SEABUDS

Precipitating a SEA Change in the Beneficial Use of Dredged Sediment

Technical Report

A review of

- The drivers and opportunities for using dredged sediments for coastal habitat restoration
- The barriers that are preventing a more widespread use of the technique in the UK

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RSPB, The Lodge, Sandy, Bedfordshire, SG19 2DL, UK

Precipitating a SEA Change in the Beneficial Use of Dredged Sediment (SEABUDS)

RSPB Technical Report

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Malcolm Ausden[1], Mark Dixon[2], Leigh Lock[1], Rosie Miles[1], Nathan Richardson[1], Colin Scott[3]

[1] RSPB, The Lodge, Sandy, Bedfordshire, SG19 2DL, UK
[2] Independent Coastal Management Consultant
[3] ABPmer

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Section 1 - Executive Summary

Every year in the UK, large quantities of sediment are dredged to maintain access to our ports and harbours. Although much of this dredged sediment could be used to protect and enhance our coastal habitats, the vast majority is deposited away from our coasts where it provides little or no benefit. This is despite there being a desire amongst regulators for these sediments to be 'beneficially used'. This report describes some examples of how the use of dredged sediment has been used to restore and create valuable coastal habitats, and what needs to be done to encourage more such beneficial use projects in the UK.

UK coastal habitats are at an increasing risk of erosion resulting from the impacts of sea level rise and storminess predicted to be associated with climate change. These habitats are not only critical for wildlife and are protected as such under both UK and international designations, but also provide valuable services to society including contributing significantly to coastal and flood defence and to greenhouse gas emission reductions, through the absorption and storing of carbon. Furthermore, many coastal habitats provide income to local communities through their recreational and amenity value, as well as a provisioning resource for fishing.

To date most intertidal habitat restoration has involved setting back sea defences and flooding areas of land to create intertidal flats and marshes, a process referred to as managed realignment. However, it is becoming increasingly difficult to offset coastal habitat losses through this method alone and alternative approaches need to be considered.

Approximately 40-50 million m^3 of sediment is dredged from ports and harbours around the UK each year, the vast majority of which is disposed of at sea as a waste product. However, other countries around the world make better use of this material, including to recharge and restore coastal habitats. This technique, referred to as beneficial use, is utilised in the UK, but only with around 1% of the material dredged each year. Therefore, we believe there are significant opportunities being missed.

There are numerous UK and international policy drivers for restoring coastal habitats, and specifically using dredged sediments to do so. There also appears to be a consensus among stakeholders that we should be making more use of the valuable sediment resource in the UK. As such there has been some work done recently by various organisations to investigate what is preventing it from being a more widespread technique. This report follows on from this work with the aim of initiating conservations about what needs to be done to get beneficial use working in the UK.

This report has found that there are a few key issues that are limiting the amount of beneficial use being undertaken in the UK. These include a licensing process that is difficult to navigate and isn't facilitating or supporting beneficial use, a lack of communication about opportunities leading to difficulties coordinating supply and demand, and the added costs that can be associated with delivering beneficial use projects when compared to disposing at sea.

There are potential solutions to these issues such as better recognition and implementation of the natural capital approach to fund beneficial use schemes, better strategic oversight and coordination of opportunities through the policy and planning framework and the use of databases to match supply and demand. Furthermore, through this project we have facilitated

the formation of a Beneficial Use working group to investigate and trial potential measures that will help make the licensing process more enabling for beneficial use projects.

Consultation on the subject has identified a desire from all relevant stakeholders to resolve the barriers, but it is hoped that as a result of this report, a more collaborative approach can be taken, with commitment from all stakeholders to participate and take ownership for specific actions that will contribute to this.

Section 2 - Background

Dredging is an essential activity for maintaining access to ports and harbours and is vital to the UK economy. It has long been established that the material dredged can be used beneficially in the coastal zone and this is reflected in the numerous UK and international policies, legislation and guidelines that promote beneficial use (see Section 5 for further information). Furthermore, there are numerous practical examples showing how material can be placed to increase the level of coastal protection from flooding, erosion and sea-level rise, to restore or create wildlife habitats and to create areas for amenity and recreation development or enhancement (see Section 6 for further information).

At least 90% of the sediments produced from navigational dredging operations around the world comprise unpolluted, natural, undisturbed sediment, which is considered acceptable for recycling in a wide range of beneficial uses (IADC, 2005). Yet, currently in the UK the majority of the 40-50 million cubic metres of material dredged each year continues to be disposed of at sea as waste, with less than 1% being used for coastal habitat creation and restoration (Bolam & Whomersley, 2005). By comparison there is significantly more re-use of dredged material in other countries around the world. For example, in the US only around 20% is disposed of at sea, with 30% being used directly in beneficial schemes and the rest recycled back into the estuary system through sediment retention schemes (Parson & Swafford, 2012). In Japan it is reported that more than 90% of material dredged was re-used in 2003 (CEDA, 2010). However, in the UK there have been only around 20 projects over the past 25 years where dredged material has been used beneficially for coastal habitat restoration.

There are a number of priority bird species, including internationally important populations of wintering waders and wildfowl as well as breeding populations of shoreline nesting seabirds, which are expected to be at increasing risk of population decline in the UK because of climate change-driven loss of coastal habitat. Species that nest on beaches (for example terns, gulls, ringed plovers and oystercatchers) are likely to be most at risk and it is these species that are already under stress from increased human recreational pressure and development in coastal areas. Furthermore, species that have the capacity to colonise the UK, or whose ranges are predicted to shift as a result of climate change, are limited by the availability of suitable coastal habitat for breeding and feeding (see Section 3.1 for further information).

However, habitat to benefit all these species, for example shingle ridges and islands, saltmarsh and mudflat, can be created and restored through sediment recharge and there is potential for large quantities of appropriate sediment to be obtained through the beneficial reuse of dredged material (see Section 6 for further information).

Furthermore. beneficial use of dredged sediment represents a ‘win-win’ solution to these issues, since reducing the loss of valuable coastal wildlife habitats not only has consequences for nature conservation, but also has the potential to improve flood defence, benefit fisheries, and have other ecosystem services such as sequestering carbon and increasing the amenity and recreational value of a coastal area. Any suitable sediment that is being disposed at sea represents a lost opportunity for coastal habitat restoration which could have wide ranging benefits (see Section 3.2 for further information).

The RSPB is not the first organisation to identify this missed opportunity, there have been, and continues to be, many projects and reports investigating beneficial use here in the UK. A few of the recent examples are summarised in Table 2.1 below.

Project/Group	Project Summary / Main Aims
ABPmer, 2014 – Sediment Compatibility and Opportunistic Use Pilot (SCOUP)	A "Getting Beneficial Use Working Demonstration Project", aimed at developing mechanisms and tools designed to increase the frequency and scale of beneficial use schemes in the future
Using Sediment as a Resource (USAR)	Interreg funded project looking at strategies for using sediment in different ways. Includes a project being led by Exo-Environmental trialling methodologies for beneficial use in Essex
MMO - Use of Beneficial Dredged Materials in the South Inshore and South Offshore Marine Plan Areas.	Includes a report on factors that are limiting the progression of beneficial use projects
CEDA UK Beneficial Use Working Group	An investigation into the commercial and economic barriers limiting the beneficial use of dredged material
ABPmer - Coastal Habitat Creation conference on using dredged sediment to benefit our coast	Focusing on reusing and recycling dredge materials and other 'waste' excavations for coastal habitat restoration and protection
Solent Forum – Beneficial use of dredging in the Solent project (BUDS)	A project aiming to bring about beneficial use of dredging within one or more Solent sites, using an incrementally phased approach to scope and cost sediment sourcing and sediment receiver sites, building a system of protocols and guidance.

Table 2.1. Recent examples of projects looking at getting an increase in beneficial use in the UK.

Yet despite all the interest and work going into investigating beneficial use there has been limited progress made at getting more projects off the ground.

Our main aims of this report, therefore, is to build on the work started by others by:

1. Highlighting the drivers for restoring coastal habitats and beneficially using dredged sediment to do so Sections 3, 4 and 5).
2. Describing examples from around the world how dredged sediment has been used to restore and create valuable habitat (Section 6).
3. Reviewing the issues and barriers which are thought to be preventing more widespread adoption of the technique in the UK, and recommend how they might be overcome (Sections 7 and 8).

It is hoped that, as a result of this report, we can emphasise the win:win opportunities that can be achieved from re-using dredged sediment beneficially. We hope to encourage parties to work together to seek resolutions to the current barriers which will enable more widespread adoption of the technique that can deliver multiple benefits including significant benefits to nature conservation.

Section 3 - The value and benefits of coastal habitats

3.1 Conservation value

The coastal habitats around the UK are of international conservation importance, in part due to the significant proportion of habitat they provide for coastal birds; the UK holds more than 30% of European estuarine area and more than 30% of the saltmarsh area in Europe.

Coastal features, such as saltmarsh, sand dunes, mudflat, vegetated shingle and saline lagoons are all considered to be of outstanding ecological importance and consequently are protected by national and international conservation designations, as well as being identified as priority habitats under the England Biodiversity 2020 Strategy. More than 80% of the saltmarsh in the UK is protected by national and international conservation designations and there are 52 Special Areas of Conservation (SACs) with coastal and intertidal habitat features and 46 Special Protection Areas (SPAs) in the coastal zone or with coastal supporting habitats in England alone. Overall coastal habitats make up around 40% of the SAC network in England designated under the EU Habitats Directive (Adaptation Sub-Committee, 2013) and 75% of Northern Ireland's coastal margin is officially protected (National Ecosystem Assessment, 2011).

In general terms intertidal sand and mudflats have limited invertebrate diversity but are extremely productive and therefore support huge biomass. Estuaries receive a continual supply of nutrients from both river and sea and so are among the most productive ecosystems in the world. They are therefore havens for foraging birds. In addition to rich food sources they provide relatively secure and undisturbed roost sites, resting areas and moulting areas and so attract internationally important numbers of wildfowl, waders and seabirds. The network of estuarine intertidal habitat is considered one of the UKs most important natural assets, supporting a mid-winter population of 1.74 million waterfowl (60% of the all the waterfowl in Britain or 6% of the waterfowl in north-west Europe) and 15% of the waders using the East Atlantic flyway (Davidson & Buck, 1997).

On sheltered upper shores, behind barrier islands or on very flat mudflats, saltmarsh may develop, typically dissected by tidal creeks and channels. Saltmarsh provides rich feeding grounds for grazing birds such as wigeon, brent geese and pintail and also support large populations of invertebrate feeders such as redshank. Upper saltmarshes provide important high tide roosts for birds foraging over wider expanses of the adjacent intertidal habitats. They are also important for breeding redshanks and oystercatchers, and can support gull and tern colonies. Marine invertebrates dominate on the lower shore, where particularly ragworms and lugworms (which filter mud) and surface feeders (such as gastropod snails) are of greatest value for birds. Saltmarsh is also an important nursery ground for a wide variety of fish, including commercially important species such as sea bass.

