

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' 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' 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.

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

1. List of Research Ideas

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

Activities & Impacts

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

How can we calculate sustainable take for non-commercial species?

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 methods can be developed for monitoring wave and tidal devices for mobile species behaviour and collision?

Benthos

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

What impact does introduced hard substrate (turbines, mattresses, rock dump) have on the biological and ecological structure and functioning of designated sediment habitats in Marine Protected Areas (MPAs)?

What impact does potting have on *Modiolus* beds?

What are the reasons for the decline of specific species and benthic habitats across the Marine Protected Area (MPA) Network in Wales?

Why is the population of pink sea fan around Skomer MCZ in poor condition and not recruiting?

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 anchoring on marine 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?

How effective are alternative mooring systems in reducing damage to sensitive habitats?

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?

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?

How can we best restore Welsh islands to benefit seabirds?

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

Coastal Habitats

What are the impacts of woodland management and tree felling on estuarine habitats?

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

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

To what extent are saltmarsh habitats used as fish nurseries and how could management improve saltmarshes for fish?

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

Do sand dunes in Wales provide a natural filtration service?

What are the impacts of coastal defences on coastal habitats?

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

What is the carbon sequestration and storage potential of sea cliff habitats?

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

Can we use eDNA to assess species in lagoons?

What are the grazing levels, timing and effects of abandonment for saltmarsh, sand dunes and cliffs?

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

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

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?

Does habitat condition affect carbon sequestration potential in marine and coastal blue carbon habitats?

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

Fish

What are the critical inshore and coastal migration routes and marine habitats used by diadromous fish in Wales?

What areas of Welsh waters are used by different fish species and how?

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

How will climate change impact upon fish and shellfish in Welsh waters?

How do fish respond to noise and vibration?

What are the impacts of electromagnetic fields (EMF) on fish?

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

How can we assess incremental losses to fish populations?

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

How does habitat loss affect fish populations?

Where in Welsh waters is sandeel habitat?

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?

What are the pressures/threats on basking shark populations? Should we be concerned about impacts in Welsh waters?

How do changes in olfactory cues impact diadromous fish?

What are the wider benefits provided by healthy fisheries?

Invasive Non-Native Species

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?

How have numbers of Chinese mitten crab changed in the Dee Estuary?

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

Do the benefits of antifouling paints outweigh any negative environment effects?

Can eDNA be used to estimate Invasive Non-Native Species abundance?

What impact are Chinese mitten crab (*Eriocheir sinensis*) having on protected habitats and species features?

Marine mammals

How effective are noise abatement methods in Welsh waters?

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

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

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

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

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

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

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

How do marine mammal populations respond to removals of individuals?

To what extent do recreational activities disturb marine mammals?

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

How does noise disturb marine mammals?

What are the impacts of acoustic surveys on marine fauna?

Are otters at the coast at risk from contaminants in coastal waters and prey?

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

What are the current disturbance levels of marine mammals in Wales? Is this disturbance having an impact at the population level?

Is litter causing mortality or otherwise 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 SW Britain?

Physical processes

What are the impacts of renewable energy devices on physical processes?

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

How can we improve models to predict behaviour of physical processes, and/or the complex interactions between physical, biological and ecological components of a marine and coastal environment?

How quickly do coastal systems recover from storm events?

How can we improve the collection and analysis of bathymetric and topographic data?

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

What shingle do we need to support nature based solutions at the coast and where could it come from?

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 do different types of renewable energy devices interact in terms of physical processes and how can the impact of these interactions be assessed?

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

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

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

How can we improve models to assess the potential effects of renewable energy devices on complex interactions between physical, biological and ecological components of different marine and coastal systems?

Are there any nature based solutions for cable or pipeline protection measures which can reduce the effects on physical processes and other receptors?

Can we improve our assessments of seabed mobility to more accurately predict cable/pipeline protection requirements?

Water Quality

Where do nutrients that impact our estuaries come from?

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

What are the impacts of new and emerging chemicals and substances on the marine environment?

