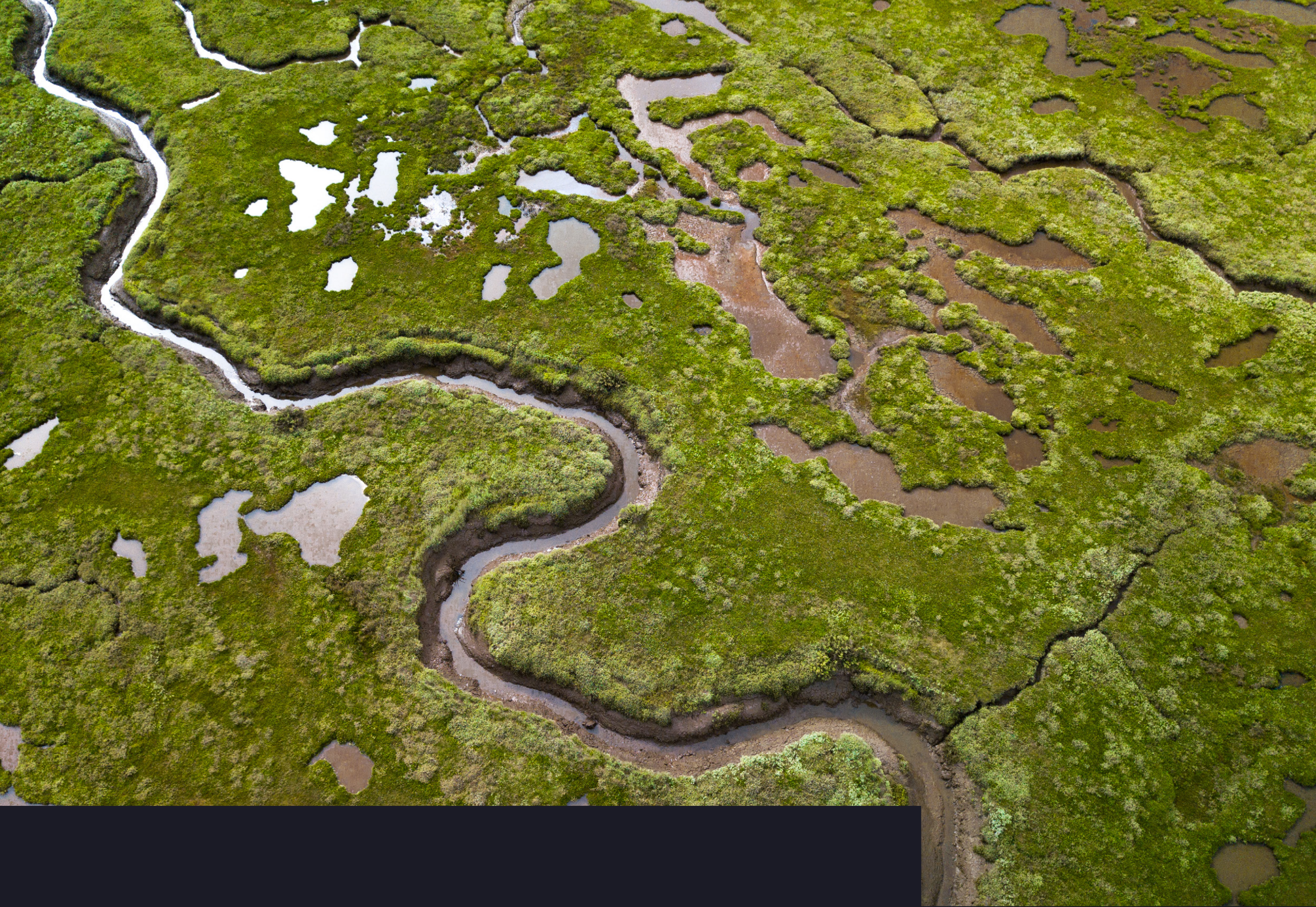

Blue carbon
Ocean-based solutions to fight the climate crisis

A report by the Marine Conservation Society and Rewilding Britain

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Summary

Governments have been slow to properly protect marine ecosystems despite the widely accepted benefits of doing so. It's been known for many years that protecting and restoring UK marine ecosystems such as seabeds, saltmarshes and seagrass meadows makes sense because they all deliver important ecosystem services such as enhanced biodiversity, increased stocks of commercially fished species and coastal protection.

What's received less attention is the role coastal and marine habitats can play in drawing down carbon dioxide from the atmosphere and storing the carbon in long-term solutions such as seabed sediments, seaweeds, saltmarshes and seagrass beds. This is referred to as blue carbon, with two key aspects to this process, one that is active and the other preventative in nature:

1. Increasing blue carbon habitats, via rewilding and other methods, stores carbon which leads to a reduction of carbon in the atmosphere.
2. Halting the destruction of marine environments which actively contributes to carbon emissions being released into the atmosphere.

Seabeds are significant carbon stores (or 'carbon sinks') that are vulnerable to disturbance from activities such as bottom trawling and dredging. These activities result in the carbon being re-suspended in the water, exacerbating ocean acidification and potentially escaping into the atmosphere as carbon dioxide[1,2]. The UK's shelf seas cover some 500,000 km^2 and are estimated to store 205 million tonnes of carbon[3], some 50 million tonnes more than held within our entire stock of standing forests[4].

While seabeds store huge amounts of carbon, saltmarshes and seagrass habitats actively fix *and* store (a process known as sequestration) vast quantities of carbon each year – estimates suggest 43,000 tonnes annually. Scientists estimate these habitats sequester carbon at 2-4 times the rate of mature tropical forests[5], meaning the UK's entire stock of saltmarshes and seagrass beds have the carbon storage potential of between 1,000 - 2,000 km^2 of tropical forests.

Globally, saltmarshes and seagrass are vital carbon sinks. It's estimated that the 0.4 million km^2 of global saltmarshes draw down between 60.4 and 70 million tonnes of carbon (and possibly up to a maximum of 190 million tonnes) a year and 0.33 million km^2 of seagrass beds between 27 and 44 million tonnes (and up to 82 million tonnes) a year[6].

Saltmarshes and seagrass - blue carbon sinks - draw down and store between them 235-450 million tonnes of carbon a year; almost half the emissions from the entire global transport sector[7].

Globally, the rewilding of key blue carbon securing marine and coastal ecosystems could deliver carbon dioxide mitigation amounting to 1.83 billion tonnes[8] - 5% of the emissions savings we need to make globally. This figure doesn't include the enormous quantities of carbon stored in fish and other marine wildlife[13], in marine ecosystems such as coral reefs, seaweeds and shellfish beds, or the vast stores of carbon in our seabed sediments[3,4]. It is vital that we better protect ocean ecosystems for both biodiversity and blue carbon.

Ocean-based solutions must be part of the many urgent and varied solutions required to address the climate crisis. Nature-based solutions could provide one third of the climate change mitigations required, but currently they attract less than 3% of the funds invested globally in

addressing climate change[9]. In recognition of the vital role our ocean must play in urgent climate change mitigation and adaptation, these ocean-based solutions must be adopted with pace, and at scale, by 2030.