On the sand dunes and shingle features the characteristic breeding bird species are oystercatcher, ringed plover and little tern but in some areas large colonies of terns and gulls occur including the sandwich, common and little terns at Blakeney Point and Scolt Head Island, the massive black-headed and Mediterranean gull colonies in the Solent, and formerly the herring gull and lesser black backed gull colonies at Orfordness in Suffolk. Sand and shingle features can also be used as high tide roosts and resting areas for huge numbers of over-wintering waders; typically oystercatcher, ringed and grey plover, knot, sanderling, dunlin and bar tailed godwit.

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Curlew, like various other species of waterbirds and wildfowl for which the UK is internationally important, spend the non-breeding season around our coasts. Here, they utilise a wide range of coastal habitats including mudflat, saltmarsh and coastal grazing marsh, coastal agricultural fields and rocky shores.

Oystercatchers, along with millions of waterbirds, spend the non-breeding season on our internationally important estuaries. Here, they rely on the vast food resources supplied by intertidal mudflats.

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Redshank, are one of the UK waterbird species that remain on the coast for the breeding season. While some of the population migrate, a proportion, around 10,000 pairs, breed on coastal saltmarsh. The largest populations are found in East Anglia.

Little tern, like a range of seabirds and waders, breed on coastal beaches of sand and shingle around the UK. They rely on the presence of nesting habitat that remains above the high tide for the duration of the breeding season.

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Species that use these sand and shingle features are already under stress from conflict with increasing recreation and development pressure at the coast. Any further loss of habitat could have significant impacts on the breeding success rates of species like little tern and ringed plover as they are forced to nest in less suitable areas where they are more likely to come into conflict with human-related disturbance, or where they are more susceptible to tidal flooding and predation.

Figure 3.1. Beach nesting species such as little terns are particularly susceptible to human disturbance with chicks and eggs being exposed to the elements and predation whenever the adult birds are flushed from their nests by the presence of humans. © Kevin Simmonds

Bird species included on the Birds of Conservation Concern 4 (Eaton *et al,* 2015) Red and Amber lists that make significant use of coastal habitats for at least part of their life-cycle are shown in Table 3.1. These 71 species represent 27% of the birds in the Red List and 55% of the birds in the Amber List, indicating the importance coastal habitats play in the conservation of bird species in the UK.

Red List	Amber List	
Black-tailed godwit	Arctic tern	Avocet
Common scoter	Barnacle goose	Bar-tailed godwit
Curlew	Bean goose	Bewick's swan
Herring gull	Black guillemot	Black-headed gull
Lapwing	Black-necked grebe	Black-throated diver
Long-tailed duck	Brent goose	Caspian gull
Pochard	Common gull	Common sandpiper
Red-necked grebe	Common tern	Curlew sandpiper
Ringed plover	Dunlin	Eider
Roseate tern	Glaucous gull	Goldeneye
Ruff	Great black-backed gull	Great northern diver
Scaup	Greenshank	Grey plover
Shag	Greylag goose	Iceland gull
Slavonian grebe	Knot	Lapland bunting
Twite	Lesser black-backed gull	Little tern
Velvet scoter	Mallard	Mediterranean gull
Whimbrel	Mute swan	Osprey
White-fronted goose	Oystercatcher	Pink-footed goose
	Pintail	Purple sandpiper
	Redshank	Sanderling
	Sandwich tern	Shelduck
	Shorelark	Snipe
	Snow bunting	Spoonbill
	Spotted redshank	Teal
	Turnstone	Water pipit
	Whooper swan	Wigeon
	Yellow-legged gull	

Table 3.1. Avian species on the BoCC4 Red and Amber lists that make significant use of coastal habitats for at least part of their life-cycle. Note that cliff/burrow-nesting seabirds are not highlighted, as these habitats are not the primary features of concern in this report. Also not highlighted are “terrestrial” generalist bird species that can be found in coastal habitats in addition to a range of other habitat types (e.g. skylark, short-eared owl and hen harrier), but included are some “wetland” generalist species that use coasts as well as other types of wetland (e.g. pochard, snipe).

Summary

- Published in 2015, the BoCC4 gives the most up-to-date assessment of avian conservation priorities across the UK and more than 40% of the species listed in the BoCC4 Red and Amber lists make significant use of coastal habitats for at least part of their life-cycle illustrating the conservation priority of coastal habitats.

- Coastal birds are particularly susceptible to climate change driven habitat changes:

    - Sea level rise reduces the area and quality of foraging habitat, as well as the amount of time that foraging areas are accessible.
    - Sea level rise and increased storminess increases the risk of nests being flooded reducing breeding productivity.
    - Climate change is driving range shifts in a northerly direction to areas where there may not be sufficient habitat available.

- It is an UK conservation priority to preserve and restore the diversity and area of habitats for priority birds, in accordance with Article 3 of the Birds Directive. There are a number of initiatives that can help contribute to this in the face of climate change for example by:

    - Improving the condition of existing sites
    - Make existing sites more resilient to sea level rise
    - Creating new sites in more sustainable locations
    - Creating new sites north of existing sites to account for range shifts

3.2 Other Ecosystem Services Delivered by Coastal Habitats

Coastal habitat loss isn't just an issue for wildlife; these habitats provide a number of other ecosystem services as well. The UK National Ecosystem Assessment (Technical Report 2011) reports that the total value of ecosystem services coastal habitats provide is estimated at around £48 billion.

For example, in accordance with the 2005 Millennium Ecosystem Assessment, saltmarsh can provide the ecosystem services as shown in Table 3.2.

Ecosystem Service	Type of Service	Examples
Flood and Coastal Defence	Supporting / Regulating	Absorption of tidal/wave energy protects land and infrastructure landward of the saltmarsh and reducing engineering costs associated with hard sea defences
Carbon Sequestration and Storage	Regulating	Sequestering carbon from the atmosphere and then locking it into the soil substrate, as well as accreting carbon-rich sediments, acting as a carbon sink
Tourism and Recreation	Cultural	Attracting tourism and recreation to the area through activities such as bird watching and walking
Fisheries Production	Provisioning	Providing habitat for fish nurseries and shellfish helping to support the commercial fishing industry
Water Quality Improvement	Regulating	Trapping sediment and absorbing pollutants improving water quality

Table 3.2 Ecosystem Services commonly associated with the creation of saltmarsh habitat, described in accordance with the Millennium Ecosystem Service Assessment Framework (Millennium Ecosystem Assessment, 2003).

This has also been reflected in the Environment Agency's 2017 report on Working with Natural Processes to Reduce Flood Risk, which demonstrates using graphics the many ecosystem service benefits from various natural flood risk management techniques such as the one below for intertidal habitat management and restoration (Figure 3.2):

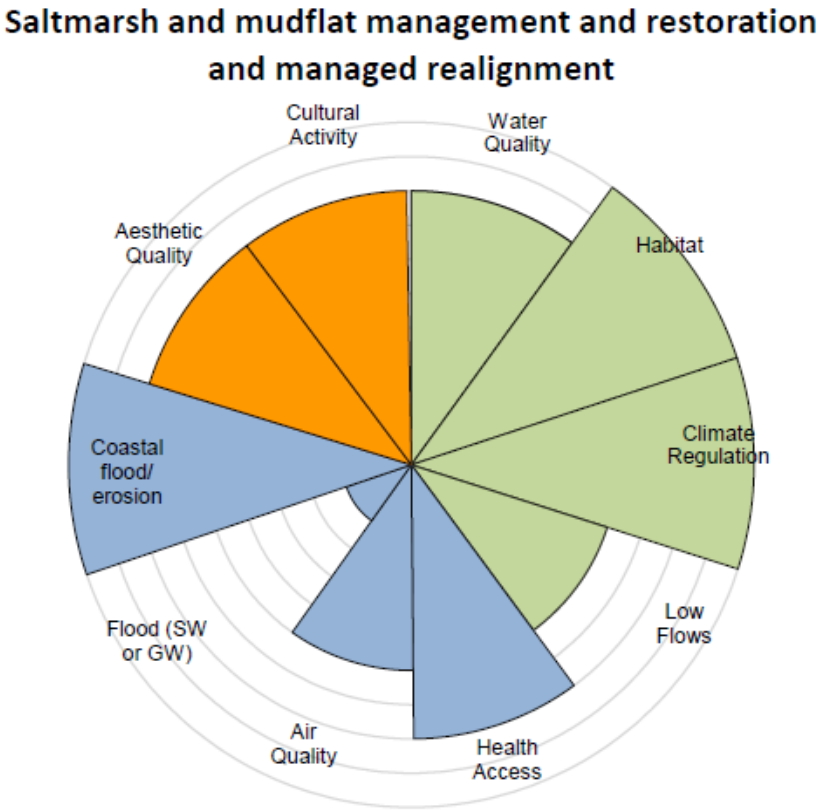

Figure 3.2. A benefits wheel indicating the potential benefits that can arise from the management, restoration and creation of saltmarsh and mudflat. Taken from Working with Natural Processes to Reduce Flood Risk Summary Report (Environment Agency, 2017).

3.2.1 Flood and Coastal Defence

Coastal habitats like marshes, dunes and shingle barriers play an important role in coastal defence by acting as a natural buffer for flood protection and erosion control through wave and tidal energy dissipation, protecting the land and sea defences behind them and also acting as a sediment trap, helping to promote accretion (van der Werf et al, 2015). The Environment Agency (2017) conclude that there is a medium to high confidence in the flood risk benefits of saltmarsh, mudflat and sand dunes.

It is generally well accepted that saltmarshes and other natural defences such as sand dunes or mudflats can help protect our coastlines from erosion, with up to 80% of wave energy being dissipated over 160m of saltmarsh under low energy conditions (Eftec, 2015) and 50% of the wave energy being absorbed in just the first 10-20m (Möller, 2006). Furthermore, recent experiments undertaken by the University of Cambridge have shown that saltmarsh reduced the height of surge wave conditions by 18% over a distance of 40m (Möller et al, 2014). These studies indicate that healthy, natural coastal habitats can help protect our coasts under stormy conditions that are projected to increase with climate change. In turn, this could reduce the costs associated with the construction and maintenance of flood and sea defences.

There have been numerous assessments that have tried to convey these benefits as monetary values, on the basis that more substantial, and hence costly, sea defences are required when there is less saltmarsh fronting them. Values will vary significantly from site to site depending on the nature of the area but the principle can be represented by the generalised schematic below (Figure 3.3) produced in the 1990s. The specific values are now out of date but the general relationship between the costs of maintaining hard sea defences and the width of natural habitat are still true.