2. Project Details

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

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

Suggested level of research: PhD

How can we calculate sustainable take for non-commercial species?

Currently little is known about sustainable catch/collection levels for several living marine resources that are not covered by Total Allowable Catch / quota. Work could take the form of a stock assessment and might include species such as seaweeds, razor shells and winkles. Acceptable take limits could be developed. Ecosystem impacts as a result of removal of these species should also be investigated, although other options could also be explored in project development.

Suggested level of research: MSc and above

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 methods can be developed for monitoring wave and tidal devices for mobile species behaviour and collision?

There is a need to develop instrumentation to monitor mobile species behaviour around tidal stream turbines (including near-field responses). This includes methodologies to detect avoidance of tidal stream turbines, collision events and consequences of collisions. As the instruments will need to operate in high energy waters there are a number of operational challenges that need to be addressed including: hydrodynamic forcing, corrosion and biofouling, pressure and sealing and development of solutions to reduce electronic interference between instruments on platforms. In addition advancements are required to improve efficiencies in storing, processing and analysing large amounts of data generated by monitoring.

Suggested level of research: Various

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

There is a growing focus on the ability of the marine environment to store and sequester carbon, and a requirement to both maintain and enhance blue carbon stores to help achieve net zero. Particular focus at present is on blue carbon habitats such as saltmarsh and seagrass, with a view to include them in the UK's Greenhouse Gas Inventory. Existing studies show that marine habitats play an important role in carbon storage and sequestration, but we have little current knowledge on how impacts on them, and / or changes to habitat condition, may affect their ability to provide this ecosystem service.

Suggested level of research: Various

What impact does introduced hard substrate (turbines, mattresses, rock dump) have on the biological and ecological structure and functioning of designated sediment habitats in Marine Protected Areas (MPAs)?

The introduction of hard substrate to sedimentary benthic habitats has the potential to change their ecological characteristics and biological composition. A better understanding is needed of the tipping points that lead to changes to community structure and function.

Suggested level of research: Various

What impact does potting have on *Modiolus* beds?

Modiolus modiolus beds are an extremely sensitive habitat and there have been indications that even infrequent activity may have the capacity to degrade the habitat. Therefore there is a need to investigate the possible impacts of any activity that takes

place that involves physical contact with a *Modiolus* bed. This study could be carried out in a number of ways, including direct observations of fishing activity, or an experimental potting study.

Suggested level of research: Various

What are the reasons for the decline of specific species and benthic habitats across the Marine Protected Area (MPA) Network in Wales?

Monitoring has shown a decline in the health of various habitats and species in Welsh Marine Protected Areas (MPAs). Work is needed to identify the causes of these declines. This will include the following: maerl and herring around Milford Haven in Pembrokeshire Marine Special Area of Conservation (SAC), sponges in the Menai Strait and Conwy Bay SAC, *Modiolus modiolus* (horse mussel) beds in the Pen Llyn a'r Sarnau (PLAS) SAC, sandbank infaunal diversity across the MPA Network. This will allow effective management measures to be identified that will improve our understanding of the ways to improve the condition of MPA features, improving the resilience of marine ecosystems across Wales.

Suggested level of research: Various

Why is the population of pink sea fan around Skomer MCZ in poor condition and not recruiting?

The population of pink sea fan around Skomer MCZ is currently in poor condition and there is a lack of new sea fans being recruited. Work is needed to identify the cause(s) of the decline in numbers and health.

Poor condition relates to an increase in necrotic (dead) tissue and increased epibiota and entangled elasmobranch eggs. Questions about the current health of the sea fan and their resilience to grow back new tissue and recover, and potential links to sea water temperature?

The population is under pressure from individual losses and there are wider questions about the potential longevity of the population due to the lack of recruitment/connectivity. Elements could include determining whether reproduction is taking place, aging fans, connectivity with other populations, larval supply

Suggested level of research: Various

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

The Ecostructure project has significantly increased our knowledge of the artificial enhancements that could be installed on existing and new structures to increase biodiversity. However, work to complete monitoring of installed structures is still ongoing. When completed, this will build on the current evidence available regarding aspects such

as the optimal number of enhancement structures required, preferred citing and configuration for the most effective biodiversity enhancement. Monitoring of any additional newly installed enhancement structures is essential.

