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 and impacts

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

HIGH PRIORITY Investigations into impacts on maerl from water quality

HIGH PRIORITY How might pathogens and parasites be impacting the horse mussel bed off the Llŷn Peninsula, currently and in light of future climate change?

HIGH PRIORITY How might rising sea temperatures be impacting horse mussel development and physiology at all life stages (Llŷn Peninsula bed and other affected beds)?

HIGH PRIORITY Genetics, larval modelling and connectivity of horse mussel beds in Welsh waters and the surrounding seas; what is happening now and what will change with rising sea temperatures?

HIGH PRIORITY Are there novel (and ideally non-damaging) methods such as eDNA /eRNA /ROVs that are able to quantify horse mussel spawning, spat presence and larval settlement? And other sensitive subtidal species?

HIGH PRIORITY Understanding past horse mussel habitats to inform future management and restoration under climate change

HIGH PRIORITY How does water quality (agriculture and sewage) impact sponge growth and health and what is the relationship between water quality and the sponge’s microbiome? Are there sponge species that can act as indicators/bio-monitors for water quality monitoring?

HIGH PRIORITY How long do species within the fragile sponge and anthozoan section 7 habitat live for?

HIGH PRIORITY How do species within the fragile sponge and anthozoan Section 7 habitat recover from impacts?

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

How might sediments be impacting the maerl in Milford Haven?

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?

What are the impacts of potting on fragile sponge and anthozoan communities?

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

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

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

HIGH PRIORITY Developing a methodology to record habitat rollback at the coast

Do sand dunes in Wales provide a natural filtration service?

What are the impacts of coastal defences on coastal habitats?

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?

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?

What are the impacts of short term heatwaves on Marine Protected Areas in Welsh waters?

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 Migration and habitat use of diadromous fish in Wales and the Bristol Channel

HIGH PRIORITY Migration and habitat use of diadromous fish in Wales and Liverpool Bay

HIGH PRIORITY What areas of Welsh waters are used by different fish species and why?

HIGH PRIORITY Are there novel (and ideally non-destructive) methods such as eDNA /eRNA /ROVs /modelling that are able to quantify herring spawning and larval movements in the Milford Haven?

HIGH PRIORITY What are the environmental drivers for herring population trends in Celtic and Irish seas? Use of historic data to understand current dynamics.

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?

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?

What is the status and behaviour of sandeels in the Severn Estuary?

Is there a spawning population of Twaite shad in the rivers Dwyfor and Dyfi in North Wales?

Is there a spawning population of European smelt in the rivers in North Wales?

What are the effects of electromagnetic fields (EMFs) from unshielded electric cabling (such as from floating wind farms) on elasmobranch fish?

Invasive Non-Native Species

HIGH PRIORITY 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 (*Eriocheir sinensis*) in north Wales?

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?

What is the prevalence of hull fouling in Welsh marinas?

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, seabirds and diadromous fish 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

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 How do sub-sea cabling practices affect sand wave and sand bank morphodynamics, and the wider sedimentary system?

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

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

Measuring wave attenuation by wave energy converters.

How can we improve our understanding of 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?

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

HIGH PRIORITY What is the impact of nitrogen deposition on Welsh estuarine water quality? If there are significant impacts, what are the management measures?

HIGH PRIORITY What is the impact of ground water on Welsh estuarine water quality? If there are significant impacts, what solutions can we seek?

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

What is causing high contaminant levels in sediment in Cosheston Pill?

How do we best incorporate/account for aerial deposition of nitrogen in estuaries and their catchments?

Which land management activities have the greatest impact on nutrient levels in the estuaries?

How have weather events impacted Water Framework Directive classifications?

How do differing methods of sampling for water quality impact water body assessments?

2. Project details

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 Invasive Non-Native Species.