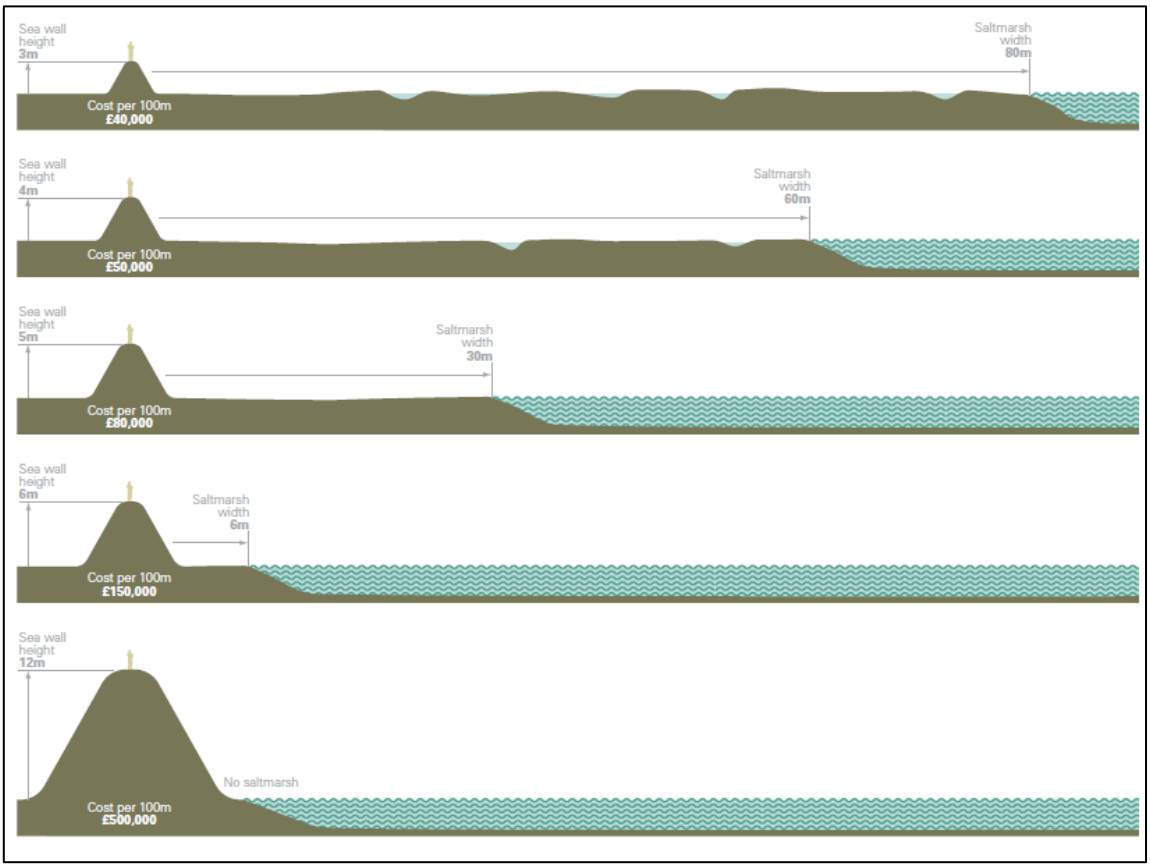

Figure 3.3. A schematic showing the relationship between the width of saltmarsh and the subsequent required height of sea defence behind it. (Adapted by the RSPB for the '*Living Tides'* project from Dixon et al, 1998). While exact numbers will vary widely from site to site depending on the hydrogeology of the area, the principle is that more substantial sea defences are required when there is less saltmarsh fronting them. It should also be noted that the cost per 100m of sea defence are based on assessments done in the 1990s and therefore may not be applicable today.

This concept that the presence of saltmarsh reduces sea defence maintenance requirements has in the past been applied to saltmarsh creation through managed realignment schemes, for example at Freiston Shore where one of the primary drivers for the managed realignment scheme was that the maintenance of the existing sea wall was becoming uneconomical. However, the principle should be transferrable to beneficial use schemes, where the recharge and stabilisation of marshes fronting sea defences has the potential to reduce wave energy impacts on the defences. Just like how the concept is already applied to beach nourishment schemes. As such, it is possible that beneficial use could be an important tool for various policy regimes set out in SMPs, such as reducing the maintenance costs associated with 'Holding the Line'.

With a large proportion of the world's population living on low-lying and dynamic coastlines, there is a continuous requirement for coastal management activities, and this is only set to increase with the projected rise in sea levels and storminess resulting from global climate change. Traditional hard coastal defences such as sea walls and groynes are becoming increasingly uneconomic and impractical to maintain in the UK. Therefore, it is vital that more sustainable solutions are sought for coastal management going forward. Consequently, creating or restoring even small areas of coastal habitats may lead to substantial cost savings and offer a sustainable coastal defence solution, particularly for areas like Essex, where along 25% of the coast the increased maintenance of the sea walls is deemed uneconomic as it would cost more than the value of the land protected.

3.2.2 Carbon Sequestration and Storage

Another way the restoration or maintenance of coastal habitats is key to meeting the UK's climate change mitigation objectives is because its presence contributes substantially to carbon sequestration and storage.

The process of re-afforestation as a tool to counter climate change, in the form of carbon sequestration, is well known, and Natural England has made restoring peatland for carbon storage a priority. However, studies have indicated that healthy, and accreting, temperate saltmarsh can sequester almost 10 times the amount of carbon, and then fix it into the soil down to depths of 8m, when compared to terrestrial forests of an equivalent areal extent (Mcleod et al, 2011). Furthermore, saltmarsh potentially releases significantly less greenhouse gas than other wetland environments, including peatlands, since the sulphide present in the soil inhibits bacterial-driven methane production (Alonso et al, 2012, Chmura et al, 2003). Alonso et al (2012) also acknowledge that sand dune habitat is potentially responsible for a significant amount of carbon storage as a result of soil organic matter accumulated due to the production of litter and dead roots.

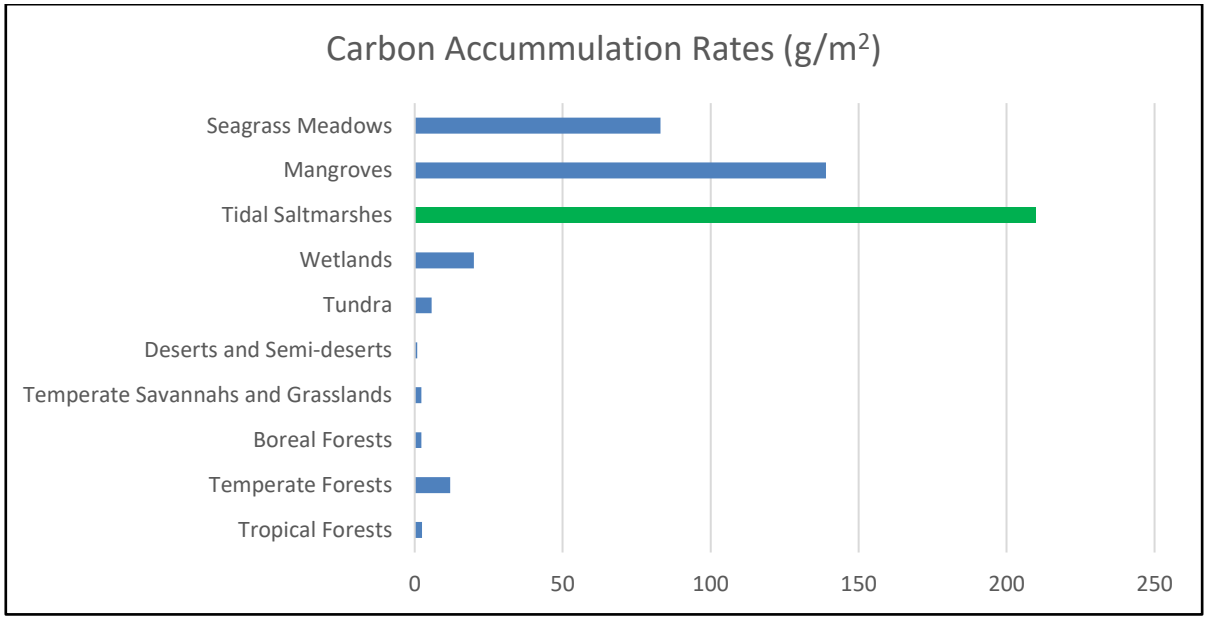

Figure 3.4. A comparison of carbon accumulation rates in key ecosystems. (Adapted by the RSPB for the 'Living Tides' project from UNEP/FAO/UNESCO, 2009)

The Office for National Statistics (ONS) calculate the potential monetary value of carbon storage currently in coastal habitats as around £25.7 million (ONS, 2016). However, carbon storage is only effective in healthy stable marshes, with degrading habitats likely to release their carbon stores. Therefore, restoring and creating coastal habitat could be an important aspect of mitigating against climate change effects, with saltmarsh creation having the potential to result in an increase in carbon burial of around 30 tonnes per year per km^2 (Alonso et al, 2012).

3.2.3 Tourism, Amenity & Other Socio-Economic Values

Along with coastal defence, the amenity value of coastal habitats has one of the highest financial values. Seaside tourism is valued at around £17 billion, with over 250 million visits to the coast made by tourists every year – a third of which are to natural habitats (UK National Ecosystem Assessment, 2011). Nature-orientated visits to just four RSPB coastal reserves around the UK are valued at around £1.2 million a year (The Environment Bank, 2015). The knock-on benefits for the local economy, including through job creation, are significant. For example, a survey undertaken in 1999 showed that spending by visitors at RSPB Titchwell Marsh nature reserve resulted in an extra £1.81 million each year being spent in the local economy, supporting 39 direct and indirect FTE jobs; and at Cley Marshes (Norfolk Wildlife Trust) an extra £2.45 million was spent each year supporting 52 FTE jobs (RSPB, 2000).

There are numerous other socio-economic values associated with restoring habitats; for example, it is becoming well established that having access to nature areas can have positive impacts on people's physical and mental health. It has been suggested that physical activity could significantly reduce the risk of numerous diseases including strokes, Alzheimer's and heart disease, which cost society billions of pounds every year in treatment. What's more, the British Heart Foundation and British Trust for Conservation Volunteers' 'Green Gym' initiative have demonstrated that people are more motivated to exercise when outdoors in nature (RSPB, 2000). Furthermore, Natural England published a report in 2016 showing that taking part in nature-based activities may have positive benefits for people who are suffering from mental ill-health; it advises that 'green care' interventions can provide an increasingly important and cost-effective way of supporting mental health services (Bragg & Atkins, 2016).

Therefore, ensuring that coastal habitats are maintained and restored is important to the socio-economic value of the local area.

3.2.4 Provisioning values

Saltmarsh provides vital nursery grounds for many fish species, including commercially important species such as sea bass and herring, as well as mullet, sand smelt, goby, stickleback, flounder, European eel and shellfish such as oyster. In a study of fish use within saltmarsh in Europe, it was identified that young sea bass colonise intertidal marsh on spring tides, consuming over 8% of their body weight in only a couple of hours, having arrived with empty stomachs (Laffaille *et al,* 2001). Overall these fish are obtaining around 45% of their entire diet during the short time periods spent within the marsh (Laffaille *et al,* 2001). It is concluded that saltmarsh is a significant resource for the juvenile fish and one that must be crucial to their survival to recruitment to the adult stock (Stevenson, 2002).

Saltmarshes can also provide grazing ground for sheep and cattle, with there being a potential market for saltmarsh-grazed meat.

3.2.5 Water Quality Provisioning

Coastal saltmarsh is involved in the regulation of water purity through the take-up of excess inorganic nutrients such as nitrates and phosphates, therefore reducing the potential for eutrophication (Natural England, 2012). Furthermore, saltmarshes are able to regulate water pollution, by significantly reducing faecal organism concentrations and absorbing heavy metals such as mercury, cadmium and uranium from the water (Natural England, 2012). The Environment Agency (2017) report that extra provision of coastal wetland has a value of £1,793 per hectare per year for water quality improvement.