We are calling on the UK Government and devolved administrations to act with urgency to invest in, co-develop and implement a four-nation Blue Carbon Strategy. Specifically, the Blue Carbon Strategy should focus on three key nature-based action areas, where Governments should:

SCALE UP THE REWILDING OF OUR SEAS FOR BIODIVERSITY AND BLUE CARBON

- Deliver at least 30% of UK seas as Highly Protected Marine Protected Areas (hpMPAs), including at least 10% Fully Protected Marine Protected Areas (fpMPAs) by 2030[10]. This should start with the exclusion of bottom-towed trawling and dredging from all offshore MPAs designated for benthic features in UK waters by 2024 at the latest.
- Implement bottom-towed fishing gear free zones around the entirety of the UK coast in **nearshore** waters, the extent of which should be dependent on local and regional considerations, to recover marine ecosystems, support the recovery of fish and shellfish stocks and protect and restore blue carbon habitats.
- Support ambitious projects to restore key blue carbon habitats such as seagrass, saltmarsh, oyster reefs and kelp forests around the UK coast.
- Unlock the value of the natural capital of our ocean, alongside the innovation and resources of the private sector, through the development of sustainable market finance initiatives.

INTEGRATE BLUE CARBON PROTECTION AND RECOVERY INTO CLIMATE MITIGATION AND ENVIRONMENTAL MANAGEMENT POLICIES

- As part of a Blue Carbon Strategy, commit UK governments to specific and ambitious blue carbon habitat recovery, restoration and protection targets in the UK's next Nationally Determined Contribution to the Paris Climate Agreement in 2025.
- Fully account for blue carbon in UK carbon budgeting.
- Develop a comprehensive 'Ocean Charter' that integrates nature recovery plans with climate change mitigation and adaptation policies, including those for Blue Carbon. This will provide a pathway for the UK to meet its commitments to Sustainable Development Goal 14 and the Decade of Ocean Science for countries to develop national 'Sustainable Ocean Plans' to deliver a sustainable Blue Economy, by 2030.

WORK WITH THE PRIVATE SECTOR TO DEVELOP AND SUPPORT SUSTAINABLE AND INNOVATIVE LOW-CARBON COMMERCIAL FISHERIES AND AQUACULTURE

- Commit to fully sustainable management of UK commercial fish and shellfish stocks, applying an ecosystem-based approach and halving fisheries related carbon emissions by 2030 to deliver climate and nature positive fishing.
- Fully invest in the development of innovative low-carbon aquaculture technologies and best practice, including processing and feed production, to halve UK aquaculture carbon emissions by 2030.

- Support and invest in the development of UK markets for sustainable, low-carbon wild-caught fish and innovative aquaculture products, with a roadmap for delivery produced by 2022/23.

Introduction

We are facing interlinked climate, health and ecological emergencies that require us to make huge changes to the way we live and to reduce the impact we have on the planet's natural ecosystems. In order to tackle the climate emergency, we need global governments to create a policy framework that demands action from nations around sustainability outcomes, and penalties if this doesn't occur within the set timeframe.

As part of the UK's commitment to the Paris Climate Agreement, and to keeping global temperature rises to below 1.5˚ C, in 2020 the UK Government announced it aims to cut carbon emissions by 68% compared with 1990 levels over the next decade (and 78% by 2035), with a legislated commitment to meet net zero greenhouse gas emissions by 2050[11,12]. The devolved Governments have also announced their aspirations for net zero. It will require an unprecedented joint effort to achieve this.

Table - UK and devolved nations emissions reductions targets

UK	
2030	68%
2050	Net zero
Scotland	
2030	75%
2045	Net zero
Wales	
2030	58% (aim)
2050	Net zero
Northern Ireland	

N.B.: Northern Ireland contributes to the UK target under the Climate Act 2008[13].

One important way of contributing to the reduction of carbon emissions is to increase the quantity of carbon dioxide that's taken out of the atmosphere and stored in long-term natural solutions. These solutions include protecting and rewilding ecosystems in our ocean.

The significant role of the world's forests in helping to reduce carbon emissions has been formally recognised in, for example, the UN's Collaborative Programme on Reducing Emissions from Deforestation and forest Degradation (REDD+). The idea of REDD+ is that developing countries with large forest resources are paid for not cutting them down, or to manage them in a sustainable way, removing the financial incentive to fell trees and replace them with agricultural plantations.

It is vital that we invest in protecting our marine ecosystems. Our coastal and marine habitats also provide ecosystem services such as generating oxygen, protecting coastal communities from rising sea levels and removing pollutants from the water. They act as nursery grounds for commercial fish and shellfish species, havens for wildlife and store carbon in huge quantities.

From tropical mangrove forests and tidal saltmarshes to seagrass meadows, seaweeds and even the whales, dolphins, seabirds, fish and invertebrates that live in our ocean – all have the potential to absorb carbon emissions in a similar way to tropical rainforest ecosystems. The role of these ocean-based, blue carbon solutions to help fight the climate emergency is largely unrecognised by governments around the world. There is no formal mechanism, such as REDD+, to finance their conservation.

Extent of blue carbon sequestering habitats in UK waters

Three blue carbon habitats in UK waters - saltmarsh, mudflats and sands - have been estimated to capture 'between 10.5 and 60.1 million tonnes of carbon dioxide equivalent per year'[14]. This compares favourably with the total carbon sequestration from terrestrial habitats of 28 million tonnes per year.

The amount of carbon removed from our atmosphere by just three blue carbon ecosystems, in one year, has an estimated value of between £742 million and £4,259 million (in 2019 prices)[15].

The UK has made some progress in developing a system for paying landowners to protect their soils, look after their wildlife and manage their land in such a way that it stores carbon. Legislation that paves the way for so-called "public money for public goods" has recently been passed by the UK Parliament in the shape of the Agriculture Act – a huge, progressive and necessary step forwards.

But just as past government policies encouraged the loss of carbon-rich peat bogs, current policies are resulting in the loss of carbon-rich saltmarshes and seagrass meadows and the disturbance of seabed sediments that hold millions of tonnes of carbon. Though more progress is needed, there is now a more enlightened attitude to conserving peatlands, but the same cannot be said of similarly important coastal and marine habitats.

The UK's Nationally Determined Contribution (NDC) to the Paris Agreement describes how we will reduce our national emissions and adapt to the impacts of climate change[1]. In the document, published in December 2020, the UK Government refers to the UK National Adaptation Programme, which *"outlines how the UK will address marine climate risks by introducing a Sustainable Fisheries policy, giving consideration to climate change in marine planning, building ecological resilience at sea and protecting natural carbon stores through the UK's network of Marine Protected Areas".* While the UK Government in Westminster has acknowledged the importance of marine carbon stores in fighting climate change, it has made no concrete commitments to protecting and restoring this blue carbon, and doesn't include blue carbon in its national carbon budgeting[16].

This report lays out the importance of the UK's blue carbon resources, and the scale of the losses the UK faces should it continue to treat its coastal resources as expendable. It also reveals the potential additional carbon emissions current policies could produce. It shows that to achieve our carbon reduction goals we should make in some cases radical, yet sensible and necessary, changes to the way we manage our marine environment. New approaches that include marine rewilding will have the added benefit of restoring biodiversity. To meet this challenge across the UK requires a cooperative approach between Westminster and the devolved administrations in Scotland, Wales and Northern Ireland.