Suggested level of research: PhD and above

HIGH PRIORITY 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 progress being made 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. Better understanding is needed of the human activities and environmental variables that affect carbon sequestration and storage to help us manage and protect these natural resources in the future. There is a wide scope for research projects under this topic. This could include work on, for example, seagrass, saltmarsh, seaweeds, seabed sediments, fisheries or offshore industries, and include field measurements and laboratory work.

Suggested level of research: PhD and above

HIGH PRIORITY Investigations into impacts on maerl from water quality

There has been a decline in the extent of the maerl bed in the Milford Haven and although historic impacts have likely affected the bed significantly, it is also likely that poor water quality is preventing recovery of the maerl bed and more needs to be done to understand what the direct and indirect impacts are from water quality on maerl (nutrients, organic enrichment, suspended solids, de-oxygenation). Unless we understand the cause(s) of the declines, we cannot make robust decisions about the most appropriate management actions (if any) to take. This project would look at whether modelling can be used to understand how water quality management can improve maerl condition.

Suggested level of research: PhD and above

HIGH PRIORITY How might pathogens and parasites be impacting the horse mussel bed off the Llŷn Peninsula, currently and in light of future climate change?

There has been a decline in the extent and condition of horse mussel beds off the North Wales coast and some of the possible causes are pathogens and parasites, which may in turn interact with increased sea temperatures. Evidence on pathogens and parasites affecting horse mussels remains limited, despite bivalves being capable of accumulating a wide range of viral, bacterial and protozoan pathogens that have caused severe mortalities in other species. With climate change expected to increase disease prevalence and severity, targeted research is needed to assess current pathogen and parasite pressures on the Llŷn Peninsula horse mussel bed and to understand how these impacts may change under future climate scenarios. Horse mussel beds are considered threatened habitats and are protected or listed under multiple pieces of legislation. Unless we understand the impacts, we cannot make robust decisions about the most appropriate management actions (if any) to take.

Suggested level of research: PhD and above

HIGH PRIORITY How might rising sea temperatures be impacting horse mussel development and physiology at all life stages (Llŷn Peninsula bed and other affected beds)?

Horse mussel reefs, particularly those located at the edge of their reef-forming range such as the North Llŷn Peninsula, are predicted to be highly vulnerable to rising sea temperatures, with modelling studies indicating a widespread contraction and northward retreat of suitable habitat across UK waters under future warming scenarios. Despite this predicted risk, empirical evidence on the thermal sensitivity of horse mussels remains limited, especially for larval and early life stages, highlighting the need for research across multiple beds and life stages, including physiological responses and in situ biomonitoring, to better understand vulnerability, resilience, and potential refugia under climate change. Horse mussel beds are considered threatened habitats and are protected or listed under multiple pieces of legislation. Unless we understand the impacts, we cannot make robust decisions about the most appropriate management actions (if any) to take.

Suggested level of research: PhD and above

HIGH PRIORITY Genetics, larval modelling and connectivity of horse mussel beds in Welsh waters and the surrounding seas; what is happening now and what will change with rising sea temperatures?

There has been a decline in the extent and condition of horse mussel beds off the North Wales coast. Horse mussel beds are considered threatened habitats and are protected or

listed under multiple pieces of legislation. Connectivity is critical to the resilience and recovery of horse mussel beds, which persist as a network of stepping-stone populations across Welsh waters and the wider Irish Sea and are an important consideration in Marine Protected Area (MPA) network design and management. Rising sea temperatures are expected to alter larval development and dispersal, potentially reducing connectivity and changing source–sink dynamics between beds. Integrated genetic analyses and multi-year larval modelling under warming scenarios are therefore needed to identify key source populations, assess whether connectivity remains sufficient to support recovery, and provide evidence to inform adaptive management of MPA networks and dispersal corridors under climate change.

Suggested level of research: PhD and above

HIGH PRIORITY Are there novel (and ideally non-damaging) methods such as eDNA/eRNA/ROVs that are able to quantify horse mussel spawning, spat presence and larval settlement? And other sensitive subtidal species?

