Environment Agency

Blue Recovery – estuary and coast ecosystem resilience through collaborative partnerships.

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This paper details a theoretical bid for a **'Blue Recovery Fund'** for restoring estuaries and coasts (aligned with the EA-led Restoring Meadows, Marsh and Reef Initiative, ReMeMaRe), funded over 4 years but with benefits that will extend over a 40-year period.

Summary

The **Blue Recovery Fund** is for **£24.4 million** of capital investment over 4 years towards estuarine and coastal habitat restoration and £1 million of revenue into additional staff.

£20.4m of this is for restoration of 800 ha of saltmarshes, 25 ha of seagrass meadows and 50 ha oyster beds, plus a pilot study for restoring 2 ha of kelp forests.

£4m is for the setup of aquaculture facilities that will be able to scale-up production of oyster seed and seagrass seedling required for realising the ambition of ReMeMaRe to restore 15 % of our estuarine and coastal habitats by 2043 and achieve targets set in the Defra 25 YEP.

The fund will aim to secure an additional **£30.6 million** of private, academic and environmental NGO sector finance and resources (e.g. partnership/external funding and staff time at a ratio of £1:1.5) towards estuarine and coastal restoration, using a similar approach to how WEIF funding is awarded. This will provide a total Blue recovery fund of £56 million to achieve the total **target of 875 ha restored**.

The whole programme has a Net Present Value of **£30.5 million** and a Benefit-Cost Ratio of **2.39,** creating an estimated **£52.5 million** of monetised benefits to 2061, the 40 year lifespan of the project.

1. Background

a) Our estuaries and coasts are in a perilous state. 79.8 % of our estuaries and 56.4% of our coastal waterbodies are failing to achieve good ecological status (GES). The Defra 25 YEP target aims to achieve 75% of our waters to be close to their natural state as soon as practicable. There are 143 estuarine and coastal waterbodies (excluding lagoons), equal to ~20% of English surface waters by area.

b) Our existing estuarine and coastal habitats provide important benefits. Our current saltmarsh provides £1 billion worth of flood protection, and enhances our existing coastal defences where it sits in front. Our existing saltmarsh can sequester 5 t carbon ha^{-1} yr^{-1} mitigating climate change, and 0.8 tonnes nitrogen ha^{-1}, reducing the risk of eutrophication. Our saltmarsh and seagrass beds act as nursery sites for coastal fish such as cod, wrasse & sea bass, and all three habitats can significantly enhance the biodiversity of the shore and seabed.

c) Seagrass and saltmarsh habitats are being lost to physical modification, coastal development (including flood defence and port expansion) and coastal and estuarine erosion due to sea level rise and increased storm events. Physical modification is the biggest factor impacting on the quality of the estuarine and coastal environment. However, our seagrass and oyster bed habitats are also at risk from poor water quality (diffuse and point source), physical modification through seabed trawling (fisheries), boat mooring and anchoring. The combination of these pressures has led to 85% of our saltmarsh being lost since 1800's, extirpation of seagrass in ~50% of waterbodies where it once occurred, and the disappearance of 95% of our oyster beds in England.

d) Restoring our estuaries and coasts by creating new habitats will provide targeted environmental improvements and would re-naturalise waters currently failing GES or favourable condition (for marine protected areas, MPAs), particularly those classed as highly modified waterbodies. We could reverse the historical loss of habitats due to land claim for development and agriculture, and at the same time provide natural flood management and nature-based solutions to mitigate against climate change. Restoring these habitats will also improve the functional value for biodiversity by increasing the habitat available to support fish nurseries & migratory routes. It will also improve water quality of the 80% of estuarine & coastal waterbodies that are at less than GES, by locking away heavy metals, persistent organic pollutants and absorb nitrogen.

e) This programme of investment will build the capacity of the UK to undertake estuarine and coastal restoration projects, develop the programme and implement a range of projects that will create over 850 ha of priority habitats. This programme goes beyond on the existing Habitat Compensation Programme (HCP) managed by the EA's FCRM function (which creates new saltmarsh to compensate for losses from construction and continuing maintenance of flood defences) to create habitats that will increase the UK's overall stock of saltmarsh, seagrass, oyster reef and, on a smaller scale, other priority habitats such as kelp forests.

f) We know that seaside towns are more deprived on average (England's Seaside Towns: Bench Marking Study) and that the Ministry of Housing, Communities and Local Government SDP is committed to boosting growth and supporting communities across the country through the Stronger Towns Fund, Local Growth Fund and Coastal Communities programmes. (SO 4.2 Invest in places and our communities). Our restoration programme will provide a focus to boost those communities by creating up to 100 jobs.

g) The Environment Agency, in partnership with Defra partners (Marine Management Organisation, Natural England, Cefas, Joint Nature Conservation Committee, Inshore Fisheries and Conservation Authorities and the Crown Estate), leads the 'Restoring Meadows, Marshes and Reef' (ReMeMaRe) initiative, and would lead on this funding programme. Habitat restoration projects will blend funding with partners and consortiums to collaboratively deliver estuarine and coastal habitat restoration.