Acting now to protect and restore our blue carbon ecosystems does not mean we can ease up on efforts to reduce carbon emissions from the use of fossil fuels. Nevertheless, it would play its part in helping the UK reach its net zero carbon goal and ensure the health and long-term future of our rich, varied, internationally important and beautiful marine habitats.

What is blue carbon?

Just as trees and other plants on land draw down carbon from the air through photosynthesis and then store it – a process known as sequestration – so does the vegetation in marine ecosystems. Globally, the important carbon sink habitats are mangroves, salt or tidal marshes and seagrass. Mangroves are only found in tropical parts of the world, with some UK Overseas Territories hosting extensive mangrove forests. In the UK there are extensive saltmarshes and seagrass beds, though both of these habitats have declined greatly over recent decades.

Seabed sediments hold the greatest quantities of carbon, but are not actively taking carbon dioxide out of the atmosphere. Instead, organic matter comes from marine and terrestrial ecosystems and is deposited on the seabed to form these sediments.

Increasingly, we also understand that marine vertebrates such as fish, seabirds, whales and dolphins store and 'move' large amounts of carbon[17]. Large marine mammals, in particular, may contribute to processes that result in both the long-term storage of carbon in the ocean depths and accelerate the growth of phytoplankton. After they have died, the carcasses of large marine organisms sink and store carbon in the deep ocean. A study published last year calculated that ocean fishery catches have resulted in the release of at least 0.73 billion tonnes of carbon dioxide into the atmosphere since 1950 through a combination of the removal of biodiversity from the sea and emissions from fisheries' fossil fuel consumption[18].

Small marine organisms also help to store carbon in the deep ocean. Microscopic plants (phytoplankton) and algae on the surface of the ocean absorb atmospheric carbon dioxide and are then consumed by zooplankton that descend to the deep ocean during the day, where they are in turn consumed by invertebrates in the bottom sediments. This process has the effect of locking carbon away in the seabed.

Across the world, scientists have mapped nearly 55,000 km^2 of saltmarshes – almost three times the area of Wales - across just 43 countries, and have speculated there could be as much as 400,000 km^2 overall, 1.5 times the land area of the UK. Seagrass beds could be even more extensive, covering somewhere between 300,000 km^2 and 600,000 km^2 worldwide[19].

All of these habitats – mangroves, saltmarshes and seagrass – are of course wonderful and vital marine ecosystems. Saltmarshes are well known to birdwatchers and other wildlife lovers as great places to see many species of waders and wildfowl that feed in the rich mudflats exposed at low tide. Seagrass beds are less visible to the casual observer, but globally they act as crucial nurseries for juvenile fish; foraging habitats for sea turtles, manatees and dugongs in the tropics and for geese, ducks, seahorses and other fish species around UK's coast.

Saltmarshes provide a number of important ecosystem services. As flood defences, for example, by reducing the force of waves coming into a coastal area. In Essex – one of the lowest-lying parts of the UK – where there is an 80m wide saltmarsh, only a 3m high wall is needed to give adequate protection from the sea. In contrast, where there is no saltmarsh, or it has been lost, a 12m high wall is needed to obtain the same level of protection[20]. Saltmarshes also act like filters, taking out pollutants from land run-off, helping to improve water quality in coastal areas.

It's becoming increasingly clear – and significant – how these ecosystems are also vital stores of carbon. A newly created saltmarsh stores carbon at a rate of more than 1 tonne per ha per year, slowing to 0.65 tonnes per ha per year after 20 years, giving an estimated overall accumulation of 74 tonnes of carbon per ha after 100 years[21]. Newly planted native woodland in Scotland, by contrast, is only expected to store 50 tonnes of carbon per ha after 100 years[22]. In the long run, newly created saltmarsh locks in much more carbon than the equivalent area of newly planted woodland. The creation of more saltmarsh in the UK is important for people, biodiversity and blue carbon.

Other studies have shown faster rates of carbon accumulation for saltmarshes – 6-8 tonnes of CO_2 per ha per year, equivalent to 1.6-2.2 tonnes of carbon per ha per year, estimated to be 2-4 times the rate of accumulation in tropical rainforests[23]. Restoration of existing saltmarsh habitats is key in our race to net zero.

Seagrass also fixes and stores huge quantities of carbon, estimated to average 0.83 tonnes of carbon per ha per year. Globally, seagrass beds store nearly 20 billion tonnes of carbon within the top 1 metre of their sediments[24].

While forests mainly store carbon in the biomass – trunks, stems and leaves – of trees, both seagrass and saltmarshes store carbon in rich sediments. Perhaps as much as 99% of carbon stored in seagrass and saltmarsh is in sediments around the plants, these stores can be up to 6m deep and lie undisturbed for thousands of years[25].

Not only can these functioning ecosystems continue to draw down carbon dioxide from the atmosphere if we do not damage or destroy them, but they could potentially release millions of tonnes if they are degraded, exacerbating the impacts of human activities such as the burning of fossil fuels.

Current rates of loss of all coastal ecosystems (mangroves, saltmarshes and seagrass) result in the loss of between 0.15 and 1.02 billion tonnes of CO_2 a year[26]. This should provide a double incentive to maintain and restore these ecosystems; taking CO_2 out of the atmosphere and preventing more being added.

In addition to carbon securing coastal habitats, the muds, sands and silts on the ocean floor are the planet's largest store of organic carbon. Scientists have estimated that about 3117 gigatonnes of carbon lie secure in the ocean floor[27], and if left undisturbed this carbon can remain secure for millennia. About 52% of this stock lies within Exclusive Economic Zones, so is under the jurisdiction of national governments. Unfortunately, activities that disturb the seabed, such as bottom towed fishing gear, dredging and aggregate extraction, disturb these carbon stores and release them into the water column, negatively affecting water chemistry and the ocean's capacity to absorb carbon dioxide[28]. There is growing awareness of the urgent need to protect these vital seabed carbon stores.

Marine Rewilding

The idea of rewilding on land has taken hold in the UK in a big way. Rewilding Britain has a rapidly growing network of projects across the country. Members include the 1,400 ha Knepp Estate in West Sussex and Trees for Life's Dundreggan project in the Scottish Highlands, where nearly 500 ha have been reforested, with a target of rewilding the whole 4,000 ha estate.

Rewilding Britain defines rewilding as follows:

"Rewilding is the large-scale restoration of ecosystems to the point where nature is allowed to take care of itself. Rewilding seeks to reinstate natural processes and, where appropriate, missing species – allowing them to shape the land and sea and the habitats within.

Rewilding encourages a balance between people and the rest of nature so that we thrive together. It can provide opportunities for communities to diversify and create nature-based economies; for living systems to provide the ecological functions on which we all depend; and for people to reconnect with wild nature"[29].

Marine rewilding is the same idea applied to coasts and seas. In some areas, that will mean ceasing all harmful activity, including damaging commercial fishing methods, such as bottom trawling, aggregate extraction, dredging or oil or gas exploitation and allowing the ecosystem to recover. In others, it may mean giving recovery a helping hand, for example through active restoration; reseeding an area with seagrass or returning lost species such as oysters.