Summary

Most areas of coastal habitat deliver one or more of these potential ecosystem services, the values of which will vary from site to site. Furthermore, in all instances as the habitat becomes degraded and is lost, the associated values decrease. Healthy, stable coastal habitats deliver greater ecosystem services. However, the full suite of ecosystem services that are delivered are not currently being fully realised.

The Natural Capital Committee (NCC, 2015), in their third report to the Economic Affairs Committee, sets out where investments in natural capital, targeted at the best locations, would deliver significant value for money and generate large economic returns. They advise that there is a strong economic case for creating intertidal habitat, with the wide range of ecosystem service benefits arising from the presence of coastal habitats, the cost-benefits ratios for creating new intertidal habitat are in the region of 2 to 3:1 (NCC, 2015).

With respect to beneficial use projects specifically, the cost–benefits ratios are less well studied. In general, beneficial use is a significantly lower cost option when compared to managed realignment; however in most cases the benefits are less easy to define. This is largely because the area of habitat 'benefitting' is less distinct as most projects are restoring or improving existing habitat rather than creating a new area of habitat (there are exceptions to this for example where dredging islands are created). Despite this, a report on the economic case for investment in natural capital in England (Eftec, 2015) notes that beneficial use schemes are likely to have very clear economies of scale where large areas of intertidal habitat could be restored at comparatively low cost.

The cultural value associated with coastal habitats is extremely high, leading to '*willingness to pay'* estimates for SSSI conservation activities for sand dunes being higher than any other habitat, around £1,377 per hectare per year for a 'maintain funding' scenario (Environment Agency, 2017). The '*willingness to pay'* estimate for saltmarsh and mudflat restoration is also significant, around £1,035 per hectare per year for a 'maintain funding' scenario (Environment Agency, 2017).

As highlighted by the government's 25 Year Environment Plan published in January 2018, there needs to be greater appreciation of these wider benefits from natural capital in order to make the process of habitat restoration economically viable.

Section 4 - Coastal habitat condition and projected losses

4.1 Current state of coastal habitats

Over the past 100 years we have seen significant losses to coastal habitats around the UK. The Office of National Statistics (ONS, 2016) summarise trends in UK coastal habitat extent and condition as follows:

- **Saltmarsh has declined by approximately 15% since 1945, equating to >8,000ha**, largely as a result of land reclamation for agriculture and development.
- **Sand dunes have declined by 30% since 1990 alone, >16,000ha have been lost since 1945**. These declines were historically driven by urban expansion and forestry planting, but more recent losses are also attributable to land reclamation for agriculture and development. The UK NEA reports that sand dunes have not only changed in extent but also in character, with a consistent trend towards increased vegetation cover.
- **Shingle and machair** areas have decreased mainly due to erosion and sea level rise. Shingle has decreased by **46% since 1945, equating to >5,000ha**.

The loss of mudflats has not yet been quantified, but is likely to have declined by a similar magnitude as that of saltmarshes (Adaptation Sub-Committee, 2013).

These losses have led to the deterioration in condition of coastal habitats around the UK, and to date, in England, only 336ha of new intertidal habitat has been created as mitigation for losses experienced since 1994 resulting from coastal squeeze (Environment Agency, 2018). There has been very minimal habitat compensation work completed elsewhere in the UK, other than that required for direct compensation for development (as opposed to mitigating against the historic losses). As a result of this overall loss of coastal habitats, a UK report on the conservation status of EU designated and protected habitat in 2013 (see Figure 4.1 below), showed that the majority of our most important coastal habitat types are not in favourable conservation status, and not just in respect of the area they cover, but more significantly their structure and function. So not only do we not have we lost a significant area of coastal habitat, but that which remains is of poor quality and therefore unlikely to be providing the ecosystem services it has the potential for.

Habitat name	Habitat Area	Structure & function
Estuaries	Unknown	Bad
Mudflats and sandflats not covered by seawater at all times	Unknown	Bad
Coastal lagoons	Favourable	Inadequate
Annual vegetation of drift lines	Inadequate	Bad
Perennial vegetation of stony banks	Inadequate	Bad
Vegetated sea cliffs of the Atlantic and Baltic coasts	Inadequate	Bad
Salicornia and other annuals colonising mud and sand	Inadequate	Bad
Spartina swards (*Spartinion maritimae*)	Bad	Bad
Mediterranean and thermo-Atlantic halophilus scrubs (Sarcocornetea fruticosa	Inadequate	Bad
Embryonic shifting dunes	Inadequate	Bad
Shifting dunes along the shoreline with Ammophila arenaria (`white dunes`)	Inadequate	Bad
Fixed dunes with herbaceous vegetation (`grey dunes`)	Inadequate	Bad
Atlantic decalcified fixed dunes (Calluno-Ulicetea)	Favourable	Bad
Dunes with Hippophae rhamnoides	Favourable	Bad
Dunes with Salix repens ssp. argentea (Salicion arenariae)	Inadequate	Bad
Humid dune slacks	Inadequate	Bad
Large Shallow inlets and bays	Favourable	Bad
Atlantic salt meadows	Inadequate	Bad

Figure 4.1 UK Coastal Annex 1 Habitats and their Conservation Status (data from JNCC 3rd UK Habitats Directive Report 2013 http://jncc.defra.gov.uk/page-65

When looking at individual protected sites, in England, 57% of the SAC designated saltmarsh, 76% of coastal vegetated shingle and 66% of sand dunes have been assessed as being in unfavourable condition (Adaptation Sub-Committee, 2013).

4.2 Projected losses

Unfortunately, this trend of deterioration is only set to continue as the UK coastline is under threat from climate change, including rising sea levels and increased storminess. The effects of climate change on coastal habitats are not consistent across the UK, but some areas are particularly at risk. For example, in the south and east of England the land is tilting seaward due to isostatic rebound following the melting of the ice sheets which covered Britain during the last ice age. This intensifies the impacts of rising sea levels. Under normal circumstances the intertidal zone would evolve with rising sea levels, migrating inland. However, in many areas of the UK coastal habitats are prevented from evolving naturally through landward migration into the coastal plain due to the presence of artificial hard sea defences, this causes them to steepen and erode unnaturally fast as sea levels rise. It is estimated that up to 72% of the remaining intertidal habitats in England could be impacted by this effect known as coastal squeeze (Adaptation Sub-Committee, 2013). Similarly, in Wales, 44% of the marine, estuarine, coastal and island Natura 2000 sites are considered to be at risk of erosion from flood risk and coastal management activities (NRW, 2015).

These losses are further exacerbated because natural accretion rates in some areas are decreasing due to the presence of groynes (which alter the distribution of sediment via longshore drift) and the stabilisation of eroding cliffs (which reduces the amount of sediment available to feed coastlines elsewhere).

While in some areas habitats are naturally accreting, the overall trend across the UK coastal habitats is an increasing and continuing decline in extent. The Environment Agency (2011) estimate that 1800km (40%) of the English coastline is at risk of erosion and in Scotland the recent NCCA report indicates that the proportion of coastline estimated to be eroding by 2050 will increase to 16%, with only 9% estimated to be accreting.

Across the UK as a whole, ONS (2016) project further losses of coastal habitats over the next 20 years, due to coastal erosion and sea level rise, as:

- Saltmarsh – 4.5% loss
- Sand dunes – 2% loss
- Machair – 2% loss

In England, The Environment Agency has committed to creating habitat to address statutory compensation requirements as a result of coastal squeeze of internationally protected wildlife sites associated with flood and coastal risk management (FCRM) activity. In their most recent review (Environment Agency, 2018), they project losses to intertidal habitat (net change of saltmarsh and mudflat combined) of 1,021ha by 2025. Loss estimates beyond 2025 have not been finalised and estimates for other coastal habitat types have not yet been completed.

In Wales, Natural Resources Wales have also committed to creating habitat to address statutory compensation requirements as a result of coastal squeeze of internationally protected wildlife sites associated with flood and coastal risk management (FCRM) activity. Their latest review was published in 2015 and projects losses of intertidal habitat (net change of saltmarsh and mudflat combined) of 784ha by 2025, 1861ha by 2055 (cumulative) and 4663ha by 2105 (cumulative). NB there are some overlaps and hence double counting of losses with England within the Severn and Dee estuaries. They also have not completed estimates of losses for other coastal habitat types.

In Scotland, there is not currently a programme in place to create habitat to address statutory compensation requirements as a result of coastal squeeze of internationally protected wildlife sites associated with flood and coastal risk management (FCRM) activity. However, the recent NCCA project projects that 266.8ha of SPA habitat and 222.9ha of SAC habitat will be directly impacted by erosion by 2050. The proportion of loss for different habitat types are not defined.

There are currently no projections for coastal habitat loss in Northern Ireland.

Overall, there is projected to be at least ~60ha of Natura 2000 designated intertidal habitat lost in the UK per year over the next ~20 years as a direct result of coastal squeeze.

Section 5 - Policy and Legal Drivers for Coastal Habitat Creation

The value of coastal habitats is reflected in policy framework, strategy and guidelines as summarised in Table 5.1 below.

Table 5.1. Policies, Strategies and Guidelines relating to coastal habitat creation and restoration

Policy Framework, Strategy or Guideline Document	Description
Habitats Directive Articles 6(1) and 6(2)	Requires that, within Natura 2000, Member States: • Take appropriate conservation measures to maintain and restore the habitats and species for which the site has been designated to a favourable conservation status; • Avoid damaging activities that could significantly disturb these species or deteriorate the habitats of the protected species or habitat types.
Birds Directive Article 3	Requires that Member States preserve, maintain or re-establish a sufficient habitat diversity and area of habitat for all species of birds in Article 1. Where this obligation is not being met, for instance as a result of coastal squeeze, replacement habitat must be created in sustainable locations.
UK Post-2010 Biodiversity Framework Strategic Goal B – Aichi Target 5	By 2020 the rate of loss of all natural habitats is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.
UK Biodiversity Strategy 2020	By 2020 we will have put in place measures so that biodiversity is maintained and enhanced, further degradation has been halted and where possible, restoration is underway, helping deliver more resilient and coherent ecological networks, healthy and well-functioning ecosystems, which deliver multiple benefits for wildlife and people, including: • 1A. Better wildlife habitats with 90% of priority habitats in favourable or recovering condition and at least 50% of SSSIs in favourable condition, while maintaining at least 95% in favourable or recovering condition; • 1B. More, bigger and less fragmented areas for wildlife, with no net loss of priority habitat and an increase in the overall extent of priority habitats by at least 200,000 ha; • 1C. By 2020, at least 17% of land and inland water, especially areas of particular importance for biodiversity and ecosystem services, conserved through effective, integrated and joined up approaches to safeguard biodiversity and ecosystem services including through management of our existing systems of protected areas and the establishment of nature improvement areas; • 1D. Restoring at least 15% of degraded ecosystems as a contribution to climate change mitigation and adaptation.
Investing in Natural Capital 2015	The Natural Capital Committee advises government on the sustainable use of natural capital and advise that there is a strong economic case for creating intertidal habitat