Suggested level of research: Various

What are the impacts of dredge disposal on subtidal habitats?

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

Suggested level of research: PhD and above

What are the impacts of anchoring on marine habitats?

Experimental studies are needed to progress our understanding of the impacts of anchoring, with an emphasis on the potential impacts on a range of sensitive marine habitats. A recent desk study has highlighted a number of Welsh sites where anchoring is potentially causing an impact to sensitive habitats and part of this evidence requirement will involve investigating these sites and assessing the current impacts and severity.

Suggested level of research: PhD and above

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 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

How effective are alternative mooring systems in reducing damage to sensitive habitats?

Studies are required on the effectiveness of Advanced Mooring Systems in terms of reducing impacts on important habitats, e.g. seagrass beds. This work would need to build on the research which is already underway at other locations and tailor this to the sites in Wales. This work would involve a literature review of the current studies and trials so far.

Suggested level of research: MSc

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 is needed to examine whether lower shore habitats in North Wales are more resilient to, or 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 sea bed. 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 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 and diet at seabird colonies. Can be done for these species: Atlantic puffin, black-legged kittiwake, common guillemot, lesser black-backed gull, razorbill, shag cormorant, tern species, gulls etc.

Suggested level of research: Various

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

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

Suggested level of research: MSc and above

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

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

Suggested level of research: MSc and above

How can we best restore Welsh islands to benefit seabirds?

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

Suggested level of research: PhD

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

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

Suggested level of research: MSc and above

What are the impacts of woodland management and tree felling on estuarine habitats?

Forestry plantation occupies a significant proportion of the catchments of many of our estuaries. Our understanding of the impacts of this land use on estuarine habitats and species is limited. Large scale cultivation of non-native coniferous trees and forestry operations such as clear-felling and track construction and maintenance could lead to pressures on the protected estuary features within Marine Protected Areas, for example increased sediment input, increased nutrients, acidification and remobilised pollutants arising from erosion. A range of impacts on estuarine habitats and species should be reviewed as part of this work.

Suggested level of research: MSc and above

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

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

Suggested level of research: PhD and above

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

There is currently conflicting evidence regarding the resilience of coastal ecosystems. There is an assumption that saltmarsh will naturally move inland as sea level rises. However, there is little evidence to back this up. A research project to test this assumption in Wales would help with understanding of resilience and coastal management. Long term

surveillance would be required at locations where there are no constraints (e.g. sea defences) to the landward movement of saltmarsh.

Suggested level of research: Long term research programme

To what extent are saltmarsh habitats used as fish nurseries and how could management improve saltmarshes for fish?

There is a lack of evidence surrounding the use of saltmarsh habitat as fish nurseries. The study will determine the potential of specifically Welsh saltmarsh to act as a fish nursery and investigate links to biodiversity, economic benefits and the provision of ecosystem services. It should also further our understanding of the management required of saltmarsh for juvenile fish.

Suggested level of research: MSc and above

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

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

Suggested level of research: PhD

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 desk based project should provide a review of this process and its applicability in Wales.

Suggested level of research: PhD

What are the impacts of coastal defences on coastal habitats?

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

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

Suggested level of research: MSc and above

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

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

Suggested level of research: PhD

What is the carbon sequestration and storage potential of sea cliff habitats?

The rates of carbon sequestration and storage potential for cliff habitats (particularly coastal grassland and maritime heath) is not known. An investigation into rates of carbon sequestration and storage potential in these habitats would provide a better understanding of the ecosystem services these coastal margin habitats provide.

Suggested level of research: PhD

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

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

Suggested level of research: MSc and above

Can we use eDNA to assess species in lagoons?

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

Suggested level of research: PhD and above

What are the grazing levels, timing and effects of abandonment for saltmarsh, sand dunes and cliffs?