Our ocean is in dire need of rewilding. Globally, only 55.2 million km^2 out of a total area of 500 million km^2 – just 13% – is today considered "marine wilderness"[30]. Britain's seas were once home to some of the world's largest creatures, including blue, fin, sei, humpback and sperm whales, but these are rare visitors today. Highly industrialised fishing techniques have seriously impacted commercial fish species populations, while bottom trawling and dredging have ploughed up once vibrant seabeds.

Countries all over the world are attempting to reverse this trend by setting up Marine Protected Areas (MPAs). The idea of MPAs is that activities such as extractive industries and fishing, especially more intensive forms such as trawling, are banned.

We have numerous MPAs around the coast of the UK, including Marine Conservation Zones (MCZs), which were set up under Westminster legislation introduced in 2009, nature conservation Marine Protected Areas established with Holyrood legislation introduced in 2010, and Special Protection Areas (SPAs) and Special Areas of Conservation (SACs), protected areas that were designated under European legislation. Put all 372 MPAs together and they cover 338,049 km^2 out of a total 885,430 km^2 for all inshore and offshore UK waters. This means that 38% of our waters theoretically have some kind of protection[31].

But, as numerous critics have pointed out, many of these protected areas are 'paper parks', protected in name only, often with no management in place so damaging activities continue unchecked. Data gathered by Global Fishing Watch and analysed by the Marine Conservation Society found that bottom trawling and dredging are taking place in 98% of the UK's offshore MPAs. Furthermore, by analysing the sediment storage capacity of MPAs, seabed trawling could release up to 20 million tonnes of carbon. In terms of mitigation costs, the trawling activities could cost the UK economy a billion pounds over a 25 year period[32]. If biodiversity is to recover and flourish in these MPAs, and the seabed carbon to remain secure, then these sites can't just be lines on a map, they must be effectively managed too. To start with, bottom towed trawling and other activities that may damage seabed ecosystems must be banned from our MPAs, for biodiversity and blue carbon protection.

> ***"We have an impressive 38% of UK waters in some form of Marine Protected Area. Sadly, most of these sites aren't properly managed. Because damaging activities are allowed within these sites the seabed simply isn't being protected, with marine wildlife and their habitats regularly destroyed. Our governments could rewild huge swathes of our seas by simply excluding bottom-towed fishing gear and other activities that damage the seabed from these areas. That would be good for biodiversity, fish stock recovery and the protection in perpetuity of millions of tonnes of carbon locked away in the sediment. Ultimately, proper protection of these sites would provide enormous benefits to society."***
>
> **Dr Jean Luc Solandt, Marine Conservation Society**

Rewilding principles

Rewilding Britain has five key principles for rewilding – here's how they can apply to marine projects.

1. Support people and nature together

This is critical. Creating a situation where ecosystem recovery can take place can only be done with the support of affected communities. It was local people who led the way for the creation of Scotland's first no-take zone in Lamlash Bay in the Isle of Arran, in the Firth of Clyde, in 2008. Covering 2.67 km^2, the no-take zone has seen a recovery of biodiversity, including in commercial species such as lobsters and scallops. This sort of conservation initiative also has benefits for low impact fishing, tourism and food security. See case study, p22.

2. Let nature lead

Where possible, rewilding is all about allowing natural processes to start working again. Removing artificial sea defences, for example, reignites natural processes so that once extensive saltmarshes can recover and help protect coastal communities from flooding. There are some excellent examples of this in the UK, including at Fingringhoe in Essex, where 22 ha of new intertidal habitat has been created by making a 300m breach in the seawall. More than 15 species of waders and wildfowl have been recorded using the site, and the new intertidal area acts as a fish nursery for species such as sea bass[33] . Restoring predator populations can also have benefits for marine ecosystems. In North America, the rebounding of sea otter populations has led to a decrease in sea urchins (because sea otters feed on them) and a consequent increase in kelp abundance. See case studies section for further examples of marine and coastal habitat restoration p20.

3. Create resilient local economies

On land, rewilding can create opportunities for new livelihoods that thrive, alongside enhanced biodiversity, including more sustainable food production and tourism. In Lyme Bay, on the Dorset and Devon coast, a ban on destructive mobile fishing such as trawling and voluntary agreements on the scale of potting for crabs and lobsters has led to a huge resurgence in numbers of many commercially fished species, leading to sustainable incomes for local fishermen. See case study, p20.

4. **Work at nature's scale**

Rewilding works better when done on a large scale. Banning bottom trawling across all the UK's offshore MPAs, for example, would allow the recovery of ecosystems across 140,000 km^2, which dwarfs what is possible in the UK's farmed area. On a more modest scale, the Sussex Inshore Fisheries and Conservation Authority (IFCA) has banned trawling all year round from a 304 km^2 area of the Sussex coastline in order to allow underwater kelp forests to recover, which will have positive impacts for the area's biodiversity. See case study, p22.

5. **Secure benefits for the long term**

Leaving a positive legacy for future generations is essential. Off Spurn Point, in the Humber Estuary, a partnership between Yorkshire Wildlife Trust and the University of Hull is trialling aquaculture of mussels, oysters, razor clams and seaweed. Oysters help purify water, create conditions where other species flourish and are a sustainable food whose production is associated with significantly lower carbon emissions compared to other sources of protein[34]. The long-term goal is to reintroduce native oysters throughout the Humber Estuary, which could have all manner of positive impacts for local communities in the years to come.

How significant a role can blue carbon play as a natural climate solution?

The contribution of the ocean in mitigating the impacts of climate change is undervalued[35] but includes: renewable energy such as wind, wave and tidal power, transport, marine ecosystems and sources of nutrition through fishing and aquaculture.

"Ocean-based mitigation options could reduce global greenhouse gas emissions by nearly 4 billion tonnes of carbon dioxide equivalent (CO2e)* per year in 2030 and by more than 11 billion tonnes of CO2e a year in 2050, relative to a projected business-as-usual emissions."[36]

*** Carbon dioxide equivalent (CO2e) is a measure comparing the emissions of different greenhouse gases on the basis of their global-warming potential. For example, 1 million tonnes of methane is equivalent to 25 million tonnes of CO_2 and 1 million tonnes of nitrous oxide to 298 million tonnes of CO_2.**

Blue carbon solutions are only part of this overall picture, but coastal and marine ecosystems could offset between 0.32 and 0.89 billion tonnes of CO2e a year by 2030 and 0.50 and 1.38 billion tonnes of CO2e by 2050. Fisheries, aquaculture and shifting people to less carbon intensive diets could reduce emissions by between 0.3 and 0.94 billion tonnes of CO2e by 2030 and between 0.48 and 1.24 billion tonnes of CO2e by 2050.

In the best-case scenario, conservation and restoration of marine ecosystems and how we exploit the seas for food could deliver mitigation amounting to 1.83 billion tonnes of CO2e by 2030 and 2.62 billion tonnes of CO2e by 2050[37].