1.1. Objectives and deliverables

The **strategic objectives** for the "Blue Recovery – estuary and coastal ecosystem resilience programme" are to

i. Achieve the targets set in the Defra 25 YEP
ii. Achieve, in part, the targets set out in the Convention on Biological Diversity to restore 15% of degraded ecosystems
iii. Increase our collaborative capacity to undertake estuarine and coastal restoration
iv. Expand the portfolio of estuarine and coastal habitats that can be restored to include kelp forests, reefs and other shellfish beds.
v. Improve people's access, engagement and awareness with and of, our estuaries and coasts.
vi. Follow the Clean Growth Strategy to create habitats that provide wider socio-economic benefits, such as job creation in coastal communities and mitigate against climate change.
vii. Improve the connectivity of estuarine and coastal habitats,
viii. Position the UK as a global leader on estuarine and coastal nature-based solutions to climate change particularly in the lead up to COP26.
ix. Enable coastal communities' better access to support, advice and funding to help improve, restore and adapt their coast.

The quantifiable **SMART Objectives** are to:

i. Restore at least 2 % by 2025 and 15 % of our current extent of saltmarsh, seagrass and oyster reef habitats by 2043.
ii. Achieve Good Ecological Status in our River Basin Management Plans for estuarine and coastal waters water bodies for angiosperm (seagrass / saltmarsh) elements with newly-restored habitats and contribute to Good Environmental Status for Regional Sea Areas for biodiversity and seabed habitats
iii. Begin the restoration of 5250 ha of functioning saltmarsh, 300 ha of seagrass and 200 ha of oyster beds by 2043
iv. Restore or initiate the creation of up to 800 ha of saltmarsh, 25 ha of seagrass and 50 ha of oyster beds by 2025, both inside and outside of marine protected areas.
v. Store up to 200 kT of carbon emissions by 2043 (end of the Defra 25 YEP), and sequester an additional 27 kT C^{-1} per year by 2043.
vi. Remove up to 6.4 kT of nitrogen from the water by 2043 (end of the Defra 25 YEP).
vii. Work to set up a pioneering aquaculture facilities that will generate up to 12 million seed oysters per year by 2030 to restore oyster habitats around the UK.

1.2. Theory of Change - how the objectives will be delivered with reference to inputs, outputs and outcomes

Inputs

Through this programme, we will invest…

- £24.4 million of capital investment towards estuarine and coastal habitat restoration.
- £30.6 million of private, academic and eNGO sector finance and resources (e.g. partnership/external funding and staff time) towards estuarine and coastal restoration.
- £1 million of revenue into additional staff.
- In house skills, experience and expertise from within the Environment Agency and from partners across the Defra ALBs who collaborate in the ReMeMaRe initiative (e.g. for monitoring & evaluation).
- Private, academic and eNGO sector partnership funding, expertise and experience to support the development of the CoBA groups.

Outputs

- The restoration of up to 800 ha of functioning saltmarsh through ~16 managed realignment and beneficial use of dredged material projects.
- The restoration of 50 ha of oyster beds and 25 ha of seagrass beds and successful pilot studies trialling the restoration of kelp forests.
- Contribute to climate change mitigation by removing 0.3 $MtCO_2e$ of carbon dioxide through sequestration.
- Achieve good ecological status for saltmarsh and seagrass elements under WFD.
- Construct, with partners in industry and academia, up to 4 small-scale closed shellfish hatcheries across England with the primary aim of growing oyster seed and seagrass for restoration projects that will produce millions of oysters per year.
- Annual progress report on joint restoration activity across England with input from devolved administrations.

Early Outcomes

- A united drive for restoring our estuarine and coastal habitats across government.
- An increase in public and stakeholder awareness and positive attitude of the benefits provided by our coastal habitats, leading to positive change in natural resource use.
- Increase in employment opportunities in deprived coastal communities with nearby restoration projects and oyster hatcheries.
- Increased connectivity of coastal stakeholders and communities can unlock and stimulate private and third sector investments – funding attracted per stakeholder.