Grazing is an integral part of maintaining coastal habitats in favourable condition. A review is required to evaluate grazing levels, timings and effects of grazing abandonment on coastal margin habitats, particularly saltmarsh, sand dunes and cliffs.

Suggested level of research: MSc

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

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

Suggested level of research: PhD

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

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

Suggested level of research: PhD

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

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

Suggested level of research: PhD

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

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

Suggested level of research: MSc and above

What impact could climate change have on marine ecosystem services?

A review is required to investigate potential changes in marine ecosystem services in Welsh waters resulting from climate change. This will include the known impacts that

climate change could cause (e.g. water temperature and chemistry, sea level rise, non-native species). It will assess how these changes could affect those provisioning, regulating and cultural services that marine ecosystems provide.

Suggested level of research: PhD

Does habitat condition affect carbon sequestration potential in marine and coastal blue carbon habitats?

NRW Evidence Report 428 highlights an evidence gap around how habitat condition affects carbon sequestration in habitats such as saltmarshes and seagrass beds. This project would review available information on how different habitats components that contribute to condition - e.g. diversity and function - can impact carbon sequestration. This would include looking at the potential of restored habitats to sequester carbon.

Suggested level of research: PhD

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

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

Suggested level of research: MSc and above

What are the critical inshore and coastal migration routes and marine habitats used by diadromous fish in Wales?

Based on recommendations in NRW Evidence reports; 'Feasibility Study of Methods to Collect Data on the Spatial and Temporal Distribution of Diadromous Fish in Welsh Waters' and 'Acoustic tracking in Wales – designing a programme to evaluate Marine Renewable Energy impacts on Diadromous fish'. The project would hydroacoustically tag and track diadromous fish from a selection of Welsh rivers, to collect data on their distribution, particularly in marine energy resource areas. The evidence would be used to inform modelling tools to establish risk to salmon, sea trout, eel and shad populations from tidal range and tidal stream developments in Wales.

Suggested level of research: Varied

What areas of Welsh waters are used by different fish species and how?

An assessment of abundance, distribution and structure of marine fish species in Welsh waters through the year. Review of available data and recommendations for gap filling. An update to Ellis et al. (2012) for Wales but also considering other species and lifestages and

not just spawning and nursery grounds. Derivation of fish and shellfish species lists to include as receptors in EIAs and HRAs.

The majority of the datasets used for Ellis et al. are freely available online, and many of the surveys continued past 2012 (with some still ongoing in 2020). Therefore, it would be possible to produce an updated version of the study for Welsh waters or more broadly if desirable – also integrating habitat mapping data for Welsh waters too for the species which show habitat preferences – herring, sandeel, plaice, gobies, black bream etc. Also consider trying to get hold of some of the more fine-scale surveys done for individual developments or projects. Most developers are likely to be amenable to their use for this purpose. Finally, as well as nursery and spawning grounds, wider fish density maps could be produced to also cover feeding/foraging lifestages.

Suggested level of research: MSc and above

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. Trawling is also needed 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

How will climate change impact upon fish and shellfish in Welsh waters?

A desk based review is required which will investigate how climate change (including changes in water temperature and chemistry, sea level rise and invasive non-native species) might affect key fish and shellfish populations and communities in Welsh waters.

Suggested level of research: MSc and above

How do fish respond to noise and vibration?

This practical study will investigate responses of key fish species to noise and vibration. This is likely to be through monitoring of piling in situ or experimental trials.

Suggested level of research: MSc and above

What are the impacts of electromagnetic fields (EMF) on fish?

This practical research project would investigate responses of key fish species to Electromagnetic Fields. It would involve monitoring of cables or experimental trials.

Suggested level of research: PhD and above

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 can we assess incremental losses to fish populations?

Understanding how incremental year-on-year losses of fish from development impacts or commercial fishing may affect population abundance, structure and functioning is important when conducting environmental assessments and assessing how projects will change the abundance or structure of a population. Development of models for key fish species in Welsh waters is needed, building on existing work.

Suggested level of research: MSc and above

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

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

Suggested level of research: PhD

How does habitat loss affect fish populations?