Horse mussel beds are considered threatened habitats and are protected or listed under multiple pieces of legislation. The condition of horse mussel beds is commonly assessed using extent and density metrics, but understanding current status and future change requires improved measures of population dynamics, including spawning success, spat presence, and larval settlement. Existing spat collectors are logistically expensive, limited in spatial and temporal coverage, and restricted in their ability to quantify recruitment or detect trends, highlighting the need to develop and trial novel, low-impact monitoring approaches such as improved spat collector designs, expanded multi-site deployments, age-based spat analysis, larval pathway modelling, and emerging non-invasive tools (eDNA, eRNA, and ROV-based methods) to enhance monitoring of horse mussels and other sensitive subtidal habitats.

Suggested level of research: PhD and above

HIGH PRIORITY Understanding past horse mussel *Modiolus modiolus* habitats to inform future management and restoration under climate change

Climate change may affect the future condition of horse mussel (*Modiolus modiolus*) beds in North Wales, but the scale and timing of any impacts remain uncertain. This research project would explore potential management and monitoring options where *Modiolus* habitats show signs of climate related change. The project will investigate the historical development and species composition of these reefs, including whether native oysters or other reef forming species previously contributed to habitat structure. By combining historical and contemporary evidence, the research will assess approaches such as habitat enhancement, alternative reef forming species for functional restoration, and frameworks for detecting ecological change to support adaptive, evidence based management.

Suggested level of research: PhD and above

HIGH PRIORITY How does water quality (agriculture and sewage) impact sponge growth and health and what is the relationship between water quality and the sponge's microbiome? Are there sponge species that can act as indicators/bio-monitors for water quality monitoring?

Current understanding of sponge sensitivity and ecological responses to environmental stressors remains limited, constraining their effective use as bioindicators of ecosystem health. Sponges host complex holobiont systems in which interactions between the host and associated microbial communities play a key role in resilience and stress responses; however, baseline microbiome dynamics and stress thresholds are poorly characterised. This PhD would combine controlled tank experiments to isolate the effects of key water-quality stressors (including nutrient enrichment, organic loading, and contaminants linked to agriculture and sewage) with field-based studies across sites experiencing contrasting nutrient regimes, particularly within the Menai Strait. Establishing species-specific physiological and microbial baselines would improve understanding of sponge health, distinguish natural variability from stress-induced change, and identify candidate sponge species suitable for use as bio-monitors in coastal water-quality monitoring programmes. This would help us to understand more about the interaction between nutrients and sponge communities and therefore inform management.

Suggested level of research: PhD and above

HIGH PRIORITY How long do species within the fragile sponge and anthozoan section 7 habitat live for?

Fragile sponge and anthozoan communities are listed under Section 7 of the Environment (Wales) Act as a habitat of principal importance. A process is underway to identify new Marine Conservation Zones for a range of habitats and species, including this one, and the habitat is currently present in several existing protected sites. Any designated sites will require management advice that combines knowledge of activities taking place (e.g. fishing, recreation) with information about the sensitivity of the protected habitats and species to those activities. The sensitivity of fragile sponge communities has been identified as a particular gap in our knowledge. Key components of sensitivity are resilience and recoverability (for more information see the MarLIN Marine Evidence based Sensitivity Assessment approach). This project would look at development of analytical tools/AI to track relevant species through time. NRW has extensive photo monitoring data that could be used for this purpose. Linked to this, lab based studies could look at the growth of species over time.

Suggested level of research: PhD and above

HIGH PRIORITY How do species within the fragile sponge and anthozoan Section 7 habitat recover from impacts?

