Explore the potential for developing blue carbon (marine and coastal sinks of carbon) to achieve net zero

1. EXECUTIVE SUMMARY

1.1. Blue carbon refers to the potential of ecosystems in the marine and coastal environment to remove (sequester) carbon from the atmosphere and store it within habitats, sediments and species, creating a store of carbon.

1.2. Types of blue carbon ecosystems include seagrass, kelp forest, tidal saltmarsh and marine sediment. It has been estimated that these ecosystems can sequester and store 2-5 times more carbon than terrestrial habitats such as woodlands.

1.3. Similarly, the chemistry of the sediments from these ecosystems suggests the absolute comparative value of the carbon sequestered per unit area may be greater than similar processes on land, due to their lower potential for emission of greenhouse gases (GHGs) such as methane and carbon dioxide (Laffoley and Grimsditch 2009).

1.4. Blue carbon provides an opportunity to locally offset difficult to eliminate emissions that will have to continue to some extent until 2050 and beyond.

1.5. Blue carbon ecosystems are also of high importance because of the significant goods and services they provide, as well as carbon storage potential.

1.6. A recent Isle of Man postgraduate project estimated the total current carbon sequestration capacity of our territorial seas (0 – 12 M) to be around 0.2mt/C yr-1. To put that into context, Aether estimate that in 2017 the Island's net emissions were 0.84mt/C yr-1).

1.7. Blue carbon research is relatively new and, as such, policy and international emission auditing programs have not yet factored all blue carbon ecosystems into international emission auditing frameworks; at present just seagrass, saltmarsh and mangroves.

1.8. However, research in the field is moving rapidly and it has been suggested that more attention should (and will) be paid to blue carbon ecosystems for climate mitigation and adaptation strategies in the future.

1.9. As an island with over 85% of its territory in the marine environment, it makes strategic sense to manage and maximise the benefits of the Isle of Man's seas in terms of climate mitigation and adaptation. Similarly managing the Isle of Man's territorial seas for its blue carbon could have significant potential in showcasing the Island as an innovator and at the forefront in this rapidly developing field.

1.10. As research in the field develops, it is advocated that the precautionary principle should apply when managing the Isle of Man's territorial seas in relation to activities that could adversely impact blue carbon ecosystems, whilst developing and promoting policies relating to the conservation, protection and restoration of blue carbon habitats.

1.11. The potential for future carbon offsetting schemes to include blue carbon ecosystems should also be explored.

2. THE CHALLENGE

Maximising the carbon storage and sequestration capacity of the Island's territorial sea through new management and policy

2.1. As an island with over 85% of its territory in the marine environment (Figure 1), it would be remiss not to consider managing and maximising the benefits of the surrounding seas in terms of climate mitigation and adaptation. Managing Manx waters in terms of blue carbon has significant potential to balance the most difficult emissions that will not be completely eliminated by 2050. There is also an opportunity to showcase the Isle of Man as an innovator and at the forefront of a rapidly developing field.

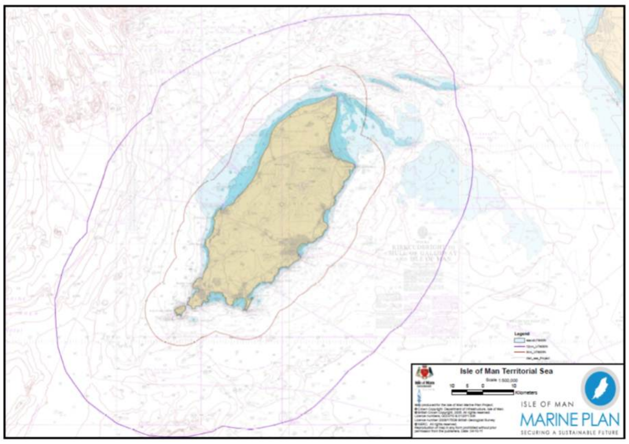

Figure 1 Isle of Man territorial waters (0-3M & 3-12M

3. BLUE CARBON

An Overview

3.1. Blue carbon is a term that refers to the carbon sequestration and storage capacities of marine ecosystems, whereby organic and inorganic carbon is sequestered and stored within marine biomass or sediments (Burrows *et al.,* 2014). It has been suggested that coastal blue carbon ecosystems could sequester as much as 2 – 5 times more carbon than terrestrial forests (based on relative area) (Murray *et al.,* 2011) and that around 50% of the carbon in the atmosphere sequestered in natural ecosystems is cycled via the marine environment (Nellemann *et al.,* 2009). Sequestration rates, storage capacity and storage times of blue carbon vary between substrate and habitat types. Significant blue carbon ecosystems include, but are not limited to, seagrass beds, salt marshes, marine sediment and mangroves (Blue Carbon Partnership, 2017).