Climate Change Risk Assessment 2017	The UK Government acknowledges that more action is needed to address the risks to natural capita, including terrestrial, coastal, marine and freshwater ecosystems, soils and biodiversity from climate change.
National Adaptation Programme 2013	The Defra-led programme which sets out actions government, businesses and society need to become more resilient to climate change. The programme identifies some key risks to coastal habitats from climate change and actions that can be implemented to help improve resilience of coastal habitats and wildlife. E.g. The Environment Agency is responsible for implementing actions to increase resilience of coastal environments. This includes developing the use of natural means of flood defence using ecosystem-based approaches with biodiversity co-benefits, for example using soft coastal defences and managed realignment. Also, identifying areas suitable for restoration or creation of priority coastal habitats, as well as working with partners to better align SMPs and Marine Plans to ensure no net loss of priority habitats.
Water Framework Directive	The WFD commits the UK to achieving good quality status of all waterbodies, including coastal and transitional water. The framework identifies saltmarsh as one of the biological elements used to classify waterbody status, focussing on both quality and extent of saltmarsh habitats. As a result, saltmarsh restoration can be a tool to help reach the good quality targets. Furthermore, for heavily modified waterbodies habitat restoration, including through different dredge disposal methods, is identified as a mitigation measure needed to reach good ecological potential.
Improvement Plans for England's Natura 2000 sites (IPENS) 2015	IPENS describe how to target efforts on important wildlife and habitat sites to get them into a healthy state. E.g. Essex Site Improvement Plan (SIP) identifies the need for investigation into the impacts of coastal squeeze and a review of the Regional Habitat Creation Programme. It states that where necessary new remedial actions will need to be designed, including the use of managed realignment and beneficial recharge, to address the impacts of sea level rise and coastal squeeze on SPA features.
Flood and Coastal Erosion Risk Management Strategies	The National Flood and Coastal Erosion Risk Management Strategy for England identifies: • There is a need for forward-thinking and adaptation to climate change. • That working with natural processes often results in more sustainable, resilient and economical outcomes when compared to structural interventions and it should be pursued as much as possible. • That using intertidal habitats to store tidal flows and dissipate wave energy can reduce risks from flooding and coastal erosion. In 2017, the Environment Agency published the results of a programme of research investigating how working with natural processes could enable flood and coastal erosion risk management to be carried out sustainably, while at the same time improving the environment for people and wildlife.
Shoreline Management Plans	Documents prepared by the Environment Agency and local councils to address the threat of coastal change. These include a Habitat Regulations Assessment to identify where flood defences have the potential to impact on coastal habitats through coastal squeeze and how this can be addressed through habitat creation.

The value of using dredged sediment as a natural resource for activities such as coastal habitat restoration and creation is reflected in policies and guidelines relating to dredging operations, waste recovery and recycling as summarised in Table 5.2 below.

Table 5.2. Policies and Guidelines relating to beneficial re-use of dredged sediment

Policy or Guideline document	Description
EU Waste Directive	States that all appropriate measures must be taken to encourage the recovery of waste by means of recycling, re-use or reclamation or any other process with a view to extracting secondary raw materials in order to conserve natural resources.
The England and Wales Waste Regulations	States that all appropriate measures must be taken to apply the internationally accepted waste hierarchy, where re-use and recycling is preferential and disposal is a last resort.
UK Marine Policy Statement	States that dredged material should not be accepted for disposal where appropriate opportunities exist to reuse and recycle.
OSPAR guidelines	State that sediment is a valuable natural resource and beneficial uses of dredged material should be pursued to the maximum extent practical
MMO guidelines	States that no waste should be disposed of at sea if there is a safe alternative. You must make every effort to re-use, recycle, or use other recovery methods for dealing with waste. Disposal should only be a last option.
Proposed EU Circular Economy Strategy	Involves promoting resource efficiency, waste management, product policy, markets for secondary raw materials, sustainable production and consumption.
Marine Plans	E.g. Proposed South Marine Plan Policy S-DD-2: Proposals must identify where use of dredge disposal sites can be minimised by pursuing re-use opportunities through matching of spoil to suitable sites.
Shoreline Management Plans	E.g. The Essex and South Suffolk Shoreline Management Plan 2010 (SMP) includes an Action Plan which highlights the need to identify options for beneficial use projects with the project area that will contribute to coastal defence management. One action point of high priority is an Environment Agency led 'Beneficial use of Dredging Study' to consider opportunities to use dredgings to recharge intertidal areas.

Despite all these drivers for using dredged sediment to restore coastal habitats, less than 1% of dredged sediments are being used in this way, indicating that the existing policies and guidelines are not being implemented to their full capacity.

Section 6 - Methods and examples of coastal habitat creation using dredged sediments

Intertidal habitat restoration has often taken the form of managed realignment, where existing sea defences are breached to create intertidal habitats such as saltmarsh and mudflats which are then used to buffer against coastal erosion naturally, as well as providing important habitat that is being lost through coastal erosion. While the RSPB's Sustainable Shores project identifies significant opportunities for managed realignment around the UK, it is acknowledged that it is likely to become increasingly difficult to compensate for past and future losses of coastal habitats through managed realignment alone. Current Shoreline Management Plans propose realigning 10% of the coast by 2030 (15% by 2060) which would create around 6200ha of coastal habitat. However, since 1990 we have only realigned around 1.5% of the coast and so the rate of managed realignment would need to increase five-fold to reach the 2030 target set out in the Shoreline Management Plans to achieve the required biodiversity objectives. This target currently appears difficult to achieve. Furthermore, simple breaching of existing sea walls only creates flats and marshes, depending on the topography of the land being flooded, so doesn't generally contribute to the replacement of other habitats being lost like nesting and roosting sites, such as shingle ridges and sand dunes.

It therefore makes sense to investigate alternative, and potentially more cost effective, opportunities for coastal habitat creation and to prioritise the maintaining and restoring of existing areas of intertidal habitat to minimise future losses, in combination with progressing managed realignment schemes.

The beneficial reuse of dredged sediment is not a new concept and, in recent years, one that is becoming more widely used around the world. Many of these beneficial use schemes involve engineering uses such as land reclamation, beach nourishment and coastal protection works, however dredged material has also been used for environmental enhancement and habitat creation.

The process of beneficial use:

- Can be used to restore and create a wider variety of habitats.
- Can be used in isolation as an alternative to managed realignment, or in combination with other processes to help create a mosaic of habitats.
- Is generally cheaper than managed realignment because the same extent of land acquisition may not be required.
- Can be used to hold, or even advance, the line so may not be viewed so much as giving up land to the sea.
- Puts material back into the system to help retain sediment balances and facilitate natural processes.

In the US, the United States Army Corps of Engineers (USACE) have been world leaders in the use of dredged material for habitat creation, proving successfully that dredged sediment can be used to restore mudflats and saltmarsh and to create dredging islands that ultimately function like natural systems and provide critical habitat for wildlife. To put this into context, over 2000 man-made wildlife islands have been created from dredged materials in the US, and these islands are estimated to accommodate approximately 1 million nesting birds each year. By 1977 over 70% of all the nesting least terns in North Carolina were using dredge disposal sites as nesting habitat (Kotliar & Burger, 1986). In addition, more than 40,000 hectares of wetland areas have been restored using dredged material (Brandon & Price, 2007).

The UK does have experience of using dredged sediments, primarily in the form of beach nourishment activities but also on a small scale within intertidal habitats to restore degraded habitat. To date many of these fine sediment recharge schemes have not been well publicised and the majority of them have been small, temporary field trials. There still appears to be a lack of confidence in beneficial use schemes in the UK.

Examples from around the UK and elsewhere in the world have shown that coastal habitats can be restored and created by using dredged sediment in a variety of ways, as shown in Table 6.1.

Type of Sediment	Type of Habitat Restoration or Creation	Type of coastal habitats able to be created / restored	Example
Silts and muds	Recharge and stabilise eroding saltmarsh and mudflats. Both in front of or behind sea defences	Saltmarsh, mudflat	Lymington Harbour, Hampshire (Figure 6.1)
Silts and muds	Raise the elevation of the land level to speed up saltmarsh evolution	Saltmarsh	Allfleet's Marsh, Essex (Figure 6.2 & 6.3)
Silts and muds	Import sediment into bunded areas or deep water lagoons to create silt lagoons	Silt Lagoons	Woolston Eyes, Warrington (Figure 6.4) Cliffe Pools, Kent (figure 6.5)
Silts, muds, sands and shingle	Create new offshore islands within bunded areas to provide disturbance- and predator-free habitat	Saltmarsh, saline lagoons, shingle beaches, reedbed	Poplar Island, US (Figure 6.6) Marker Wadden Project, The Netherlands (Figure 6.7)
Sands and shingle	Create offshore bunds which act as wave breaks or provide sediment for natural accretion of the shoreline	Sand dunes, shingle beaches	Delfland Sand Motor, The Netherlands (Figure 6.8)
Sands and shingle	Recharge and raise beaches, spits and islands to provide habitat that is not overtopped at high tide	Sand dunes, shingle beaches	Hightown Sand Dunes, Merseyside. Horsey Island, Essex (Figure 6.9 and 6.10) Blackwater Estuary, Essex (Figure 6.11)

Table 6.1. Types of habitat restoration projects possible using dredged sediments, with examples.

6.1 Saltmarsh and Mudflats

Areas of eroding saltmarsh and mudflat can be stabilised and restored by depositing fine, muddy dredging materials into confined areas where the retained material will dewater and solidify over time and raise the surface elevation of the marsh. This has been done a number of times overseas, one example being in Sonoma Baylands, United States, where dredged material was successfully used to raise the land surface height to accelerate saltmarsh development as part of a coastal restoration project. There have been numerous small field-trials in the UK as well, usually associated with mitigation or habitat compensation projects, for example at Trimley and Shotley in the Orwell Estuary, where the material was used to elevate the surface level of flats to promote saltmarsh development, increasing the surface area of marsh. At Boiler Marsh in Lymington Harbour, the material was used to stabilise an area of saltmarsh that was not only being subject to lateral squeeze but also degrading internally. The sediment recharge helped to reverse the effects of this internal die-back of marsh, as opposed to increasing the areal extent.