Fragile sponge and anthozoan communities are listed under Section 7 of the Environment (Wales) Act as a habitat of principal importance. A process is underway to identify new Marine Conservation Zones for a range of habitats and species, including this one and the habitat is currently present in several existing protected sites. Any designated sites will require management advice that combines knowledge of activities taking place (e.g. fishing, recreation) with information about the sensitivity of the protected habitats and species to those activities. The sensitivity of fragile sponge communities has been identified as a particular gap in our knowledge. Key components of sensitivity are resilience and recoverability (for more information see the MarLIN Marine Evidence based Sensitivity Assessment). There is limited empirical evidence around many of the species included in this habitat in terms of recoverability after impacts. Experimental studies looking at physical impacts and recovery in situ could be done. This could also link in with another proposed evidence need around water quality impacts on sponges.

Suggested level of research: PhD and above

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

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

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

The Ecostructure project and other national projects have significantly increased our knowledge of the artificial enhancements that could be installed on existing and new structures to increase biodiversity. However, monitoring of installed structures is crucial to assess the optimal number of enhancement structures required, preferred siting and configuration for the most effective biodiversity enhancement.

Suggested level of research: Various

What are the impacts of potting on fragile sponge and anthozoan communities?

Whilst impacts of pot fisheries on reef habitats is in part covered by the Defra Impacts Evidence Group review, there are site and intensity specific scenarios which require further consideration and understanding. Recent studies in Lyme Bay have highlighted the potential impacts of potting on fragile benthic species, like pink sea fans. A similar experimental study in Welsh waters would help us to understand at what intensity potting is likely to impact fragile sponge and anthozoan communities.

Suggested level of research: PhD

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?

Set up ringing and resighting for seabird species as well as camera traps for productivity diet and phenology 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. Ideally this would cover the features of protected sites such as SPAs and or SSSI's, although non protected sites could also be included. At the moment a lot of our information is only from the large colonies on the Pembrokeshire islands so a greater understanding of these metrics across a range of different geographical sites would help with understanding whether there are regional differences This overarching information will be used in a range of NRW's work areas, including advising on applications for new developments and management advice for protected sites.

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

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 opportunity to learn about the use of these structures by birds.

Suggested level of research: MSc and above

HIGH PRIORITY Developing a methodology to record habitat rollback at the coast

Sea level rise leading to coastal squeeze will result in loss of coastal habitats (e.g. saltmarsh, vegetated shingle) if habitat rollback does not occur (either because of constraints, or because natural processes do not progress as we expect). This habitat loss is undesirable, partly because these habitats have conservation value (e.g. being designated features of protected sites, with an objective to maintain habitat extent) and also because of the ecosystem services that they provide (e.g. flood defence). There is often an assumption that in areas that do not have constraints (either natural (e.g. cliffs backing shingle) or man-made (e.g. roads)) habitat rollback will occur, i.e. habitats like saltmarsh will move inland, with no loss of extent. However, we have a limited understanding of whether, and where, this may currently be happening. If we understood more about the conditions under which habitat rollback is occurring, we would be better able to plan management interventions (e.g. is active habitat management required, or is a policy of no active intervention sufficient?). Initially the focus should be on saltmarsh, cliff and shingle habitats, with an emphasis on understanding vegetation changes, not purely physical change. An investigation into shingle habitats might be particularly suitable as an MSc project. This will help us to understand the extent to which we can expect habitat rollback to occur on unconstrained coast. We propose a first step should be to identify areas that are both subject to change and not constrained (thus identifying those areas where habitat rollback is most likely to occur for the different habitat types of interest). The next step would be to design methodologies for monitoring some of the areas identified (including consideration of using historic information). This work will provide evidence to test the hypothesis that where man-made constraints are absent, habitats can adapt to climate change, and it will inform future management and policy (e.g. adaptation of protected sites to climate change, shoreline management plan effectiveness).

Suggested level of research: MSc and above

Do sand dunes in Wales provide a natural filtration service?

Sand dune aquifers are used as a potable water source in the Netherlands as the sand dunes naturally purify water passing through them. Similar natural filtration processes almost certainly remove nutrients from groundwater in the UK, thus reducing diffuse pollution to the marine environment. However, in the UK this is not well studied. This project should provide a review of this process and its applicability in Wales.

Suggested level of research: PhD and above

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

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 (e.g. managing grazing to control vegetation height).