3.2. Coastal (blue carbon) ecosystems also provide other important ecosystem services, including; coastal protection from storms and sea level rise, prevention of shoreline erosion, regulation of water quality, increased biodiversity and provision of habitat for commercially important and endangered species (Blue Carbon Partnership 2017). Despite their many benefits, coastal blue carbon ecosystems are among some of the most threatened ecosystems on earth, largely due to climate change, pollution and their proximity to a range of human-induced impacts and threats (IPBC, 2018). When these habitats are removed or damaged, not only is their sequestration capacity reduced, but they can also become significant sources of greenhouse gas (GHG) emissions during decomposition or disturbance (IPBC, 2018). Improved management of these ecosystems could contribute to delivering GHG emission and climate change adaptation targets through carbon sequestration and storage, and the aforementioned ecosystem services (Blue Carbon Partnership, 2017).

3.3. Three main components are involved in the carbon sequestration and storage capacity of a blue carbon ecosystem (Sifleet *et al*., 2011):

- The annual sequestration rate: the yearly carbon flux in a mature ecosystem of organic material transferred into anaerobic soils where it cannot undergo oxidation to CO_2 and be released into the atmosphere.
- The amount of carbon stored in above and below 'ground' seabed biomass
- The total carbon stock stored in sediment from prior sequestration over that habitat's particular lifetime.

International Policy on Blue Carbon

3.4. In accordance with the United Nations Framework Convention on Climate Change (UNFCCC) and its recommendations, countries use guidance for the estimation of emissions and removals developed by the Intergovernmental Panel on Climate Change (IPCC) to produce national inventories of greenhouse gas emissions and removals.

3.5. The 2006 IPCC guidelines, and earlier volumes, include limited methodological guidance relevant to the inclusion of coastal blue carbon ecosystems. However, the '*2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*' (the Wetlands Supplement) does provide emission factors and methodologies relevant to coastal wetlands, including mangroves, tidal marshes and seagrasses (IPCC 2013, wetlands supplement). As such the UNFCCC and IPCC support the inclusion of emissions and removals from these ecosystems in national GHG inventories, and several countries have begun implementing the Wetlands

Supplement in their inventory reports, including Australia, Abu Dhabi, US, Japan and Canada.

3.6. International bodies have also called for the protection of blue carbon ecosystems. In article 4. 1(d) from the fourth session of the Conference of the Parties (COP 4), the UNFCCC called for the sustainable management, conservation, and enhancement of "*sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol including… oceans as well as… other coastal and marine ecosystems.*"(COP4 1998).

3.7. More recently the Paris Agreement (2016) raised the profile of blue carbon ecosystems and their role in contributing to global emissions reductions, compelling countries to actively protect them. Article 5 of the agreement directly calls upon parties to take action to conserve and enhance coastal and marine ecosystems and all other sinks and reservoirs. So far, 29 nations, including Iceland, Australia and a number of tropical countries, have included blue carbon in their nationally-determined contributions for mitigating climate change under that agreement, whilst about 60 have included blue carbon under their adaptation actions (Herr *et al.*, 2018).

3.8. Whilst the IPCC GHG emission inventory supports the inclusion of emissions (through degradation) and removal (of CO_2 from the atmosphere) from several specific blue carbon ecosystems, there are a number of other blue carbon ecosystems that also have significant carbon storage capacity e.g. marine sediment, kelp forest and biogenic reefs. Much of the research is this rapidly developing field is new, and as it develops a paradigm shift may be required in international accounting procedures (Krause-Jensen *et al.*, 2018), particularly for countries with significant marine areas.