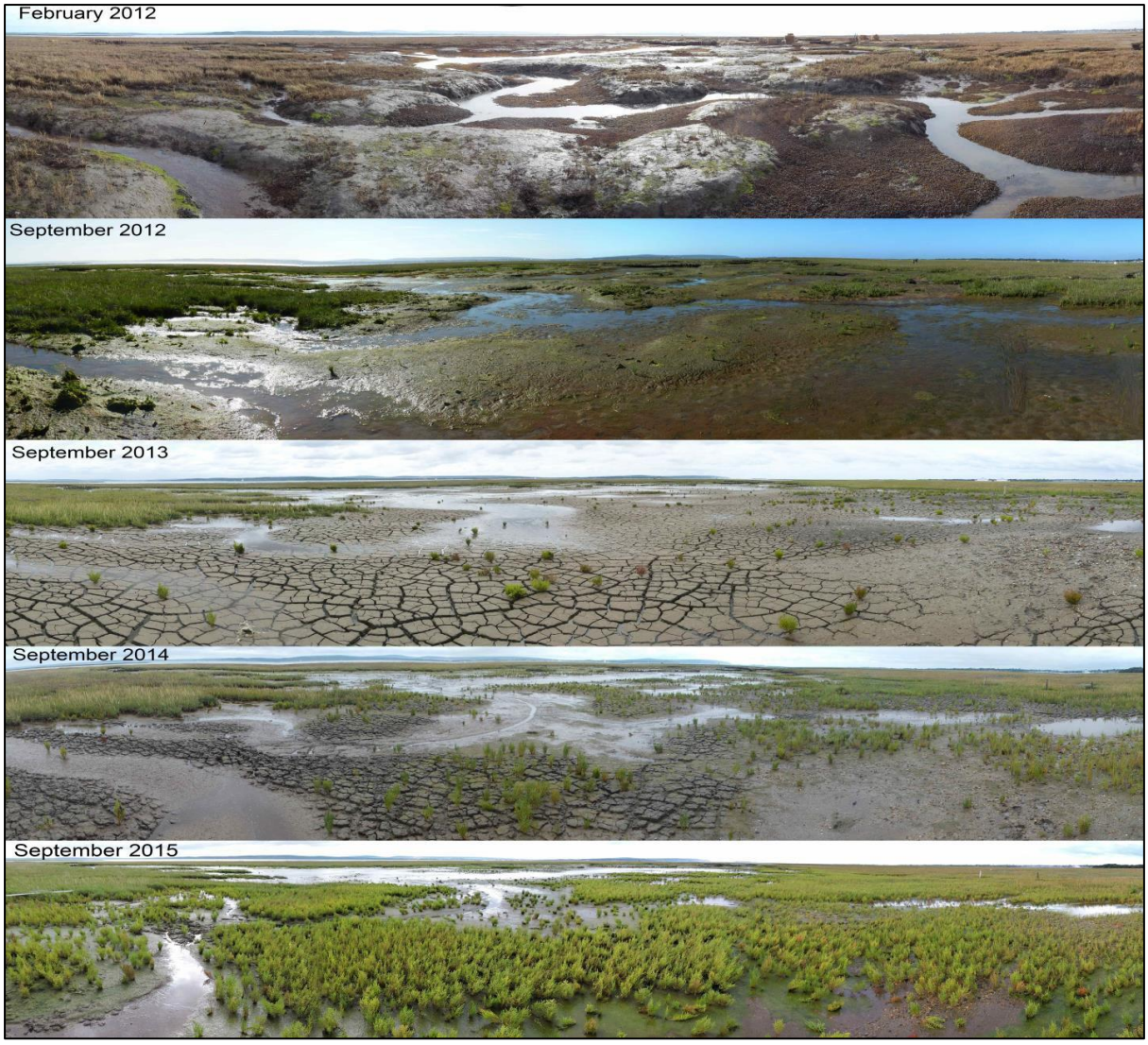

Figure 6.1. This sequence of photos at Boiler Marsh in Lymington Harbour, taken over the course of 4 years, clearly shows the degraded state of the marsh prior to sediment recharge and the subsequent regeneration of saltmarsh plants as a result of the stabilisation and elevation achieved using sediments routinely dredged from the adjacent harbour. © ABPmer

Dredging material can also be used in conjunction with a managed realignment, to raise low-lying areas of land to desired levels prior to tidal flooding, as seen at Allfleets Marsh, Essex and the Trimley Realignment, Essex. In these cases dredged sediment was used to speed up saltmarsh development landward of the breaches, to ensure compliance with compensatory habitat requirements. Dredging materials can also be used to create topography within a managed realignment in order to provide the desired variety of habitats.

Figure 6.2. Aerial image of Allfleets Marsh, Essex, where dredged sediment was imported to elevate the land surface level in advance of the area being opened up to tidal flooding through a managed realignment, in order that saltmarsh would regenerate more quickly and provide the required compensatory habitat within the required timeframes. © RSPB images

Figure 6.3. Images showing the deposition of dredged sediment at Allfleets Marsh (left) and the subsequent development of saltmarsh (right). © ABPmer.

While not using dredged sediments, the first stage of the Wallasea Island Wild Coast Project has used the same techniques using waste materials from terrestrial excavations on an enormous scale. This project has helped showcase the potential there is for significant habitat creation using managed realignment and sediment recharge.

6.2 Silt Lagoons

Dredged material can also be stored within bunded areas. In Britain, these have always been located on land, and are known as silt lagoons. Examples of these are Rainham silt lagoons in East London, and Frodsham Marsh and Woolston Eyes. The last two sites are used for the deposition of dredged material from the freshwater Manchester Ship Canal.

The mixture of mud and shallow water in these lagoons can attract large numbers of waterbirds, for example, when operational, the Rainham silt lagoons supported a maximum count of 15,000 teal. The islands created by the bunded areas can also provide valuable safe roosting and nesting sites for birds, for example in the US, they provide valuable nest sites for least terns and black skimmers. The freshwater silt lagoons at Woolston Eyes are now a nature reserve, and the mixture of productive, early successional shallow water and emergent vegetation currently supports one of the largest breeding colonies of black-necked grebes in Britain.

Figure 6.4. An aerial view of Woolston Eyes. The islands of important habitat created by depositing sediment dredged from Manchester Shipping Canal within bunded areas. © David Morris

Silt lagoons can also provide valuable habitat for a selection of rare and scarce invertebrates. At Rainham Silt Lagoons, fans of sand and gravel have settled out close to the outlet pipe where the dredged material is pumped into the lagoons. The finer mud settles out over the rest of the lagoons. These dry, sandy and gravelly areas support a rich variety of forage plants for bees, including the brown-banded carder bee *Bombus humilis*, while the sandy banks and the dead stems of herbaceous plants in these areas also provide valuable nesting habitat for bees. At Rainham, large swathes of sea aster *Aster tripolium* developed on the finer muds in the lagoons, providing foraging habitat for the sea aster mining bee *Colletes halophilus*, which nests in the sandy banks near the inlet pipes. Sea aster mining bee is rare in Britain and endemic to coasts around the southern North Sea. In all of these cases, it is the earlier stages following deposition of dredged material which tend to be the most interesting for wildlife. As succession proceeds, and areas become increasingly dominated by coarse grasses and sometimes scrub, so then they tend to support an increasingly less specialised fauna.

A variation in the silt lagoons model is the deposition of dredged material in existing, deep water lagoons. This takes place at Cliffe Pools RSPB Reserve in North Kent, where dredged materials are deposited in deep, saline lagoons that have developed in former clay pits. These dredged materials have been used to create valuable shallow water habitat for birds, together with areas of bare and sparsely vegetated, saline sand and mud, which are rare and valuable habitats in Britain

Figure 6.5. Part of a fan of sandy dredgings deposited into an otherwise deep lagoon at the RSPB's Cliffe Pools reserve in North Kent. At this site, dredged sediments have been used here to create areas of shallow water and mud for birds, and sparsely vegetated, saline areas which are valuable for invertebrates. © Malcolm Ausden.

6.3 Dredging Islands

Elsewhere in the world, such as in parts of the USA and in Venice Lagoon in Italy, bunded areas have been constructed in shallow, coastal waters, where they are known as dredging islands. This involves creating a bunded perimeter and pumping fine material from maintenance dredging operations into it. Once these dredged materials have dried and hardened, creeks and pools can be excavated in them, to create a mosaic of habitats including areas of freshwater marsh.

In Italy, in the Venice Lagoon, 57 dredge islands were made between 1988 and 2003, providing approximately 600ha of island habitat within the lagoon. Venice lagoon is an important nesting area for a number of bird species, including approximately 200 pairs of breeding little terns (Scarton, 2008). As the dredge islands were created there was an apparent shift of birds using the dredge islands to nest. In 1989 the majority of the little terns

were nesting on natural mainland beaches within the lagoon, by 2001 44% of all the nesting birds were using the dredge islands and by 2003 this had increased to 90% (Scarton, 2008). This shift of the birds from mainland beaches onto the dredge islands is indicative of how islands can offer a safe haven from land-based predators and from human disturbance.

The same process was used on Poplar Island, in the United States, where dredged materials were used to rebuild a remnant island within Chesapeake Bay, which had been subject to erosion and sea level rise causing it to reduce to less than 0.5% of its original size. The project is ongoing, receiving dredged material almost continuously since 1998. By 2016, over 21 million m^3 of dredging material had been deposited creating a mosaic of upland, wetland, intertidal marsh and open embayment habitat. The island now supports over 175 different species of birds, including least tern, snowy egret, osprey, and American black duck, as well as being the site for the most important breeding colony of common terns in Maryland (pers comm. Robin E. Armetta, United States Army Corps of Engineers, Peter C. McGowan, United States Fish and Wildlife Service and Diann J. Prosser, United States Geological Survey, April 28, 2016).

Figure 6.6. Showing the restoration of Poplar Island from 1998 (left) and 2011 (right). The red arrow indicating the same remnant part of the original island. Poplar Island in Chesapeake Bay, US, is one of the more ambitious beneficial use projects in the world. In the mid-1800's this island was about 400ha in extent, though by the 1990's the extent of the island had reduced to less than 2ha. The USACE have proposed to restore the island to an 800ha extent, to date 21 million m^3 of dredgings have been deposited creating an impressive mosaic of habitats including wetlands and shingle beaches.
© U.S. Fish & Wildlife Service

This technique is also being used in the Netherlands currently with an ambitious project called the Marker Wadden which is creating a large complex of islands and beaches for both recreational activities and for a nature reserve (Figure 6.7) with the Markermeer. The Markermeer lake has lost most of its natural shores to land reclamation and flood protection measures and is suffering from heavy siltation. As a result, fish and bird populations have declined dramatically. The islands are being constructed using the excess silt within the lake, and are designed to further trap silt and sediment helping to improve the turbidity of the lake. Furthermore, the islands are being designed with natural shorelines, providing both habitat for wildlife and areas for recreational purposes. The Marker Wadden is one of the biggest nature restoration projects in western Europe, aiming to restore an area of up to 100km^2.

Figure 6.7. A computer-generated simulation of some of the planned islands at Marker Wadden, the Netherlands. © Marten van Dij l/ Natuurmonumenten.

Construction began in April 2016 and by the 2017 breeding season there were already significant numbers of breeding birds using the site, despite construction being ongoing (see Table 6.2).

Species	No. of Breeding Pairs
Avocet	69
Black headed gull	352
Common tern	1851
Kentish plover	4
Little ringed plover	8
Ringed plover	1

Table 6.2. Breeding numbers for bird species on Marker Wadden in 2017 (pers comm Natuurmonumenten, 2017)

These dredging islands represent an excellent example of strategic use of dredged sediment where materials, which could be sourced from a number of different dredging sites, can be deposited at the one site over the course of many years. The overall result is large-scale habitat creation at a reduced per hectare cost than the equivalent would be for creating a number of different sites, as a result of the possibility of only requiring the permits for one site and only having the infrastructure and set up costs for one site.