Suggested level of research: PhD

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

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 Rhymney 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?

Investigations are required to predict 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

What are the impacts of short term heatwaves on Marine Protected Areas in Welsh waters?

There is an increasing body of work on increasing sea temperatures and changes in range and resilience of Marine Protected Area (MPA) species and features but little that is specific to how short term heatwaves affect Welsh MPA species and habitats and recoverability of these. This could have impacts on MPA monitoring, feature condition etc. This project could collate an understanding of thermal tolerances for marine species in Welsh waters, including water temperatures, length of tolerance, recoverability and secondary effects. Plus, how do we map these and address heatwave impacts when they happen?

Suggested level of research: MSc and above

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 Migration and habitat use of diadromous fish in Wales and the Bristol Channel

Diadromous fish have high conservation importance, having suffered population declines and are therefore protected under several different pieces of legislation. This means that any proposals for developments that might impact populations of diadromous fish will be subject to a high level of scrutiny (e.g. tidal energy projects where there is a collision risk, or projects using seawater for cooling where there are risk from entrapment and entrainment). If we had a better understanding of migration routes, we could more confidently predict the impacts of different proposed developments on these species. This

would influence decisions both at the planning stage (e.g. plans for the development of different sectors) and also for licencing decisions for individual developments. Research could include an MSc or PhD to analyse data existing from the Bristol Channel array, potentially combined with targeted additional tracking studies. Large amounts of information on diadromous fish behaviour and population data has been gathered by existing projects, several aspects of the data could be used as part of a PhD (or MSc), e.g. to investigate migration patterns, habitat use and biological traits of diadromous fish from rivers in the Bristol Channel. These could either be species specific or focus on wider estuarine and marine movement by multiple species to generate an understanding of the unique Severn Estuary and Bristol Channel habitat. These studies would have to work closely with researchers based at Swansea University.

Suggested level of research: PhD or MSc

HIGH PRIORITY Migration and habitat use of diadromous fish in Wales and Liverpool Bay

Diadromous fish have high conservation importance, having suffered population declines and are therefore protected under several different pieces of legislation. This means that any proposals for developments that might impacts populations of diadromous fish will be subject to a high level of scrutiny (e.g. tidal energy projects where there is a collision risk, or projects using seawater for cooling where there are risk from entrapment and entrainment). If we had a better understanding of migration routes, we could more confidently predict the impacts of different proposed developments on these species. This would influence decisions both at the planning stage (e.g. plans for the development of different sectors) and also for licencing decisions for individual developments. Research could include PhDs to investigate diadromous fish movements in the Dee Estuary and beyond. This would require further fish telemetry fieldwork and tagging studies with an expansion of the acoustic network into Liverpool Bay. The study could look at interactions with proposed and existing wind farm developments in the Liverpool Bay area. These studies would have to work closely with researchers based either at Liverpool or Aberystwyth Universities.

Suggested level of research: PhD

HIGH PRIORITY What areas of Welsh waters are used by different fish species and why?

We are currently working on improving our understanding of which areas of Welsh waters are particularly important to different fish species. However, we still have gaps in our understanding in terms of how these may fluctuate over time, both in the past and in the future. If we could understand more about the physical drivers of change of these important areas for fish, we might be able to better predict possible future changes. This would allow us to give more robust, future-proof advice on management (for example decisions on proposals for developments that are likely to cause changes in habitat type). This could include collation of information on historic/long-term underlying variable factors that could be influential to consider when advising on fish/fishing distribution trends e.g. temperature/climate change, currents, NAO, weather (rainfall, temperatures), flooding, prey/predator shifts etc. In addition, a study to gather long term data on macro externalities

that affect the marine e.g. changes in SST temperatures, chemistry, salinity etc. from the Gulf Stream, North Atlantic Oscillation, Atlantic Multidecadal Oscillation, Atlantic Meridional Overturn Oscillation, North Atlantic Subpolar Gyre, European Shelf Edge Current etc that will influence fish behaviour (location). Once this information is available, it would then be useful to compare it with fluctuations in populations of individual fish/shellfish of interest.