3.9. There are, however, mechanisms to credit the demonstrable gains in carbon sequestration and/or avoided emissions through conservation and restoration activities within voluntary carbon markets (American Carbon Registry; Verified Carbon Standard) (Macreadie et al., 2019). Similarly the Intergovernmental Oceanographic Commission released the Blueprint for Ocean Sustainability which offered measures to achieve ocean sustainability, one of which was the creation of "*a global, blue-carbon market as a means of creating direct economic gain through habitat protection*" (Intergovernmental Oceanographic Commission, 2011). Some countries are also developing their own blue carbon focused mitigation schemes that provide economic incentives for conservation and restoration of blue carbon ecosystems (Macreadie *et al.*, 2019).

3.10. In terms of the international carbon auditing process, the Isle of Man's intertidal and seagrass habits can, and should, be included in its carbon accounts. However, much of the other existing blue carbon stock is not currently recognised though this process. Nevertheless, the management, protection and restoration of other blue carbon ecosystems in the Island should not be overlooked, and efforts should be initiated to better quantify them. International auditing policy will likely change in the future as research in the concept advances rapidly. Similarly, as technology develops there is additional potential to use blue carbon biomass (such as kelp) in the transition to a zero-carbon future, through the use of biofuels, organic fertilisers and potentially carbon burial (Kraan, 2010; Nabti, 2016; Krause-Jensen *et al*., 2018). As a small island where 87% of the jurisdiction is in its territorial waters, it is vital that the Isle of Man utilises and maximises its seas for their climate in its change mitigation and adaptation potential.

Type	Extent km^2	Literature sequestration rate (g C m2 yr-1)	Annual carbon sequestration capacity (tonnes)	Primary production literature values (g C m-2 yr-1)	Primary production (tonnes)	Standing stock literature values (g C m-2 yr-1)	Standing stock (tonnes)	Additional Benefits	Main Threats
Habitat Type									
Tidal/Salt Marsh	0.073	210	15.5	N/A	N/A	N/A	N/A	Increase resistance to sea level rise, flood and storm surge protection; important feeding grounds for migrating birds; habitat for commercially important fish and wildlife	Sea level rise, environmental pollution, coastal development, habitat loss, non-native species
Eelgrass (*Zostera marina*)	0.785	83	65.2	N/A	N/A	N/A	N/A	Nursery habitat for commercially important and endangered species, absorbs pollution, coastal stabilisation	Smothering, sedimentation, excess nutrient run off, dredging, anchoring
Kelp (various species)	128.769	N/A	N/A	390	50220.263	405 - 4050	52151.811 – 521518.119	Providing natural coastal protection against storms; Elevates seafloor to protect against sea level rise; Creating high pH oases in an acidified ocean; provides habitat	Overgrazing, storms, sedimentation, coastal development, pollution
Brittlestar beds (*Ophiothrix fragilis/ Ophiocomina sp.*)	374.374	82	30698.7	N/A	N/A	66.2	24783.614	Positively effect water quality in coastal environments and may help counteract some of the potentially harmful effects of eutrophication (proliferation of	Pollution and eutrophication, coastal development and sedimentation,

								planktonic algae) caused by human input of nutrients into the sea. The beds may therefore play a significant role in the ecological functioning of coastal seas (SACS, 2019)	non-native species
Substrate Type									
Fine mud/sand	609.872	155.2	94652.2	1.5	8	39-208	2378502.322 - 12685345.721	Processes: primary and secondary production, larval/gamete supply, food web dynamics, formation of species habitat, species diversification, erosion control and biogeochemical cycling. Ecosystem services: identified were fisheries, environmental resilience, and regulation of pollution (Nature, 2012).	Aggregate extraction, dredging pollution/nutrient stimulation, land claim for development (SACS, 2019)
Sand/muddy sand	433.333	50.6	21926.7	1.5	4	39-104	1690000.075 – 4506666.869	Same as above	Same as above
Biogenic habitat type									
Maerl (*Phymatolithon calcareum*)	170.424	9.5-29.3	1619.0 – 4993.4				10,634,911.6	Processes: primary and secondary production, food web dynamics, larval/gamete supply, formation of species habitat, erosion control, biogeochemical cycling and water purification. Services: fisheries, fertiliser/feed, natural hazard protection, regulation of pollution, climate regulation,	Dredging, heavy anchors and mooring chains, rising temperatures and ocean acidification