Undisturbed islands will become increasingly important for wildlife as mainland habitat continues to come under pressure from coastal erosion and increased development and recreational pressures, but can also have many other benefits such as coastal defence and providing space designated for recreational activities.

6.4 Offshore Berms, Sacrificial Bunds and Sand Engines

Offshore berms and bunds can be created out of a mixture of dredged materials depending on their desired function. A stable berm, usually constructed of rock or clay relies on the material remaining in situ and acts as a coastal protection structure, dampening waves and sheltering the land on the shoreward side. Feeder berms or sacrificial banks, on the other hand, are usually constructed of sand or shingle and rely on the material being dispersed shoreward through natural processes to supply sediment to an eroding shoreline. This is often considered to be a cheaper and less disturbing alternative to direct beach nourishment projects.

The Delfland Sand Engine in the Netherlands is an ambitious version of a feeder berm where more than 21.5 million m^3 of sand has been used to create an approximately $1km^2$ sandbar-shaped peninsula just offshore of an eroding coastline. It is designed so that the sand will be redistributed through natural processes to nourish the coastline, improving coastal defence and climate change adaptation.

Figure 6.8. A time sequence of aerial images of the Delfland Sand Engine taken from 'Interim results 2011-2015. The Sand Motor: driver of innovative coast maintenance.' © Rijkswaterstaat, 2016.

The interim results from the Delfland Sand Engine are positive. Rijkswaterstaat report that:

"The Sand Motor has indeed resulted in a wider coastal zone. The sand has gradually been spread to the north and south by the wind, waves and currents. The area increasingly resembles dynamic coastal areas like those we know on the Friesian Islands. A variety of plants, birds and other animals have settled in the new, attractive coastal landscape. The area also plays a major role as a leisure location for nature lovers and active athletes. The Sand Motor has become an internationally renowned icon of innovation."

6.5 Shingle Ridges and Islands

The coarser grained sediments typically obtained through capital dredging operations can be used to create new, or raise the height of eroding, shingle islands and banks which not only provide critical habitat for shoreline nesting birds but can also act as a coastal defence mechanism by creating a barrier on the seaward side of sea walls, or at-risk saltmarsh, reducing the wave action upon them. In many cases it is used in combination with a saltmarsh recharge scheme to protect the marsh while it is stabilising and act as a bund to the deposited fine sediment. These coarse-grained materials are typically projected into place using a rainbow dredger and is the same process through which beach nourishment occurs in many places around the UK.

This process was shown to work effectively at Horsey Island, Essex, where a shingle bar was deposited seaward of an eroding shoreline, which now provides valuable protection for an eroding sea wall and allowed saltmarsh to develop giving additional coastal protection and habitat. The result has been to stabilise the coastline in this area significantly. Furthermore, the shingle ridge was quickly colonised by little tern and the Horsey Island site now supports the largest population of breeding little terns in the Essex region.

Figure 6.9. Standing on the shingle ridge at Horsey Island, Essex in 2016. The shingle was deposited in front of the failing sea defences to provide protection to the land behind. Since its placement flats and marshes have developed in its lee further stabilising the coastline. © Susan Rendell-Read.

Figure 6.10. Nesting little tern on the dredged shingle ridge at Horsey Island, Essex. While the shingle ridge at Horsey Island was placed as a coastal erosion mitigation measure, it has since become the nesting site for the largest colony of little terns in Essex supporting on average approximately 50 breeding pairs. © Susan Rendell-Read

There are a number of examples where dredged shingle has been used to recharge islands and ridges around the UK, particularly within the estuaries of Essex. Many of these have had instant and significant positive results for birds such as little tern, observed either by an increase in the number of pairs using the recharged area to nest or an increase in productivity rates compared to prior to the recharge. The RSPB uses shingle recharge at a number of sites around the UK as a management technique to support breeding birds like terns.

Strategic, repeated, small-scale shingle recharge could be a significant conservation tool for species such as little tern which are particularly susceptible to sea level rise, storm surges and coastal erosion, and show a preference for un-vegetated and dynamic shingle habitats.

Figure 6.11. Common terns flying over their nesting area, a shingle bank created using otherwise unwanted coarse dredging materials, in the Blackwater Estuary, Essex. © Malcolm Ausden.

Section 7 - A review of the blockages to the process

Why do we not make more use of dredged sediment in the UK for restoring and protecting our coastline in ways that benefits people and wildlife?

We have collated the information gathered by the various projects highlighted in Table 2.1 (Section 2), as well as from a variety of other sources, to establish what the key issues appear to be that are preventing more widespread adoption of beneficial use in the UK.

We believe the issues can be divided into four main categories:

1. **A lack of understanding of the potential impacts which leads to a risk-averse approach.**
2. **A licensing procedure that deters rather than champions the process.**
3. **A lack of communication, which leads to the inability to match supply and demand and plan for projects strategically.**
4. **The cost of delivery making many schemes, and particularly small-scale projects, financially unviable.**

7.1 Potential Effects

One of the biggest issues that has been inhibiting the advancement of beneficial use schemes in the UK has been a lack of confidence in the potential environmental impacts, particularly when using fine sediment. This leads to an onerous requirement for modelling and monitoring in order for licences to be issues. It is believed this could act as a deterrent to many potential applicants.

The fact is however, that there are numerous schemes already completed from which there is plenty of monitoring and modelling data available. These cover a variety of different methodologies and sediment types and, while every scheme has been different and so produces different results, the impacts are generally found to be within a certain frame of reference and our understanding of how to manage a project in order to minimise any impacts is now well developed.

In addition, there have been a number of studies assessing the environmental effects of beneficial use schemes using fine materials, both taking samples from field trials and also undertaking laboratory experiments (Widdows et al, 2006; Bolam et al, 2010; Defra, 2004; Van der Werf, 2015). While specific results vary the conclusions from these studies are similar and can be summarised as:

- **Stability of the newly deposited material can be achieved very quickly provided the right sediment handling techniques are used.**
- **Benthic recovery of the disposal area is relatively quick.**
- **It is an effective methodology for mitigating against the effects of inter tidal erosion by stabilising and raising the elevation of flats and marshes.**

There is a consensus, supported by Defra and Natural England, that provided highly sensitive sites are avoided, on balance, the long-term wider benefits will outweigh any short-term, localised damage to the environment. This assumption is particularly important when dealing with areas that are already degraded and will be under continuing threat from erosion if action

is not taken. It should also be a consideration where deteriorating habitats or the fauna that they support are protected under designation regulations and therefore there is a requirement to undertake restoration measures.

7.2 Regulations

Consultation has shown that many people are deterred by the licensing process, and in many cases potential projects have been abandoned because the licensing requirements were felt to be inhibitive. While the UK has the policies and guidelines promoting beneficial use, the complexity, timeframes and costs involved with obtaining a licence are in many cases less supportive of the process in practice. This is particularly apparent for small-scale schemes where the licensing costs can amount to as much as half of the total project costs, and where delays caused by requests for in-depth pre-application monitoring and modelling result in opportunities being missed because dredging operations needed to be progressed before the beneficial use licences gained approval.

Currently, there is little guidance and clarity available for potential applicants to establish what the requirements are before committing financially to the process. In some cases, the interpretation of definitions relating to beneficial use are in themselves unclear and need establishing in order to determine what the licencing requirements will be. Many consider that the very fact that this valuable natural sediment resource is considered to be a waste product requiring disposal licences may in itself be inhibitive.

The MMO (2014), who are responsible with issuing licences for dredge disposal, acknowledge that "*securing the necessary permits as well as securing a consensus 'buy in' from all consenting bodies and their advisers can take a long (and often prohibitive amount of) time*". They recognise that "*the overall objective of beneficial re-use is to facilitate sustainable development and therefore is in keeping with the principles of current legislation, but while the legal, planning and policy rationale exists to allow for beneficial re-use, in practice the processes involved make it an unrealistic option for most operators*".

Regulations are of course critical. They are needed to protect both people and the environment. But it is important that any licensing procedure is proportionate and that evolves as new information becomes available. The current process isn't aligned with the EU and UK guidelines for recycling and reusing natural resources, as currently it is far easier and more economical for dredging operators to dump the resource material at sea as waste.

7.3 Communications

One of the requirements of obtaining a licence to dispose dredged material at sea is that the applicant shows there are no practical alternative means of use. However, there is no system in place for dredging companies to identify sites that would benefit from sediment recharge and therefore this requirement is only loosely enforced. In addition to this, commercial sensitivities surrounding dredging operations and the timescale limitations of dredging licences make it extremely difficult for potential end users of dredged sediment to identify suitable sources that will be available at the right time, with many habitat restoration projects taking years to get from conception to completion. Currently, there are very few drivers or mechanisms for beneficial use opportunities to be investigated thoroughly.

One of the reasons why the US may have been so successful at implementing beneficial use schemes may be that it is the same federal agency (USACE) that is responsible for maintaining navigable waterways and also for shoreline protection. From as early as the 1940s USACE identified that these two responsibilities can be achieved simultaneously by re-using dredged material for beach nourishment, wetland enhancement and island creation (Lott et al, 2007). Furthermore, it was quickly discovered that the habitat being newly created through

dredging disposal was also contributing to sustainable environmental outcomes, particularly in terms of providing critical habitat for birds. Over the years, habitat creation objectives have become more of a priority, through the proactive integration of dredging, coastal protection and habitat restoration schemes (Lott et al, 2007). As a result, any potential opportunities are easily identified and work is planned for strategically.

Similarly, in many countries in Europe dredging operations are government-led and therefore the sediment is considered to be a resource and there is a responsibility to use it strategically. By comparison, dredging in the UK is undertaken by private operators, resulting in a competitive and commercially sensitive industry that has limited opportunities for strategic oversight.

7.4 Costs

Many beneficial use projects are abandoned at the feasibility stage when they are deemed to be economically unviable to the developer. Furthermore, there are no incentives for dredging operators to engage in any beneficial use scheme unless it there is an economic case for it.

As already discussed some of the costs relate to the licensing procedure, particularly with respect to the pre-application monitoring and modelling requirements, which in some cases (for instance small-scaled schemes) are disproportionately high and so don't make the project worthwhile investigating.

However, most of the costs are likely to be associated with the actual delivery of the project. Transporting the material and disposing it onto land, as well as manipulating the sediment to create the desired habitats, is in many cases inevitably going to cost more than disposing the sediment at sea. It is believed that beneficial use schemes cost on average an additional £3 per m^3, or between 3-10 times the cost of disposing at sea, just for the added transport and handling overheads.

Currently, the multiple ecosystem service benefits and natural capital approach are not being used to finance beneficial use projects, and as such there is no additional funding provided up front to bridge this cost gap. There isn't an economic incentive for dredging operators to pursue beneficial use projects.

Section 8 - The way forward

Here we summarise the key potential solutions that could be implemented to get more beneficial use happening.

As part of this SEABUDS project the RSPB facilitated the formation of a Beneficial Use Working Group with the objective of progressing some of these solutions. In particular, this group is focussing on actions relating to the regulatory and strategic planning side of the process.