Suggested level of research: PhD

HIGH PRIORITY Are there novel (and ideally non-destructive) methods such as eDNA /eRNA /ROVs /modelling that are able to quantify herring spawning and larval movements in the Milford Haven?

Herring have been in decline in the Milford Haven and potential issues are changes to the spawning grounds and impacts to the larvae. This research would look into methods to assess spawning ground type, extent and suitability to support spawning (e.g. suitable particle size, absence of constraints such as slipper limpets etc.) and fate of the larvae post spawning using eDNA/eRNA or other methods to understand this phase in the lifecycle within the Milford Haven. This would help to inform potential management options to halt and reverse the decline in this population.

Suggested level of research: MRes or PhD

HIGH PRIORITY What are the environmental drivers for herring population trends in Celtic and Irish seas? Use of historic data to understand current dynamics.

This study would explore the environmental drivers influencing herring population trends in the Celtic and Irish Seas, examining how factors such as oceanographic conditions, climate variability, and ecosystem changes, shape stock dynamics. By integrating historic survey records, fisheries data, and long-term environmental datasets, the project would aim to uncover the relationships between past environmental fluctuations and current population behaviour. This background context enables a deeper understanding of how legacy pressures, shifting habitats, and changing productivity patterns contribute to present-day herring distribution, recruitment, and resilience.

Suggested level of research: MRes or 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

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 sustainable fish populations?

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 is the status and behaviour of sandeels in the Severn Estuary?

We have little information on the sandeel population of the Severn Estuary and the role they play in this ecosystem. This could be gathered by a survey programme using either sandeel dredges or grab sampling.

Suggested level of research: PhD

Is there a spawning population of Twaite shad in the rivers Dwyfor and Dyfi in North Wales?

Twaite shad are an Environment (Wales) Act Section 7 species and if present in these rivers would be the most northern confirmed presence in Wales. The projects could be delivered through shad egg surveys.

Suggested level of research: Post doc

Is there a spawning population of European smelt in the rivers in North Wales?

Smelt are an Environment (Wales) Act Section 7 species. A project is required to confirm spawning locations and movement in the Dee and if populations also exist in neighbouring rivers. Spawning locations could be confirmed through larval surveys, and eDNA could be used to determine if populations exist in other rivers.

Suggested level of research: Post doc

What are the effects of electromagnetic fields (EMFs) from unshielded electric cabling (such as from floating wind farms) on elasmobranch fish?

Effects of electromagnetic fields (EMFs) from most subsea cables are fairly well understood and can be largely mitigated through cable burial and shielding with material surrounding the cables. However, for floating wind farms cables are suspended in the

water column and as such the EMFs are likely to be less contained and potentially pose a larger risk of effects on electromagnetic sensitive fish species, such as elasmobranchs. This would need to link to various projects already underway.

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. It would involve investigating the specific DNA methods that could be used and the practical nature of taking these samples. 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 around southeast Anglesey due to a number of records from 2020 onwards. NRW wish to understand more about the likely 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 likely method of introduction of this species to this area. This project could involve further detailed genetic analysis of this species allowing further examination of the pathway of introduction, which has suggested an origin in Kent. It could also involve an investigations into pathways from the suspected area into Milford Haven e.g. shipping routes and shellfish movement. 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.

Suggested level of research: MSc and above

What are the likely impacts of the carpet sea squirt *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

HIGH PRIORITY 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 in large amounts off of the north Llŷn Peninsula in North Wales. This is also the location of Wales' only horse mussel (*Modiolus modiolus*) reef, which is a protected under Annex 1 of the Habitats Directive, and some *Crepidula* have now been found on the reef. Understanding the potential negative impacts on this habitat from this newly arrived invasive non-native species would be valuable in terms of Marine Protected Area management and condition assessment. This should involve fieldwork / diving or use of others' field work data collected as evidence is not readily available through existing literature.

