Pembrokeshire Marine Special Area of Conservation is currently unfavourable due to a variety of factors mainly related to water quality. NRW advice on casework and our ability to address the unfavourable condition is hampered by uncertainty around whether the sediments are of marine or terrestrial origin. Land management upstream may be leading to more sediment in the two Cleddau estuaries than was present historically. This investigation needs to present evidence to determine if this is the case to enable NRW to develop management actions.

Suggested level of research: PhD

Where might beneficial use of dredge material be appropriate in Welsh waters?

This review is aimed at identifying opportunities where beneficial use of dredge material may be possible in Wales. Whilst the concept of 'beneficial use' is advocated in policy in proactive terms there are many barriers to delivery. One of the obstacles is not knowing where opportunities exist for implementation. This evidence project will look to help support operational delivery and will assist with putting into practice NRW Guidance on the Sustainable Management of Coastal Shingle and the Sustainable Management of Marine and Coastal Sediment. Working with key partners will be important for this work, and this handbook should be used to inform the approach needed: https://catchmentbasedapproach.org/wp-content/uploads/2021/10/Restoring-Coastal-Habitats_V8.pdf

Suggested level of research: PhD and above

What are the array scale effects of wave and tidal stream devices on physical processes over the medium to long-term?

There is a need to better understand potential array scale effects of wave and tidal stream devices on physical processes (e.g. water flow and energy removal). As these are embryonic renewable energy devices, there is limited validation of impacts at an array scale. Improvements could be made to numerical model validation by using data collected for single or small scale array projects, and / or through developing modelling capabilities (including resolution).

Suggested level of research: PhD

How can we predict the rate of sediment erosion, transport and deposition within and in between tidal lagoon developments?

Identify the approach and techniques that may be used to quantify and qualify the rate of sediment erosion, transport and deposition within and in between tidal lagoons at local (single lagoon) and regional scale (multiple lagoons). Associated works such as aggregate extraction to supply construction material, plus likely maintenance dredge and disposal operations if these need to be done at scale need to be factored in to the determination of the sediment budget and pathways.

Suggested level of research: PhD

How can we improve models to predict medium to long term morphological changes from tidal range developments?

Predicting medium to long-term morphological changes arising from single or multiple tidal range developments is difficult to achieve with any degree of certainty. There is a requirement to increase confidence in predicted impacts of numerical models and to develop and improve model capabilities. For example, iCOASST explores the use of decadal scale modelling for estuarine and coastal evolution. We need to consider whether these tools could be applied to assessing tidal lagoon impacts over the longer term, or learn from these tools in terms of capabilities and limitations.

Suggested level of research: PhD and above

How can we use models to assess effects of decommissioning scenarios for renewable energy developments on physical processes?

There is a need to clarify how decommissioning impacts to the physical processes receptor is adequately assessed. Generally, construction phase modelling is used to inform the decommissioning impacts but the length of time and the future scenarios e.g. climate change impacts won't have been factored in. This research could involve testing model predictions incorporating climatic change influences (e.g. sea level rise, increase in storminess) on various decommissioning scenarios to establish the most appropriate course of action.

Suggested level of research: PhD and above

What is the impact of large scale floating offshore wind farms in the Celtic Sea on hydrodynamics and wave climate?

There is an ambition to have ~4GW of floating offshore wind (FLOW) in the Celtic Sea, the scale of development means physical systems may be impacted. Past research has suggested that turbulence generated by FLOW moorings might affect vertical mixing. Likewise, the large atmospheric wakes from offshore wind farms (significant deficits measured 100km downwind from farms) have been shown to produce vertical transport in the North Sea. It will be important to assess the likelihood of this and potential implications for the Celtic Sea. Wave climate in the lee of the farm will be affected by passage through a floating offshore wind farm and there is little information as to the extent of any attenuation for farms of floating devices. Equally, the atmospheric wakes may alter the generation of wind waves in the lee of wind farms. Given that the farms are likely to be directly upwind of the Welsh coast for prevailing winds, some impact on wave climate might be expected. Understanding the significance of any change is required. Particular consideration should be given to cumulative effects, considering maximum future deployment projections.

Suggested level of research: PhD

What is causing persistent cliffing of frontal dunes?

It has been hypothesised that over-vegetation of frontal dune systems reduces a dune system's ability to recover after a storm event and hence lowers a system's resilience to future erosive events. In brief, the belief is that vegetation anchors sand and prevents dune slumping and avalanching of erosive scarps, which means that 'cliffed' dunes with near vertical slopes persist. The near vertical slope of the frontal dune not only reduces the capacity for entrapment of aeolian sand but makes the dune more susceptible to further wave-driven erosion. Another important factor is likely to be the supra-tidal beach width, if the supra-tidal beach width is narrow, even moderate wave events may scour any deposited sand from the base of the scarp. Fieldwork could help test the processes leading to limited recovery after storm events.

Suggested level of research: PhD

Sensitivity and vulnerability of the Habitats Regulations features to elevated nutrient concentrations

We do not have good knowledge of the sensitivity of Habitats Regulations features (e.g. Annex I habitats) to high levels of nutrients. Studies are required to determine the impact of high levels of nutrients (Nitrogen and Phosphorus) to features such as saltmarsh and reef. This study will aim to determine whether high nutrient loading is detrimental to features or whether they are unaffected.

Suggested level of research: MSc and above

Is Phosphate in estuaries and coastal waters an important factor for eutrophication?

We need to understand whether phosphate is an issue in estuaries. Under current legislation, Dissolved Inorganic Nitrogen (DIN) is considered to be the limiting nutrient and as such, Phosphate (P) is not reported on. However, we have cursory evidence which suggests P is an issue though this has not been fully assessed. NRW can supply data (P is collected in estuaries though not reported on) for assessment. This assessment needs to include whether there is an impact on biological elements such as phytoplankton or macroalgae.

Suggested level of research: PhD

How important are river flushing events for estuarine habitats and dispersion of contaminants and nutrients in Welsh estuaries?

The EA and NRW use a hands-off flow criterion to protect downstream water resources; however, it allows a certain amount of peak flow to be taken away, reducing the amount of water received by the estuary during peak flows. How important are these losses to the removal of contaminants from the estuary?

Suggested level of research: MSc and above

How do the dynamics of the Severn Estuary and Bristol channel control the exchange of freshwater and nutrients from river to sea?

We have nutrient problems in the Bristol Channel and need to understand the causes of these failures. We tend to focus on the small scale (i.e. water body level), but there is a need to understand the Severn Estuary system as a whole. For example, how does the residual flow of water affect the transport of nutrients offshore?

Suggested level of research: MSc and above

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Next update due January 2026

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