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

Suggested level of research: PhD and above

Where in Welsh waters is sandeel habitat?

Habitat is often defined as preferred, marginal or unsuitable for sandeel occupancy. However, within the preferred and marginal habitats, there are sub-classifications (prime, sub-prime etc.) and many marginal habitats / substrates are unsuitable for sandeels. A more refined sandeel habitat map than that available from the British Geological Survey seabed sediment map is required considering these sub-classifications.

Suggested level of research: MSc 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?

Based on recommendation in the Evidence report: 'Feasibility Study of Methods to Collect Data on the Spatial and Temporal Distribution of Diadromous Fish in Welsh Waters'. A strategic and comprehensive marine eDNA survey to establish presence or effective absence of key fish (and other) species in each marine energy resource zone. A two-year, comprehensive survey using automated samplers to collect eDNA across full tidal cycles, with replicate samples spread across each area. 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

What are the pressures/threats on basking shark populations? Should we be concerned about impacts in Welsh waters?

A review of the status and trends of this species in Welsh waters is needed to inform our advice on projects which may impact the species.

Suggested level of research: PhD

How do changes in olfactory cues impact diadromous fish?

There are a number of evidence gaps identified on the impact of changes in olfactory cues for diadromous fish. However, the implication of individual -level impacts to the population has not been considered at all and a review of the evidence / evidence gaps on this subject would be valuable.

Suggested level of research: PhD

What are the wider benefits provided by healthy fisheries?

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

valuation derived from fisheries and summarise their role in supporting local economies and employment opportunities.

Suggested level of research: PhD

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

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

Suggested level of research: PhD

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

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

Suggested level of research: PhD

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

We are aware that an established population of the slipper limpet (*Crepidula fornicata*) is in the Menai Strait and south east Anglesey due to a number of records in 2020 and 2021. NRW wish to understand more about the method of introduction of this species to North Wales. An established population exists in Milford Haven and Northern Ireland but it is unclear whether this species has arrived through natural spread or whether it was introduced through a specific introduction event, either a new event or whether the species has been present since the previous introduction event of 2006. This project could involve genetic analysis and an examination of pathways. Evidence on the method of introduction is important to ensure existing biosecurity protocols are adequate and will help target pathways for potential future introductions to an area.

Suggested level of research: MSc and above

How have numbers of Chinese mitten crab changed in the Dee Estuary?

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

Suggested level of research: MSc and above

What is the likely impact of Agarophyton (*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.

Suggested level of research: MSc

Do the benefits of antifouling paints outweigh any negative environment effects?

Carry out tests to assess which antifouling paints are most effective against Invasive Non-Native Species (INNS). There is tension between INNS control and releasing toxic compounds from anti-fouling paints. The aim would be to identify paints that are effective against INNS but also do not release toxins that pollute the marine environment.

Suggested level of research: PhD

Can eDNA be used to estimate Invasive Non-Native Species abundance?

Investigate the ability of eDNA to estimate abundance of marine Invasive Non-Native Species.

Suggested level of research: MSc and above

What impact are Chinese mitten crab (*Eriocheir sinensis*) having on protected habitats and species features?

There are still outstanding evidence gaps regarding the impacts of this species on protected species and habitats. One key evidence gap was impacts on seagrass beds through grazing which could be a key potential threat. The species is also known to feed on fish eggs, the impact which this predation may have on species laying eggs in river systems (particularly salmonids - Dee River / Estuary) is not fully understood, but may be significant.

Suggested level of research: MSc and above

How effective are noise abatement methods in Welsh waters?

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

Suggested level of research: Varied

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 recommended 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. The need is for experimental research observing reactions to ADDs at sea. There is also a need to explore how ADDs optimised for one receptor (species) could affect other receptors, particularly given differences in hearing range, auditory sensitivity, and behaviour in reaction to underwater noise. Finally, research is needed to evaluate longer term ADD deployments, and whether these could have lasting displacement or disturbance effects on different receptors.