								tourism, and nature watching (Nature, 2012).	
Horse mussel *Modiolus modiolus* (biogenic) reefs	20.960	40	838.4				143.078 – 5373.009	Processes: Secondary production, larval/gamete supply, formation of species habitat, food web dynamics, species diversification, biogeochemical cycling, climate regulation and water purification. Ecosystem services: identified were fisheries, other wild harvesting, aquaculture, natural hazard protection, environmental resilience and aquaria (Nature, 2012).	Marine aggregate extraction, coastal development, dredge fishing gear, loss of substratum, pollution, non-natives, increased temperatures, an increase in storm occurrence and intensity and sea-level rise
Source: Towel, 2018, **References:** Burrows *et al.,* 2014; Kain,1977; Kain,1979; Manx Marine Environmental Assessment Ecology/ Biodiversity Habitats Coastal Ecology									

Table 1 showing Manx Marine Environmental Assessment

Case Study from the Blue Carbon Partnership: Australia

3.11. Australia is progressively implementing the 2013 IPCC Wetlands Supplement in its national greenhouse gas inventory, and has prioritised coastal blue carbon ecosystems due to their extent and importance in Australia. Australia's 2015 National Inventory Report (released in June 2017) contains national greenhouse gas emission estimates for the period 1990-2015, including changes in mangroves and tidal marshes following the Wetlands Supplement guidance.

3.12. Edith Cowan University researchers and an international team of collaborators have more accurately quantified the amount of greenhouse gasses being absorbed and emitted by Australian's blue carbon ecosystems. Published this month (October 2019) in Nature Communications, the paper shows Australian seagrass, mangrove and salt marshes absorb 20 million tonnes of carbon dioxide each year, which remains locked up in their soils for millennia. The research shows damage to the same ecosystems is causing 3 million tonnes of carbon dioxide to be released back into the atmosphere each year as a result of human development, severe weather and the effects of climate change (Serrano et al., 2019).

3.13. This quantification of Australia's blue carbon is the most accurate of any country and paves the way for conservation and restoration of these ecosystems to be counted toward the country's commitments to emissions reductions such as the Paris Agreement. The research also provides a financial baseline for investors looking at blue carbon projects to offset emissions.

Existing Blue Carbon Stock On-Island

3.14. A recent on-Island postgraduate research project estimated the total carbon sequestration capacity for the Isle of Man territorial sea (0 - 12M) at around 0.2 Mt/C yr^{-1}. To put that into context, emissions auditor *Aether* estimated that in 2017 the Island's net emissions were 0.839 Mt/C yr^{-1}). By comparison the amount of carbon sequestered from the Island's recognised IPCC wetland habitats (tidal marshes and seagrass beds) equated to just over 80 tonnes per year (Table 1). This is because although such habitats are highly productive, their contribution to the overall carbon budget is very small because of the limited extent of each habitat on the island.

3.15. The main contributing habitats to the total carbon sequestration capacity were fine grained marine sediments; with an annual sequestration capacity estimated to be around 116,715 tonnes (Table 1), equating to 60% of total Manx blue carbon sequestration (Towle, 2019). Kelp beds were estimated to have the highest annual sequestration capacity with an annual removal of 50,220 tonnes of carbon (Table 1) via primary production carbon fixing, equating to 25% of total carbon sequestration within the territorial sea. Brittle star beds were estimated to sequester over 30,600 tonnes per year (Table 1).

3.16. The study estimated that 10.64 Mt organic carbon is stored within the top 10 cm of territorial sea sediments (Towle, 2019). Of the three fine-grained sediment types identified as carbon stores, mud/fine sand, with an estimated reported storage capacity of between 39 – 201 kg/orgC/m^3, stored 71% of the total organic carbon within the top 10 cm of territorial sea substrate.