The group currently consists of representatives from:

- RSPB
- Marine Management Organisation
- Natural England
- Environment Agency
- Centre for Environment, Fisheries and Aquaculture Science
- The Crown Estate
- ABPmer

The group has committed to meeting every 6 months, first forming in September 2017. A list of defined action points has been created, which are looking at a variety of topics including getting clarity and consensus on definitions and interpretations of the legislation, providing better guidance to the public on licencing requirements, determining under what circumstances is there confidence in the short-term impacts being outweighed by the long-term benefits and streamlining the licencing process for low risk projects. Progress on many of the action points is already well under development, with a commitment from all group members to continue.

8.1 Review of the potential effects and regulation process

In their report investigating the feasibility of beneficial use schemes in the South Marine Plan Area (MMO, 2014), the MMO state that they consider "*there is now sufficient knowledge and understanding of the environmental effects and processes to have confidence in the approach and its value".* However, in practice, applicants are being asked to undertake in-depth surveying and pre-application modelling to predict the environmental impacts, without freely available guidelines on what needs to be provided for different types and scales of activity. As such, the licencing process continues to be laborious.

To alleviate this burden, the Beneficial Use Working Group is preparing a document detailing what the likely impacts are for different beneficial use activities and what licences and associated assessments would be required for those types of activities. It is hoped that this will form part of some guidelines that are made publicly available, to provide greater clarity to the beneficial use process. This should help improve the consistency of licence applications, provide greater confidence to the regulatory authorities in issuing licences and speed up the licencing process.

In addition to this, the group is investigating potential ways to apply a proportionality approach to the licensing process. For instance, identifying criteria that when applied provide confidence that significant impacts will be unlikely, such as the acknowledgement of low sensitivity sites

and methodologies. If this approach can be agreed upon and applied, the licensing process should become significantly streamlined.

It is beyond the scope of this Beneficial Use Working Group, but we would also recommend that stakeholders in the industry work together to produce best practice guidelines that illustrate what techniques can be used to minimise any significant impacts, and are the most time and cost-effective methods of project delivery.

8.2 Review of the policy framework and strategic planning of beneficial use

This is acknowledged by the MMO in their South Marine Plan preparations (2014) that "*greater guidance and more strategic clarity on beneficial use is needed to create a policy climate in which beneficial use is viewed as a relevant, realistic and even necessary option for coastal management in the future. Creating such a climate, and applying regulations in a reasonable and proportionate way, will help to empower those who are interested in doing such projects*".

Some actions that could be applied to achieve this include:

- Clear policy statements supporting beneficial use incorporated into plans and policy framework (e.g. Marine Plans, Shoreline Management Plans, coastal strategies, adaptation plans) to make beneficial use a priority tool particularly in areas where protected habitats are degraded and there is a requirement to restore them.

- Beneficial use is managed more strategically on a national and regional scale. For example, thinking more long-term and identify strategic sites that could receive sediment at regular intervals over a long period of time, from a number of different sources. This is an option that is used regularly in the US particularly where dredging islands have been created. This would better enable recipients to avoid missing opportunities from maintenance dredging schemes, and reduce the costs associated with getting new licences every time material becomes available. On-site handling costs are also reduced because infrastructure is already in place from the onset to receive material from a variety of sources over the course of a long time period.

8.3 Coordination of supply and demand

It is generally acknowledged that there needs to be improved communications, both nationally and regionally, between sediment suppliers, potential end-users and regulators to allow better coordination of supply and demand. An official mechanism, possibly through the use of an online database tool, where supply and demand for sediment must be formally registered, has been flagged by many stakeholders as a tool that would allow for sediment needs and timing opportunities to be better coordinated. Similar websites exist elsewhere in the world and in the UK within the construction industry promoting the recycling of unused building materials that would otherwise go to landfill and for terrestrially sourced sediment through the CL:AIRE database. A web-based database was set up in the US by the Great Lakes Commission in partnership with USACE, which works as a preliminary screening tool for communities and organisations to identify potential sources of sediment for recharge projects. This could be managed at a regional level, but with national oversight to ensure that both local, small-scale opportunities and large-scale strategic projects are identified.

This sort of mechanism would be a valuable tool in preventing missed opportunities, as potential receiver sites can be identified ahead of time, and the consents applied for well in advance of the sediment coming available. To get even more value out of such a tool we could not only match one beneficial use with a donor site, but identify priority sites where the most beneficial results can be achieved. The coordination of where material is most at need will

maximise the potential benefits and, as a result, the possible funding avenues, increasing the viability of any scheme.

However, to get a system like this to work there needs to be an organisation or group to take ownership and commit to managing the database. It is not clear where this responsibility should lie. Furthermore, the commercial sensitivities around dredging activity also need to be overcome.

8.4 A recognition of the wider ecosystem services and commitment to fund the natural capital associated with restoring coastal habitats.

The recent ABPmer (2017) review of the costs and benefits associated with beneficial use schemes, highlights that in some cases the costs to deliver dredged sediment to a beneficial use site are cheaper than the disposal at sea option. However, this is site dependent and if it is only these kinds of projects that are progressed then many valuable opportunities will be missed.

Therefore, one of the key solutions to making beneficial use projects financially viable is to establish the monetary values of all the potential benefits, allowing for multiple funding streams which will bridge the gap between the cost of disposing at sea and using the material beneficially. Specifically, the beneficiaries will need to transfer a proportion of their financial gains to those incurring additional costs. For example, flood protection authorities and nature conservation bodies who are benefiting from the services provided by the scheme may need to supply funding to cover the additional costs dredging operators and port authorities would otherwise incur to supply the material compared to disposing that material at sea as usual.

The Natural Capital Committee, who report to Defra on the sustainable use of natural capital, advise that saltmarsh creation is one of five key habitats where there are good cost-benefit ratios for investing in natural capital. In the NCC's third report on the state of the natural capital in England it is noted that "*saltmarsh restoration has BCRs [benefit cost ratios] of between 2 and 3:1*" and that "*it is very likely that sediment recharge projects in particular could have clear economies of scale and could lead to large areas of marsh being protected and/or enhanced at a comparatively low cost*" (Environment Bank, 2015).

The government already acknowledges that the economic benefits provided by the natural environment's regulating and provisioning services are likely to increase with climate change and that this may create new markets if these services can be given a monetary value (Defra, 2013). However, there are other ecosystem services that coastal habitats provide that so far have not been quantified fully or a consensus reached as to how a Payments for Ecosystem Services type system will be applied for projects such as these.

The government's 25 Year Environment Plan emphasises the need for natural capital driven financing mechanisms in order to make the process of habitat restoration economically viable. This sentiment now needs to be carried through with concrete actions and systems trialled.

Section 9 Conclusions and Recommendations

Conclusions

Coastal habitat loss is a major conservation challenge in the UK with many of our internationally important and protected species of wildlife at risk. Significant proportions of our coastal habitats have been lost in recent history, resulting in the degradation of habitat quality and functionality. Furthermore, habitat loss at the coast is likely to continue as a result of climate change.

To date, in the UK coastal habitat creation has largely involved managed realignment. However, it is becoming increasingly difficult to meet habitat creation requirements through managed realignment alone and there are alternative approaches such as through the beneficial re-use of dredged sediment that need proper consideration.

There are numerous policies and guidelines within the UK that support and encourage the beneficial use of dredged sediment; however, compared to many other countries around the world the UK currently makes little use of this resource. Less than 1% of the sediment routinely dredged from ports and harbours around the UK is used to restore coastal habitats.

Coastal habitat restoration and creation is a win-win, having multiple benefits and ecosystem services. It can help move towards a more sustainable and economical approach to coastal management based around natural processes. However, currently the value of this natural capital and the ecosystem services the coast provides are not being utilised to their fullest extent and therefore in most cases beneficial use schemes are economically unviable.

There is a consensus between regulatory authorities, dredging operators, conservation NGOs and developers that we should be doing more beneficial use projects. The issues preventing its more widespread use are well established, potential solutions are available, but they need to be investigated and trialled with more urgency and commitment from all involved.

Recommendations

To get more beneficial use happening in the UK we suggest the following:

1. Continued commitment from the Beneficial Use Working Group to progress actions that will:
    a. Provide better clarity and guidance on the legal and regulatory requirements for beneficial use
    b. Ensure transparency and efficiency in the marine licensing process (recognising legal requirements and case example evidence)
    c. Provide advice on future project applications to understand/showcase how the proposed changes make the licencing process more efficient.
    d. Help collate and communicate lessons from different projects to feed into the above actions
2. Taking forwards the results from the CEDA UK project looking at the potential solutions to the commercial and economic barriers. This will require commitment from a group of stakeholders to take ownership of trialling the solutions, such as a sediment database.
3. Greater strategic oversight of beneficial use. This may include incorporating it into Shoreline Management Planning and Marine Planning framework, beneficial use could become an integral part of a UK coastal adaptation programme in response to climate

change. It should also be recognised as an important tool for coastal management, for example it can be used as a means to deliver protected site (e.g. SSSI) restoration and WFD mitigation requirements. Strategic planning could also be improved by having a sediment database managed at a regional and/or national scale, by stakeholder groups (for example coastal groups, estuary partnerships or dredging liaison groups etc).

4. Commitment from the government to progress their recommendations in the 25 Year Environment Plan to facilitate the natural capital approach in order that beneficial use projects become an economically viable option for habitat restoration.

The RSPB is dedicated to assisting with the removal of the blockages by participating in the following actions:

1. Continuing to engage in the Beneficial Use Working Group.
2. Being an advocate for beneficial use.
3. Working with partners to deliver some case examples of beneficial use projects to help showcase viable ways to get projects delivered.
4. Assisting with evidence-based knowledge of impacts from case-studies and monitoring data to reduce the knowledge gap and impact uncertainty and providing guidance on how adverse effects can be avoided or mitigated.
5. Identifying sites that would benefit from sediment recharge from a conservation perspective, which can be supplied to a “national/local online mapping tool/database”.
6. Look for specific opportunities for the creation of nesting tern habitats in areas where current sites under threat.
7. Participating in communications with other stakeholders to identify sites that will have multiple benefits to recognise potential innovative sources of funding.

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Abbreviations Used

ABPmer – Associated British Ports Marine & Environmental Research

BoCC4 – Birds of Conservation Concern 4

DEFRA – Department of Environment, Food and Rural Affairs

EU – European Union

FCERM / FCRM – Flood and Coastal (Erosion) Risk Management

FTE – Full Time Equivalent

Ha - Hectares

IPENS – Improvement Programme for England's Natura 2000 Sites

MMO – Marine Management Organisation

NCC – Natural Capital Committee

NCCA – National Climate Change Assessment

NGOs – Non-Governmental Organisations

NRW – Natural Resources Wales

ONS – Office for National Statistics

RSPB – Royal Society for the Protection of Birds

SAC – Special Area of Conservation

SCOUP - Sediment Compatibility and Opportunistic Use Pilot

SIP – Site Improvement Plan

SMP – Shoreline Management Plan

SPA – Special Area of Protection

SSSI – Site of Special Scientific Interest

UK – United Kingdom

UK NEA – United Kingdom National Ecosystem Assessment

US – United States of America

USACE – United States Army Corps of Engineers

USAR – Using Sediment as a Resource (Interreg 2 Seas Project)

WFD – Water Framework Directive