Total global greenhouse gas emissions from land clearing and burning of fossil fuels were estimated to be 55.3 billion tonnes of CO_2e in 2018 and are projected to rise to 60 billion tonnes of CO_2e by 2030. To keep global temperature rise below 1.5˚ C, as per the Paris Agreement, it's projected that we need to cut emissions to 25 billion tonnes of CO_2e by 2030 - a reduction of 35 billion tonnes of CO_2e[38].

Globally, rewilding seagrass beds, saltmarshes and mangrove forests alone could deliver more than 5% of the carbon savings required to stop global temperatures rising above 1.5˚ C.

In addition, properly protecting enough of the seabed will secure vast quantities of blue carbon and stop it from disrupting ocean chemistry and potentially re-entering the atmosphere[4].

Blue carbon solutions in the UK

The seas around the UK have plenty of great blue carbon solutions to help achieve our emissions reduction target.

Sea sediments

Scientists have recently estimated that seabed sediments within the UK EEZ store up to 592Mt of organic carbon and 2,750Mt of inorganic carbon - with muddy sediments storing the greatest quantity of organic carbon[39]. The 540,000 km^2 of UK shelf seas[40] – defined as shallow sea areas up to 200 metres in depth – host much of this muddy sediment, with estimates suggesting they contain 205 million tonnes of carbon, 50 million tonnes more than in the whole of the UK's forests[41]. When saltmarshes and seagrass meadows are included, the UK blue carbon estimate rises to 220 million tonnes, while marine fish populations hold a further 1 million tonnes – also known as 'fish carbon'[42,43].

Unlike our woodlands, one of the UK's most important carbon stores is hidden out of sight and, largely, out of mind. But that doesn't mean it isn't vulnerable to disturbance. Increasingly we are understanding that bottom trawling and dredging are not only destroying critical seabed ecosystems but re-suspending carbon in the water, reducing the ocean's capacity to absorb carbon dioxide, as well as potentially resulting in carbon being released back into the atmosphere as carbon dioxide[44].

Bottom trawling is a highly damaging method of fishing and has largely reduced often complex, three-dimensional seascapes with a rich marine fauna into monotonous, flat expanses of gravel, sand and mud devoid of life. "[Bottom] trawling represents a major threat to the deep seafloor ecosystems at the global scale," the authors of one study concluded[45].

The UK's offshore MPAs are heavily exploited – with most of our offshore MPAs subject to bottom trawling or dredging at least once a year[46]. The UK has 372 MPAs which cover nearly 340,000 km^2 - 38% of inshore and offshore waters combined. Yet bottom trawling and dredging is only banned in 2% of UK seas. Recently, the Westminster Government has proposed banning bottom trawling from a few more offshore MPAs, including the Dogger Bank Special Area of Conservation (SAC), which alone stores an estimated 4.4 million tonnes of carbon, just over 2% of the UK's shelf sea sediments[47].

Imagine the millions of tonnes of carbon we can protect for perpetuity if all of our MPAs are forever protected from bottom trawling and dredging. We believe that, within the next decade, 30% of UK seas should be within a network of highly protected Marine Protected Areas (hpMPAs)[48] that exclude the most damaging activities, like bottom towed fishing gear and dredging, from the entirety of the site. Within that network, 10% of our seas should be within fully protected Marine Protected Areas (fpMPAs)[41] where all extractive activities are banned.

Best- and worst-case scenarios

Best
The Marine Conservation Society has called for bottom trawling to be banned in all offshore MPAs, an area covering nearly 140,000 km^2, which would have the effect of safeguarding almost 55 million tonnes of blue carbon. It would also allow wildlife living on the seabed to recover, reviving whole ecosystems and supporting the recovery of commercially fished species. We want at least 30% of our seas to be in hpMPAs by 2030.

Worst
If current bottom trawling effort continues as business as usual, then our shelf sea sediments could lose more than 13 million tonnes of stored carbon over the next decade[49].

Saltmarshes and tidal mudflats

Highly distinctive, the typical British saltmarsh consists of islands of vegetation surrounded by an intricate maze of muddy channels in a tidal estuary. At low tide, areas of mud are exposed, providing rich feeding grounds for wading birds. As the tide comes in, it gradually covers first the mud and then those vegetated islands. It's an ever changing, evocative landscape, cold and windswept in the winter, replete with the calls of curlews and other iconic British birds.

What defines a saltmarsh, however, is plant species such as cordgrass and edible marsh samphire that are tolerant of salt water. Saltmarshes are important for wildlife, both as spawning sites and nursery areas for fish and as feeding grounds for waders and overwintering wildfowl such as brent geese and wigeon. Saltmarshes are also important sequestrators of carbon, thus representing another vital blue carbon store.

Saltmarshes are found all around the UK coastline, but areas best known for them include The Wash in Norfolk and Lincolnshire, the coasts of Essex and north Kent, the Solent on the south coast, the Severn Estuary, the South Wales estuaries and the Solway Firth.

Saltmarshes are shrinking as a result of 'coastal squeeze'. Historically, they have been lost to development and conversion to agriculture, but increasingly they are caught between rising sea levels on one side and man-made sea defences (usually seawalls) on the other, so they are unable to expand inland as they would naturally do.

The UK has about 42,700 ha (427 km^2) of saltmarshes, and we are losing an estimated 100 ha a year, a rate of loss of about 0.2 per cent a year[50]. Losses are predicted to reach 8% of total extent by 2060[51].

What does this mean for the UK's blue carbon store? Research into the blue carbon of Wales' marine habitats suggested its 76.1 km^2 of saltmarshes sequestered 6,397 tonnes of carbon, a rate of 84 tonnes of carbon per km^2 [52]. Applied across the whole of the UK (427km^2), that gives a figure of 36,000 tonnes of carbon a year.

However, we can not only stop these declines, but reverse them. Saltmarshes can be restored and recreated through a process called 'managed realignment' or 'managed retreat'. This involves breaching or knocking down seawalls to allow tidal estuaries to flood low-lying agricultural land. Over time, sediment deposits allow salt tolerant plants to colonise and expand the saltmarsh inland.

There are a number of areas in the UK where this has been trialled. At Abbotts Hall, on the Blackwater Estuary in Essex, 80 ha of new saltmarsh have been created since breaches in the seawall were first made in 2002. Others include Alkborough Flats on the Humber Estuary, Medmerry, on the Sussex coast and Steart Peninsula on the Severn Estuary in Somerset. See case study, p21.

In these four projects alone, hundreds of hectares of new intertidal and saltmarsh habitat, plus reedbeds and saline lagoons, have been created. In Medmerry, it's calculated that 183 ha of inter-tidal habitat is 1,000 times better at protecting local homes, businesses and infrastructure (348 properties, a caravan park, a sewage works and a main road) than the previous sea defence of a 3-metre-high shingle bank. The project cost £28 million, but benefits to the local community are valued at £90 million.

In 2018, the Department of Environment, Food & Rural Affairs (DEFRA) began a coastal habitats conservation programme called Restoring Meadow, Marsh and Reef (ReMeMaRe) which aims to restore saltmarsh, seagrass beds and oyster reefs. The five-year project includes an ambition to create an additional 53km^2 of saltmarsh in England, increasing the 355km^2 current extent by 15%[53].