3.17. It was suggested the biogenic habitats, e.g. maerl, horse mussel reef, hold significant carbon reservoirs in Manx waters, with an estimated total standing stock of 10.64 Mt/Org C stored within biogenic substrate tissue (Towle, 2019). The most significant habitat for carbon sequestration was maerl beds (*Phymatolithon calcareum)* with an estimated 10.63 Mt/org C stored with maerl $CaCO_3$(or just calcium carbonate) skeletons (Towle, 2019).

Emerging Blue Carbon Research

3.18. Kelp - Kelp ecosystems are often overlooked in blue carbon assessments, this is largely due to the fact that kelp production isn't stored permanently within kelp beds, and therefore kelp beds alone do not offer fixed potential for carbon sequestration. However, a recent meta-analysis has estimated that macroalgae growing in soft sediments may have a carbon burial rate similar to the lower range of estimates for tidal marsh (Krause-Jensen *et al.,* 2016). Recent studies have also suggested that kelp sequesters carbon through the transport of biomass (and hence carbon) into deeper waters, in addition to cycling carbon throughout the ecosystem. It has been suggested that around a quarter of the carbon captured in primary productively in kelp may be permanently locked in kelp detritus stored in deep sea or coastal sediments (Krause-Jensen *et al.,* 2016). These findings suggest that macroalgae may be supporting higher global carbon burial rates that seagrass, tidal marshes and mangroves combined (Macreadie *et al.,* 2019).

3.19. Echinoderms - Dense populations of brittle stars and other echinoderms may play a significant role in marine carbon cycling (Lebrato *et al.,* 2010). As these research fields become more established and the role these ecosystems play in the global carbon cycle becomes more apparent, it is likely that global recognition of the importance of these ecosystems will increase, potentially including within the international carbon auditing frameworks.

4. THE OPPORTUNITIES

4.1. Valuing blue carbon ecosystems in climate change policy and management allows for its inclusion in future mitigation and adaptation strategies, as a way of mitigating climate change and offsetting GHG emissions, in addition to contributing to conservation interests (Macreadie *et al.,* 2019).

4.2. If more countries include blue carbon ecosystems in their Nationally Determined Contributions (NDC's), it sends a strong message to the rest of the world regarding the important role that natural ecosystems can play in climate action (Herr & Landis, 2016). Healthy, well-managed ecosystems also tend to be much more resilient to the impacts of climate change, thereby ensuring continued provision of other important services.

4.3. As an island with around 87% of its territory in the marine environment, it makes sense for the Isle of Man to manage and maximise the benefits of the sea in terms of its climate mitigation and adaptation initiatives. It is evident from the literature that there is significant potential in the Island's blue carbon ecosystems, and the managingof its territorial seas with this in mind, could demonstrate the Isle of Man as an innovator and at the forefront of this rapidly-developing field.

Offsetting

4.4. Carbon offsetting is a reduction in GHG emissions made in order to compensate for emissions made elsewhere and is likely to play a role in the transition to a zero carbon future. Studies suggest that blue carbon sediments are 2-5 times more efficient in the sequestration of carbon that terrestrial forests (Murray *et al.,* 2011, CEAB, 2019). As such, the restoration and conservation of blue carbon ecosystems could be used to offset terrestrial emissions and may be more cost effective than using terrestrial ecosystems due to their efficiency at storing carbon and relative size compared to terrestrial lands (CEAB, 2019).

Case study: Seagrass restoration in Cardigan Bay

4.5. Seagrass absorbs carbon 35 times faster than a terrestrial rainforest; it also absorbs pollution, protects coastlines and acts as important nursery grounds for many species, including commercially important fish such as cod and plaice. 92% of seagrass has been lost in the UK in the last century. Swansea University have partnered with Sky Ocean Rescue, launching the largest ever sea grass restoration project in the UK. This project has so far been successful and is leading the way for future mass seagrass restoration projects across the UK. The cost of this project has not yet been established. However, Isle of Man Seasearch and he Department of Environment, Food and Agriculture have begun collaborating in this work by providing licenced collection of Manx seeds during 2019.

4.6. Seaweed aquaculture also has the potential to provide a form of offsetting in the oceans (Froehlich *et al*., 2019); due to seaweed's high uptake of carbon and fast growth rates. The practise of artificial propagation could offer additional benefits to coastlines that are affected by eutrophic, hypoxic and/or acidic conditions, whilst increasing biodiversity and coastal protection, as well as commercial products (Froehlich *et al.,* 2019).