Medium-term Outcomes

- An integrated 'catchment to coast' approach to habitat restoration and partnership projects across the country.
- Increase resilience and reduced maintenance costs for coastal defence structures associated with restored habitats.
- Improve wellbeing, mental and physical health due to people from all backgrounds spending more time in higher quality, clean and natural blue spaces created through restoration.
- The development of new relationships and interactions between coastal stakeholders to work together towards collective action.
- Enhanced connectivity of coastal communities and businesses to Government and academia, gaining a better awareness of climate impacts, understanding their responsibilities, and the actions needed to prepare them for coastal change.

Impacts / Long-term results

- **Enhanced natural capital** across the coast.
- Increased coastal resilience to extreme events including environmental, economic and social.
- Restored habitats providing functioning nature-based solutions for mitigating the impacts of climate change.
- Improvement of economies in deprived coastal communities.
- Increased public awareness and engagement within their local environment.
- Reduction in pollution and improvement in water quality due to the nitrogen and contaminant-capturing actions of restored habitats.
- **Enhanced financial capital** – would include an improvement in the ratio of public / private / civil society sector financing and resourcing of partnerships.
- **Enhanced social capital -** an increase in capacity for collaborative governance by catchment communities; improved cross sector coordination; improved collective action and; improved local community resilience
- Support to public health outcomes (mental and physical) through recreation around restored areas and amenity benefits especially in deprived areas / communities.

2. Economic analysis

2.1 Theoretical ‘Restoration Scenario’ for economic analysis

For undertaking the economic analysis, a ‘restoration scenario’ was created where 33 (out of 143 in England) estuarine and coastal waterbodies were selected. These waterbodies were all (a) failing WFD assessments for saltmarsh/seagrass or (b) had known physical modification pressures impacting the waterbody. Therefore, all could have successful restoration projects applied which could significantly contribute to improving the condition of the waterbody, which could then lead to it achieving good ecological status. Subsequent calculations for environmental and social benefits used (where required) the saltmarsh, seagrass and oyster restoration potential areas published by the Environment Agency that were present in the selected waterbodies.

The regional distribution of the waterbodies for restoration cost-benefit analysis was as follows:

North East: 6%, **North West**: 6 %, **East Midlands**: 12 %, **East**: 15%, **South East**: 27%, **South West**: 33 %.

The West Midlands does not have any estuarine and coastal waterbodies, and the Yorkshire & Humber and London areas did not have any waterbodies in our scenario available for large-scale restoration potential – however this does not exclude these areas from restoration should funding be available.

50 % of the areas for restoration in the scenario were within 5km of urban centres of populations >10,000 people (from 2011 census).

33 % of the waterbodies had coastal communities containing wards in the lowest 10% of the 2019 Index of Multiple Deprivation

2.2 Cost-benefit analysis

The profile of the cost-benefit analysis by financial year (to 2061) is set out below. Environmental and social benefits (including ecosystem services) were calculated for the potential area of each restored habitat (800 ha of saltmarsh, 25 ha of seagrass beds and 50 ha of oyster beds) and then summed together. For details on how these benefits were valued for each habitat, please see the Appendix. The Kelp forest restoration pilot was not included in the benefits. The benefits of the oyster hatcheries were only assumed to be in the 'direct/indirect job creation'. ***Figures are all in £millions****; costs/adjustments are in red.*

	Benefit	Total 2021-2061	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
1	Environmental benefit – nutrient reduction	6.27	0	0	0.05	0.1	0.11	0.12	0.14	0.15	0.16	0.17
2	Environmental benefit – contaminant burial	4.43	0	0	0.02	0.05	0.07	0.09	0.12	0.12	0.12	0.12
3	Environmental benefit – net carbon sequestration	24.85	0	0	0.07	0.11	0.22	0.33	0.51	0.59	0.62	0.7
4	Social benefit – flood defence	73.99	0	0	0.4	0.79	1.2	1.6	2	2	2	2
5	Social benefit – commercial fisheries enhancement	1.48	0	0	0.01	0.03	0.03	0.03	0.03	0.03	0.04	0.04
6	Social benefit – recreation & tourism	7.35	0	0	0	0	0	0	0.21	0.21	0.21	0.21
7	Social benefit – direct and indirect job creation	10.64	2.66	2.66	2.66	2.66	0	0	0	0	0	0
8	Total benefits	129.01	2.66	2.66	3.21	3.74	1.63	2.17	3.01	3.1	3.15	3.24
9	Optimism bias adjustment	32.25	0.67	0.67	0.80	0.94	0.41	0.54	0.75	0.78	0.79	0.81
10	Estimated risk costs	0.50	0.13	0.13	0.13	0.13	0	0	0	0	0	0
11	Adjusted Total Benefits (8-(9+10))	96.26	1.87	1.87	2.28	2.68	1.22	1.63	2.26	2.33	2.36	2.43
12	Adjusted Total benefits (discounted)	52.46	1.87	1.81	2.13	2.42	1.07	1.37	1.84	1.83	1.79	1.78
13	Capital (CDEL) Costs	24.4	1.53	3.05	9.91	9.91	0	0	0	0	0	0
14	Capital (CDEL) Costs (discounted)	21.95	1.53	2.91	9.00	8.51	0	0	0	0	0	0
15	Net social benefits (discounted) (12-14)	30.51	0.34	-1.10	-6.87	-6.09	1.07	1.37	1.84	1.83	1.79	1.78