<u>Best- and worst-case scenarios</u>

Best
The final report for the Natural Capital Committee in 2015 suggested the saltmarsh extent of England and Wales – estimated at 405 km^2 – could be increased by 220km^2 or 54%[54]. This would increase the blue carbon potential of our saltmarshes by more than 18,000 tonnes a year.

Worst
If saltmarshes decline by 8% by 2060, that would reduce their extent by a further 34km^2 and their carbon storing potential by 2,900 tonnes a year.

Seagrass beds

Seagrasses are flowering plants commonly found in shallow coastal habitats. They grow long narrow leaves and spread over large areas, giving them the appearance of underwater meadows. They are rooted in mud or sand, thus acting to stabilise the seabed, and – because they need plenty of light to photosynthesize – will only grow down to a depth of about 6m. Eelgrass is the UK's most common seagrass species.

Seagrass is found in sheltered areas around the coast, including the Solent, Studland Bay in Dorset, the Exe and Tamar Estuaries in Devon, Milford Haven in Pembrokeshire, the Moray Firth on the east coast of Scotland and Strangford Lough in North Ireland.

The swaying 1m tall seagrass leaves offer shelter for marine life. Britain's two native seahorse species can be found in seagrass beds, as can juvenile flatfish, cuttlefish, gobies and wrasse. Eelgrass leaves can be colonised by diatoms, algae, stalked jellyfish, hydroids and anemones. Polychaete worms and bivalve shellfish such as cockles burrow in the soft sediments around their roots. Wildfowl feed on exposed seagrass at low tide. In addition, seagrass is a significant store of blue carbon.

But the UK's seagrass beds are in trouble. In the 1930s a significant proportion of eelgrasses around Britain died from a wasting disease from which they have never properly recovered. Between 1980 and 2005 it was estimated that the eelgrass extent had declined by up to 50%[55]. The current extent of seagrass cover in the UK is estimated at 86.52km^2 [56].

As well as declining in their extent, most seagrass beds that still exist are in poor condition because of factors such as poor water quality from fertiliser run-off from land and the physical impact of moorings and boats setting anchors within them[57].

If current trends continue and we do nothing to protect our seagrass beds, then scientists predict they could disappear at a rate of up to 2% a year[58], which would see the total extent shrink by 49% over 20 years, a loss of a further 42.4 km^2.

We can stop and even reverse these declines, though seagrass restoration is not carried out at any scale in the UK. In the US, over a period of 20 years, scientists from the Virginia Institute of Marine Science (VIMS) planted 200 ha of seabed in sheltered coastal bays with more than 70 million seagrass seeds, which has since spread to cover more than 3,600 ha[59].

The return of eelgrass has meant VIMS, together with partner organisations, has started reintroducing scallops – functionally extinct since 1933 – to the seagrass beds. The restored seagrass bed is now sequestering carbon at an average rate of 3,000 tonnes a year. It is also taking nitrogen out of the water to the tune of 600 tonnes a year.

Efforts to restore seagrass meadows in the UK are at a much earlier stage, with work by WWF and Swansea University to reseed a 2 ha plot in Dale Bay, Milford Haven, starting last year. See case study, p21.

A new project - LIFE ReMEDIES - that began in 2020 aims to replant 8 ha of seagrass beds in five MPAs across the south coast of England and protect existing beds by putting in environmentally friendly moorings for boats and creating codes of behaviour for boat owners and others (such as people collecting bait at low tide). The ReMEDIES (Reducing and mitigating erosion and disturbance impacts affecting the seabed) project will work in the Isles of Scilly, the Fal and Helford estuaries in Cornwall, Plymouth Sound and Estuaries, the Solent and the Essex estuaries[60].

<u>Best- and worst-case scenarios</u>

Best

We stop these declines and, through restoration efforts, start to increase seagrass cover throughout the UK, allowing sequestration of thousands of tonnes of carbon each year.

Worst
With a sequestration rate calculated at 83 tonnes of carbon per km^2 per year[61], the loss of 42.4 km^2 of seagrass beds would result in a corresponding decrease in carbon stored of 3,520 tonnes a year.

Kelp and other seaweeds

Kelp and other seaweeds are called macroalgae, they are the most extensive coastal marine habitats around the world and estimated to cover 3.5 million km^2.

Seaweeds are divided into three distinct groups – green, red and brown – but while green and red are classified as plants, brown seaweeds are more closely related to true algae and diatoms. And, as anyone who has ever visited one of Britain's rocky shores or beaches knows, seaweeds grow extensively around these islands – some 600 species have been found in British waters.

Some of the most common and best known seaweeds are bladderwrack *Fucus vesiculosus* and spiralwrack *F. spiralis* (both brown seaweeds) with their distinctive air-filled bladders. Also common and easily identified is kelp, which forms thick strands of leathery brown leaves. Oarweed and cuvie, which form dense underwater forests, are two of the more common species. Kelps are coldwater species found all around the UK, though in particularly large quantities around the coast of Scotland.

All seaweeds are critical habitats for other species, acting as a place where small or juvenile fish and crustaceans can take cover from predators. By acting as a break for waves, kelp forests also help to reduce coastal erosion and have tourism value as a productive and biodiverse habitat for divers and wildlife watchers.

Unlike seagrass or plant species that grow in saltmarshes, kelp does not grow out of the soil or seabed, instead it uses root-like holdfasts to fasten itself to rocks and stones, so there is no gradual accumulation of carbon in the soil or seabed as a result. However, kelp forests do fix carbon. As the plants die and decompose, some of that carbon is deposited in the seabed sediments, so kelp can be seen as a carbon conveyor. It's estimated that the kelp growing around the coast of Scotland alone covers 2,155 km^2, with the standing stock containing 1.73 million tonnes of carbon in its biomass, making it another significant blue carbon store[62].

In recent years there has been a growth in kelp harvesting, with the alginates they contain used in food production, pharmaceuticals, textiles, paper and biotechnology. Kelp also has potential as a biofuel. Around the world, around 20 countries harvest an estimated 620,000 tonnes of wild brown seaweeds – such as kelp - a year. In the UK, it's estimated that between 2,000-3,000 tonnes of seaweeds were harvested in 2013[63].

In 2018, alarm was raised about the sustainability of an Ayr-based company's plans to harvest up to 34,000 tonnes of kelp every year, an estimated 0.15% of Scotland's entire stock, using a mechanical device resembling a giant comb. Mechanical harvesting rips out the whole plant, including the holdfast, meaning it is unable to grow back. The Scottish Parliament decided to ban mechanical harvesting, but the increasing interest in kelp means the threat hasn't gone away.

In addition to unsustainable harvesting, issues such as climate change, increased run-off from the land of sediment and nutrients and increased grazing by species such as sea urchins could all impact kelp cover.

Seaweed aquaculture represents a potentially sustainable alternative to harvesting wild kelp. Seaweed farming is carried out in 37 countries around the world over an area of about 1,600km^2, with an annual yield (in 2014) of 27.3 million tonnes and a growth rate of about 8% a year[64].

One study suggested seaweed farming could play a role in offsetting the carbon emissions of agriculture at a local level and improve water quality in coastal areas affected by nutrient run-off or where the water is oxygen depleted[65].