Suggested level of research: MSc and above

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

Currently there is no formal monitoring programme of Mitten Crab, however, some data on population trends are 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

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

What is the prevalence of hull fouling in Welsh marinas?

We currently lack information on the levels of hull fouling in Wales. This is required to provide evidence around the risks of recreational boats spreading invasive non-native species and provide further evidence into the risks of this pathway. This should also include where boats are coming from and going to and the levels of fouling on boats.

Suggested level of research: MSc

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 for marine mammals and fish – particularly where they occur within or near sites designated for harbour porpoise. 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 different hydrographical conditions 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.

This information will allow us to make an informed decision on whether ADDs are an appropriate mitigation technique for tidal energy and other developments and, if so, under what conditions. There could be multiple research areas on this topic, including:

1. Efficacy of ADDs on delphinids

2. Long-term/cumulative energetic and fitness impacts of ADD deployment on marine mammals

3. Long term/cumulative displacement and disturbance effects of ADD deployment on marine mammals

4. Efficacy and longer term/cumulative impacts of ADDs on fish in Welsh waters

5. Efficacy and longer term/cumulative impacts of ADDs on birds in Welsh waters

6. Applicability and effectiveness of ADDs optimised for one receptor or species to other receptors or species

Suggested level of research: PhD

HIGH PRIORITY Developing Collision Risk models for marine mammals

With the increasing interest in tidal energy developments, there is a risk of marine mammals and other mobile species colliding with underwater turbines. This risk needs to be modelled as part of the process of assessing potential environmental impacts of these developments. Existing collision risk and encounter rate models do a reasonable job at providing an indication of possible risk. However, there are some significant shortcomings. They are designed with certain tidal energy device designs in mind and do not fit all designs on the market. Moreover, the resulting collision risk is limited to largely static variables that are entered into the model and does not necessarily reflect the likely variation in collision risk we might expect to encounter. Can new improved models be developed to capture different turbine designs and the dynamic variation expected in each case? These models could then be used when predicting potential impacts of tidal energy developments and during the decision making process

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 is stomach content information from stranded and bycaught harbour porpoise: data is currently being analysed within a UK project. 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 supporting habitats and prey availability. This project will primarily involve 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, seabirds and diadromous fish in Welsh waters?

Mapping the extent of netting activities in Welsh waters and examining the overlaps with areas that are used by marine mammals, seabirds and diadromous fish 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 and seabird 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 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

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 How do sub-sea cabling practices affect sand wave and sand bank morphodynamics, and the wider sedimentary system?

Cable laying activities can include sand wave clearance, cable burial via trenching and cable protection measures. These have the potential to impact protected sites, especially sandbanks, which are a feature of Special Areas for Conservation. The morphological impacts on sand waves and sand bank systems caused by these activities are poorly understood. Equally, the implications of any change on the wider sediment budget, especially links to the coast, requires investigation. Key questions include: Does cable protection block bedload transport pathways? Do sand waves recover after clearance and what are the timescales? Does sand wave clearance affect the form and function of the sandbank system? Will the impact of cabling practices alter the natural coastal protection that sand banks provide? It is particularly important to understand this for areas of Wales where cable routing and landfall is expected; for example, the North Wales coast and the Pembrokeshire coast.

Suggested level of research: Post doc

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

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 Acoustic Doppler Current Profiler 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

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

How can we improve our understanding of 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

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

HIGH PRIORITY What is the impact of nitrogen deposition on Welsh estuarine water quality? If there are significant impacts, what are the management measures?