Notes:

Project appraisers have the tendency to be over optimistic. Explicit down-adjustments (**optimism bias**) should therefore be made to the estimates of a project's costs, benefits and duration, which should be based on data from past or similar projects, and adjusted for the unique characteristics of the project. Following discussions with economists, this programme was considered low risk and an **optimism bias** of 25 % was applied to the benefits.

An estimate of £0.125m per year **estimated risk** was added for four years of funding – this was to consider risks from not being able to achieve partnership funding for some projects, and potential impacts from fieldwork risks, e.g. inclement weather, halting operational projects.

Discounting in the public sector allows costs and benefits with different time spans to be compared on a common "present value" basis. The public sector discount rate adjusts for social time preference, defined as the value society attaches to present, as opposed to future, consumption. It is set at 3.5% per year. More details on discounting, risk and optimism bias can be found in the Green Book.

2.3 Regional Breakdown of costs and benefits:

Costs and benefits were split between the regions based on the theoretical restoration scenario as detailed in section 2.1. Figures are all in £millions.

Region:	NE	NW	YH	EM	WM	E	L	SE	SW	Non-Identifiable
Benefits	£9.10m	£9.10m	£0	£17.24m	£0	£20.83m	£0	£32.46m	£40.27m	
Investment Costs	£2.20m*	£2.20m*	£0	£2.53m	£0	£4.10m	£0	£5.60m	£7.80m	£1.0m (staff costs)

2.4. Greenhouse Gas Impacts

The **greenhouse gas impacts** of the Blue Recovery programme, over its lifetime and over the Carbon Budget periods set out in the Climate Change Act 2008 are set out below:

Greenhouse gas impacts, in $MtCO_2$ equivalent				
Lifetime (2021-2061)	**Carbon Budget 3 (2018-2022)**	**Carbon Budget 4 (2023-2027)**	**Carbon Budget 5 (2028-2032)**	**Other period if applicable 2032-2043 (25 YEP end)**
-0.310 $MtCO_2e$	**0 (likely +ve due to construction work)**	**-0.018 $MtCO_2e$**	**-0.042 $MtCO_2e$**	**-0.092 $MtCO_2e$**

3. Programme Delivery

The Environment Programme operates under a well-established delivery mechanism, facilitated through the Catchment Based Approach (CaBA). Catchment partnerships exist throughout England and in 19/20 75% of the Water Environment Investment Fund (WEIF) programme was delivered via this means. The remainder being delivered in-house through Environment Agency framework contracts. A number of alternative delivery models have been assessed and the findings demonstrate that there are clear advantages to funding a long term programme delivered through a ***partnership by default*** model.

The CaBA mechanism ensures that local needs and national water quality priorities are met and it enables the capital programme to draw in significant partnership and external funding. CaBA is an effective and inclusive, civil society-led initiative and is essential to maximise natural capital.

Partnership by default reduces pressure on the public purse, reduces public body project management time and will ensures the programme meets local needs and opportunities. The aim of this programme is to set up a parallel Coastal Based Approach running alongside CaBA.

It is intended that the new and strengthened Estuarine and Coastal Partnerships would play a pivotal role in driving forward collaborative projects that focus on Blue Recovery, linking up the partnerships and driving the identification and delivery of shared objectives.

3.1 Delivery Risks

We have assessed the following as the Primary Delivery Risks to the Blye Recovery Programme.