UK macroalgae stocks represent a significant conduit for blue carbon, while seaweed cultivation could play an important role in carbon sequestration and reduction of greenhouse gas emissions.

Experimental seaweed projects have been established by Queen's University, Belfast, in Northern Ireland, the Scottish Association for Marine Science in Scotland, the University of Highlands and Islands in Shetland and Swansea University in Wales. According to a report published by the Centre for Environment, Fisheries and Aquaculture Science (Cefas), these pilot facilities are mainly producing brown seaweeds such as sugar kelp *Saccharina latissima* to investigate the use of seaweeds as biofuels, chemicals and speciality products[66].

Cefas also identified the possibility of integrating seaweed farming with other forms of aquaculture such as fish and bivalve farms, known as Integrated Multi-Trophic Aquaculture (IMTA). One example of IMTA showed that growth rates of sugar kelp and red dulse increased by 61% and 48% when grown close to a salmon farm, while removing up to 12% of waste nitrogen (for red dulse) from the water and 5% in the case of sugar kelp.

However, the report also noted that the market for algal biomass – which has the potential to be used in the production of liquid fuels, fish feed, high-value chemicals, fertilisers and biogas – is being held back by high costs and a supply shortage.

Finally, in Scotland alone, maerl – a purple-pink coloured hard red seaweed that forms complex underwater beds – has been estimated to act as a store for 440,000 tonnes of carbon. Biogenic reefs – solid structures typically formed by mussels and tubeworms – are estimated to store a further 142,000 tonnes. Resulting in a combined carbon store of nearly 600,000 tonnes[67]. Maerl reefs are highly complex habitats that provide homes for many other species, but these habitats are extremely vulnerable to dredging and bottom-towed gear, and these days maerl reefs are scarce in UK waters.

Best- and worst-case scenarios

Best

Regenerative ocean farming, in which seaweed and shellfish farming are combined to the benefit of both people and the environment, along the lines of that developed and promoted by GreenWave in the USA (see case study, p21) provides a way forward in the UK.

Worst
All the kelp in Scotland covers an estimated 2,155km^2 and absorbs 1.73 million tonnes of carbon a year[68]. Some of this could be at risk if mechanical harvesting were introduced over a widespread area.

Shellfish

The role that both shellfish growing naturally and those that are cultured for commercial purposes play in carbon sequestration is far from clear, but they are undoubtedly low carbon food alternatives to terrestrial livestock.

In the waters around the UK, mussels, oysters and scallops all grow well, and there is significant harvesting of all three. While farming mussels is regarded as completely sustainable (it receives the highest sustainability rating in the Marine Conservation Society's Good Fish Guide[69]), dredging for scallops has a devastating impact on the seabed habitat on which they live.

Wild native oyster beds are one of the most endangered marine habitats in Europe, and their population in the UK has crashed by 95%, largely due to historic over-harvesting[70]. In 19th century Britain it was a massive industry; 700 million oysters were consumed in London and 120,000 people were employed as oyster dredgers in the whole of the country[71].

The recovery of oyster beds has been significantly impaired by habitat loss, smothering, contamination by synthetic compounds (particularly Tributyltin (TBT) antifouling paints) and the introduction of microbial pathogens and parasites. The loss of native oysters has been so severe that natural replenishment of their native grounds is limited and is now unlikely to occur without intervention. There are currently a number of exciting projects attempting to restore native oyster beds in the UK and Ireland as part of the Native Oyster Network[72], including the Dornoch Environmental Enhancement Project (DEEP) (see case study on p20).

Shellfish farming offers considerable potential to reduce the pressure on species and ecosystems. Mussel farming has multiple advantages, as both a low carbon protein alternative to meat from livestock but also because it can benefit other species[73]. Mussels are grown on ropes that hang vertically in the water. Below the ropes edible brown crabs and lobsters feed on clumps of mussels that have fallen to the seabed, attracting large shoals of mobile predators such as horse mackerel, sea bass and grey mullet. Mussel farms could even act as *de facto* MPAs and provide a source population of commercially important species.

While carbon is fixed in the shells, shellfish also produce carbon emissions as a result of respiration, and it is not straightforward to establish what exactly is the net quantity stored[74]. One study of oyster farms estimated the amount of carbon sequestered at between 4.39 and 17.94 tonnes of carbon per ha per year[75].

What is not in doubt is that mussel farming has one of the lowest carbon footprints of any method of animal food production, producing 0.6 kg of CO_2 per kg of meat. British beef, in contrast, produces the equivalent of an estimated 19 kg of CO_2 per kg of meat, British sheep 18 kg per kg of meat and British poultry 6.5kg per kg of meat. Farmed salmon has a footprint of 4.1 kg of CO_2 per kg of meat. So, the carbon footprint of rope grown mussels is 7 times less than that of salmon, about 10 times less than chicken and about 30 times less than the carbon footprint of beef production[76]. Responsible and sustainable aquaculture can provide low carbon sources of protein at considerable scale.

Best- and worst-case scenarios

Best

The potential for farming and harvesting of shellfish in UK waters, as well as the restoration of native oyster beds, is undoubtedly vast and offers numerous benefits in terms of carbon storage and lower carbon emissions associated with food production. Global production of marine bivalves has grown hugely in the past 60 to 70 years, and in the UK, this could be further driven by putting aquaculture farms further offshore, where there will be less conflict for space. Scaling up the restoration efforts of initiatives like the Native Oyster Network would provide significant benefits for marine biodiversity conservation and blue carbon storage.

Worst

Continued damage will be done to our seabeds and associated marine ecosystems should scallop dredging continue as it is. The recovery of our oyster reefs is unlikely to happen without intervention.

Case studies

Seagrass, Pembrokeshire, Wales

The extent of the UK's seagrass meadows was ten times greater 100 years ago than it is today, but those that still exist are hotspots for marine biodiversity and – per hectare – sequester carbon faster than tropical forests. Restoring seagrass meadows could therefore play a significant role in offsetting carbon emissions. A collaborative project between WWF, Swansea University and Sky Ocean Rescue, is attempting to recreate 2 ha of seagrass meadow in Dale Bay, in Milford Haven. Volunteer divers and snorkelers collected seagrass seeds from existing meadows and these seeds were cultivated at the university. The seeds were placed in specially prepared sand-filled bags which were then dropped into the project area in Dale Bay at 1 metre intervals. Those involved with the project hope it could pave the way for similar nature-based solutions to our climate crisis. Seagrass restoration has been done before – 200 ha of coastal bays in Virginia, on the east coast of the USA, were seeded with eelgrass *Zostera marina* between 1999 and 2010, and this has now expanded to be more than 3,600 ha of eelgrass habitat.