Suggested level of research: Varied

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

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

Suggested level of research: MSc and above

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

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

Suggested level of research: MSc and above

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

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

Suggested level of research: MSc and above

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

Mapping the extent of netting activities in Welsh waters, and examining the overlaps with areas that are used by marine mammals to identify potential risk areas. Dependant on sourcing fisheries data.

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 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 dynamics (including age and sex ratios).

Suggested level of research: Postdoc or research programme

How do marine mammal populations respond to removals of individuals?

Update and improve understanding of marine mammal population responses to anthropogenic pressures, particularly removals as a result of marine industrial developments. Following a recent review on marine mammals there will be a need to regularly update and review information on existing models, population parameters, spatial scales, and pressures.

Suggested level of research: Postdoc or research programme

To what extent do recreational activities disturb marine mammals?

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

Suggested level of research: PhD

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

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

Suggested level of research: MSc and above

How does noise disturb marine mammals?

Information on the behavioural effects on marine mammals from underwater noise such as seismic surveys, unexploded ordnance detonation, or piling, is limited. Standard deterrent ranges are used in some assessments, but they are often based on limited evidence, and there is a lack of consensus over whether they would apply under different hydrographical conditions such as those in Welsh waters. An understanding of how underwater noise might disturb Annex II species, particularly harbour porpoise; and what the spatial footprint of such disturbance might be, is urgently needed to inform consenting advice for imminent offshore wind projects.

Suggested level of research: PhD 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

Are otters at the coast at risk from contaminants in coastal waters and prey?

There have been some big declines in otter in hydrometric areas with large rivers that feed into Carmarthen Bay and Estuaries and Pembrokeshire Marine Special Area of Conservation (Tywi, Loughor, Cleddau). These may be related to water quality issues in these areas.

Suggested level of research: PhD

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

What are current disturbance levels of marine mammals in Wales? Is this disturbance having an impact at the population level?

This study would look at current disturbance levels of marine mammals in Wales. This could be disturbance from several impact pathways from recreational use or other non-regulated activities, or from regulated activities such as developments (underwater noise). It would also include grey seal disturbance at haul out sites in Wales. Further investigations would then look at whether these disturbances are likely to be having an impact at the population level.

Suggested level of research: PhD and above

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 / impacting on marine mammal populations around Wales.

Suggested level of research: PhD and above

Is prey availability limiting marine mammal populations in Welsh waters?

Prey availability is a key aspect of marine mammal ecology and conservation / 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 SW Britain?

Estimates of bycatch of grey seals in the South West 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 are the impacts of renewable energy devices on physical processes?

We need to understand how embryonic renewables technologies (e.g. wave & tidal) will impact on changes to energy, and how that manifests itself in terms of impact on natural variability. There is a need to differentiate between natural processes and anthropogenic impacts, and to understand regional scale and medium to long-term effects of energy extraction on morphodynamics and sediment transport regime on other receptors such as habitats, flood risk etc.

Suggested level of research: Varied

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

NRW wants to improve the evidence base on sediment budgets in Welsh waters, by conducting a review of the adequacy of existing information, the methodology applied, identification of any data / evidence gaps and areas that need to be updated. The review, intended to be a desk based study, should provide recommendations as to the merit in updating the sediment budget. This will inform further work on sediment budgets in NRW. Whilst this evidence request applies to the whole Welsh coast it can be delivered through smaller scale projects applied regionally. The methodology should be informed by this handbook <https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/sediment-budget-analysis-practitioner-guide>

Suggested level of research: MSc and above

How can we improve models to predict behaviour of physical processes, and/or the complex interactions between physical, biological and ecological components of a marine and coastal environment?

NRW is interested in the development of new numerical models or the improvement of existing numerical models which could be applied to the marine and coastal environment. Potential models of interest to NRW include those which predict physical processes behaviour, and models which are able to predict the complex interactions between physical, biological and ecological components of a coastal / estuarine / marine system.

Suggested level of research: PhD 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

How can we improve the collection and analysis of bathymetric and topographic data?