1. Lack of capacity and capability of partners to deliver the programme – recovery from Covid 19 has the potential to increase this risk: 60% of the programme is projected to be delivered through partners.
2. Some Estuarine and Coastal Partnerships and habitat restoration plans are at an early stage of development and are insufficiently developed to identify projects required to achieve the programmes objectives.
3. Delayed delivery in latter stages of programme due to requirement to obtain external funding
4. Exit from the European Union and the potential loss of EU sources of external funding could impact ability to achieve programme objectives
5. Climate change could bring long term environmental instability negating expected benefits of investment

We plan to mitigate for these risks by:

1. Developing a multi-year Medium Term Plan pipeline programme enabling our partners to plan resources for delivery and their funding strategy at the programme outset. We will continue to identify training needs and provide relevant support to partners through the Defra group national steering group.
2. Refinement of national restoration maps to produce a nationally strategic set of priority sites.
3. Using the steering group and the estuarine and coastal partnership funded co-ordinator role, challenge and support the development of estuarine and coastal plans that address the priority objectives.
4. Profiling delivery to show year on year increase throughout the programme, to provide time for partners to successfully obtai n external funding, and develop their capacity.
5. Maintaining clear governance to set programme ambitions and objectives through the National Programme Office (NPO). The NPO assures the delivery of the programme; identifies, monitors and manages risks and issues. The National Programme Manager maintains oversight of the programme, flags issues and makes recommendations to adjust the programme as appropriate to optimise delivery.
6. Ensuring ongoing support in stakeholder engagement through the Coastal-Based Approach to delivery partners.
7. Using of Climate Change Impacts sensitivity testing tool such as https://www.gov.uk/government/publications/climate-impacts-tool

Appendix – Supporting studies underpinning economic analysis and non-quantifiable benefits

Flood defence

Saltmarsh – Morris & Camino value the flood control and storm buffering of additional coastal wetlands at £2498 per ha (from Defra ENCA Services Databook). This is multiplied up to 800 ha to cover all restored saltmarsh.

Morris & Camino (2011) UK National Ecosystem Assessment Working Paper - Economic Assessment of Freshwater, Wetland and Floodplain (FWF) Ecosystem Services. UK NEA Economics Analysis Report.

Nutrient reduction & contaminants

Saltmarsh: This follows the '[Economic appraisal for River Basin District Planning'](Economic appraisal for River Basin District Planning) This assumes that for Estuaries and Coast, the cost of moving an element from Moderate to Good (an exert assumption for Dissolve Inorganic Nitrogen (DIN) failure) is (average) £9050 per km^2 yr^{-1}. Assuming that the mean waterbody area is $4km^2$, then it costs £36.2K per WB yr^{-1} (for one element failure). Using the 2019 WFD classifications, all waterbodies for saltmarsh restoration in the 'scenario' used had a DIN failure. Saltmarshes can store significant volumes of nitrogen – 0.81 kg ha^{-1} to 30 cm sediment depth, and more at greater depths. A 50 ha managed realignment can lock away 40.6 kg N, plus seasonal storage in plant leaves that gets released in winter, and further removal by denitrification. . However, the denitrification rate of realigned saltmarsh can vary significantly, and we have not attempted to quantify it here. The seasonal removal of nitrogen reduces the risk of eutrophication and the development of nuisance algal blooms in adjacent waters.

We have 16 saltmarsh projects to achieve 800 ha restored target for this bid, and have assumed one realignment can remove 10% of nitrogen that would needed to be removed in order for a waterbody to achieve Good status. Therefore the benefits are 10% of £36.4, x 7 to take account of all saltmarsh projects. For contaminants, all estuarine and coastal waterbodies failed for at least two priority substances in the 2019 WFD classifications (primarily mercury and PDBEs) – so the same assumptions have been made for nutrients, and the value doubled to reflect that two elements need to be improved to good status.

Seagrass: Aoki et al. (2020) estimate nitrogen burial rate of 3.52g N m^{-2} yr^{-1} in restored seagrass after 10 years. This is equivalent to 35.2kg N ha^{-1} yr^{-1}. When multiplied up to the 25 ha of beds created through bid, this is total of 880 kg yr^{-1}. Nitrogen is valued using report from Oxera (2008) that estimated mean of £7.40 per kg N removed from small sewage treatment works (STW). Equivalent value is saved by N being removed by seagrass instead. £7.40 x 880 = £6512, which is scaled accordingly to be reached after 10 years after restoration starts.

Oysters: Denitrification values are taken for *Crassostrea virginica* by Humphries et al. (2016), there are no values for *Ostrea edulis*. Oysters (at 54 per m^2) enhanced bare sediment denitrification rates by 557.5 µmol N m^{-2} hr^{-2}. This is calculated to be 1.26 g N yr^{-1} per oyster. Extrapolated up to 50 ha, using a target density for restored oyster beds at 10 oysters m^{-2} (100,000 per ha) , this could provide 6300 kg N yr^{-1} removed. This was valued using the Oxera (2008) report as for seagrass.