Case study: Help Our Kelp Campaign

4.7. A new campaign aims to restore large expanses of kelp forest along the Sussex coast in the first marine kelp restoration project. The west Sussex coastline was once home to a 40km stretch of kelp forest that extended 4km seaward. However, this habitat has largely been destroyed due to storm damage, changes in fishing practices and the dumping of sediment by dredging boats. The restoration project, if approved, will improve nursery grounds, water quality, biodiversity and carbon storage in the region. The 'Help Our Kelp' campaign is supporting a new bylaw proposed by the Sussex Inshore Fisheries and Conservation Authority (IFCA) to stop trawling within 4 km of the coast. Once the trawling management is in place, the partnership will be able to take forward plans to restore the forest. The project is led by the Sussex Wildlife Trust, Blue Marine Foundation and the Marine Conservation Society.

Biofuels

4.8. Much work is being done to find more sustainable sources of energy for the world's growing population. One of the solutions could be from seaweed.

4.9. Seaweed is a viable feedstock for the production of sustainable energy by anaerobic digestion (AD). Anaerobic digestion processes traditionally use crops such as maize and beet as well as agricultural and food wastes. However, seaweed is, potentially, more of a sustainable source of biomass. Benefits include:

- Grows quicker than terrestrial plants
- Higher photosynthetic capability than terrestrial plants
- Sequesters carbon dioxide from the atmosphere quicker and more efficiently than terrestrial plants
- High polysaccharide content
- Potential increase in marine habitat biodiversity and fish stock improvements
- Does not require fertiliser, fresh water, or agricultural land for production.

4.10. Challenges include:

- Seaweed farming can be an expensive process - the farming and harvesting of seaweed needs to become more efficient
- Large scale farms needed for large scale energy production
- Spatial management/competition in relation to existing marine users
- Management of large-scale aquaculture
- Potential local environmental impact through increased nutrient uptake which could impact food webs

Case study – SeaGas Project

4.11. The SeaGas project is assessing the technical and financial viability of farming sugar kelp (*Saccharina latissima*) for the production of bioenergy through anaerobic digestion. The three-year project brings together expertise in AD process development, seaweed growth and storage, economic modelling, environmental and social impact and the supply chain – from seabed access for seaweed farming through to biogas injection into the national grid.

5. KNOWLEDGE GAPS AND FUTURE CHALLENGES

Impact of Climate Change on Sequestration Potential

5.1. Research suggests that several marine habitat types, such as seagrass meadows, saltmarshes and associated carbon stores are at moderate risk at 1.5 °C global warming, with risk increasing with further warming (IPCC, 2019). However, some blue carbon ecosystems may experience increased productivity due to higher CO_2 levels, and distinguishing these effects from human intervention to enhance productivity and therefore carbon storage may be challenging (Climate Analytics, 2017).

5.2. By contrast, the ability of some blue carbon ecosystems to sequester carbon in the future may decrease though climate change (sea level rise, ocean warming, and storminess) and increased anthropogenic pressure. It is therefore challenging and potentially risky to quantify and rely on these ecosystems to deliver significant, quantifiable and sustained reductions in carbon. However, based on current knowledge these ecosystems, when functioning well, can contribute to climate mitigation strategies, and therefore policy and management should ensure that these ecosystems are adequately protected from threats.

Anthropogenic Impacts

5.3. Blue carbon ecosystems are affected by anthropogenic impacts. Impacts include nutrient runoff from land, development, sedimentation, boat disturbance, fishing activities, dredging and waste and sewage outflows. Whether these impacts change or increase in the future is unknown, but it appears likely without appropriate protection, and the precautionary principle should be used when developing policy that affects blue carbon ecosystems.

Sequestration Rates and Emissions through Disturbance

5.4. As noted, while carbon may be sequestered in marine ecosystems, it can also be emitted due to habitat damage or disturbance. Quantifying or measurement of carbon fluxes in coastal and marine systems is harder than other emission sectors. Similarly, research into how sequestration rates and existing sediment carbon stocks are affected by ecosystem loss and/or modification is still developing (McLeod *et al.,* 2011; Macreadie *et al.*, 2019). There is potential that with the protected areas here, the Island could be a place where such things could be measured under relatively controlled conditions.