More information: https://www.swansea.ac.uk/press-office/news-events/news/2020/03/750000-seeds-planted-in-wales-inuks-biggest-seagrassrestoration-scheme-.php

Dornoch Environmental Enhancement Project (DEEP) - restoring oysters in the Dornoch Firth, northeast Highland, Scotland

This pioneering project was founded in 2014 by the Glenmorangie Company with the Marine Conservation Society and Heriot-Watt University. In 2017, 300 native oysters, from what is now the UK's only large population in Loch Ryan in Dumfries and Galloway, were translocated to two separate sites in Dornoch Firth to see if they would survive. They did, and more have since been introduced to the firth on hard substrate provided by waste shells from scallops and mussels. The plan is to increase the total number of oysters to four million over a five-year period so that they cover an area of about 40 ha. The scientists in charge of the project believe this will be sufficient for the reintroduced population to become self-sustaining. Oysters have been compared to beavers because – like Europe's largest native rodents – they are ecosystem engineers. A single oyster can filter 200 litres of water every day, and purifies it by doing so, removing pollutants, chemicals and particulates. Their intricate reefs also harbour other plants and animals, creating greater diversity in the marine environment. A community-led oyster reintroduction project has recently started in Loch Craignish, south of Oban on Scotland's west coast. Both of these projects are part of the Native Oyster Network.

More information: https://nativeoysternetwork.org/portfolio/deep/

Whole site protection, Lyme Bay, Dorset[77]

Lyme Bay is an MPA home to rare British species such as pink sea fans and the sunset cup corals, as well as valuable shellfish such as king scallops and edible crabs. Dredging for these commercial species was damaging the entire site. Small areas of the Bay were first closed to this activity in 2001 and then extended to 200 km^2 of the Bay in 2008 and more than 300km^2 in 2010. The protected area was closely monitored by scientists from Plymouth University and they recorded a 22% increase in pink sea fans following the ban, while the abundance of all bottom living species within the area was three times that of those outside. Once some limitations on static gear (such as creel pots) and other regulations were introduced, commercially valuable stocks increased too; scallop landings doubled and brown crab catches rose by 2.5 times. Fish populations are also now on the rise, as they have more habitat within which to shelter and feed. Overall, the scientists say that the reef ecosystem within the Bay is still in the early stages of recovery, but that it is recovering as expected.

More information: https://www.lymebayreserve.co.uk/

Coastal wetland restoration: Steart Marshes, Somerset

Marine habitat restoration can take a number of forms. For example, the sea can be allowed to flood low-lying farmland to recreate saltmarsh, as has been done in various parts of the UK. One of the most recent examples of this is at Steart, on the Severn Estuary, where a project involving the Wildfowl & Wetlands Trust and the Environment Agency has recreated 477 ha of inter-tidal habitat, compensating for other losses in the region. As well as creating a habitat that is accumulating blue carbon (the scale of this to date is being assessed but not currently known), the project has had a hugely beneficial impact for biodiversity – in the winter of 2018/19, nearly 30,000 individual birds representing 53 species were counted using the marshes, including avocets, dunlins, golden plovers and lapwings. During the summer, skylarks and avocets breed there. Fish, plant and invertebrate biodiversity have also all increased.

More information: https://www.wwt.org.uk/wetland-centres/steart-marshes/

Combined seaweed and shellfish farming

Over the past two decades, Bren Smith, a former trawlerman from Newfoundland, Canada, has pioneered what he calls "regenerative ocean farming". Growing seaweeds and shellfish together improves the quality of the water in the surrounding environment, offsets carbon emissions, provides high-quality food products with a low carbon footprint and creates habitat for other species. A single oyster can filter more than 200 litres of water a day while seaweed removes carbon dioxide (for photosynthesis) from the sea, making the water less acidic. Shellfish grow better in less acidic waters. Seaweed has all sorts of low carbon potential, for example as a biofuel to replace fossil fuels or as a supplement for livestock feed which can reduce the methane output of cattle by up to 60% and sheep by 80%. According to the World Bank, farming seaweeds in less than 5% of US waters could absorb 122 million tonnes of carbon a year. A relatively small 4 ha regenerative ocean farm can, according to GreenWave, the organisation that Bren Smith founded, produce 23,000kg of kelp and 250,000 bivalve shellfish with the potential to net $100,000 (£75,000) a year.

More information: https://www.greenwave.org

Managed realignment, Abbotts Hall Farm, Essex

Abbotts Hall is a farmland nature reserve owned by Essex Wildlife Trust. In the late 1990s, it became increasingly clear that Essex's saltmarsh habitat was rapidly disappearing, with an estimated 60% loss over a 20-year period. Over the past 400 years the losses have been even more stark; before humans started putting in artificial sea defences to reclaim land for agriculture, it was estimated there were some 40,000 ha of saltmarsh in East Anglia. Today, that has shrunk to 2,600 ha, 6.5 per cent of the original extent. At Abbotts Hall, a 3.5 km sea wall that protected farmland from the Blackwater Estuary was becoming increasingly expensive to maintain as a result of rising sea levels, and so five breaches in the wall – four of between 10-20 metres wide and one 100 metres wide – were made in 2002, opening up 80 ha of land as a flood inundation zone. This area quickly reverted to saltmarsh, coastal grazing land and mudflats and attracted bird species including Brent geese, redshanks, lapwings and (to the newly created rough grasslands) short-eared owls. The marshland, specially constructed creeks, and semi-permanent pools that are flooded at high tide are also refuges for young sea bass, herring and 14 other species.

More information: https://www.essexwt.org.uk/nature-reserves/abbotts-hall-farm

Lamlash Bay No Take Zone, Isle of Arran, Scotland

In 2008, the northern part of Lamlash Bay on the east side of Isle of Arran in the Firth of Clyde became Scotland's first No Take Zone (NTZ) as a result of lobbying and campaigning by the local community group, the Community of Arran Seabed Trust (COAST). Previously heavily exploited by trawlers, the 2.67 km^2 highly protected area has now become a refuge for wildlife that had largely disappeared, with lobsters and scallops both four times more abundant within the NTZ than outside it. Lobsters are also bigger within the protected area of the Bay, and because egg production increases with body size, they produce nearly six times as many eggs. Sponges and seaweeds also became more abundant within the NTZ, creating the "structurally complex" habitats that act as nursery areas for juvenile fish and shellfish. A greater area of 279km^2 has since been designated as the South Arran MPA in which mechanical dredging is prohibited throughout and bottom trawling prohibited from the inner 178km2 (64%). The MPA has been recognised as a valuable store of blue carbon, with an estimated stock of 8,046 tonnes per km^2 [78] .

More information: https://www.arrancoast.com/

Sussex Inshore Fisheries and Conservation Authority (IFCA)

In 2020, Sussex IFCA agreed a new byelaw that would exclude trawling from 304km^2 of the coastline all year round. The byelaw, recently signed off by Secretary of State for the Environment, will allow kelp forests to recover along the Sussex coastline, in some places out to a distance of 4km. Dragging nets through this area has repeatedly ripped kelp from the seabed, while sediment dumping by dredgers has also had an impact. In addition, removal of large fish has resulted in increased population of sea urchins, which eat kelp. If the kelp can be helped to recover by removing trawling pressure, it will result in fish populations recovering, and consequently lower sea urchin numbers. According to Sussex Wildlife Trust, it would result in an enhanced value of ecosystem services from protected kelp forests of more than £3 million a year. Though 9 trawlers that use the area will be affected, the proposed ban would benefit inshore potters and other fishermen. Evidence from Lyme Bay, where trawlers have also been excluded, suggests that potting industries have benefited four-fold.

More information: https://sussexwildlifetrust.org.uk/helpourkelp

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