Aoki, L.R. et al. (2020). Seagrass restoration reestablishes the coastal nitrogen filter through enhanced burial. Limnol. Oceanogr. 65, 1–12 https://doi.org/10.1002/LNO.11241.
Humphries, A.T. et al. (2016) Directly Measured Denitrification Reveals Oyster Aquaculture and Restored Oyster Reefs Remove Nitrogen at Comparable High Rates. Frontiers in Marine Science 3, Article 74. http://dx.doi.org/10.3389/fmars.2016.00074

Oxera (2008). What is the costs of reducing ammonia, nitrates and BOD in sewage treatment works effluent. Ofwat commissioned report. https://www.ofwat.gov.uk/wp-content/uploads/2015/11/rpt_com_oxera080107.pdf

Carbon sequestration

Saltmarsh – a scenario of 33 potential waterbodies for saltmarsh restoration was created. For these, the saltmarsh restoration potential areas within each waterbody were identified, and the proportion of existing habitat which would be replaced with intertidal saltmarsh (through managed realignment) was estimated for each waterbody and summed to provide an overall proportion. The carbon sequestration rates:

Existing Habitat	% of restorable area	Existing habitat C sequestration rate (tC ha^{-1} yr^{-1})	Restored saltmarsh C sequestration rate (tC ha^{-1} yr^{-1})	Net C sequestration rate (tC ha yr^{-1})
Freshwater grazing marsh	61%	0.7	3.37	2.67
Arable	24%	0.1	3.37	3.27
Other grassland	8%	0.4	3.37	2.97
Lowland Fen	3%	0.7	3.37	2.67

The habitat C sequestration rates are provided by the Defra ENCA Services Databook; for restored saltmarsh, 3.37 was taken from Holt (2019). Carbon valuation was taken from the central short-term traded carbon value (BEIS, 2019) adjusted for each year of benefits to 2030.

Seagrass – The seagrass net C sequestration rate (1.9 tC ha^{-1} yr^{-1}) was provided by the Defra ENCA Services databook, extrapolated to 25 ha and valued as for saltmarsh.

Oysters – The oyster net C sequestration rate (inorganic + organic carbon, assume 10 oysters ha^{-1}), was calculated from Lee et al. (in press) at 91.3 kg C ha^{-1} yr^{-1}. This was reduced by an assumed 20% to take account remineralisation, resuspension and erosion to 73 kh C ha^{-1} yr^{-1} and extrapolated to 50 ha and valued as for saltmarsh.

BEIS (2019). Updated short-term traded carbon values used for public policy appraisal. Department for Business, Energy & Industrial Strategy.
Holt, A. (2019). Valuation of carbon storage, sequestration and sea bass production in the Deben Estuary. Report for the Suffolk Marine Pioneer. Natural Capital Solutions Ltd.
Lee, H. Z. L. et al. (In Press). Missing the full story: First estimates of carbon deposition rates for the European flat oyster, *Ostrea edulis*. Aquatic Conservation.

Commercial fish potential

Saltmarsh: Figures were only provided for sea bass, following method set out in Luisetti et al. 2011. Sea bass that enter market at 5 years was valued at £11.55 per ha of saltmarsh (note that this was the 2011 market price for sea bass, further updates will use the 2020 price).

Seagrass: This followed the approach of Luisetti et al. (2011) to value commercial seagrass fish. The only semi-quantifiable density survey of UK seagrass fish is from McCloskey & Unsworth (2015). Commercial fish identified were cod, Pollack, plaice and three species of wrasse. All fish were assumed to be 1 year, and natural mortality and weight at when they enter the fishery (assumed to be MLS for cod/Pollack/plaice or at maturity for wrasse) was calculated from Fishbase (https://fishbase.in). Fish were valued per kg by mean landings values provided by the MMO (or £1 per fish for wrasse), and the summed values per ha of seagrass were extrapolated to 15 ha.