Many of our transitional and coastal waters fail for DIN (Dissolved Inorganic Nitrogen) and six of our marine Special Areas of Conservation and their features are in unfavourable condition due to DIN. We need to investigate the sources and apportionment of nutrients coming into our estuaries and causing failures there. Nitrogen is considered the limiting

nutrient in marine waters. We do not have an understanding of what the impact of aerial deposition is on marine water quality. This project will need to demonstrate the apportionment of aerial deposition on marine water quality via modelling, considering deposition directly and indirectly to estuaries. Major sources and management measures should be identified. Estuaries failing Water Framework Directive Regulations standards for Nitrogen include (but are not limited to): Milford Haven, Three Rivers estuary, Burry Inlet / Loughor estuary, Erch, Solfach, Braint, Cefni and Ffraw.

Suggested level of research: PhD

HIGH PRIORITY What is the impact of ground water on Welsh estuarine water quality? If there are significant impacts, what solutions can we seek?

Many of our transitional and coastal waters fail for DIN (Dissolved Inorganic Nitrogen) and six of our marine Special Areas of Conservation and their features are in unfavourable condition due to DIN. We need to investigate the sources and apportionment of nutrients coming into our estuaries and causing failures there. Nitrogen is considered the limiting nutrient in marine waters. We do not have an understanding of what the impact of groundwater sources of nitrogen is on marine water quality. This project will demonstrate the apportionment of groundwater sources to estuarine water quality and identify management measures, where required. Estuaries failing Water Framework Directive Regulations standards for nitrogen include (but are not limited to): Milford Haven, Three Rivers estuary, Burry Inlet / Loughor estuary, Erch, Solfach, Braint, Cefni and Ffraw.

Suggested level of research: MSc or 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 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

What is causing high contaminant levels in sediment in Cosheston Pill?

Milford Haven estuary inlets have raised sediment contaminant levels. These are contributing to the unfavourable condition assessment for some of the Pembrokeshire Marine Special Area of Conservation features. Some inlets such as Cosheston Pill have levels that suggest local source input rather than main waterway input. High contaminant levels in sediment in Cosheston Pill may be affected by a historic intertidal landfill site that discharges to the pill. This would be a bespoke project to identify sources of contamination, specifically quantifying what is coming out of the landfill and determining whether it is a significant contribution to contaminants displaying ecologically significant levels. The Carew/Cresswell inlet also has unusually high levels of some contaminants and local sources of these could also be investigated. This would enable management to improve feature condition.

Suggested level of research: PhD

How do we best incorporate /account for aerial deposition of nitrogen in estuaries and their catchments?

Nutrient issues in our estuaries is a prevalent problem in Wales. Aerial deposition of nitrogen (N) has been accepted as a pathway for N to enter various environments and we wish to improve our ability to account for this contribution when assessing sources of nutrients in our transitional and coastal water bodies.

Suggested level of research: MSc or PhD

Which land management activities have the greatest impact on nutrient levels in the estuaries?

Currently it is difficult to quantify nutrient contributions from varying land management activities. Improvement of our understanding of these activities and how much nutrients they contribute to our estuaries would help better identify measures to improve water body

status and reduce nutrient levels. The project could aim to explore new methods to assess this, including remote sensing, or otherwise.

Suggested level of research: PhD

How have weather events impacted Water Framework Directive classifications?

Due to limited monitoring frequency and changing climate, datasets used to classify various elements under the Water Framework Directive (WFD) and resulting classifications may have biases due to weather events (e.g. increased sunlight and temperature increasing opportunistic macroalgae growth, high/low rain periods and severity of storms impacting runoff). Better understanding of how weather has impacted WFD datasets and classifications will help inform management decisions and monitoring programmes.

Suggested level of research: MSc

How do differing methods of sampling for water quality impact water body assessments?

Current water quality monitoring programmes utilise spot sampling and continuous monitoring through sondes, passive samplers, etc. to collect water quality data from surface waters. How much do the assessments of a waterbody differ based on these varying methods and frequencies? This project would aim to explore the different monitoring methods and strategies to identify the most effective and cost efficient ways to assess waterbody condition which also meet statutory requirements.

Suggested level of research: MSc

This list was last updated in February 2026.

Next update due January 2027.

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