6. LOCAL MANAGEMENT OF BLUE CARBON ECOSYSTEMS

1990 Wildlife Act

6.1. The Wildlife Act 1990 protects certain species of plant and animal in Manx territory. Eelgrass (*Zostera marina*) is a protected plant under Schedule 7, section 12 and 23, which means it is an offence to damage, destroy or uproot the species.

Marine Nature Reserves

6.2. The Island's network of Marine Nature Reserve's (MNR) make up over 50% of our inshore 0-3 M zone. Under section 33 of the Wildlife Act 1990, the Manx Marine Nature Reserves Byelaws 2018 were introduced, which provides protection to blue carbon habitats by limiting destructive activities within the reserves:

- *Byelaw [4]* No person may extract of remove any sand, gravel or rock, except in accordance with a permit
- *Byelaw [5]* No person may deposit or permit the deposit of any substance
- *Byelaw [6]* No person may use any towable fishing gear

6.3. Specific blue carbon habitats are also protected though the byelaws:

- *Byelaw [8]* No person may extract or damage any of the following:
- Eelgrass b) kelp forest d) horse mussels g) maerl
- *Byelaw [11]* No person may extract or damage any of the following: a) the intertidal mud habitat of the Langness Marine Nature Reserve

6.4. Additionally there are restrictions on anchoring within the reserves:

- Byelaw [9] (1) Anchoring using any towable fishing gear is prohibited
- Byelaw [9] (3) Anchoring by any means is prohibited within any Eelgrass Conservation Zone

6.5. There are specific restrictions within Eelgrass Conservation Zones

- Byelaw [13] (1) no person may;
  a) use a pot b) use towable fishing gear to trawl or dredge c) anchor
- Byelaw [13] (2) no person may undertake recreational rod and line angling
- Byelaw [13] (3) no person may collect any living animal or plant on the foreshore or in the sea, by any means, including hand gathering

6.6. Despite the prohibitions contained in the byelaws, DEFA may, if it considers it appropriate, issue a permit to any person to undertake certain activities, such as recreational fishing and research or investigations.

6.7. As such, blue carbon restoration or research could be listed under future permit approved practices.

Management Plan for the 0-3 M Marine Zone

6.8. Under the Isle of Man Programme for Government there is a commitment to introduce a management plan for the 0-3 M Marine Zone by December 2019. The plan will have two streams, conservation and fisheries, and blue carbon will feature in both; with traditional habitat protection, conservation, and potential restoration of ecosystems (including blue carbon) a key feature in the conservation stream and lower-carbon fisheries management in the fisheries stream.

6.9. The draft 0-3 M management plan proposal suggests there could be opportunities for coordinated management of carbon sequestration, storage and emissions in the 0-3 M zone and states the following goals in relation to blue carbon.

6.10. Marine Conservation Outcome

- Investigate the production of a carbon audit of the marine nature reserves, linked to their management plans and with the intent to enhance their carbon storage and sequestration potential.

6.11. Through the following objectives:

- Develop a carbon audit for each marine nature reserve, including carbon-management objectives.
- Develop MNR- specific management plans, reflective of their respective features, specific conservation and carbon-management objectives and potential.

6.12. Fisheries Management Outcome:

- Investigate the production of a carbon audit of the fishery, linked to its management plans, and with the intent to reduce carbon emissions and enhance carbon-storage and sequestration potential.

6.13. Through the following objectives:

- Investigate a carbon audit for the fishery, including carbon-management objectives.

Management Recommendations

6.14. Management of the 0-3 M and potentially 3-12 M territorial waters should embed policy that promotes the conservation, restoration and research of blue carbon ecosystems in the Island, and identify pathways to ensure their long-term conservation for climate and biodiversity outcomes.

7. ASSUMPTIONS

7.1. Due to time constraints this report has had to rely largely on the validity of a postgraduate research project in estimating the carbon sequestration and carbon stock of the Island's territorial seas. These findings should be checked and verified at a later date.

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