Luisetti, T. et al. (2011). Coastal and marine ecosystem services valuation for policy and management: Managed realignment case studies in England. Ocean and Coastal Management 54: 212-224. https://doi.org/10.1016/j.ocecoaman.2010.11.003
McCloskey, R. & Unsworth, R. (2015). Decreasing seagrass density negatively influences associated fauna. PeerJ, 3, e1053, https://doi.org/10.7717/peerj.1053,

Recreation and tourism

Saltmarsh – unpublished work by the EA showed that 28% of managed realignments in England >10 ha have an associated visitors centre. Assuming we have 16 saltmarsh realignments from this bid (at 50 ha each, 800 ha in total), then 4.5 of the 16 realignments may have associated visitor centres. The Medmerry visitor centre has on average 22,000 visitors per year paying. Visitors contribute £4.17 to £4.62 to enter a reserve – we used £4.17 for our calculations (Atkins 2017). Multiplying £4.17 x 22,000 (visitors) x 4.5 (reserves) x 0.5 (to take account of other habitats of value at the reserve) = £206,415 per year.

Atkins (2017). Medmerry Ecosystem Services Valuation, Final Report. Report 5153271 for the Environment Agency.

Job creation

Oysters – Allen (2019) highlights that one job is created for 200,000 oysters in Scotland (£24.5K salary), with associated 0.4 FTE of indirect employment from oyster work. As we require minimum of 5m oysters for the completed restored reefs (at 10 oysters ha^{-1}), over 4 years, then 6 FTE + 2.4 FTE of indirect employment may be created to grow oysters and staff the hatcheries. This is assumed to come from partnership funding.

Seagrass – As seagrass restoration may be aquacultured, then it is assumed a similar number of jobs will be required, although will be half the FTEs of the oyster restoration jobs as half the oyster extent is planned to be restored for seagrass (25 ha): 3 FTE + 1.2 FTE indirect employment.

Saltmarsh – Following from oyster work, as 16 projects will be planned (at 50 ha per project), it is assumed that each project will have 1 FTE + 0.4 FTE indirect employment from partnership funding. This may be an underestimate of the coordination required (16 FTE + 6.4 FTE indirect employment). Salary is assumed to be 24.5K for each FTE.

The total is 0.86m a year of benefits from 35 FTE of direct and indirect employment. Such job creation benefits will likely last longer than the 4 years of CDEL funding, but it is not possible to quantify this.

Allen, H. (2019). Towards an economic valuation of native oyster restoration in Scotland: Provisioning, Regulating and Ecosystem Services. Report by Centre of Expertise for Waters (CREW), Aberdeen.

Non-quantifiable benefits:

There are a large number of benefits from estuarine and coastal restoration projects (compared to terrestrial restoration projects) that are currently lacking evidence that allow them to be valued:

Economic productivity

- **Fisheries enhancement** – Restored oyster beds will lead to larval spillover, creating new naturally-occurring oyster beds which, in time, could be harvested for fisheries (Peters et al. 2017). This has been shown to occur in restored American oyster reefs, and is assumed would occur with native oysters in the UK.
- **Farming opportunities** - there may be in time ability to provide niche farming opportunities, such as saltmarsh lamb and samphire harvesting in restored marshes. Both are premium products with a growing market, and this has been considered for the restored Steart marshes in Somerset (Viera da Silva et al. 2014).
- **ELMS payments** – agricultural land that is turned into restored saltmarsh through a managed realignment will likely be rewarded with payments through Tier 3 of the new Environmental Land Management Scheme (ELMS). It was not possible to quantify these payments at this time.
- **Hatchery potential beyond the project**. As of 2016, there are only three fully commercial oyster hatcheries in England, Wales and Northern Ireland, which primarily produce Pacific oyster (*Crassostrea gigas*), rather than native oysters, and as such there are too few existing hatcheries to guarantee consistent production for restoration work (Hambrey & Evans 2016). The initial investment of £4m in setting up a series of hatcheries in partnership with existing SMEs, academia and NGOs across the country (that can also be used for seagrass culture) will provide benefits beyond the 4-year scope of CDEL funding including:
    - Economic benefits from continued production of a stable supply of oyster seed for ongoing restoration projects
    - Expansion into aquaculture of other high-value species such as scallops or lobsters.
    - A potential export market to reflect the increasing demand from SE Asia and China for shellfish as food.

Hambrey and Evans (2016) estimate that from the 3 current commercial hatcheries, there is annually **£0.3-0.5 million of benefits** and £0.5-0.75 million of revenue.