This evidence need relates to collection of topographic and bathymetric data and analysis to address gaps in our understanding. For example, we are aware that topographic and bathymetric data within Welsh estuaries is a significant data gap. It is also required to support routine monitoring undertaken by external partners such as the Wales Coastal Monitoring Centre which requires NRW support. NRW require an evidence review of the existing methods for collection and analysis of bathymetric and topographic data and how methods could be improved through new methodologies and instrumentation.

Suggested level of research: MSc 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

What shingle do we need to support nature based solutions at the coast and where could it come from?

A review is required to develop the evidence concerning the type and quantity of shingle required to help deliver nature based solutions at the coast and identify whether there are suitable supplies. The purpose of the review is to assist NRW's use of appropriate nourishment material. The British Geological Survey directory of quarries lists all potential sources of land based quarries, however, it would be valuable to understand what size, colour and mineralogy they can supply, and what reserves are available (if possible) and then match these to coastal shingle resource. This could inform where nourishment material could be sourced from and whether there is adequate resource available.

Suggested level of research: BSc 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 increased 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 use of 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 do different types of renewable energy devices interact in terms of physical processes and how can the impact of these interactions be assessed?

There is a need to better understand potential interactions and associated impacts of different of wave and tidal stream devices on physical processes. As these are embryonic renewable energy devices, there is limited understand of the impacts of devices on water flow and energy removal alone, and even less so when different devices are used in relatively close proximity. Improvements could be made to numerical model validation by using data collected for single or small scale array projects, and / or through developing modelling capabilities (including resolution).

Suggested level of research: PhD

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

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

Suggested level of research: PhD

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

Predicting medium to long-term morphological changes arising from single or multiple tidal range developments is difficult to achieve with any degree of certainty . There is a

requirement to increase confidence in predicted impacts of numerical models and to develop and improve model capabilities. For example iCOASST explores the use of decadal scale modelling for estuarine and coastal evolution. We need to consider whether these tools could be applied to assessing tidal lagoon impacts over the longer term, or learn from these tools in terms of capabilities and limitations.

Suggested level of research: PhD and above

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

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

Suggested level of research: PhD and above

How can we improve models to assess the potential effects of renewable energy devices on complex interactions between physical, biological and ecological components of different marine and coastal systems?

NRW is interested in the development of new models or the improvement of existing models which could be used to assess the potential effects of renewable energy devices on complex interactions between physical, biological and ecological components of different marine and coastal systems

Suggested level of research: PhD and above

Are there any nature based solutions for cable or pipeline protection measures which can reduce the effects on physical processes and other receptors?

Review nature based solution methods that would be appropriate to use as cable or pipeline protection measures for renewables infrastructure. This is with a view to minimise potential impacts to physical processes and other receptors, secure a more sustainable approach and increase environmental resilience and opportunities for enhancement.

Suggested level of research: PhD

Can we improve our assessments of seabed mobility to more accurately predict cable/pipeline protection requirements?

Review available project assessment and monitoring information to review / refine seabed mobility calculations / factors for use in cable protection assessments and design. Recent projects may have underestimated the seabed mobility factor and the cable protection required.

Suggested level of research: PhD

Where do nutrients that impact our estuaries come from?

We need to investigate the sources of nutrients coming into our estuaries and causing water quality failures. Modelling is needed to identify those sources. Many of our transitional and coastal waters fail for Dissolved Inorganic Nitrogen (DIN) and five of our Special Areas of Conservation are in unfavourable condition due to DIN also. Any modelling would need to be able to represent diffuse and point sources, including continuous and intermittent discharges. The model should also be able to identify the portion of the catchment where the diffuse sources are originating and the land use type.

Suggested level of research: Varied

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

What are the impacts of new and emerging chemicals and substances on the marine environment?

There is ongoing work to assess the risk emerging contaminants to the water environment, such as NRW's passive sampling screening and the Environment Agency-led Prioritisation and Early Warning System. These are not specifically targeted to the marine environment and often tend to use mostly inland water monitoring sites. Are there emerging substances that would be of a particular concern to the marine environment that need a separate look from this angle?

Suggested level of research: PhD

This list was last updated in December 2022.

Next update due December 2023

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