Human capital information

- **Improving coastal communities** – Using our scenario for modelling restoration ecosystem services, we expect 33 % of the restoration projects (40 % of oyster restoration projects) taking place to be in waterbodies with coastal communities containing wards in the lowest 10% of the 2019 Index of Multiple Deprivation, therefore any human or social capital benefits will directly improve these communities. Notably for aquaculture work, Westbrook (2017) identified that in remote and deprived parts of Scotland, aquaculture (including shellfish facilities) can:
    - Provide a mixture of employment provided for existing residents (generally relatively young) and new residents when new farms have been established, with work available across a range of roles with career advancement potential locally.
    - Long employment duration – reflecting the lack of alternative or more attractive employment, relatively high pay in the local context, and on and off the job training provided by employers to develop employees' skills.
    - Company and employee expenditure that has helped to sustain local businesses and avert closures due to otherwise insufficient annual demand from residents and visitors. Businesses supported include hotels and other accommodation and catering establishments (which also provide for site visitors), fuel supply, hardware supply, divers, house building and maintenance, leisure boat moorings, and those providing repair and maintenance services to company operations, access roads and sites, etc.

Social capital

Wellbeing and mental health The coast has been shown to play a role as a therapeutic and restorative landscape for promoting well-being and mental health (Defra 2019). People living by the coast report better mental health compared to those living further inland. There is no evidence to suggest that living by the coast influences people's reports of subjective well-being (happiness, anxiety and worthwhileness). Individuals report increased happiness when spending time in marine and coastal margins, compared to green spaces and urban environments.

Volunteering benefits. Many realignments and coastal restoration projects are managed as nature reserves by eNGO volunteers following completion, such as the Wildlife Trusts. Bagnall et al. (2019) showed that activities delivered by local Wildlife Trusts are effective in both maintaining good all-round health and tackling poor wellbeing arising from social issues such as loneliness, inactivity and poor mental health and :

- Shows a return of £8.50 for every £1 invested in regular Wildlife Trust volunteering programmes
- Shows a return of £6.88 for every £1 invested in Wildlife Trust projects for people with health or social needs (this lower return is largely due to the higher running costs of such projects).

- **Oyster cultural benefits** – Oyster festivals may be set up in some towns as a result of restoration work. Stranraer oyster festival, set up in association with Loch Ryan oysters, was estimated to bring in £1.1 million to the local economy in 2018 for town considered to be in economic decline. There are also many other cultural aspects of oyster fishing (Allen, 2019).
- **Intellectual benefits** – There is significant potential for PhD students to undertake research on restoration sites. Current restoration sites, such as Medmerry & Steart (saltmarsh) and Solent (oysters) have PhD students supported by NGOs managing the restored site (Atkins, 2017).

Environmental / climate impacts

- **Nitrogen seasonal uptake** (for seagrass/saltmarsh) – there is additional seasonal uptake of nitrogen in saltmarsh plants and seagrass blades on top of what is buried in sediments. This uptake removes N from the waters over the spring/summer growing season, reducing eutrophication risk. This gets released back into the water when the plants die back in winter. It was not considered possible to value this N temporarily locked into plants.
- **Seagrass wave attenuation.** Seagrass shows some evidence of reducing wave attenuation (and providing sediment stabilisation as a result) by 25-49% compared to bare sediment (Reidenback & Thomas 2018).
- **Stabilising existing saltmarsh to protect existing carbon stores.**
- **Habitat provision** – We have only directly quantified commercial fish as a biodiversity benefit. Restored saltmarsh provides nesting sites for wading and rare birds and habitat for passaging and overwintering birds. Seagrass will also provide food for migratory bird communities, and both seagrass and oysters will support increased species richness compared to adjacent bare sediment richness due to their complex habitats, including protected species such as seahorses. There may be an increased willingness to pay as a result of restoration at these sites.

Additional references for non-quantifiable benefits:

Bagnall, A.M. et al. (2019). Social Return on Investment analysis of the health and wellbeing impacts of Wildlife Trust programmes. Report by Leeds Beckett University for the Wildlife Trusts.

Hambrey J. and Evans, S. (2016). Aquaculture in England, Wales and Northern Ireland: an analysis of the economic contribution and value of the major sub-sectors and most important farmed species. Report SR694 for Seafish.

Peters, J.W. et al. (2017). Oyster Demographics in Harvested Reefs vs. No-Take Reserves: Implications for Larval Spillover and Restoration Success. Frontiers in Marine Science https://doi.org/10.3389/fmars.2017.00326
Reidenback, M.A. & Thomas, E.L. (2018). Influence of the Seagrass, Zostera marina, on Wave Attenuation and Bed Shear Stress Within a Shallow Coastal Bay. Frontiers in Marine Science https://doi.org/10.3389/fmars.2018.00397
Viera da Silva et al. (2014). Ecosystem services assessment at Steart Peninsula, Somerset, UK. Ecosystem Services 10: 19-34.
Westbrook, S. (2017). The value of aquaculture to Scotland. A report for Highlands and Islands Enterprise and Marine Scotland, June 2017.